Bacteriology and surgical technique for nurses / by Emily M.A. Stoney.

BACTERIOLOGY

AND

SURGICAL TECHNIQUE

FOR NURSES

BY

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"Every bit of knowledge that we cannot use for the uplifting of our physical, intellectual, or emotional life is so much waste of time and labor. Everything taught is worth the knowing, but not worth the putting away in the pigeon-holes of memory, to be recalled some day by accident."

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TO

DR. JOHN R. SLATTERY

THIS VOLUME IS DEDICATED BY THE AUTHOR

IN GRATEFUL REMEMBRANCE OF MUCH ENCOURAGEMENT AND PERSONAL KINDNESS

PREFACE.

THE following pages constitute the notes of a series of lectures on "Bacteriology and Surgical Technic" which followed closely upon my lectures on "Materia Medica." The first part of the book is devoted to Bacteriology and Antiseptics; the second part to Surgical Technic, Signs of Death, Autopsies.

No attempt has been made to write a complete treatise on bacteriology, but merely to outline and simplify that branch for nurses.

It was deemed advisable to add the chapter on "Signs of Death and Autopsies," as many nurses are unacquainted with the preparations for an autopsy in private practice.

So many changes have taken place in surgery since the lectures were delivered that it has been necessary to rewrite many of the chapters. In this I was assisted by Dr. A. S. Allen and by Professors J. B. Murphy, Christian Fenger, and Joseph L. Miller, of the Northwestern University Medical College. I am glad of this opportunity to thank them for their assistance.

Free use has been made of the works on bacteriology by McFarland, Crookshank, and Woodhead; of "Aseptic Surgical Technique," by Dr. Hunter Robb; "Operative Gynecology," by Dr. Howard A. Kelly; and "Aseptic Treatment of Wounds," by Dr. C. Schimmelbusch.

I am unable to express my indebtedness to Dr. Joseph P. Comegys for his valuable assistance with the manuscript and its preparation for the press.

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EMILY M. ARMSTRONG-STONEY.

SEPTEMBER, 1900.

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PART I.

BACTERIOLOGY; ANTISEPTICS.

CHAPTER I.

HISTORY OF BACTERIOLOGY.

THE eye is one of the most beautiful and delicately contrived organs in the body, and yet its vision unaided is very limited in its scope. We see so much that we rarely stop to think of what an enormous world exists in and all about us which we cannot see at all—a world peopled by organisms so very small that they can be seen and studied only by the aid of the most powerful magnifying lenses, and so numerous that they are quite beyond any calculation.

Bacteria exist nearly everywhere; they are almost universal, except that they are not found deep down in the ground nor high up in the air. They and their spores, or seeds, float in the air we breathe, swim in the water we drink, grow upon the food we eat, and luxuriate in the soil beneath our feet. Wherever man, animals, and plants live, die, and decompose, bacteria are sure to be present. The surface of the body never escapes their establishment, and so deeply are some individuals situated beneath the epithelial cells that the most vigorous scrubbing and washing and the use

of powerful disinfectants are necessary to remove them from the surgeon's hands.

The mouth is said to be always replete with them; and, since many are swallowed, the digestive tract always contains them. The germ of pneumonia, for instance, is said to be habitually present in the mouth of almost every healthy person; consequently, its entrance into the lungs is only a matter of accident.

The existence of these bacteria has been known for many years, but it is only during the past few decades that any great advancement in our knowledge of them has been made.

Over two hundred years ago a man named Athanasius Kircher, a German, mistook blood-corpuscles and pus-corpuscles for small worms, and built up a new theory of the causes of disease and putrefaction with these worms as a basis of it. At the same time, Christian Lange, a professor in the medical school at Leipzig, expressed his opinion that the rash that appeared on the skin in the eruptive fevers, etc., was the result of putrefaction conveyed by small living worms in the body. Shortly after these observations came those of Anthony van Leeuwenhoek, a native of Delft, in Holland, who, in his early years, had learned the art of polishing lenses, and who was able, ultimately, to produce the first really good microscope that had yet been constructed. He saw, and described with astonishing clearness, various forms of bacteria found in the material taken from the teeth of an old man who never cleaned his teeth. He gave an accurate description of the rod-shaped bacteria, motile and motionless; of the longer threads, now called bacilli; of the spiral threads, or spirilla;

and of rounded micro-organisms, or micrococci. Although he did not attempt to theorize as to the meaning of these organisms in the mouth at the time, later on, in 1713, after finding similar organisms in the greenish pellicle formed on the surface of the water in an aquarium, he came to the conclusion that the various forms of bacteria found in the material scraped from the teeth found their way into the mouth through the medium of the drinking-water that had been stored in barrels, and that some of these found there a nidus in which they multiplied.

This was the real beginning of bacteriology; and from this origin the study advanced with considerable rapidity in spite of ridicule and much opposition. Various opinions regarding the connection of these germs with disease and putrefaction, were put forward; but it was not until 1831 that any important advance was made in our knowledge of this connection. Previous to that time a large mass of facts in regard to these little living organisms was being gradually accumulated, and fresh discoveries were constantly made by various workers; but since no systematic attempts to classify the newly observed facts were made, the scientific results were very small.

The first real advance made in our knowledge of the presence of a "contagium vivum," or living contagious element in the production of disease and fermentations, was made by Frederick Müller, of Copenhagen, and was the result of a systematic attempt to arrange the knowledge which had been accumulated during all those years. From that time to the present, the science has made great strides; so that we have now an accurate knowledge of the bacteria which

cause a number of different diseases. The knowledge of methods and details of work is now so general that the science of bacteriology is rapidly growing, and has revolutionized already very many branches of medicine.

In 1840, Henle was led to believe that the cause of miasmatic, infective, and contagious diseases must be looked for in living fungi, or other minute living organisms. Unfortunately, at that time the methods of study employed prevented him from demonstrating the accuracy of his belief. It was left for Pasteur and Koch to complete the work. Davaine, in 1848, was the first to see and to recognize disease-producing bacteria—he saw anthrax-bacilli in the blood of sheep dead of splenic fever.

Pasteur then took up the work; and in 1857 his faultless demonstration of the germ-theory of disease was brought out as a result of his experiments on fermentation and putrefaction, and on the bacteria of wine and those of the silkworm. He showed that the acetic fermentation, viscosity, bitterness, and turning flat of wines are due to the action of certain organized ferments, and demonstrated a causal relation between certain lowly-organized parasitic organisms and special diseases in animals and insects. Upon Pasteur's observations Lord Lister based his successful system of the treatment of wounds, known as "antiseptic surgery."

We all know of the wonderful success which now marks the operations of major surgery, and of the daring boldness of operators who attempt what was utterly impossible as long as antiseptic surgery was unknown. Lister, accepting the truth of Pasteur's

statement—that germs are the producers of fermentations—concluded that germs entering wounds from the outside might be the cause of suppuration; and since germs are always and everywhere floating in the air, suspended in water, and attached to the surgical instruments, dressings, and sponges used in operations, he judged correctly that it was highly advantageous to employ an antiseptic agent in order to kill any of the suspended or adherent organisms before any materials could be allowed to come in contact with wounded tissues; consequently, the hands of the operator and his assistants, the surgical instruments, sponges, dressings, sutures and ligatures, were kept constantly saturated with a solution of carbolic acid (1 : 40), and the operation was performed under a spray of carbolic acid (1 : 20). Carbolized dressings were used; and if the discharge was profuse, the dressings were changed once in twenty-four hours under a constant use of the spray. The researches of a later date have shown, however, not only that the atmosphere cannot be disinfected, but also that the air of ordinarily quiet rooms, while containing the spores of numerous saprophytic organisms, rarely contains many pathogenic bacteria. We also know that a direct stream of air, such as is generated by an atomizer, causes more bacteria to be conveyed into a wound than ordinarily would fall upon it, thereby increasing instead of lessening the danger of infection. Lister, we must remember, was not the discoverer of carbolic acid nor of the fact that it would kill bacteria; but, convinced that inflammation and suppuration were caused by the entrance of germs from the air, instruments, sponges, and dressings, into wounds, he suggested the antisepsis which

would result from the use of sterile instruments, clean hands, dressings, towels, and the like; and made applications intended to keep the surface of the wound moistened with a germicidal solution in order to kill such germs as might accidentally enter. He also introduced the practice of concluding operations by the application of a protective dressing, such as would tend to preclude the entrance of germs at a subsequent period. Listerism has spread slowly but surely to all the departments of surgery and obstetrics.

Since Lister's treatment was first inaugurated, many details of its application have been variously modified and great additions to our knowledge have been made. In bacteriology much important work has been done, and great advances are being constantly made. There are a number of diseases, each one of which has been definitely proved to be caused by a germ of its own, a germ which causes no other disease. There is also a list of diseases in which the proof is not yet conclusive, but for which the probability is that a specific germ will be found. The following data have been gathered chiefly from the works of McFarland and Woodhead.

In 1845, Langenbeck discovered that the specific disease of cattle known as actinomycosis could be communicated to man. His observations, however, were not given to the world until 1878, one year after Bollinger had discovered the cause of the disease in animals.

In 1847, Semmelweis, on the basis of his own observations, formulated the precept that puerperal fever is the result of the introduction of organic ferments into the puerperal genital tract. This dis-

covery, established by himself and confirmed by the observations of many others, marked an era in obstetrics. The organic ferments have since been identified as specific bacteria. Semmelweis, in this way, anticipated in practical antisepsis the discoveries of Lister and Pasteur; while the late Oliver Wendell Holmes, in a paper entitled "Puerperal Fever a Private Pestilence," published in 1843, and republished in 1855, in treating of its prophylaxis, anticipated the teaching of Semmelweis. Semmelweis was first led to recognize the source of puerperal infection by the case of Prof. Koletschka, of the University of Vienna, who, having received a dissection-wound, became thereby fatally infected. In consequence of this, Semmelweis concluded that there was an identity between this infection and that of which so many hundreds of puerperal women died. In the school for instruction in practical obstetrics, with which he was connected, there were two departments, one for medical students, the other for midwives; the students going as a rule directly to the obstetric ward from the autopsy-room. He first noted the much greater mortality in the students' ward, and in May, 1847, began to require the students to wash their hands in chlorin-water before making vaginal examinations, thereby reducing the puerperal mortality to a point lower than had been ever before reached.

In 1863, Davaine established by experiments the bacterial nature of splenic fever, or anthrax.

In 1869, the first complete study of a contagious affection was made by Pasteur, in two diseases affect-

ing silkworms—pébrine and flachérie—which he showed to be due to micro-organisms.

In 1875, Koch described more fully the anthrax-bacillus, gave a description of its spores and the properties of the same, and was enabled to cultivate the germ on artificial media; and, to complete the chain of evidence, Pasteur and his pupils supplied the last link by reproducing the same disease in animals by artificial inoculation from pure cultures. The study of the bacterial nature of anthrax has been the basis of our knowledge of all contagious maladies; and most advances in technic have been made first through the study of the bacillus of that disease.

In 1879, Hansen announced the discovery of bacilli in the cells of leprous nodules. They were subsequently clearly described by Neisser. From the nature of the symptoms and from the course of the disease, leprosy up to this time was long considered to be a disease similar to tuberculosis, and the discovery of the bacillus paved the way for the reception of Koch's discovery of the tubercle-bacillus.

In the same year Neisser discovered the gonococcus to be the specific cause of gonorrhea.

In 1880, the bacillus of typhoid fever was first observed by Eberth, and independently by Koch.

In 1880, Pasteur published his work upon "chicken-cholera," an epidemic disease which affects turkeys, pigeons, chickens, ducks, and geese, and which causes almost as much destruction among them as the occasional epidemics of cholera and small-pox produce among man.

In the same year Sternberg described the pneumococcus, calling it "Micrococcus Pasteuri," which he

secured from his own saliva; and in the same year Pasteur also found the same organism in saliva; though it is to Fraenkel, Talamon, and particularly Weichselbaum, that we are indebted for the discovery of the relation which the organism bears to pneumonia.

In 1882, Robert Koch made himself immortal by the discovery of and work upon the bacillus of tuberculosis, one of the most dreadful, and unfortunately most common, diseases of mankind. While great men of the earlier days of pathology clearly saw that the time must come when the parasitic nature of this disease would be proved, and some, as Klebs, Villemin, and Cohnheim, were "within an ace" of the discovery, it remained for Koch to succeed in demonstrating and isolating the specific bacillus, and to write so accurate a description of the organism and the lesions it produces as to render the discovery one of the most complete ever made in the history of medical science.

In the same year Loeffler and Schütz reported the discovery of the bacillus of glanders, an infectious disease almost confined to certain of the lower animals; although occasionally persons whose habitual association with and experimentation upon animals bring them into frequent contact with such as are diseased, have become accidentally infected.

In 1884, Koch discovered the "comma-bacillus," the cause of cholera.

In the same year Loeffler discovered the diphtheria-bacillus, and Nicolaier that of tetanus.

On October 26, 1885, Pasteur made the first application to human medicine of his method for the

cure of hydrophobia, nearly ten years before the time we began to understand the production and use of antitoxins.

In 1890, Koch issued to medical men what is now known as tuberculin, a brownish, syrup-like fluid used in the diagnosis and treatment of tuberculosis.

In 1892, Canon and Pfeiffer discovered the bacillus of influenza.

In the same year Canon and Pielicke first found a bacillus now thought to be the specific cause of measles.

In 1894, Yersin and Kitasato independently isolated the bacillus causing the bubonic plague then prevalent at Hong-Kong, and now threatening Europe.

Sanarelli, in 1896, reported the discovery of the micro-organism of yellow fever. His conclusions were based on the presence of a certain germ in 58 per cent. of cases examined, and the production of symptoms and pathologic changes in the lower animals resemble those present in man. Sanarelli's observations have been confirmed by a commission of the U. S. Marine-Hospital Service; but Sternberg and his assistants doubt the specific relation of the Bacillus icteroides, as it is called, to yellow fever.

Epidemic cerebrospinal meningitis, or spotted fever, is now known to be caused by a specific germ present in the cerebrospinal fluid of patients suffering from this disease. The route of infection is not fully determined, but it is probably through the nose.

Malta-fever, a disease of the Mediterranean islands, and occasionally of the Antilles and Central and

South America, is due to a micrococcus discovered by Bruce, and called Bacillus melitensis.

Malarial fever is an infectious disease; but, unlike those mentioned, it is not caused by a vegetable germ, a bacterium, but by a microscopic animal, the *Plasmodium malariæ*, which is found in the blood of the afflicted individual. How it enters the blood is not definitely known, but the best authorities hold that its entrance is brought about by the stings of mosquitoes.

There is a widespread belief that malignant tumors—cancers and sarcomas—are due to infection with parasites. The nature of the parasite is as yet unknown; but the latest researches point to a tiny organism, a yeast-plant or blastomycete.

CHAPTER II.

BACTERIA AS THE CAUSES OF DISEASE.

DISEASES may be divided into two great classes—the constitutional, which are due to such causes as errors in diet, alcoholic excesses, overwork, or age; and the infectious or contagious, which are due to the introduction into the body of a living poison. We no longer look upon infectious and contagious diseases as due to an unexplainable something, whose source we cannot know, whose course we cannot predict, and whose end cannot be hastened by any efforts on our part. Investigation has shown that we are no longer fighting an unknown enemy in the dark, but that we have before us a definite, living thing, whose part in the plan of creation is as surely fixed as our own, whose life-history can be told, and whose growth is as dependent on the right amount of light, food, heat, and air as that of the rose in our garden.

The word *bacteria* is a general name for all the plant micro-organisms. Of these there are many different classes with different names. They vary much in shape and size, some being round, some thread-like, some rod-shaped, and some of a spiral form. Each single organism consists of a small speck of protoplasm or vegetable albumin, to which may be given the name of a cell; and these cells are so minute that they can be seen only with the aid of the best

microscopes at our command. The rounded organisms, or micrococci, as they are called, are seldom more than $\frac{1}{25000}$ of an inch in diameter; the elongated cells average a little more perhaps, and are from $\frac{1}{12000}$

FIG. 1.—Various forms of bacteria: 1 and 2, round and oval micrococci; 3, diplococci; 4, tetracocci, or tetrads; 5, streptococci; 6, bacilli; 7, bacilli in chains, the lower showing spore-formation; 8, bacilli showing spores, forming drumsticks and clostridia; 9 and 10, spirilla; 11, spirochetæ (McFarland).

to $\frac{1}{6000}$ of an inch in length. Different forms naturally vary from this standard of size; but these figures will give a good idea as to the actual size of the forms under consideration.

The fungi connected with disease in man are divided into three classes:

1. Moulds, or hyphomycetes.
2. Yeasts, or blastomycetes.
3. Bacteria, or schizomycetes.

Some bacteria, or schizomycetes, induce the various fermentations; while others are productive of putrefaction, and are called saprophytes. Others, again, known as the pathogenic bacteria, are the cause of various diseases; while those which do not ordinarily cause disease are known as the non-pathogenic bacteria. The chief forms of bacteria are:

1. The coccus—berry-shaped or spherical bacterium.
2. The bacillus—rod-shaped bacterium.
3. The spirillum—corkscrew bacterium.

And these, which are species relatively monomorphous —*i. e.*, preserve their shape—are practically the only ones with which we have to do.

The cocci are named according to their arrangement with one another; if, for instance, they are in pairs, they are called diplococci; if in a chain, they are

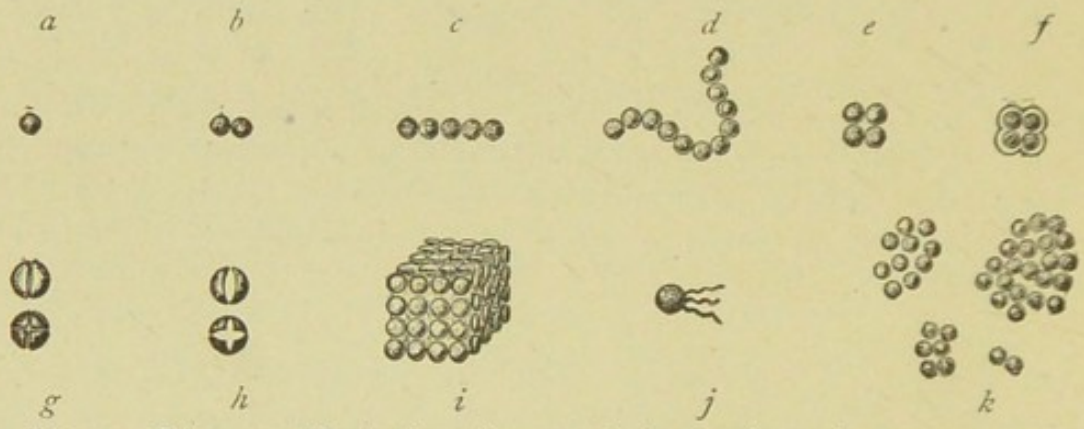


FIG. 2.—Diagram illustrating the morphology of cocci: *a*, coccus or micrococcus; *b*, diplococcus; *c*, *d*, streptococci; *e*, *f*, tetragenococci or merismopedia; *g*, *h*, modes of division of cocci; *i*, sarcinæ; *j*, coccus with flagella; *k*, staphylococci (McFarland).

called streptococci; if in a cluster, like a bunch of grapes, they are called staphylococci; and if in an irregular mass, stuck together by a thick substance, they constitute a zoöglea. Those developing in fours are called tetrads; in eights, sarcinæ.

The cocci are also named according to their functions, as, for instance, "pyogenic," or pus-forming; the specific name also describing the form, arrangement, color, and function; for example, *Staphylococcus pyogenes aureus* signifies a spherical colorless micro-organism forming a yellow pigment, arranging itself with its fellows into the form of a bunch of grapes, and producing pus.

Bacteria reproduce in two ways: By direct division (fission) and by the development of spores or seeds

(sporulation). The most common mode is by binary division, one body dividing itself so as to form two other bodies; these two re-dividing, and so on. It can readily be imagined how quickly an appalling increase in their numbers can be thus brought about; but fortunately this multiplication only takes place to advantage under certain favorable conditions; if these are not present, the bacterium begins to degenerate, but usually does not die until it has left behind a spore. When the formation of a spore is about to commence, a small bright point appears in the protoplasm, and increases in size until its diameter is nearly or quite as great as that of the bacterium. As it nears perfection a dark, highly refracting capsule is formed about it. As soon as the spore arrives at perfection the bac-

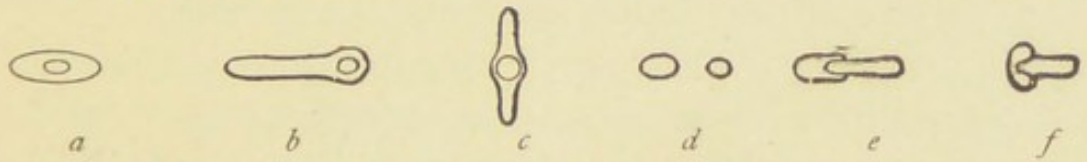


FIG. 3.—Diagram illustrating sporulation: *a*, bacillus inclosing a small, oval spore; *b*, drumstick-bacillus, with terminal spore; *c*, clostridium, with central spore; *d*, free spores; *e* and *f*, bacilli escaping from spores (McFarland).

terium seems to die, as if its vitality were exhausted in the development of the permanent form. As soon as the young bacillus escapes it begins to increase in size, develops around its soft protoplasm a characteristic membrane, and having once established itself presently begins the propagation of its species by fission. In those forms of organism in which spores are not found the germs die very rapidly unless the conditions for their nutrition and multiplication remain very favorable. If all bacteria were of this kind, it would be possible to exterminate them with consider-

able rapidity. Spores will survive a great heat, a heat which will kill the organism from which the spore came; they will also live under a treatment with germicidal solutions which renders the bacteria inactive. In other words, the spores are much more resistant to the effect of germicides than the bacteria themselves. Cold does not kill them; they live through it and develop whenever favorable surroundings for their growth present themselves. They may lie dormant in the system for years, waking into activity only when they come into contact with some damaged, weakened, or diseased part which affords them a nest in which to develop and multiply, the cellular activity of the weakened part being unable to cope with the organisms.

The conditions which influence the growth of bacteria are, first, a temperature ranging from 85° to 104° F., some forms requiring a higher and some a lower temperature. Some forms of bacteria are not influenced in their growth by the presence or absence of light. To some, sunlight is destructive. A few hours' exposure to the sun is fatal to the anthrax-bacillus and to cultures of the Bacillus tuberculosis. The rays of the sun, however, must come into contact with the germs and are usually active only on the surface of cultures.

The majority of bacteria grow best when exposed to the air. Some develop better if the air is withheld; some will not grow at all if the least amount of oxygen is present. Those that grow in oxygen are called the aërobic bacteria, and those that will not grow in the presence of oxygen are the anaërobic bacteria.

A certain amount of water is always necessary for the growth of bacteria, though the amount required may be very small. If dried, no form will multiply and very many forms will die.

A soil consisting of highly organized compounds is also necessary for their growth and multiplication, and slight modifications in it may prove fatal to some forms of bacterial life, but be highly advantageous to others.

With age bacteria lose their strength and die. So we see that a suitable soil, and a proper amount of light, heat, and air are absolutely necessary for the growth and development of bacteria, for they carry on all the functions of a higher organized life; they breathe, eat, digest, excrete, and multiply.

The disease-producing bacteria effect entrance into the interior of the body through the skin and superficial mucous membranes, wounds, alimentary canal, respiratory tract, and placenta.

The entrance of bacteria into the tissues through the sound skin is very rare indeed, although some authorities claim that infection has taken place through the rubbing of bacteria or their spores upon the skin. The dangers of infection through the broken skin are well recognized; hence every wound, no matter how slight, should be protected as soon as possible.

Bacteria enter the alimentary canal through the food and drink. Typhoid infection has taken place through the rectum, its occurrence being due to the wearing of underclothing previously worn by typhoid fever patients, and to the use of enema syringe tips which had not been sterilized after their previous use.

Bacteria enter the respiratory tract through the mouth and nose, as in a deep inspiration, or an act of coughing, sneezing, or the like. Pneumonia and tuberculosis are said to be the result of inspiration of the specific organisms. The direct transmission of bacteria from a parent to the fetus has long been a disputed question, but is now generally conceded. The micro-organisms pass through the placenta and infect the fetus. Tuberculosis of the ovaries, Fallopian tubes, and uterus may originate through the blood, and infection from without through the vagina. Infection through the blood is evidenced by the general tuberculosis of all the viscera. Infection from without may result in tuberculosis of the uterus, ovaries, and Fallopian tubes.

The channels by which bacteria can enter the body are, then very numerous; and there is scarcely a moment in which some part of the body is not in contact with them. All the disease-producing germs have their favorable seat in some part of the body where they grow more or less luxuriantly, and in the secretions and excretions of which the chief source of their infection lies. The pneumonia-germ prefers the lungs; the typhoid fever germ selects the lower portion of the small intestine; the diphtheria-germ the throat; the cholera-germ the intestinal tract; the germ of tuberculosis prefers the lungs, but it is called a "medical tramp," because it will lodge in any part of the body and make its home there. Hence we hear of tuberculous glands of the neck, tuberculous knee, intestinal tuberculosis, tuberculosis of the kidney, bladder, uterus, ovaries, Fallopian tubes, tuberculous peritonitis, etc. A tuberculous

area is always a danger to the system, and may infect distant organs or give rise to a general tuberculosis.

To prove that a microbe is the cause of a disease it must fulfil Koch's circuit. It must always be found associated with the disease, and it must be capable of forming pure cultures outside the body. These cultures must be capable of reproducing the disease, and the microbe must again be found associated with the morbid process thus reproduced. In other words, we must prove the bacteria to be always present; we must then isolate them, then prove that they can produce the disease in a healthy animal, and, finally, having succeeded in doing all this, we must prove that no other form of bacteria can produce the disease, and that where these bacteria cannot be obtained the existence of the disease is impossible. All these requirements have been met in many instances, and now there are a large number of diseases each one of which has been definitely proved to be caused by a germ of its own, a germ which produces that disease and no other. Most of the germs need a special train of circumstances in order that they may be active, so that, fortunately for us all, the mere presence of the germ itself is not sufficient to produce the disease. For instance, we know that diphtheria is caused by a germ of its own which causes that disease and no other; still, exposure to that germ does not invariably produce diphtheria—if it did, we should all be infected with it. This is because other conditions than the mere presence of the germs are needed to produce the disease. The germs must be active, and they can act only under certain conditions. It will usually be found that the

attack of the disease has been preceded by a local inflammation of the throat, thus making a suitable place for the specific action of the diphtheria-germs. In typhoid fever the germs require a suitable condition of the bowels before they can produce the disease. This is also true of cholera, and explains why taking care of the health makes such a difference in the taking of this disease. The germs find their way into the body through the food and drink. Cases are reported that show how the germs enter drinking-water, which is sprinkled over vegetables sold in the streets of cholera-infected districts, how they are carried about in clothing, and taken to articles of food upon the table by flies which have preyed upon cholera excrement. Healthy lungs are not a suitable location for the development and activity of the germs of tuberculosis. If we are not fully in good health, or if we inherit a tendency to this special disease, we may acquire it very readily, since we often inhale the germs of it. Should the disease take root in our lungs, it may be controlled to a certain extent by a change of climate and surroundings; by going, for example, from a low and damp locality to the mild and dry atmosphere of Colorado, the Carolina mountains, Southern California, or of the other Southwestern States, where there are few cloudy days and where violent atmospheric changes are rare. The germs there cannot be so active, for the air is stimulating, pure, and invigorating to the nervous system. The rarefaction of the air causes deep and strong involuntary respiratory movements, and there is consequently enforced a better ventilation of the lungs and a better oxygenation of the blood, in conse-

quence of which there follow more active tissue-changes throughout the body and a strengthening of the respiratory muscles.

On finding favorable conditions it takes germs some days to develop and produce the disease; this time is known as the period of incubation.

The question is often asked, Why, when we are so constantly in contact with disease-germs, do we not contract the diseases? All bacteria leave the body through the skin, lungs, kidneys, or bowels; and by a faithful use of disinfectants and antiseptics the germs may be kept confined to their original position. After their escape from the body they are difficult to control. The scales of skin or dandruff from a case of scarlet fever, measles, or small-pox, or the dust that arises from the dried sputum of a pneumonia or tuberculosis patient, or the poisonous material which may enter our drinking-water from too close proximity of the well and the sewer into which typhoid discharges have been emptied, may readily be the means of propagating disease. These sources of infection should be scrupulously avoided. Another protective factor is the natural or acquired power of resistance to disease-producing germs.

Immunity is either natural or acquired. Of acquired immunity we have two varieties, that which comes from acclimatization, and artificial immunity.

By **natural** immunity is meant the natural and constant resistance to disease-producing germs. The individual is immune by Nature, and sometimes by racial characteristics. **Acquired** immunity is a power of resistance attained through various circumstances. Thus, a single attack of some of the in-

fectious and contagious diseases usually confers immunity against subsequent attacks. Such immunity generally follows an attack of typhoid fever, small-pox, scarlet fever, mumps, whooping-cough, measles, or yellow fever. Second attacks may occur; but, as a rule, a patient who has had an attack of one of these diseases has immunity for life. Influenza, pneumonia, cholera, diphtheria, and erysipelas are among the diseases in which one attack is not protective. Vaccination usually insures immunity against small-pox; but this is ordinarily not so complete or permanent as that resulting from an attack of the actual disease.

Acclimatization immunity is exemplified by various diseases which do not trouble natives or those long resident, but which may affect strangers not inured to the climate.

Racial immunity is that in which certain races are safe from certain diseases; for instance, negroes seldom suffer from yellow fever, but are more susceptible than whites to small-pox. It is asserted that the Arabs seldom or never have typhoid fever. An analogous example is afforded by the fact that white mice are not affected by the same diseases as the gray mice are, even though subjected to the same influences in respect to climate, food, etc.

Artificial immunity may be produced in various ways. It is said that an injection of the antitoxin of diphtheria will give protection against the disease for from four to eight weeks. Tetanus has been prevented in a similar manner. It is impossible here to enter, except to a slight degree, into the consideration of the many theories of immunity, since they are very

intricate, and not one has been advanced so far that can clearly explain it. The theory of phagocytosis and the theory of antitoxins are the two most important.

Phagocytosis is the destruction of bacteria by the white cells of the blood and the cells of fixed tissues. The cells which eat up and destroy the germs are called "phagocytes." When the two meet a battle occurs, the bacteria fighting the cells with their active ferments, while the cells on their side put forth every effort to protect the body against the assaults of the disease. In a majority of the cases the bacteria win to the extent that the phagocytes die; but others take their place until the infection is overcome or the patient dies. The white blood-cells and tissue-cells having thus been educated to withstand the poison, their descendants inherit this capacity and are born insusceptible. This theory was suggested by Carl Roser in 1881. Sternberg and Koch afterward put forth the same view, but it is usually credited to Metschnikoff, who published his observations in 1884. The theory is now known as the "Metschnikoff theory of phagocytosis," and assumes an educated white corpuscle and body-cell.

The other theory—the so-called antitoxic theory—is founded on numerous more or less convincing experiments. If an animal be injected with certain pathogenic bacteria or their toxins in gradually ascending doses, it can be immunized to doses that under other circumstances would prove fatal. The blood-serum of an animal thus immunized has the power, when injected into another animal, of rendering it also immune to the bacteria that have

originally been used; and in some cases the serum is even capable of curing the disease after it has developed in another animal. These properties with which the blood-serum has become endowed depend upon the presence of what are called antitoxins and antibacterial bodies. In man also, after recovery from certain infectious diseases, it is possible to demonstrate in the blood-serum the presence of antitoxic substances; and it is now the general belief that immunity, at least of the acquired form, is due to such antitoxins. The uses and practical preparation of antitoxins will be described in the next chapter.

The most important of the special surgical micro-organisms—*i. e.*, those most frequently met with in surgical work—are the following, the majority being pus-producers:

1. *Staphylococcus Pyogenes Aureus.*—This is the most common form; it is quickly killed by carbolic acid (1 : 20), bichlorid of mercury (1 : 1000), or by a few moments' boiling. It is found in the mouth, alimentary canal, and under the nails; it lives in the eyes, nose, ears, mouth, in the superficial layers of the skin, and is distributed in the water, soil, and air, especially in the dust of houses and surgical wards where the proper precautions are not taken.

2. *Streptococcus pyogenes* is a most important pathogenic micro-organism, and is thought by many authorities to be identical with the streptococcus of erysipelas. The Streptococcus pyogenes is frequently associated with internal diseases, and has been found in the uterus in cases of infective puerperal endometritis, ulcerative endocarditis, acute septicemia, and

other diseases. It is one of the most common causes of post-operative peritonitis.

3. The *Bacillus coli communis* is always present in the intestine, and is thought to be a frequent cause of acute suppurative peritonitis.

4. The *Staphylococcus pyogenes albus* resembles the aureus in form, but is less virulent. It is a common cause of suppuration, and although it has been found alone in acute abscesses, it is usually associated with other pyogenic cocci, chiefly the Staphylococcus pyogenes aureus.

5. The *Staphylococcus epidermitidis albus* is a micrococcus which is almost always present upon the skin, not only upon the surface, but also in the Malpighian layer.

6. The *Staphylococcus pyogenes citreus* is not quite so common nor so pathogenic as the other forms, and is less important.

7. The *Bacillus pyocyaneus* exists in pus (especially in open wounds), and gives to it a peculiar bluish or greenish color.

8. The *Bacillus aërogenes capsulatus* is a gas-producing bacillus that sometimes causes death after operations on the uterus; it may also enter through accidental wounds.

9. The *Bacillus tuberculosis* is the cause of all tuberculous processes. The chief cause of the spread of infection is found in the dried sputum, which becomes pulverized and is then inhaled as dust; and since one patient may expectorate as many as four billion bacilli in twenty-four hours, his capacity for harm is very considerable. The bacilli retain virulence for five

months in dried sputum, and in putrid sputum for forty-three days.

10. The *Micrococcus lanceolatus*, known also as Streptococcus lanceolatus, pneumococcus, and Diplococcus pneumoniæ, is the cause of croupous pneumonia and of many of the acute inflammations of the serous membranes of the body. It is also a pus-producer, and has been found in empyema and acute abscesses.

11. The *bacillus of tetanus* is found particularly in garden-soil, in the dust of halls, walks, cellars, street-dirt, and in the refuse of stables. It is not a pus-producer. Tetanus is a disease due to the absorption of its toxins, which poison the nervous system precisely as would dosing with strychnin.

12. The *diphtheria-bacillus* causes the dreaded diseases diphtheria and membranous croup, as well as inflammations of the eyes and nose; at times it also attacks open wounds.

CHAPTER III.

THE THEORY OF ANTITOXINS.

GREAT progress has been made of late in the field of serum-therapy, though much remains open to question and many recorded facts cannot yet be explained. The field for the investigator is perhaps larger than ever before. For a better understanding of the subject of antitoxins and their therapeutic application, a few essential facts should be borne in mind. An antitoxin is not the direct result of bacterial action, but is properly described as an unknown body resulting from the resistance of the healthy organism to the toxins of pathogenic bacteria. According to the prevailing theory, antitoxins are the products of the body-cells, formed under the influence of the bacterial toxin. In therapeutic practice the antitoxic body comes to us in the blood-serum of an animal, usually the horse. When properly prepared and properly kept in aseptic containers the antitoxins are not at all dangerous; they are as innocuous as an equal amount of blood-serum or normal salt solution administered in the same way. Antitoxins are used both to counteract the effects of the toxins which are elaborated by pathogenic bacteria in the body, and to render the system immune, so that it may resist the action of the bacteria should they gain access to the body. The antitoxins do not destroy the bacteria; in other words,

they are not germicides. In fact, the antitoxic serums are themselves good culture-media. One theory of their action is that they neutralize the toxin, thus giving the natural bactericidal powers of the body an opportunity to exercise their function.

The following is a brief description of the process employed in the laboratory of Parke, Davis & Co., for the preparation of diphtheria-antitoxin :

Young horses in perfect condition are selected and kept under careful observation by an expert veterinarian for three or four weeks. During this time they are carefully tested with tuberculin for the possible existence of unsuspected and undeveloped tuberculosis, and with mallein for glanders. When a horse is found to be perfectly healthy it receives its first dose of diphtheria-poison, or more properly a solution of the toxin of the diphtheria-bacillus. This is prepared in the following manner : A culture is obtained from the throat of a patient suffering from a virulent attack of diphtheria. The diphtheria-bacillus is isolated from this culture and planted in a flask of bouillon or beef-tea, which is then kept in an incubator from three to four weeks. At the end of this time it has attained its maximum toxicity and the bacteria begin to die of their own poison. The toxin which they have elaborated in the course of their existence is held in solution in the beef-tea. This bouillon solution of toxin is then filtered through porcelain to remove the bacterial cells and any other extraneous matter. It is then ready for injection into the horse. About one-tenth of one cubic centimeter is injected intravenously. The horse responds with all the constitutional symptoms of diphtheria, such as a chill, fever,

loss of appetite, more or less pharyngeal paralysis, with regurgitation of food. Sometimes death occurs from heart-paralysis. Upon recovery, which comes within a few days, a slightly larger dose is given. This treatment is continued for about one year, at the end of which time the horse will take from 2000 to 3000 times the initial dose without reaction. It is then ready for bleeding. About 6000 cubic centimeters of blood are drawn from the external jugular vein. This is allowed to clot, and the serum obtained is known commercially as antitoxin. It is customary to add an antiseptic, such as trikresol, to preserve the serum.

In preparing the streptococcus antitoxin a culture is made of bacteria obtained from two sources—erysipelas and puerperal septicemia. This is done because some eminent bacteriologists believe that the streptococcus of erysipelas is not identical with the streptococcus of puerperal fever. It is but fair to say, however, that others equally eminent assert the identity of the two streptococci. To meet the possibility of the non-identity of the organisms, a culture obtained from the two sources is used. Its virulence is increased by passing it through rabbits. After passing through about fifty rabbits a culture is planted in beef-tea, and the same course pursued as for diphtheria-antitoxin. Antitubercle serum is obtained by immunizing horses with the original Koch's tuberculin.

As to the therapeutic action of antitoxin, little or nothing is known positively. It seems reasonable to conclude from experimental evidence that the antitoxin neutralizes the toxin in the body and thereby gives the natural germicidal powers an opportunity

to dispose of the bacteria. It may be that it has the additional property of stimulating the phagocytic and possibly other bactericidal functions. The following experiments made by Martin and Cherry in England, and described in the *Journal of the American Medical Association* of August 27, 1898, are of interest in this connection. Behring, Ehrlich, and Kanthack have advocated the theory that the antagonism between toxins and antitoxins is a chemic one, somewhat analogous to the neutralization of an acid by an alkali; while Buchner, Metschnikoff, and others have maintained that it is indirect and operates through the cells of the organism. Martin and Cherry used a snake-venom antitoxin. A large number of guinea-pigs were used. At 60°C. the antitoxin was destroyed, while the venom retained its virulence. In the control-experiment with the venom only, all the animals died within a few hours. A number of mixtures were made of 1 c.c. of antitoxin with twice the fatal dose of venom; others with three or four times the fatal dose. These mixtures were allowed to stand at the usual laboratory temperature (20° to 23° C.) for two, five, ten, fifteen, and thirty minutes respectively, then heated to 68° C., and afterward injected.

As remarked above, this heat destroyed the antitoxin, so that none was injected. The animals subjected to the mixture of the stronger doses of ten minutes or less died or were seriously affected; all of those receiving the fifteen-minute mixture survived; while the thirty-minute mixtures produced no symptoms whatever. Similar results were obtained with diphtheria-antitoxin and toxin. These experiments seem to show, as far as anything can, that the neutraliza-

tion of toxins may occur in the test-tube, and that the vital processes in the organism and the body-cells are not essential. These gentlemen made further experiments by passing a mixture of toxins and antitoxins through a Pasteur-Chamberland filter. This was porous for toxin, but not for antitoxin, owing to the difference in the size of their molecules. The toxin which passed through the filter, after having been mixed with antitoxin, was neutral. The unavoidable conclusion from this experiment is that the toxin was neutralized before filtration.

Experiments have been tried in order to prove the theory that toxins are albumoses and antitoxins globulins; but these experiments do not appear to be conclusive as to this point.

The supposition that the administration of antitoxin is followed by a stimulation of the germicidal powers of the body seems to be reasonable, at least in the case of the antistreptococcic serum, since the streptococci disappear with the passing away of the signs and symptoms. On the other hand, the Klebs-Loeffler bacillus is found in the throat for weeks and even months after the disappearance of all symptoms of diphtheria in cases treated with the antitoxin.

The present status of diphtheria-antitoxin may be presented in a few words. It has established itself as a specific in the treatment of this disease. During the past year the use of larger doses has become more general, and it seems certain that better results were obtained. The administrators of the Chicago Department of Health give 2000 units in all cases of suspected diphtheria, and employ 1000 units as an immunizing dose. During the months of November

and December, 1898, this department treated 219 cases of bacteriologically proved diphtheria—all charity cases—with a death-rate of 4.1 per cent. Some two and a half years ago, when antitoxin was not used, the death-rate from diphtheria treated by this department was about 35 per cent.

Antistreptococcic serum gives promise of being second only to the diphtheria-antitoxin in point of therapeutic value. It has been most successful in erysipelas and puerperal septicemia. Cases of scarlet fever are reported in which it has been useful in shortening the duration of the disease and in preventing unfortunate complications and sequelæ, such as otitis media and other suppurative processes due to streptococci.

A mixture of the toxin of the streptococcus of erysipelas and the products of a harmless germ, the Bacillus prodigiosus, is used by Coley and others as an injection in malignant tumors that are past the stage of operation or are so situated that an operation is impossible.

It is to be regretted that tetanus-antitoxin does not in clinical use do all that it will do in the laboratory. It has been used in a considerable number of cases, but in nearly every instance without any result that would justify us regarding it as a great curative agent. Nevertheless, it should be used early in every case of tetanus and in large doses, because it is, like the other serums, harmless and the patient has a somewhat better chance of recovery.

One or two cases have been successfully treated with intracerebral injections of antitoxin, the theory being that the antitoxin should be placed where it

could neutralize the toxin which is producing the convulsions by means of its action on the nerve-centers. The value of this method of administration has not been proved.

As a preventive measure the use of tetanus-antitoxin is strongly commended.

The antitubercle serum has not shown itself to have more value than a great number of other remedies vaunted as specifics in tuberculosis.

Method of Injecting Antitoxin.—The serums and toxins are given hypodermically, the injection being made into the back, thigh, side of the breast, or over the chest. Perfect antisepsis for the operation is absolutely necessary. The puncture-wound is closed with a collodion dressing. It is not necessary to use massage for the purpose of causing more rapid absorption of the injected serum—the swelling generally disappears in a short time of itself. Sometimes the site of the injection becomes very painful. In certain cases, pains in the joints and various skin-eruptions (erythema, hives) develop after the injection. They are not of great moment, but the physician's attention should be called to them.

The reaction following an injection of Coley's mixture is sometimes severe, and may correspond to the symptoms beginning an attack of erysipelas—chill, local redness, and high temperature.

CHAPTER IV.

ANTISEPTICS, DISINFECTANTS, AND DEODORANTS.

SUBSTANCES which retard or check the growth of bacteria amid otherwise suitable surroundings are called antiseptics.

Articles and wounds which are entirely free from bacteria and their spores are termed aseptic or sterile.

Disinfectants or germicides entirely destroy the vitality of bacteria. Excessive heat, dry or moist, is a true disinfectant, because it entirely destroys bacteria, while cold is an antiseptic; it does not kill bacteria, but retards their development.

A chemic agent which will cause the death of bacteria is called a *germicide*.

A deodorant is an agent that destroys bad odors. A disinfectant is an antiseptic, and may be a deodorant; but because a substance has the power to destroy bad odors it does not follow that it has the power to destroy the bacteria which are the cause of the odor. Carbolic acid, for instance, is a disinfectant and deodorant; while Platt's chlorides is a prompt deodorant, but has almost no disinfectant power.

The power of a chemic agent to destroy bacteria depends on several conditions :

First. The kind of bacteria, some being easily killed

by an agent which is entirely harmless to others. Spores are much more resistant than the bacteria from which they are derived.

Second. The number of bacteria present.

Third. The temperature at which the exposure to the disinfecting agent is made; the higher the temperature the greater the effect.

Fourth. The strength of the solution; a small quantity of a strong solution of corrosive sublimate is much more efficient than a large amount of a weak solution.

Fifth. The nature and quality of the associated material. If the bacteria are associated with a large amount of organic matter, the chemical agent used may combine with the latter and may thus be converted into an ineffective material before it has an opportunity to act upon the bacteria. This result must be especially guarded against in the disinfection of sputum and fecal matter.

The agents capable of destroying bacteria are numberless; but there are many which cannot be employed in practice because they are too weak or act too slowly, or are too poisonous, or too expensive for general use in the required quantity, or are too destructive to the objects with which they come in contact. Water at a high temperature cannot be used for the disinfection of the hands of the surgeon or of the field of operation, or of organic substances in general. Corrosive sublimate cannot be employed in the sterilization of instruments, since it corrodes and blackens them; it also discolors clothing and furniture when used in strong solutions. Potassium permanganate stains everything with which it comes in contact; it also

causes pain and burns if used in very strong solutions.

By long-continued action in concentrated solution some of the agents which arrest the growth will finally lead to the death of those bacteria which have been subjected to them. Many agents, however, which arrest the growth of bacteria, are not capable of destroying them, and particularly their spores. Cold, for example, will arrest the development of bacteria but has no power to destroy anthrax-spores even when applied with the most extreme intensity. The resistance of spores is one of the strangest phenomena in nature; some can be boiled and some can be subjected to the intensely cold action of liquid air without perishing. The chief disease-producing bacteria which form spores and those which do not are :

Non-spore-forming :

1. Streptococcus pyogenes.

2. Staphylococcus pyogenes aureus, albus, and citreus.

3. Streptococcus of erysipelas (believed to be identical with the Streptococcus pyogenes).

4. Diphtheria-bacillus.

5. It is doubtful whether the tubercle-bacillus is spore-forming. The weight of opinion favors the absence of spores in this organism.

Among the spore-forming pathogenic organisms are :

1. Bacillus of malignant edema.

2. The tetanus-bacillus.

3. The anthrax-bacillus.

The germicidal or disinfecting agents at our command are of two kinds chiefly, heat and chemic

agents. The term "disinfection" is employed for the action of chemic agents, and "sterilization" for the action of heat.

Among all germicidal or disinfecting agents heat is entitled to the first place, and fire, for its thoroughness, is superior to all others. All infected articles of little value, books, playthings, etc., that can be burned should be thus destroyed, as should also sputum and bowel-movements. The very best way to treat the latter is to mix them with sawdust and then to burn them.

In surgical work, for the perfect sterilization of articles capable of withstanding it, fire is preferable because of its certain action. Edged instruments and forceps may be exposed for a very short time to the direct flame; but if continued too long the temper of the steel is affected.

We must remember that after sterilization there is always the danger of contamination, and the articles must, therefore, be carefully protected immediately after sterilization. If they are left uncovered for dust to collect upon them, the object of sterilization is defeated.

Heat may be applied in the form of hot air, moist air (steam), or boiling water.

Boiling water kills germs on contact, and destroys anthrax-spores, as a rule, in from two to four minutes.

Moist heat (steam) is the next most powerful agent. It is more thorough and more penetrating than hot air. Steam exerts its full influence only when the air is saturated with it. Saturated steam may be simple steam (quiescent), live steam (circulating steam),

high-tension steam (confined under a certain pressure), or superheated steam (that which has been heated secondarily by conducting it through iron pipes which have been raised by flame to a temperature of about 100° C.).

Live steam destroys anthrax-spores in from five to fifteen minutes, according to their degree of resistance.

Disinfection by steam is applicable to clothing, linen, blankets, towels, surgical dressings, instruments, curtains, carpets, brushes, mattresses, pillows (the two latter should be ripped open), and a number of delicate fabrics. It is not applicable to linen soiled by feces, blood, or pus, since the stains would become fixed by the process, nor to rubber articles. Under certain conditions many articles are exposed to the action of steam for one hour on three successive days, being kept during the intervals at a temperature of 70° to 80° C. to favor the development of bacteria. This is called "intermittent" or "fractional" sterilization, the object of which is to kill all bacteria that may have developed from spores that escaped the first steaming. The last sterilization is for the purpose of making sure.

Hot air is inferior to both steam and hot water. Steam at a temperature of 100° C. is more effectual than hot air at a much higher temperature. According to investigations, exposure to a temperature of 150° C. (302° F.) for one and a half hours in a hot-air sterilizer will kill all known bacteria and their spores.

The list of chemic substances used as germicides is constantly changing, and those which are now

considered the most valuable may in a little while be considered not so effectual as newer ones. Among the recognized antiseptics and disinfectants now in use are:

Carbolic acid, derived from coal-tar by distillation. When pure, it is a solid, white, or faintly rose-colored, crystalline body, readily soluble in water, alcohol, or glycerin. On exposure to air it absorbs 5 per cent. of moisture. A solution frequently employed is one of 5 per cent. strength. To make a 5 per cent. solution, 1 part of carbolic acid is added to 20 parts of very hot water and the whole shaken thoroughly. Any excess of carbolic acid above that strength falls to the bottom of the vessel as pinkish globules. Before using the solution care must be taken that the globules have been dissolved, or they will burn any living tissue with which they come in contact. Carbolic acid is considered now to be the most reliable and useful of all the germicides and antiseptics. It has the advantage over corrosive sublimate in that it does not discolor instruments nor clothing; but, on the other hand, it irritates and benumbs the skin. Pure carbolic acid is a reliable disinfectant for instruments. If an instrument that is indispensable happens to fall to the ground during an operation, it is laid for a few moments in pure carbolic acid, and then rinsed with sterile water, and is ready for use. Long-continued submersion in the acid will, however, deprive knives and scissors of their temper and edge. Symptoms of poisoning have been produced by the absorption of the drug from surgical dressings and from the use of carbolic solutions for irrigation. The first evidences of poisoning are a very dark

greenish or a blackish coloration of the urine, headache, giddiness, ringing or singing in the ears, and lassitude. The odor of carbolic acid is to a certain extent a protective against accident; yet fatalities occasionally occur. The antidote of carbolic acid is milk and lime-water or flour and water. The strength of the solutions used varies from 1:80 to 1:20. The acid is bought usually in the liquid form, having a strength of 95 per cent. To make a solution 1:20 (5 per cent.), 1:40 (2½ per cent.), 1:50 (2 per cent.), 1:80 (1¼ per cent.), 1 ounce of the 95 per cent. solution is added to 20, 40, 50, or 80 ounces of water. When obtained in the solid form, it may readily be liquefied by placing the bottle in a vessel of hot water.

Corrosive sublimate, or bichlorid of mercury, has, like carbolic acid, the advantage of being both efficacious and cheap. It has the disadvantages that it is decomposed by alkalies, that it is precipitated by albumin, and that it corrodes metals. It is used in strengths of from 1:10,000 to 1:500. The solution should be made as it is needed, because in old solutions most of the soluble corrosive sublimate has been converted into insoluble calomel, and the solution is not germicidal. By using the compressed tablets now on the market fresh solutions are readily made. A tablet usually contains the requisite amount of corrosive sublimate to make when added to one pint of water a 1:1000 solution, and by increasing or diminishing the amount of water the strength of the solution may be altered at pleasure. The tablets are very convenient, and almost compel accuracy in the preparation. Corrosive sublimate is of less

value for the disinfection of the excreta than carbolic acid, as it hardens the albuminous material which covers the outside of all fecal masses, and thus protects the inside from the desired action. Tartaric acid, chlorid of sodium, or chlorid of ammonium is often added to prevent this. Compressed tablets, each containing tartaric acid or ammonium chlorid and 7¼ grains of corrosive sublimate, or equal parts of chlorid of sodium and corrosive sublimate, are in common use. The convenient form in which this drug is put up and the readiness with which it can be used in surgical and medical work have made its adoption universal. Its poisonous character must be kept constantly in mind. The first symptoms of poisoning in consequence of the absorption of the bichlorid are profuse salivation, fetid breath, a metallic taste in the mouth, sore teeth, spongy gums, and swollen tongue. Should any of these symptoms appear they should at once be reported to the surgeon. As the solution has no odor, it is occasionally swallowed in mistake. Should this occur, symptoms of a violent gastro-enteritis appear—vomiting, burning pain, bloody stools; the kidneys are also affected, and an acute Bright's disease develops. The immediate treatment of this acute poisoning consists in the giving of white of egg, flour, or milk and lime-water, and washing out of the stomach.

There are other products of coal-tar distillation akin to, but not so poisonous as, carbolic acid. Among them are the following:

Creolin.—This is a non-irritant and practically non-toxic germicide. Though toxic symptoms have

been reported, it certainly is the least poisonous of the powerful germicides now in use. Its chief disadvantage is that when mixed with water it forms an opaque emulsion; consequently it is inapplicable for the sterilization of instruments, since they could not readily be found in it. For cleansing the hands and for irrigation, creolin is used in strength of from 2 to 5 per cent. To make a 2 per cent. solution, 2½ teaspoonfuls of creolin are added to 1 pint of water.

Lysol is a brown, oily-looking, clear liquid, with a creosote-like odor, obtained from tar-oils. When added to ordinary hard water it forms a clear, soapy liquid, as it precipitates the lime-salts in the water, but is clear if distilled water, alcohol, or glycerin be mixed with it. Its antiseptic properties under no circumstances are impaired. On account of its saponaceous character it cannot be used for instruments, because it renders them slippery. It is much employed in surgery and gynecology, in solutions of from 1 to 5 per cent. To make a 1 per cent. solution, 5 drams are added to ½ gallon of water. Its chief advantage over other antiseptics lies in its non-irritant and much less poisonous properties. It can be used for the disinfection of everything in the sick-room.

Sozal is an antiseptic obtained in small crystals which have an odor of coal-tar. It is said to possess the same advantages as corrosive sublimate without its toxic properties. The crystals are readily soluble in water, glycerin, or spirit.

Saprol is a dark-brown oily fluid with an odor of carbolic acid. When mixed with water it divides

into oil drops, some of which fall to the bottom of the vessel, while others float on the top of the water, consequently it cannot be used for surgical purposes. It is a powerful disinfectant, especially valuable in disinfecting excreta, and possesses the property of diffusing evenly through the material to which it is added.

Other disinfectants outside of the coal-tar products are :

Iodoform is largely used as a surgical dressing. It has no decided antiseptic properties. It does good by absorbing the liquids of the wound, thereby removing the nidus for germ-growth. When applied to large moist surfaces it gives off free iodin. It prevents decomposition and inhibits, but does not destroy, the germs of putrefaction and pus-formation if they are present before its use. When applied to raw surfaces it is occasionally absorbed into the system, and causes symptoms of poisoning. On account of this danger salol is often substituted for it, as is also a mixture of iodoform, 1 part to 7 parts of boric acid, it being both antiseptic and unirritating. The symptoms of absorption are headache, loss of appetite, rise of temperature, a rapid, feeble pulse, restlessness, and insomnia. These symptoms may pass away if the dressing is removed and discontinued. In grave cases there is marked anxiety, a bright-red eruption appears on the face and limbs, and there is retention of urine, with stupor, delirium, collapse, and death. Some patients are very susceptible to the toxic effects of the drug. It has a penetrating odor, which many persons find disagreeable. Spirit of turpentine will at once remove the

objectionable odor from the hands, instruments, and vessels that have been in contact with the drug. Iodoform darkens upon exposure to a bright light and is likely to cake when it becomes moist. It is used for impregnating gauze-dressings, for dusting on ulcers and wounds, and for injections, dissolved in ether or olive oil, into sinuses or tuberculous abscesses. It is also used in the form of ointment.

Iodol is a pale yellow crystalline powder, almost insoluble in water, but readily soluble in ether and alcohol, less so in glycerin or oils. It is often used as a substitute for iodoform, having the same properties. Like iodoform, it darkens if exposed to a bright light. It is used in the form of powder, solution, and ointment, and has the advantage of not being so poisonous as iodoform.

Formaldehyd is a gas formed by the partial oxidation of wood alcohol. Its use is greatly facilitated by having it combined with water and in a known definite proportion, so that the quantity used may be certain and definitely known. Its solution in water is called formol, formal, and formalin, and contains about 40 per cent. of formaldehyd gas. Formaldehyd is non-poisonous, colorless, with a pungent, irritating odor, and possessing great antiseptic, disinfectant, and deodorant powers. Its activity as a germicide is considered to be equal, if not superior, to that of bichlorid of mercury, and it is available in many cases in which the latter cannot be used. It does not corrode or tarnish metals, nor injure the finest fabrics either in texture or color. As a deodorant it removes immediately the odor of feces, urine, septic or gangrenous material. It is used externally

in the form of solution, spray, or vapor, and is sometimes added to powders. In solution as a wash or irrigation in wounds, etc., it is employed in strengths varying from 0.5 to 20 per cent. As a dusting-powder it is used in combination with gelatin. Sheets of moist gelatin after exposure to formalin fumes are ground to a coarse powder, and are used in the dressing of wounds. A slight disadvantage is that for four or five hours after its use on a raw surface it produces more or less pain of a burning nature. In the form of vapor it is used for sterilizing instruments and surgical dressings, and for the fumigation of the sick-room and its contents. The simplified method of fumigating consists of diluting one pound of formalin with three times its volume of hot water, and boiling over a flame for half an hour. The generated gas is very penetrating, and having the same specific gravity as the air soon permeates the room in which it is confined, and kills all germs, not protected by moisture, in about three hours. Special portable forms of apparatus have been devised for purposes of room-disinfection. Spray disinfection of rooms with a 2 per cent. formalin solution is also very satisfactory.

For the sterilization of instruments a 1 : 2000 solution is used. *Formalin* is also used in the preparation of catgut. The catgut is wound on a glass spool, not too tightly, and soaked for two days in equal parts of ether and alcohol, after which it is rinsed in pure alcohol for a few moments and transferred to glass bottles with tightly fitting covers, and which have been previously sterilized, containing equal parts of formalin and alcohol, enough more than to cover the

catgut. After one week the catgut is taken out and boiled for half an hour in normal saline solution, and is then placed in sterilized bottles containing alcohol until needed.

Formaldehyd vapor when inhaled irritates the lungs. It also irritates the eyes and nostrils, causing them to smart.

A fatal case of formalin-poisoning is reported, the amount taken being about 3 ounces of a 4 per cent. solution. Immediately after taking there were pain in the stomach and vomiting. The vomited matter was blood-stained and had the pungent odor of formalin. The patient died of heart-failure thirty-two hours afterward. The treatment consisted in albumin-water, free emesis, heart-stimulants, and normal saline solutions given both hypodermically and intravenously.

Aristol (thymol iodid) is a reddish-brown powder containing about 45 per cent. of iodin. It is used as a substitute for iodoform. It has not the disagreeable odor of iodoform, and its use is attended with less danger of poisoning. It is used in the form of fine powder or ointment, the strength of the latter varying from ½ to 1 dram to 1 ounce of pure lard.

CHAPTER V.

ANTISEPTICS (Continued).

Peroxid of hydrogen is a popular antiseptic. It is an excellent agent for the destruction of pus-cocci. When poured or injected into a wound, effervescence takes place, the result of chemic reaction between the wound-secretions and the hydrogen peroxid. This active frothing serves to carry off any shreds of tissue in the wound that cannot easily be reached. The peroxid is also applied to the throat in diphtheria to destroy and remove the false membrane. It readily decomposes by coming in contact with metals; consequently, if used as a spray, a glass atomizer must be employed. The peroxid of hydrogen in common use is a clear, odorless fluid, having a bitter taste. The official solution contains 3 per cent. of the pure dioxid, which corresponds to about ten volumes of available oxygen, and it is upon its readiness to yield oxygen that its activity depends. The solution should be kept in a cool, dark place, and the cork forced tightly into the bottle.

Boracic acid (boric acid) is a mild antiseptic. It is non-irritating and practically non-poisonous. It is therefore frequently used to wash out cavities, for injections, and in ophthalmic and aural practice. It is used in the form of powder, solution, ointment, and gauze. In solution, a saturated solution is used (a sat-

urated solution is one in which the water dissolves as much as it will of the drug; the remainder lying at the bottom of the vessel as an indication that the solution is sufficiently strong). It is easily made by placing one-half pound of boric acid in a half-gallon bottle filled with boiled water and shaking thoroughly until saturated. It is impossible to use a solution which is too strong, because the water cannot take up any more than 1 in 30 (about 4 per cent.), which is the usual strength used. In rare cases it acts as an irritant to the skin and produces an eczematous condition.

Boroglycerid is a non-poisonous antiseptic solution made from boric acid and glycerin, and is used as a wash, an irrigation, and for saturating tampons.

Thiersch's solution is an antiseptic of moderate power, unirritating and non-poisonous; it contains salicylic acid, 2 parts; boric acid, 12 parts; hot water, 1000 parts.

Alcohol.—Absolute alcohol is an antiseptic and disinfectant used for cleansing the skin, for the preparation of sutures and ligatures, and for the disinfection of cutting-instruments. To sterilize the hands, they are scrubbed for five minutes with soap and hot water, then scrubbed for the same length of time in absolute alcohol, and finally rinsed in an antiseptic solution. The results obtained by the disinfection and cleansing of the skin with alcohol have been ascribed to the solvent action of the alcohol upon the fatty matters on the skin, thus allowing corrosive sublimate and other antiseptics to come into immediate contact with the bacteria. Scrubbing the hands in absolute alcohol for five minutes takes up

both the fatty matters of the skin and also the bacteria, which are thus washed away.

Potassium permanganate, or permanganate of potassium, is an antiseptic, disinfectant, and deodorant, depending for its action on its oxidizing properties. It parts with its oxygen very readily to organic substances and becomes inert. Its chief disadvantage is that it stains everything a brownish-black color. It is used in solutions varying from 1:100 to 1:10. When employed for sterilizing the hands, it is followed by oxalic acid solution, which has the property of removing the stain. It is also used on wounds, especially those which have an offensive discharge, as, for example, gangenous ulcers, on which it acts as a deodorant as well as a disinfectant. It may also be employed to disinfect bowel-movements, to flush water-closets, etc. Its advantages are that it is non-poisonous in ordinary strengths, rapid and complete in its action, and shows by its change of color from reddish-purple to a brown whether it is acting or whether it is exhausted. The strength of the solution generally used is from 20 to 16 grains of the crystal to 1 pint of water.

Oxalic acid is a powerful germicide, though it is not used alone, but to remove the stains of potassium permanganate from the skin. It is very poisonous and quite irritating, but the irritation can in a measure be avoided by immersing the hands and forearms afterward in either plain water or lime-water. A series of experiments by Dr. Howard A. Kelly, to determine the relative part played by these two chemicals in the process of disinfection, led to the

conclusion that both the permanganate of potassium and oxalic acid were germicides, but that the oxalic acid at a temperature of about 40° C. (104° F.) is a much more powerful germicide than the permanganate of potassium. Oxalic acid also removes permanganate stains from white goods, and ammonia will remove the stains from black goods.

Potassium permanganate is frequently used in a solution called *Condy's fluid*, which contains 16 grains of permanganate of potassium crystals to 1 ounce of water. It is a disinfectant and deodorant.

Pyoktanin (methyl-violet, methyl-blue, blue pyoktanin), an aniline derivative, is a disinfectant and antiseptic. It occurs in two colors, blue and yellow, the yellow variety being used in ophthalmic practice only. Its great disadvantage is that it stains everything with which it comes in contact. The stains, however, may be removed with alcohol or Labarraque's solution. It is used in the form of powder, ointment, and in solutions of the strength of 1:500 and 1:1000.

Labarraque's solution is a solution of chlorinated soda, and is made from chlorinated lime and sodium carbonate. It is used as an antiseptic in solutions of 1:10, and for cleansing purposes.

Chlorinated lime, or chlorid of lime, is one of the best disinfectants for drains, infected clothes, bowel-movements, sputum, and urine. It is also a powerful deodorizer. It loses its strength if exposed to the air. The standard solution contains 6 ounces to 1 gallon of water.

Sulphuric and *hydrochloric acids* are employed in 4 per cent. solutions for the disinfection of excretions,

equal parts of the solution and the substance to be disinfected being used.

Ichthyol is a dark-brown thick liquid, with a highly disagreeable odor; it is used extensively as an antiseptic, astringent, sedative, and alterative in many skin-diseases, various inflammatory affections, wounds, abscess-cavities, etc. It is employed externally in the form of a thick liquid and ointment. Before the application of ichthyol the affected parts are washed with warm water and soap, and gently dried. After painting, or after inunction, the parts are covered with absorbent cotton or flannel and gutta-percha tissue. The applications are best employed morning and evening. Many patients object strongly to it on account of its disagreeable odor. This may be disguised by the addition of oils of citronella and eucalyptus, 1 part of each to 50 parts of ichthyol —or ichthyol (9 parts) may be combined with oil of turpentine (1 part). Ichthyol is said to have a remarkably efficacious action upon recent burns in relieving the pain and facilitating healing. It is also used in combination with the compound stearate of zinc. The stains of ichthyol may be removed by boiling the stained articles in soap and water, or by washing them with potash-soap or soap-spirit.

Balsam of Peru is used as an external application to wounds, it having both an antiseptic and a stimulant action. Glycerin is sometimes used as a menstruum for ichthyol and balsam of Peru because of its dehydrating effect upon the granulation-tissues of a wound, whereby they are held more in check and do not form so rapidly.

Orthoform is an antiseptic and a local anesthetic

having a decided action when applied to raw surfaces or exposed nerve-endings. It owes its antiseptic action to benzoic acid. It is a white, crystalline powder, without odor or taste, entirely non-poisonous, is slowly absorbed, and is used in the form of powder or ointment. In rare cases it causes severe inflammation and even sloughing of the skin.

Orthoform hydrochlorid is a combination of orthoform and hydrochloric acid, and is also an anesthetic.

Mustard, vinegar, and normal salt solution are also antiseptic.

Sterilized vinegar is said to be equal in antiseptic power to a 1 : 2000 solution of corrosive sublimate. It is less irritating to the tissues than bichlorid, and is said to stimulate the healing process in open wounds instead of retarding it, as mercury sometimes does. It is sometimes used during an operation for irrigation, especially if there is much capillary hemorrhage, which, on account of its astringent action, it controls. It is also used for the disinfection of the hands, surgical operating-rooms and wards, and to remove blood-stains from the hands.

Mustard is used for the disinfection of the hands and arms of the surgeon and his assistants, and of the field of operation. After scrubbing the hands and arms with a stiff brush and green soap, the water used being as hot as can be borne, one teaspoonful of mustard is rubbed in very thoroughly for about three minutes, after which it is washed off with hot sterilized water. The field of operation is prepared in the same way.

Resorcin is an antiseptic and deodorant, used in

the form of solution, powder, or ointment in strengths varying from 2 to 20 per cent. As a powder it is usually mixed with boric acid, 1:20 or 1:10. It is not absorbed by the unbroken skin and produces very little irritation on the cutaneous tissues.

Dermatol, also called bismuth subgallate, is used as a substitute for iodoform in the dressing of wounds. It is an antiseptic, sedative, and astringent.

Protargol is an albuminous compound of silver, containing about 8 per cent. of the metal. It is a powerful antiseptic, causing neither pain nor irritation when applied to raw surfaces. It is considered a valuable application in the treatment of wounds, and inflammatory surfaces discharging freely. It is soluble in water to the strength of about 50 per cent., and forms a clear light-brown fluid.

Listerine is a proprietary antiseptic solution used extensively on wounds, for cleansing the mouth, throat, and nose, etc.

Bicarbonate of sodium has been used with marked success as an antiseptic in the treatment of foul suppurating wounds and ulcers in a strength of 2 per cent. A 1-per-cent. solution has long been used in which to boil surgical instruments. The soda adds to the disinfectant power of the boiling water.

There are numerous other antiseptics of proprietary nature; but it is hardly necessary to refer to them. Chemists are constantly adding new preparations to the long list already in use.

PART II.

SURGICAL TECHNIC.

CHAPTER VI.

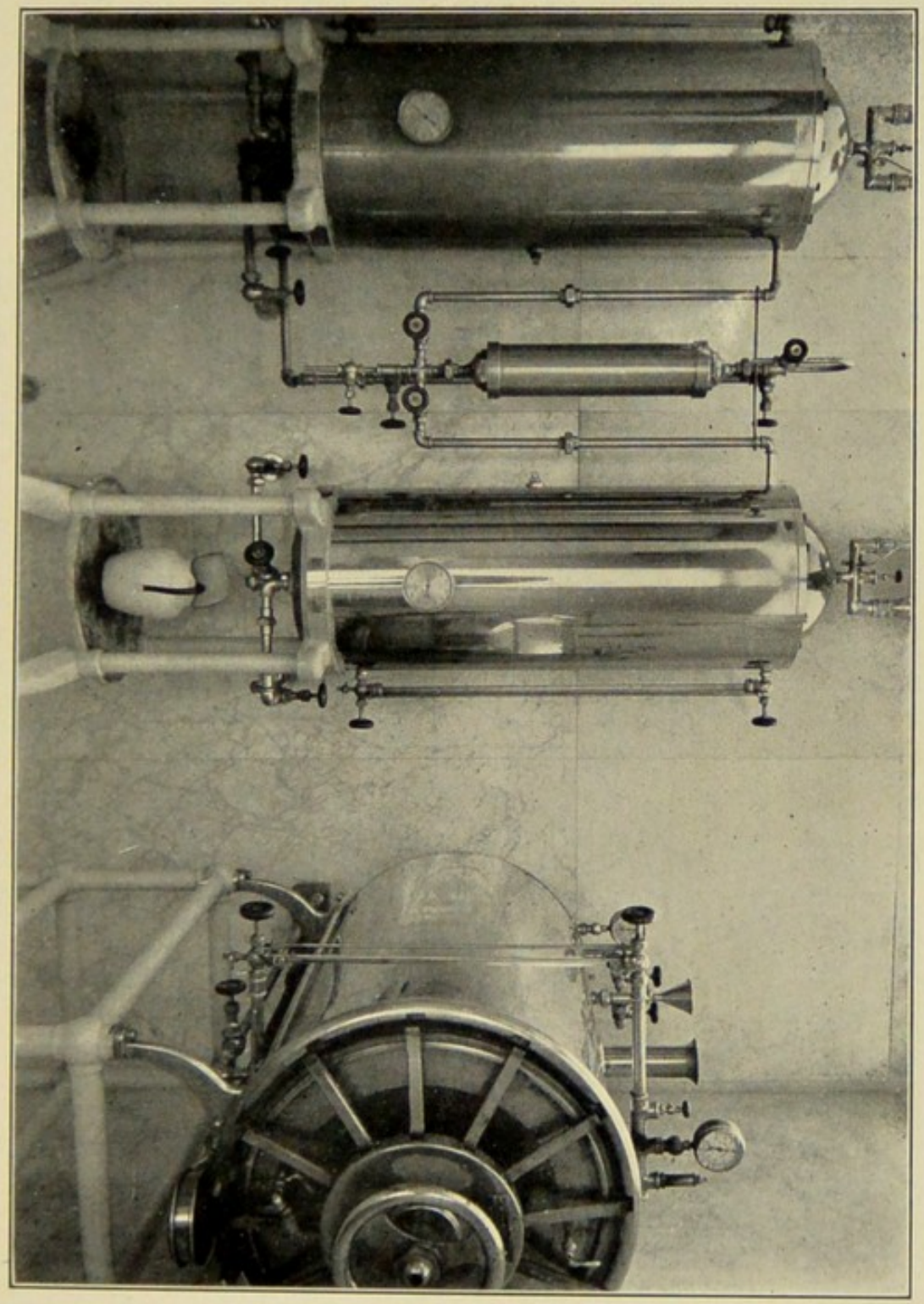
CARE OF OPERATING-ROOM; METHODS OF STERILIZATION; CARE OF INSTRUMENTS.

In almost all large hospitals there are three operating-rooms, one for general surgical, one for gynecologic, and one for septic operations.

The operating-room for septic cases should be far removed from the others, and neither surgeon nor nurse attending this room should have anything to do with the others. Rooms should also be set apart exclusively for dressing the cases, thus extending the benefit of an isolation of operating-rooms and adding greatly to the convenience of hospital work.

These dressing-rooms are otherwise very desirable, for besides having everything at hand with which to do a dressing properly, the nurse in charge of the patient has the opportunity to turn and make up the bed afresh during the patient's absence. Stretchers are used to convey patients to and from the operating- and dressing-rooms. The wheels generally have rubber tires, the top board is detachable and has four handles, two at each end. At least four stretchers are necessary in a large hospital.

PLATE I.



Sterilizing Room, Medico-Chirurgical Hospital, Philadelphia.

The material used in the construction and furnishing of an operating- and dressing-room should be of marble, metal, porcelain, and glass, all of which can readily be made aseptic. The water-faucets should be controlled by automatic foot-valves, so as to avoid

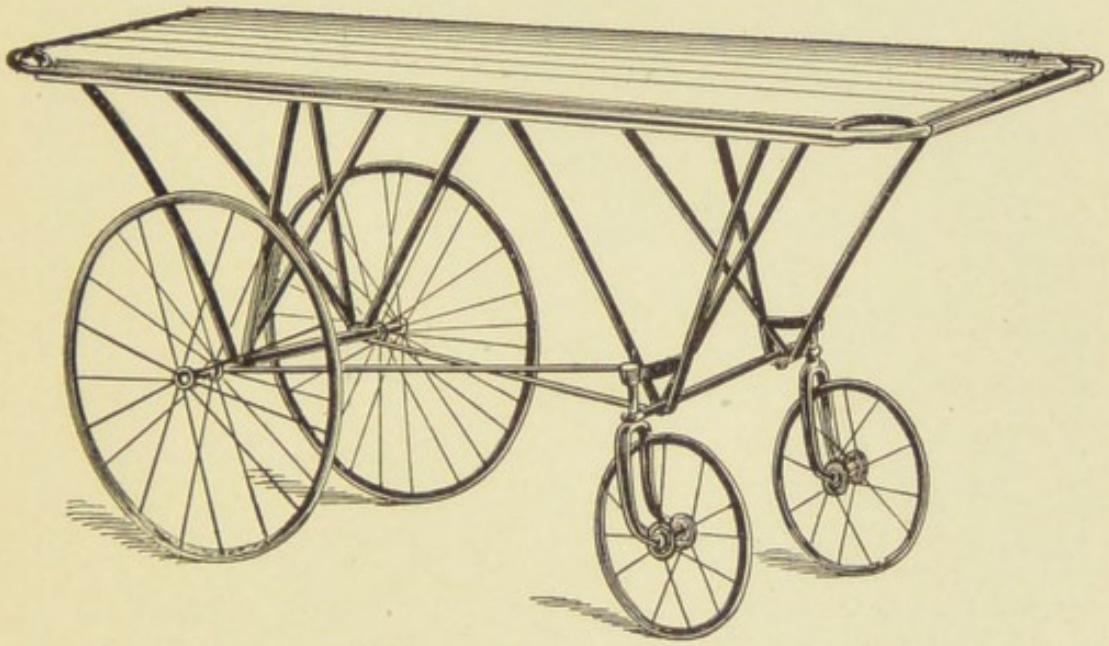


FIG. 4.—Wheeled stretcher.

contamination by turning on the spigots with the hands after they have been rendered aseptic.

The operating-room should be kept clean, and should be swept and dusted every day, and rubbed over with a damp cloth; in short, it should be in such a condition as to be ready for an operation at a few moments' notice. The supplies for dressings should not be allowed to run down, and the instruments should always be in a first-class condition. The emergency bundle, containing everything necessary for an emergency operation, should be kept in readiness.

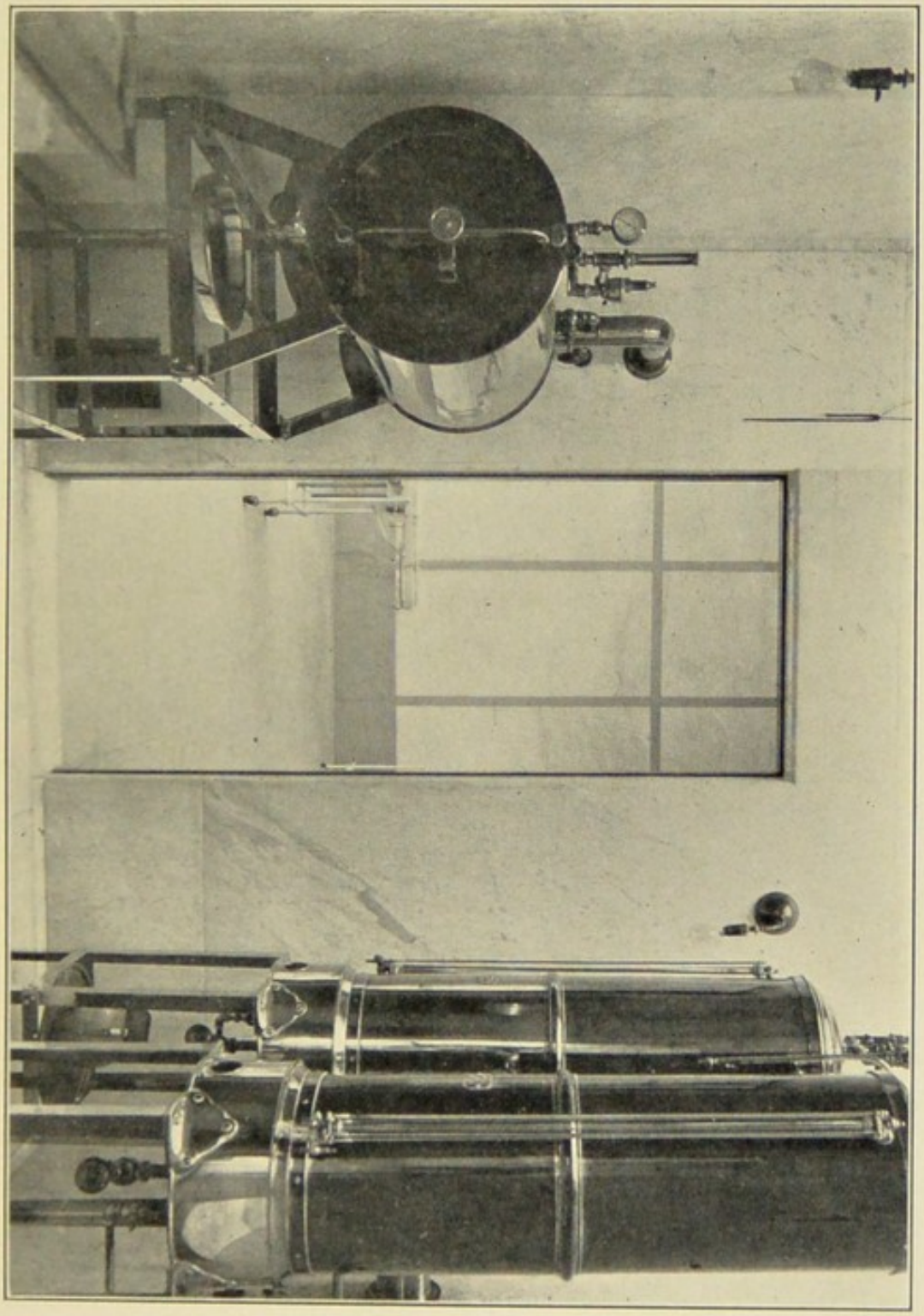
Sterilization.—Sterilization may either be dry or

moist; moist heat is preferable, because it is more thorough and more penetrating than dry heat. For dry sterilization the towels and dressings are placed in covered tin pans in an oven the temperature in which ranges from 160° to 212° F. For moist or steam sterilization, a Kellogg, a Sprague, or an Arnold steam sterilizer is used. The heat must be continued for fully one hour before the operation.

Regarding the sterilization of instruments surgeons differ; some prefer to have their instruments wrapped in a towel and put into the Schimmelbusch or Arnold sterilizer and allowed to boil for half an hour in a 1 per cent. solution of carbonate of sodium to prevent their rusting. The water must boil before the instruments are placed in it. All edged instruments to be boiled in the soda solution should be wrapped in cotton and packed so firmly that they will not be tossed against one another by the solution as it becomes agitated in boiling. This agitation seems to be the reason why they lose their edge. Many operators prefer to have their edged instruments and needles placed in a dish containing 95 per cent. carbolic acid for half an hour; then just before the operation they are taken out and rinsed with sterilized water.

After sterilization the instruments are transferred to the instrument-table, or to shallow porcelain or glass trays, in which they lie covered with sterilized towels until required.

Instruments and dressings are now sterilized with formaldehyd with excellent results, one great advantage being that neither the solution of formalin nor the gas injures the instruments in any way or dulls the edge of knives, scissors, or needles. A Schering



Sterilizing Room, Medico-Chirurgical Hospital, Philadelphia.

lamp is usually used either with a 40-per-cent. solution of formaldehyd or with formalin pastils. The best results seem to be obtained with the pastils. One

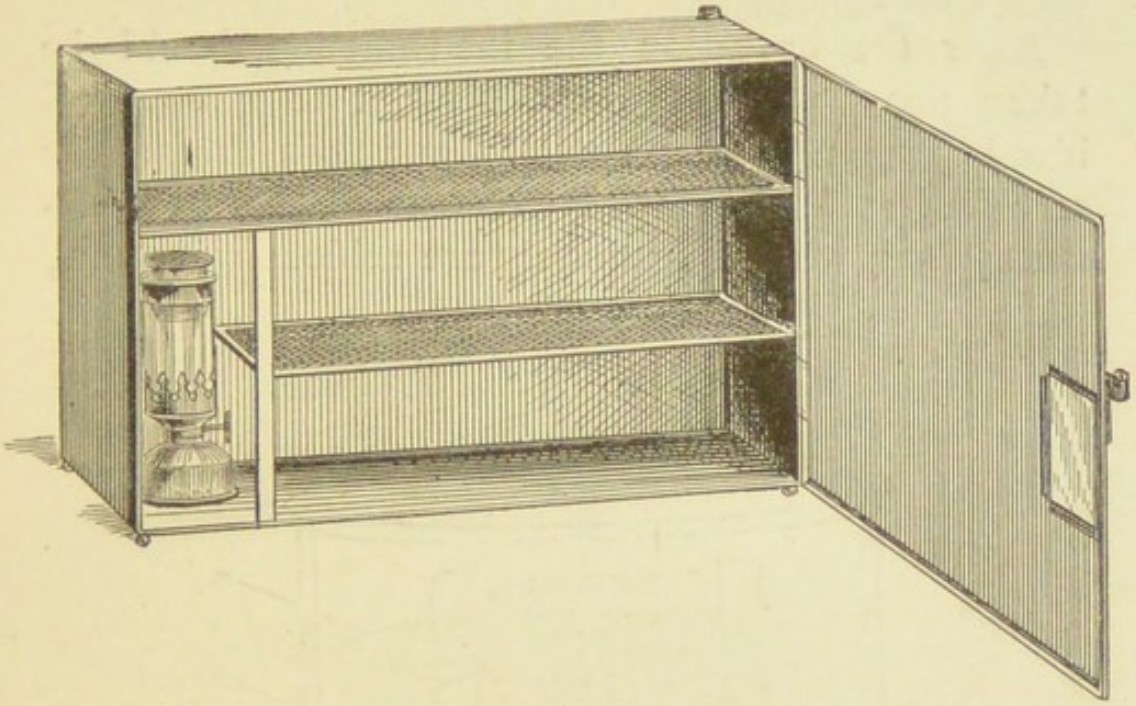


FIG. 5.—Apparatus for sterilization of instruments, etc.

pastil is constantly being evaporated in the upper cup of the lamp; but when rapid evaporation is required

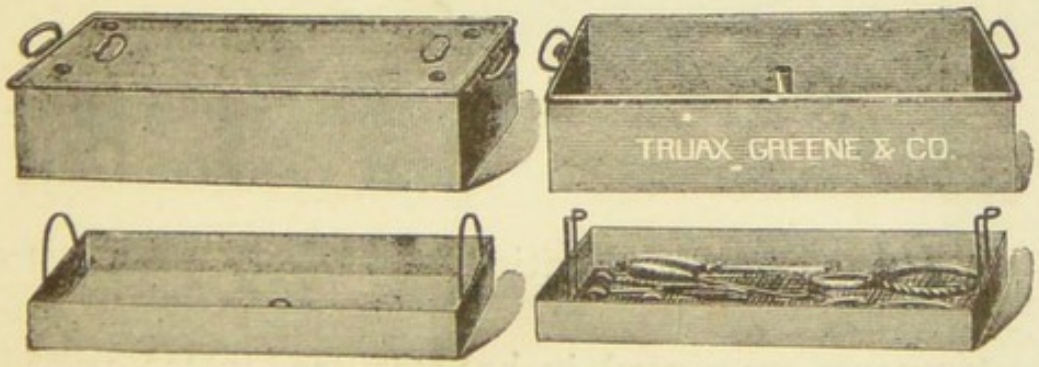


FIG. 6.—Instrument-sterilizer.

the upper cup is removed and the pastils are placed in the lower part.

During the operation, instruments which have

fallen to the floor and are needed for further use are rinsed in cold water and laid for a few moments in the 95 per cent. carbolic acid, then rinsed with sterilized water.

After the operation the instruments should be taken apart, washed in cold water to remove all blood, pus, and tissue-particles, and then thoroughly scrubbed with green soap. Instruments with permanent joints, which fortunately are seldom seen now,

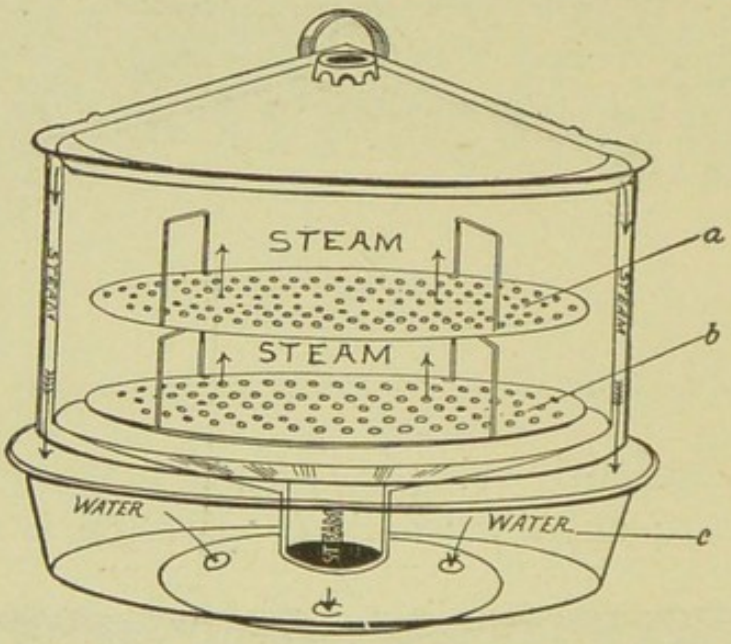


FIG. 7.—Sterilizer for instruments and dressings: *a*, for dressings; *b*, for instruments; *c*, water and solution of carbonate of sodium to prevent rusting.

must receive special attention, since it is difficult to get them surgically clean. After being scrubbed the instruments are rinsed in hot sterilized water, wiped dry with a soft towel, and then laid away in the case. The knife-blades must be rolled in cotton. The important points to be remembered in cleaning instruments after an operation are:

First, all instruments that can be so dealt with must be taken apart and the rough catches thoroughly cleansed.

Second, they must be dried carefully in order to prevent rusting; for instruments once rusted seem always to have a tendency to return to that condition.

Instrument-trays are made of glass, porcelain, agateware, or hard rubber; and are rendered aseptic by being first scrubbed with green soap and warm water, after which they are filled to the brim with 1:500 corrosive sublimate, which is allowed to remain in them for half an hour. When needed they are rinsed with salt solution or sterile water. Many surgeons prefer the trays filled with enough sterile water to cover the instruments, while others again prefer the instruments to be laid dry on the glass table, which has been previously covered with a sterilized sheet or towels.

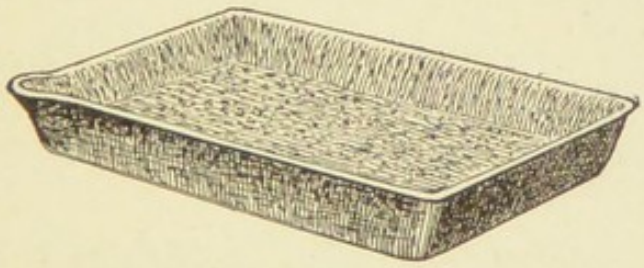


FIG. 8.—Agateware tray.

Every operating-room nurse should be familiar with the names of the instruments necessary for each different operation, so as to be able to lay them out when occasion requires. Many nurses get together after school-hours and "make believe" an operation is to take place. Each nurse has her duty assigned

to her, and each tries to fulfil it in a thoroughly professional, dignified, and quiet manner. Practice of this kind is never lost.

In the operating-room should be kept two large ledgers, in one of which the house-surgeons, after making the morning rounds with the visiting sur-

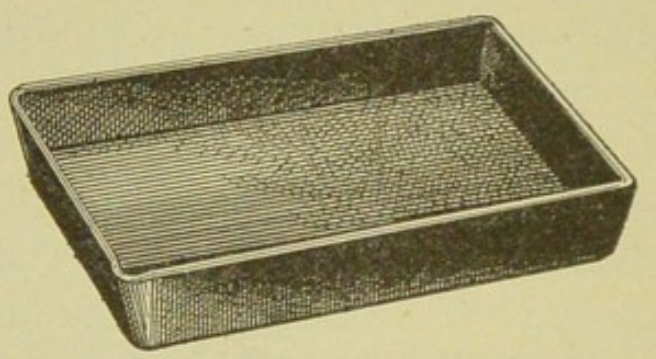


FIG. 9.—Hard rubber tray.

geons, should record the number of operations to be performed the next day, the time, name of operator, etc. The operating-room nurse is thus made acquainted, by consulting the book, of the amount of work before her for the next day, and the character of the operations for which she has to prepare.

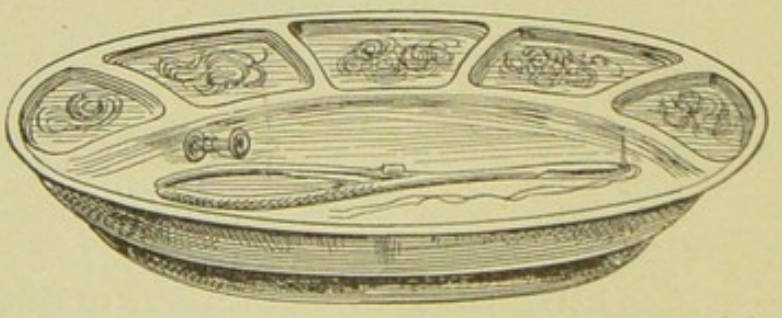


FIG. 10.—Robb's aseptic ligature-tray ; white porcelain.

On the morning of the operations she makes out a list of the floor and number of private room or letter of ward and number of bed, from which the patients are to be brought to the operating-room, and the order

in which the operator wishes them. This list is given to the male attendant, who brings up the patients in succession, in such a way that while one patient is being operated on the next is being anesthetized. The head nurse in the operating-room has two or three sets of instruments, and during one operation an assistant nurse is sterilizing the instruments and making preparations for the next operation. There is then no waiting on the part of the operator, for as the patient operated on is wheeled out of the operating-room the next patient is wheeled in. The following chart will give an idea as to the way the book is made out and the order in which the operations are written. The emergency-operations, accidents, etc., are also recorded, but after the performance of the operation.

Date.	Operation.	Floor.[1]	Time.	Operator.	Room	Ward.	Bed.	Floor.
Mar. 11.	Laparotomy.	4th.	8. A M.	Dr. Murphy.	19			3d.
"	"	"	8.30 "	" "	21			"
"	Vaginal hysterectomy.	"	9.00 "	" Johnson.	24			"
"	Cholecystostomy.	"	9.30 "	" Fenger.	16			"
"	Appendicectomy.	"	10.00 "	" Morgan.		B	10	
"	"	"	10.45 "	" Kindig.		D	6	
"	Amputation, breast	"	11.30 "	" Carter.		D	9	
"	" "	"	2. P.M.	" Andrews.	24			4th.
"	Appendicectomy.	"	3.00 "	" Fenger.	21			2d.
"	Cesarean section.	"	4.00 "	" Eyster.	21			4th.
"	Appendicectomy.	3d.	6.30 "	" Comegys.	29			2d.

The second book gives the date on which the patient was prepared for operation, by whom prepared, etc., as, for example—

[1] Clean operating-room, fourth floor; septic, third floor.

Date of Preparation.	Prepared by	Antiseptic used.	Operator.	Floor.	Room.
March 10.	E. A. S.	Corros. sub.	Dr. Eyster.	Fourth.	No. 21.

Date of Operation.	Hour.	Sutures used.	Length of time prepared.	Stitches removed.	Condition.
March 11.	4 P. M.	Silkworm-gut.	Two hours' boiling.	March 19.	Aseptic.

A book should also be kept in each dressing-room showing the number of cases dressed each day, the dressing used, and progress since the last dressing. It should be kept for the convenience of the dressing-room nurse in making an estimate of dressings for the next day, and for the convenience of the surgeon in knowing what patients are dressed, their condition, and in knowing when they are to be again dressed. It will also recall condition of last dressing.

Room or Ward.	Diagnosis.	Operated.	Operator.	Dressed.	Died or Discharged.	Remarks.
No. 29, 2d floor.	Appendicitis.	March 11.	Dr. Comegys.	March 17.	Discharged April 2.	

CHAPTER VII.

INSTRUMENTS NECESSARY IN DIFFERENT OPERATIONS, KEEPING OF CHARTS, SURGEON'S KIT, ETC.

In many hospitals, small ones especially, where there are no medical students or house doctor, the nurse has more responsibility than in larger institutions, and becomes closely familiar with such details as taking the history of the patient; the arranging and sterilization of instruments; assisting the operator, giving the anesthetic, and writing out the report of the operation. The following charts will be of use in keeping the important features of this line of duty in mind. When taking the patient's history it is a good plan to allow her to describe her condition in her own words. Any peculiarities of the patient's manner and other points which may be observed can be noted, and afterward the questions necessary for making out the charts may be asked.

Family History.

	Age.	Health.	Disease.	Cause of death if dead.
Father.				
Mother.				
Brothers (number).				
Sisters (number).				
Wife or husband.				
Children (number).				

Uncles or aunts with epilepsy, insanity, tuberculosis, or consumption.

Personal History.

When born. Where lived. Peculiarities of climate. Occupations. Habits (as to eating, drinking, sleeping, etc.). Appetite. Condition of bowels. Nervousness. Culture.

(When Female.)

Sexual History.

I. *Menstruation.*

(*a*) First at what age.
(*b*) Regularity. No. days.
(*c*) Duration. No. days.
(*d*) Amount.
(*e*) Character of discharge { Color. / Consistency. / Odor.
(*f*) Intermenstrual discharge.
(*g*) Dysmenorrhea—when.

II. *Pregnancies* { Number. / Sickness or peculiarities.

III. *Miscarriages* { Number. / Sickness. / Fever.

IV. *Labors.*

(*a*) Number.
(*b*) Character { Easy. / Difficult. / Spontaneous. / Instrumental.
(*c*) Peculiarities.
(*d*) Sickness post partum, if any.

Previous Illness.

Starting with childhood, give different sicknesses and age at which same occurred, following life of patient to present time simply with reference to sickness, including appetite, bowels, urine, headaches, pains, coughs.

Present Sickness.

Date.

Onset. Character. { Chills, pains, locations, severity, etc. Peculiarities.

Progress and changes to present time.

Changes. Appetite. Bowels. Urine, etc.

Examination.

The packing of a surgeon's bag is often done by the operating-room nurse. Many surgeons use the telescope valise, or kit, as it is more commonly called; while others employ a regular surgeon's bag. Before the bag is packed the nurse makes out the list of necessary articles, and as each article is put in it is checked off the list. When packed, a copy of the list is securely pinned upon a towel inside, where the surgeon can see it on first opening the bag. The kit is packed by first laying in two large sterilized towels, the ends of which hang over the edges of the bag. Together with the instruments, which are placed in a linen instrument-roll, and the dressings, the kit should contain three new nail-brushes, soap, razor, oxalic acid and permanganate of potassium crystals in bottles, hypodermic syringes with tablets of strychnin sulphate (gr. $\frac{1}{30}$), atropin sulphate (gr. $\frac{1}{150}$), and morphin sulphate (gr. $\frac{1}{6}$), ether and chloroform (with cone and mask), tablets of corrosive sub-

OPERATION BLANK.

Service of Dr......

Date. March 10, 1899.

Name.....

I. PREPARATION OF PATIENT FOR OPERATION.

II. ANESTHETIC. ANESTHETIST.

Temperature.

Before operation.

After operation.

Pulse.—To be taken every five minutes.

III. PREPARATION OF FIELD OF OPERATION.

IV. POSITION OF PATIENT DURING OPERATION.

V. PRIMARY MANIPULATIONS.

VI. INCISION AND HISTORY OF OPERATION.

VII. TREATMENT OF WOUND.

VIII. DRAINAGE.

IX. CLOSURE OF WOUND.

X. DRESSING.

XI. RECOVERY FROM ANESTHETIC.

XII. AFTER-TREATMENT.

limate and sodium chlorid, iodoform gauze, plain gauze, gauze sponges, white suits, caps and canvas shoes for the operator and assistants, Kelly pad, rubber gloves, brandy, alcohol, safety-pins, absorb-

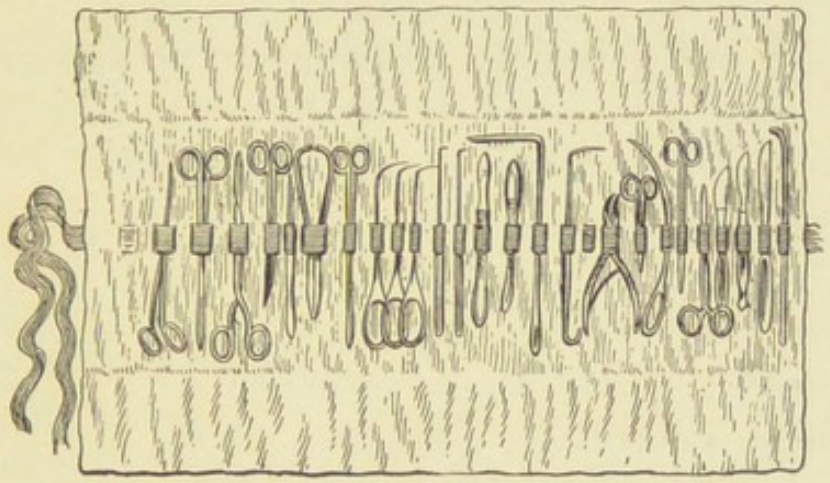


FIG. 11.—Canton-flannel roll for instruments.

ent cotton, twelve towels, a rubber apron, ligatures, sutures, and rubber and glass drainage-tubes. The glass-ware should be packed in the middle, to prevent breakage. When the kit is packed a third towel is laid over the contents, the edges of the other

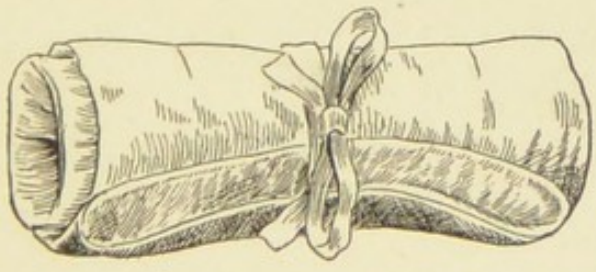


FIG. 12.—Instruments wrapped in canton-flannel roll.

two are brought up, and all pinned together with safety-pins.

The instrument-rolls are very serviceable in economizing space and in keeping the instruments as

nearly aseptic as possible. They are made of linen, canton flannel, or toweling, one yard long; and through the middle of each are adjustable loops in which the instruments are placed. When soiled the rolls may be washed and sterilized.

LIST OF INSTRUMENTS NECESSARY IN DIFFERENT OPERATIONS.

Instruments for Perineorrhaphy.

Catheter, glass, small,	1
Catheter, glass, large,	1
Forceps, hemostatic, small,	6 pairs.
Forceps, hemostatic, intermediate,	3 "
Forceps, hemostatic, long,	3 "
Forceps, hemostatic, long dressing-,	1 pair.
Forceps, hemostatic, tissue- (rat-tooth),	2 pairs.
Forceps, hemostatic, bullet-,	2 "
Forceps, hemostatic, volsella,	2 "
Scalpels,	2 "
Uterine sound and applicator.	
Tenacula, straight,	1 pair.
Tenacula, curved,	2 pairs.
Tenacula, shepherd's crook,	1 pair.
Scissors, straight,	1 "
Scissors, right-angle,	1 "
Scissors, left-angle,	1 "
Sponge-holders,	6

Needles. Sutures, silk of various sizes, and silkworm-gut.

Needle-holder. Sims speculum. Retractors. Leg-holder. Sterilized stockings. Glass nozzles. Irrigation dressings.

Tenacula are used to catch and hold movable tis-

sues which are being sutured, to hold the cervix uteri, etc. There are two kinds, the curved and the straight; and of the curved there are three varieties: the shepherd's crook, the simple curved, and the corrugated. The shepherd's crook is much used in vaginal operations, and has the advantage over the others that when once it is put in place it can be dropped without losing its hold on the tissues.

Instruments for Trachelorrhaphy.

Catheter, glass,	1
Two-way catheter,	1
Curette, dull,	1
Curette, sharp,	1
Curette, spoon,	1
Dilators, different sizes.	
Forceps, hemostatic,	8 pairs.
Forceps, volsella,	1 pair.
Forceps, bullet-,	2 pairs.
Forceps, long dressing- (Kelly),	1 pair.
Forceps, tissue- (rat-tooth),	2 pairs.
Scalpels,	2 "
Speculum, Sims, small,	1
Speculum, large,	1
Shot-compressor and shot.	
Retractor, small,	1
Retractor, medium,	1
Scissors, straight,	1 pair.
Scissors, curved,	1 "
Tenacula,	2 pairs.
Needles, curved, various sizes, short, stout, straight.	
Needle-holders,	2

Uterine sound and applicator.
Sterilized stockings. Leg-holder.
Catgut and silkworm-gut sutures.

Instruments for Dilatation of Cervix and Curetting of Uterus.

Catheter, glass, small,	1
Catheter, two-way, for irrigation,	1
Curet, sharp,	1
Curet, Martin's double blunt,	1
Curet, curved, sharp,	1
Dilators (Hank's rubber, all sizes).	
Dilator, Goodell's,	1
Forceps, long dressing-,	1 pair.
Forceps, bullet-,	1 "

Uterine sound and applicator.
Sims specula, large and small.
Kelly perineal pad. Sterilized stockings.
Irrigator. Glass nozzles. Dressings.
Small sponges. Cotton pledgets.
Churchill's tincture of iodin.
Carbolic acid, 95 per cent. Leg-holder.

Instruments for an Abdominal Operation.

(Arrange for Trendelenburg Position.)

Forceps, small, hemostatic,	6 pairs.
Forceps, medium,	6 "
Forceps, pedicle-,	4 "
Forceps, long,	4 "
Forceps, long dressing-,	1 pair.
Forceps, for drainage-tube,	1 "
Forceps, Billroth,	2 pairs.
Forceps, bulldog,	1 pair.

Forceps, rat-tooth, 2 pairs.
Aspirator. Scalpels. Vaginal packer. Uterine sound.
Paquelin's thermocautery.
Sponge-holders. 6
Scissors, long and small, 1 pair of each.
Retractors, Lange's large, 1 pair.
Volkmann's 6-prong retractors, 1 "
Volkmann's 4-prong retractors, 1 "
Long and small probe and director.
Needle, aneurysm-, 1
Needle, transfixion, right curved, 1
Needle, transfixion, left curved, 1
Needle, transfixion, pedicle, 1
Needles, large, small, and intermediate, curved and intestinal.
Murphy anastomosis button (sizes 1–4).
Murphy's forceps for holding button, 1 pair.
Murphy's forceps, intestinal clamp, 1 "
Murphy's forceps, introducing, 1 "
Flat dissector (Fenger).
Drainage-tubes, glass or aluminum, assorted sizes.
Needle-holders, 2
Dressings, ligatures, and sutures of silkworm-gut, and various sizes of silk and catgut.
Laparotomy sheet. Saline solution.
Small bolsters, made of non-absorbent cotton covered with gauze, six inches by three, to retain the intestines and to keep them from encroaching upon the site of operation.

Extra, for Cysts or Tumors.

Trocars, large and small. Rubber tubing.
Nélaton's forceps.
Billroth's tumor-forceps, 2 pairs.

Extra, for Vaginal Hysterectomy.

Sterilized stockings. Leg-holder.
Clamp-forceps, 6 pairs.
Uterine sound. Dissecting forceps. Long and short tenacula. Speculum. Curet.

Instruments for Operations on the Brain and Spine.

Forceps, hemostatic, medium, 6 pairs.
Forceps, hemostatic, small, 6 "
Forceps, rat-tooth (tissue-), 2 "
Forceps, bone, three kinds; long-jaw forceps.
Trephine—three sizes, small and medium.
Chisels, various sizes. Hammer.
Scalpels, 2
Scissors, 2 pairs.
Curets, sharp and dull.
Needles. Sutures. Ligatures. Saline solution. De Vilbis forceps.

Instruments for Amputation of a Limb.

Esmarch bandages, 2
Periosteotome, 1
Long amputating-knife.
Medium amputating-knife.
Scalpels, large and medium.
Bone-saw. Chain-saw.
Forceps, small hemostatic, 6 pairs.
Forceps, medium hemostatic, 6 "

Forceps, bone-cutting, straight, curved, and angular.
Forceps, gouging.
Forceps, rat-tooth (tissue-), 2 pairs.
Forceps, retractor, 1 pair.
Scissors, large and small, 1 pair of each.
Bone-pins.
Four-prong retractors, 2
Three-tailed gauze retractors, 2
Dressings. Sutures. Ligatures of silk, catgut (various sizes), and silkworm-gut.

Instruments for the Mouth and Throat.

Head-mirror. Snare of silver wire.
Volsella forceps for tonsils.
Uvulatome. Tonsillotome, 2
Sponge-holders, 6
Uvula scissors with and without claws.
Tongue-depressor.
A self-fastening mouth-gag.
Trachea-dilator.
Trachea-tubes. Intubation-tubes.
Long forceps, 1 pair.
Long curved forceps, 1 "
Long straight scissors, 1 "
Throat-mirror (laryngoscope).
Angular forceps, 1 pair.
Angular scissors, 1 "
Long, slender curet.
Gottstein knife (for adenoids).
Gradle forceps (for adenoids).
Bistoury. Flexible probe.

Esophageal sound and dilator.
Fish-bone catcher for foreign bodies.

Instruments for the Nose.

Polypus-snare. Silver applicator.
Nasal curet.
Saw with reversible blade for cutting up or down.
Nasal scissors, with and without saw-teeth.
Nasal bone-scissors.
Nasal bone-scissors, turbinated.
Nasal polypus-forceps.
Septum-straightening forceps, 1 pair.
Nasal speculum.
Septum-knife.
Electrocautery for hypertrophied turbinates and for hemostasis.
Chromic acid. Applicators.
Iodoform-strips for packing.
Monsell's solution for hemostasis.

Instruments for the Ear.

For Mastoid Operations.

Forceps, hemostatic, small, 8 pairs.
Scalpels, small and medium, 1 each.
Chisels and gouges, various sizes.
Mastoid drills and bone-trephines, 2
Mallet.
Ear-speculums, various sizes.
Diagnostic tube and otoscope.
Ear-syringe (hard rubber).

Sponge- and cotton-holder.
Small curet.
Irrigator.

For Middle-ear Operations.

Eustachian catheter, and Politzer's air-bag.
Curets. Ear-scoop.
Snare and wire.
Head-mirror.
Cotton-holder.
Tympanum-perforators.
Ear-aspirator for cleansing middle ear.
Case of tuning-forks and hammer.
Ear-scissors.
Ear-speculum, various sizes.
Slender polypus-forceps, 1 pair.
Slender scalpels.
Ear-probe. Irrigator.

Instruments for Rectal Operations.

Rectal speculum.
Forceps, small hemostatic.
Forceps, hemorrhoid.
Scalpel. Paquelin's cautery.
Rectal bougies.
Sterilized stockings. Leg-holder.
Kelly perineal pad.
Irrigator. Dressings. Sutures. Ligatures.
Curets, sharp and dull, 1 pair of each.
Saw and chisels for Kraske's operation.
Metal probes for tracing fistulæ.

Instruments for Urethral and Bladder Operations.

Set of sounds, curved and straight.
Catheters, various sizes.
Urethral forceps, 1 pair.
Artery-dilators, various sizes.
Endoscopes with calibrators, various sizes.
Urethral searcher.
Head-mirror. Return-irrigator.
Sounds and dilators (usually the same).
Scalpels, artery-forceps, lithotrites.
Stone-forceps, litholapaxy set.
Curets, etc., for suprapubic or perineal lithotomy, or for litholapaxy, operations on tumors, etc.

Necessary for Dressings after Gynecologic Operations.

Sims speculum.
Bullet-forceps, 1 pair.
Long dressing-forceps (Kelly).
Applicator. Scissors, straight, 1 "
Churchill's tincture of iodin.
Carbolic acid, 95 per cent. Ichthyol.
Balsam of Peru and glycerin.
Glycerin (pure). Vaselin.
Tampons. Boric acid solution.
Irrigator. Kelly perineal pad.
Andrews stitch-cutter for the removal of silkworm-gut stitches from the vagina and cervix.

For Cystoscopic Examination.

Head-mirror.
Urethral calibrator and dilator.
Urethral searcher.
Vesical specula with obturators.
Evacuator for removing urine.
Long-mouthed toothed forceps.
Applicator.
Cocain solution, 10 per cent.
Boroglycerid to lubricate the speculum and dilator.

In private practice a head-mirror or reflector can be improvised with a lamp or candle and a mirror.

CHAPTER VIII.

ANESTHESIA.

ANESTHETICS are divided into two classes, local and general. In local anesthesia the patient does not lose consciousness; but in general anesthesia consciousness is put in abeyance, the brain, together with the rest of the body, is narcotized, and there is profound sleep from which the patient awakens slowly. Both classes of anesthetics are used in surgery.

We have practically four general anesthetics, one a gas, nitrous oxid, and three in liquid form: ether, chloroform, and ethyl bromid. The last three are those which are used in surgical work, while the first is chiefly employed in dentistry. The administration of the anesthetic is a duty which often falls to the head nurse, especially in small hospitals, in private practice, and in emergency cases.

The anesthetic should be administered in a room apart from the operating-room, so that the patient may be spared the sight of the preparations for the operation and the necessary display of instruments. Before giving the anesthetic the urine, heart, lungs, and mouth are examined, the mouth because patients are apt to deny the presence of false teeth, and male patients have been known to go to the anesthetizing room with tobacco in their mouths. The patient's

habits should be inquired into. Alcoholic patients pass through the exciting stage of anesthesia with considerable struggling; they are also more liable to congestions.

An anesthetic must never be given on a full stomach, because the patient may vomit, and particles of food may lodge in the larynx and trachea and result in strangulation. The bladder and bowels must always be emptied, or they may act involuntarily. False teeth must be removed, as there is danger of their being swallowed.

Absolute silence must be maintained while the anesthetic is being administered, as anything said may be heard by the patient and be repeated. Whatever is said by the patient during the anesthetic state, or while going into or coming out of it, must be kept absolutely secret. Family secrets and other things may be told which might make great trouble if they were repeated. So a religious silence must be observed by every one with regard to any statement that the patient may make while intoxicated. Care must also be taken that the operation is not discussed. Many patients have been made very unhappy through carelessness on this point; for they can often hear everything that is said by the doctors, students, and nurse, but are totally unable to make any sign by which a bystander may know that they can hear. These are about the first lessons that should be impressed upon a nurse when she begins her operating-room service. Oliver Wendell Holmes, in his *Medical Essays*, says: "It is a terrible thing to take away hope, even earthly hope, from a fellow-creature. Be very careful what names

you let fall before your patient. He knows what it means when you tell him he has tubercles, or Bright's disease; and if he hears the word carcinoma, he will certainly look it out in a medical dictionary, if he does not interpret its dread significance on the instant."

It is not always best that the patient should know that she has carcinoma; if she hears that word, she will feel that it is a sentence of death sooner or later, and her life will be made miserable, whereas, if she is not informed as to the nature of her condition, her life can often be made more comfortable.

The giving of the anesthetic is by no means a subordinate duty. It requires a very skilled and trustworthy assistant, one who is competent to act in case of emergency, because the life of the patient is as much in the hands of the anesthetist as in those of the operator. The anesthetist's whole attention must be given to the administration of the drug. Consequently, he cannot also watch the operator.

The majority of patients are opposed to giving up consciousness, and often it costs a great struggle. It is here that a nurse should inspire her patient with confidence. Although we see many operations in the hospital in a single day, yet to the patient it is the one great event in his or her life.

Some patients have an idea that an operation is mere butchery; while others who have any control over themselves can be shown the operating-room in readiness for work. A few cheering words conveying the right meaning are all that is needed, but we should remember that these are needed.

In all operations in which an anesthetic is em-

ployed, even in those of a minor character, it is well to be prepared for accidents, such as heart-failure, arrest of respiration, or hemorrhage. There should be a hypodermic tray, with bottles containing solutions of strychnin sulphate, atropin sulphate, digitalis, whiskey, nitroglycerin, morphin sulphate, and camphorated oil. Two hypodermic syringes in good order should be in readiness. An oxygen-inhaling apparatus is a valuable adjunct to an operating-room, and may prove useful in respiratory failure. It is also advisable to have a small faradic battery near at hand. A quantity of normal saline solution should always be in readiness for injection under the skin.

The Allis inhaler is generally used, and in its absence a cone is to be preferred to a sponge, since a cone is always fresh and clean. An ether cone is made by folding a newspaper; or a straw cuff may be shaped to fit over the nose and mouth, a stiff towel being folded around and secured with safety-pins, and a clean handkerchief or piece of cotton placed inside. Ether should be given slowly; the cone should not be filled with ether and put over the face, entirely smothering the patient. The patient should be instructed how to inhale it, slowly and deeply, and also to close the eyes, because ether is an irritant to them. About two tablespoonfuls of ether are poured into the cone, which should be held a little distance from the patient's face, and as he becomes accustomed to the vapor and comes under its influence the cone may be brought nearer; the strangling sensation, of which so many patients complain, is then in a measure avoided. A little patience exercised at the beginning

obtains more satisfactory results and less shock than when the drug is crowded, and force is used to re-

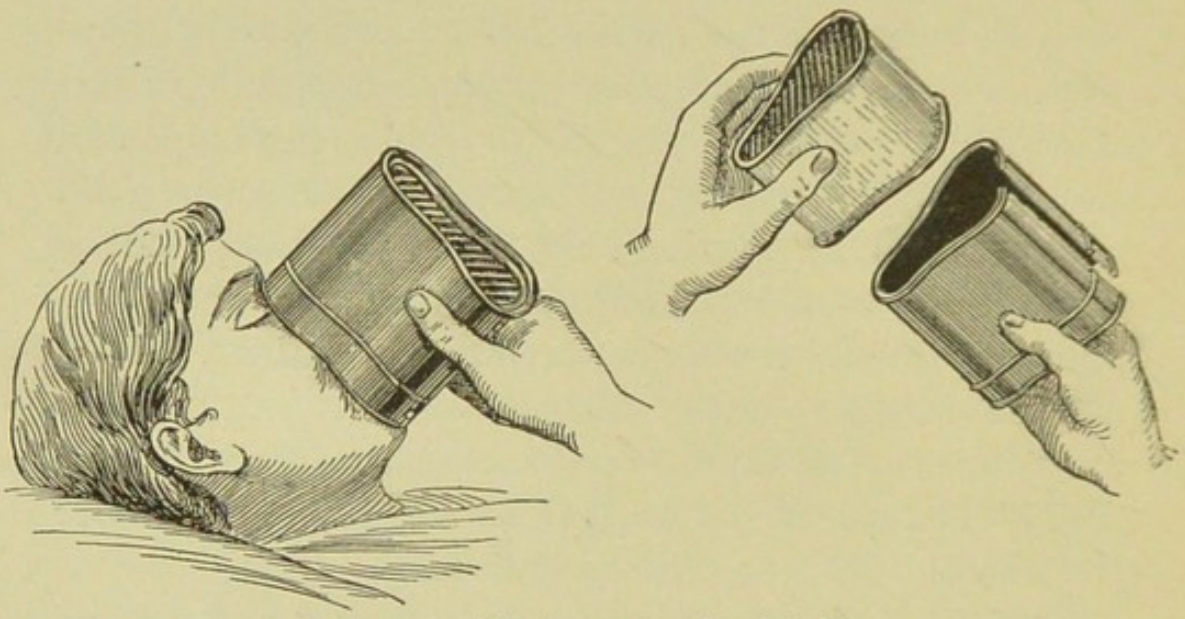


FIG. 13.—Allis's aseptic ether-inhaler.

strain the struggles of the patient. Ether generally first produces choking and coughing, followed by excitement; that is followed by the muscles becoming rigid, the face may be cyanosed, and the breathing stertorous or snoring; this stage passes away, the muscles become relaxed, and the patient is in a state of insensibility.

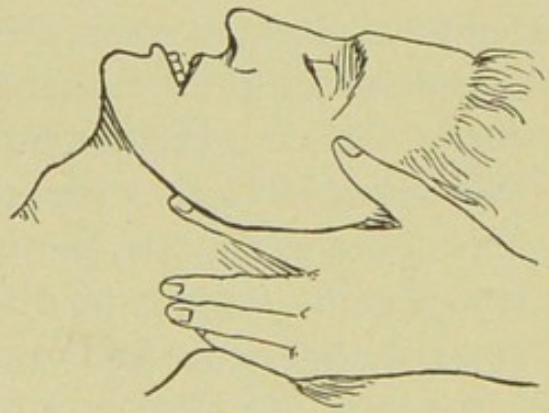


FIG. 14.—Method of pushing the lower jaw forward to prevent obstruction to breathing.

The lower jaw must be kept forward by placing the thumbs behind the angles of the jaw. Gentle pushing of the jaw forward and upward, which brings the upper behind the

under teeth, keeps the tongue from slipping back and obstructing the larynx, and gives free access of air to the lungs. Should the tongue slip back, it may be pulled forward with the fingers or with a pair of forceps. Holding the tongue forward by means of passing a suture through the tongue with a needle should not be done; neither should too much pressure be put on the tongue-forceps, for that will cause the tongue to become sore and swollen, and after the patient recovers from the anesthetic, about the first thing of which she complains is the soreness of tongue and jaws. Frequent inspirations of fresh air should be given. When completely etherized only a small quantity of the drug is needed to keep the patient under its influence. The eyeball should not be touched in order to ascertain if the patient is completely narcotized; it is liable to cause conjunctivitis. Press down the upper eyelid on the eyeball; if the patient makes no movement, and is perfectly relaxed, then insensibility is complete. Bronchorrhea usually occurs during the earlier stages of anesthesia; but if proper care is taken not to crowd the ether at the start, the mucus secreted will not be of sufficient amount to cause any distressing symptom. When it does occur, the head should be turned to the side and the mouth wiped with a gauze sponge in a sponge-holder. Bronchorrhea may prove to be a distressing complication to the administration of the anesthetic, inasmuch as the free secretion in the bronchi and bronchioles may interfere with thoroughly anesthetizing the patient, and the patient is more prone to nausea from swallowing the mucus, which is probably soaked with ether. If the patient seems inclined to vomit, the ether should be

pushed, which will generally ward it off; should she vomit, her head should be turned to one side, to allow the matter to escape more easily from the mouth. If the operation is about the neck or chest, the head must be turned to the opposite side, to prevent vomited matter from getting into the wound. Vomiting is usually due to incomplete anesthesia and the admixture of too much air with the vapor. The anesthetic must be persistently given until the vomiting ceases and complete relaxation occurs.

The mucus should be constantly wiped from the patient's mouth. The pupils should remain contracted all through etherization, and dilate when the patient is returning to consciousness. Dilated pupils mean one of two things: either that the patient is coming out of the anesthetic influence, or that she is too deeply anesthetized. We can readily ascertain which condition the patient is in by pouring a little ether into the cone. If she is coming out, she will cough, stop breathing, and give other signs of discomfort; while if too deeply etherized she will breathe on steadily and not notice the fresh supply of ether; and the pupils will remain dilated until the muscles of the eyes regain their tone, when they contract. The sudden dilatation of the pupils is generally a sign of imminent death. It is very important for the anesthetist to watch carefully the respirations, because ether kills by suffocation, the heart usually beating long after the respirations have ceased. The anesthetist should *speak out* if the pulse is growing rapid, feeble, irregular, or intermittent; if the respirations are becoming low, rapid, or gasping; if the face is becoming pale or blue; if the pupils are gradually dilating; or if

the extremities are cold and there is profuse perspiration. A very long anesthesia may lead to secondary prostration and collapse, and secondary shock from that cause alone. In other words, the prostration of the anesthetic is added to the effects of the operation.

Primary anesthesia is that moment of temporary unconsciousness which comes on after the patient has taken a few inhalations, before the stage of excitement.

In etherizing young children it is best to put them on the back and at once to place the ether-cone over the mouth and nose without temporizing. If their pleadings to have the cone taken away are listened to (and they are hard to resist), their agony will only be prolonged and the operation delayed. Children are quickly etherized, and very rapidly recover from the influence of the ether.

Death from ether is slow, by paralysis of the respiration, the signs of danger being a blue and livid skin, and low, shallow, gasping respirations. Ether is very inflammable; hence the can should never be opened near a light or fire.

Nausea and vomiting are very common after ether, but are usually over at the end of eighteen hours. Should vomiting persist until the following day, it may be due to shock or to some cause other than ether. It may be relieved by the inhalation of hot, strong vinegar fumes; a cloth wet with vinegar placed over the mouth and nose; teaspoonful doses of very hot water, either plain or with four grains of bicarbonate of sodium added to one ounce of water; crushed ice; champagne and ice; small doses

of brandy and ice; black coffee; aromatic spirits of ammonia, or sometimes tea. Cocain, one-fourth grain every two hours for five doses, has been successful in severe cases; also a mustard-leaf applied over the stomach, and the washing out of the stomach. Oxygen gas is now frequently administered both to lessen nausea and to hasten consciousness. As a last resort, when all other treatment fails and there is danger that the severe retching will exhaust the patient, morphin, one-sixth grain, is injected over the epigastrium.

Chloroform is similar in its action to ether, and is often to be preferred to it, because it is pleasanter to take, rapidly recovered from, does not produce excitement or subsequent vomiting, and the patient is brought more quickly under its influence. It is, however, more depressing to the heart than ether, and therefore more dangerous. The patient is not allowed to rise until all effects have passed off. To give chloroform, a few drops may be sprinkled on an Esmarch inhaler, a handkerchief, a towel, or a small wire framework covered with gauze. Where the operation is on the mouth, so that all available space and light is demanded, after the patient is fully anesthetized it is administered on a small gauze sponge clamped in forceps which are held several inches above the mouth. Vaselin should first be spread over the face, and especially around the lips and nose, to prevent the burning which might occur should any of the fluid drop. The same symptoms are to be watched for as in the case of ether. Death from chloroform is almost always sudden, from paralysis of the heart; the pupils become dilated, the face pale,

and the pulse flickering. These symptoms usually come on with little or no warning.

Ethyl bromid is often used as a substitute for chloroform, which it resembles in its action, except that it is more prompt. It is employed in minor operations and gynecologic examinations. About half a dram is poured on a folded towel, or chloroform-inhaler, and held close to the mouth and nose. The same amount is added at intervals until the patient is completely narcotized. The stage of excitement is short, and its elimination is rapid. It leaves a disagreeable odor of garlic on the breath, which may last several days; but, on the other hand, the patient recovers rapidly, and may be able in a very little while to resume work.

Ethyl bromid is also used as a local anesthetic in the form of a spray.

Schleich's anesthetic consists of one and a half ounces of chloroform, one-half ounce of petroleum ether, and six ounces of ordinary ether. It is given in an Esmarch inhaler, and is considered to be safer than chloroform. Unconsciousness is obtained usually in one minute and a half; there is no excitement, and the reaction is rapid. There are three forms of this solution, the other two being weaker.

Local anesthetics are those which abolish the sensibility of the peripheral nerves of a particular area (Brunton).

Cocain is the best one that we have at present; the others are ethyl chlorid, eucain, menthol-chloral, orthoform, freezing with ice and salt, carbolic acid, alcohol, ether, the so-called infiltration-anesthesia, etc.

Ice.—The disadvantage of using ice is that it is always followed by a reaction, the blood-vessels becoming filled with blood; and the patient suffers the pain and tingling sensation which follow intense cold. It is used in the following way: To a little, finely-chopped ice is added about a quarter the amount of salt; this mixture is placed in a piece of gauze and laid over the part, which in about ten minutes becomes white and numb.

Eucain is much used as a local anesthetic in surgery of the nose, throat, and ear in strengths of 2, 5, and 8 per cent. In the onset its action is slightly slower than that of cocain, from five to ten minutes elapsing before the patient is ready for operation, but when established the anesthesia is fully equal to that of cocain. The duration of the anesthesia is from ten to twenty minutes, fifteen minutes being the most usual time.

Cocain hydrochlorate is a very good anesthetic. It is ordinarily employed in a 4 per cent. solution, and is principally applied to the mucous membranes, such as the eye, the mouth, the nose, the urethra, etc. It is not so effective when applied to the sound skin; in order to produce anesthesia there it must be injected subcutaneously, when it gives rise to a rapid edema of the tissues. It has the power of shrinking up the blood-vessels and temporarily driving the blood out of the parts, which is quite an advantage in minor operations.

Eighteen grains of cocain hydrochlorate to one ounce of water is a 4 per cent. solution. One grain of boric acid added to the solution will prevent the development of fungi, and the solution remains

aseptic. The solution should be kept in a cool spot, for if placed in a temperature higher than 60° F. it begins to lose its anesthetic properties.

The use of the cocain discoids enables the nurse to prepare a desired amount of a fresh solution at a moment's notice. They are convenient and safe, and contain accurately weighed quantities of pure cocain.

The *phenate of cocain* is a local anesthetic, used in from 5 to 10 per cent. solutions. It takes longer to act than the hydrochlorate; it also coagulates the tissues and lessens absorption.

Ethyl chlorid is a local anesthetic, acting by freezing the parts. It is put up in glass tubes. The cap is removed from the tip of the tube and the bulb held in the palm of the hand, the warmth of which causes the liquid to escape in a vaporized stream. The tube is held a little distance from the part to be operated upon, which whitens and is ready for operation in about fifteen seconds.

The method of *infiltration-anesthesia* (local anesthesia by injection of solutions in the skin) was introduced by Schleich, who claims that a weak solution of cocain hydrochlorate, with common salt, and a small amount of morphin, will produce a thorough and prolonged anesthesia. There are three preparations, each of which is put up in tablet-form, containing the proper proportions :

No. 1. *Strong.*—

Cocain. hydrochlor.,	1 gr.
Morph. hydrochlor.,	$\frac{1}{8}$ gr.
Sodium chlorid,	1 gr.

No. 2. *Normal.*—

Cocain. hydrochlor.,	$\frac{1}{2}$ gr.
Morph. hydrochlor.,	$\frac{1}{8}$ gr.
Sodium chlorid,	1 gr.

No. 3. *Weak.*—

Cocain. hydrochlor.,	$\frac{1}{20}$ gr.
Morph. hydrochlor.,	$\frac{1}{8}$ gr.
Sodium chlorid,	1 gr.

The tablets should be dissolved in distilled sterilized water.

Alcohol and ether are local anesthetics, as is also any agent which evaporates rapidly and produces cold.

CHAPTER IX.

ANTISEPTIC GAUZES, TAMPONS, BANDAGES, THERMOCAUTERY, SALINE INFUSIONS, IRRIGATION, ETC.

Surgical Dressings.—Gauze and absorbent cotton are now almost universally used as wound-dressings. A dressing may be aseptic or antiseptic. An antiseptic dressing absorbs from the wound all discharges, prevents the access of germs to the wound from the outside, and also destroys all germs that may come in contact with it. An aseptic dressing has the same properties, with the exception that it cannot destroy germs.

In selecting gauze for dressings, that which possesses the greatest absorbent power should be secured. It should be soft, *pliable*, and free from irritating and gritty materials.

When applied to a wound, it should be unfolded and laid on loosely; it thus forms a softer dressing and more readily absorbs the discharges.

Absorbent cotton is ordinary cotton deprived of its oil, in order to render it absorbent. Laid over gauze, it acts as a sieve through which germs cannot pass; also as a springy protective, by means of which the wound is protected from undue pressure.

Antiseptic dressings are made by impregnating gauze

with an antiseptic, such as bichlorid of mercury, iodoform, etc.

To make *bichlorid gauze*, the gauze after the initial boiling is immersed in a 1 : 1000 bichlorid solution for twenty-four hours, after which it is dried, cut into dressings, and packed in glass sterilized jars.

Iodoform gauze may be made after the following formula :

Cheese-cloth,	5 yards.
Alcohol,	8 ounces.
Iodoform,	3 "
Ether,	7 "
Glycerin,	3 "

Shake the alcohol and iodoform together in a sterile bottle for fifteen minutes, then add the glycerin, and lastly the ether. Put all into a sterilized stone jar ; then rub the mixture into the gauze thoroughly, and cut the latter into strips two inches wide. Each strip is rolled up separately, and several strips are placed in a sterilized jar. When required for use a strip is taken out with sterile forceps.

In some cases an emulsion of iodoform is rubbed into the gauze. This emulsion, according to Wharton, is made by adding three drams of iodoform to six ounces of Castile soap-suds. This suffices to impregnate eighteen ounces of moist gauze.

The iodoform glycerin or oil which is used for injections into wounds is prepared by taking

Iodoform,	5 grams (75 grains).
Glycerin,	100 c.c. ($3\frac{1}{3}$ ounces).

Mix and place in a wide-mouthed flask of thin

glass, and sterilize for one hour, plugging the flask afterward with sterilized cotton.

Potassium-permanganate Gauze.—The formula for this is as follows :

Potassium permanganate,	160 grains.
Hot water (distilled),	33 ounces.

The gauze is cut and rolled as for iodoform gauze, and saturated thoroughly in the above solution. It should be preserved in colored glass jars.

Bismuth gauze is made after the subjoined formula :

Bismuth subiodid,	11 drams.
Glycerin,	7 "
Water (distilled),	4½ ounces.

Mix and rub thoroughly into the meshes of gauze, cut, and preserve the same as iodoform gauze.

In emergency cases old sheets and clean linen may be cut to the desired size and sterilized in an oven.

Collodion Dressing.—Collodion is a preparation of pyroxylin in alcohol and ether. On evaporation of the alcohol and ether a thin, impervious film of collodion is left. The collodion is either painted over the surface of the wound by means of a clean stick of wood or an applicator with sterile cotton fixed to the end, or thin layers of absorbent cotton are saturated with it, laid on the wound, and allowed to dry. Collodion is used only when the wound is aseptic. Various antiseptic agents, such as iodoform, boric acid, etc., may be dissolved or suspended in the collodion. The surface of the wound must be perfectly dry, or the collodion will not adhere. An ordinary dry

dressing may be applied over the collodion as a further protective.

Horsley's wax is made of seven parts of beeswax to one part each of almond oil and salicylic acid.

Rubber adhesive plaster is at times used in the later stages of wound-healing, for the purpose of drawing the edges together. The chief objection to its use is that it cannot be thoroughly sterilized. A protective dressing may be applied over it in the usual way. Rubber plaster is also used to take the place of bandages where these are inconvenient or difficult of application.

Oiled silk or *rubber protective* is used when it is desirable to prevent sticking of the dressings to the wound, as in ulcers, skin-grafting, etc. The material is applied in narrow strips which overlap each other like shingles. The strips are sterilized by washing in cold soap-suds and soaking them in a 1 : 250 solution of corrosive sublimate. They are then rinsed in sterile water or saline solution, in which they are allowed to float until needed by the surgeon.

Tents are small strips of rolled gauze used to keep a wound open for the escape of pus. They are rarely employed at present, having been replaced by the drainage-tube. The term tent more frequently designates a conical or cylindrical pencil of sponge, sea-tangle, and other substance, employed for dilating a narrow channel, such, for instance, as the cervical canal. When introduced, the tent expands from the absorption of moisture, and this dilates the part.

Tampons are made of absorbent cotton, lambs' wool, or gauze, and are about seven inches long, one

and one-half inches wide, and one-half an inch thick. They are folded and tied in the middle with a strong white thread or fine twine, leaving long ends by which to remove the tampon. The so-called kite-tail tampon is made by fastening several of these pieces of cotton to a thread about two inches apart. The tampons may after sterilization be kept in a dry, sterile jar, or they may be thoroughly soaked in water and then kept in glycerin. Tampons are principally used for introduction into the vagina. Previous to introduction they may be dipped into various special solutions. They are generally removed from the vagina on the day after the application.

Bandages.—In addition to the well-known roller-bandage, special bandages find frequent employment,

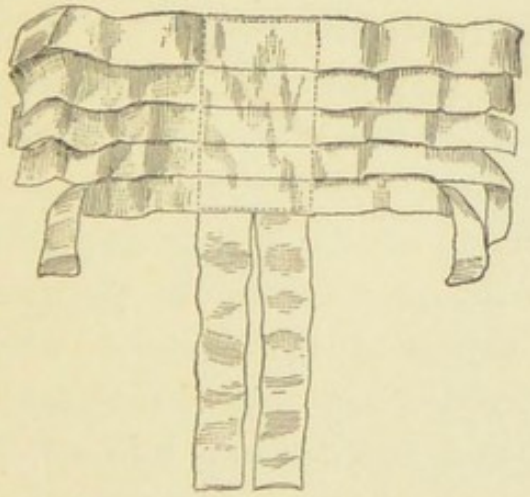


FIG. 15.—The Scultetus bandage.

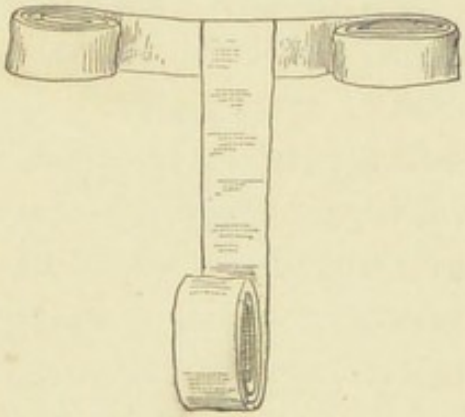


FIG. 16.—T-bandage.

particularly after abdominal operations. The most important are the Scultetus and the T-bandages.

The *Scultetus* bandage is used for surrounding the abdomen. It is made by taking two pieces of flannel or of cotton, each one yard long and four inches wide, the two pieces being placed four inches

apart; across them are sewed five other pieces of the same length and width, each piece being overlapped by the one above it by one-half its breadth. This bandage is placed under the patient's back, the cross-strips are folded over the abdomen from below upward, and the lower ends of the vertical strips are brought up between the thighs and pinned to the front of the bandage. This keeps the bandage from wrinkling and retains it in position.

T-*bandage.*—The T-bandage, which is used to secure dressings on the anus or the perineum, is made of two strips of bandage, each about five inches wide. To the middle of one strip, which is to go around the waist, the end of the other strip is sewed, which forms a letter T. This latter strip is brought forward between the thighs and pinned to the front, thus securing the perineal dressing.

Antiseptic Powders. — Reference has already been made to these. Those most frequently employed are iodoform, boric acid, acetanilid, dermatol, and mixtures of these various kinds. Iodoform and boric acid are generally combined in the proportion of one of the former to seven of the latter. The powders are kept in sterilized glass salt-cellars with silver-tops, which are covered with gauze when not in use, or in sterile wide-mouth bottles over which a piece of gauze is stretched. As the bottle may not be thoroughly clean on the outside, it should be handed to the surgeon wrapped in a sterile towel up to the top.

The **thermocautery,** known also as the Paquelin cautery, because of its invention by Paquelin, of Paris, is frequently employed in surgery to control

bleeding, and also to produce counter-irritation. The efficacy of this instrument depends on the fact that when the vapor of some highly combustible carbon compound is driven over heated platinum its rapid incandescence is sufficient to maintain the heat of the metal. Platinum points of various shapes and sizes are attached to a rubber tube, which is connected with a metal container half full of benzine or alcohol, the vapor of which is pumped through the tubing and holder into the platinum point. In

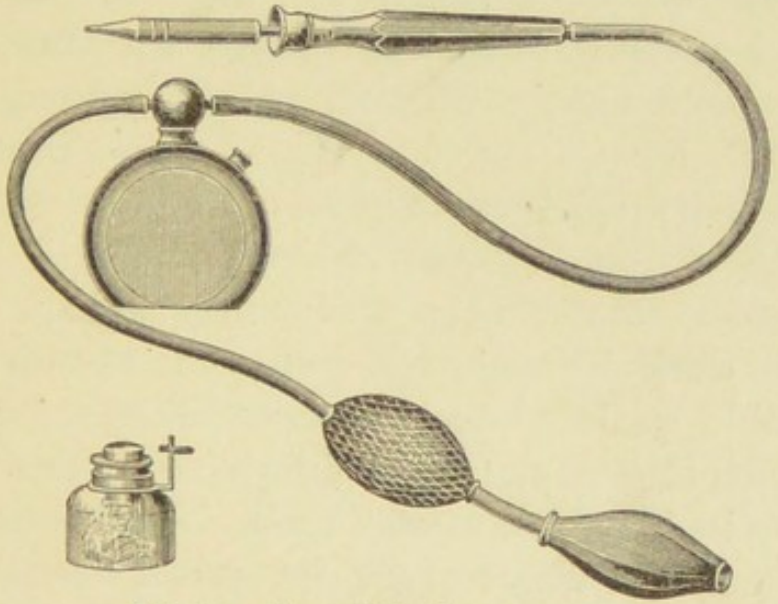


FIG. 17.—Paquelin's thermocautery.

order to prepare the instrument for use, a sponge is first placed in the bottom of the container, and over that is poured a small quantity of benzine or alcohol. Two pieces of rubber tubing, the one with a bulb, and another to the handle of which is screwed the platinum point, are connected by means of the stopper to the container. The tip of the platinum point is held in the flame of an alcohol lamp until it begins to glow, after which the flame is extinguished, and the action of working the bulb gently

forces the air charged with benzine through the tubing to the point, where it ignites and keeps the point glowing.

After using, the container should be completely closed, and the points while hot must be removed from the handle and laid away to cool; they must not be put into water, but wiped perfectly clean. The handle when cool must be removed from the tubing, and each part must be carefully laid in its own compartment in the case.

Normal saline solution is made to correspond as nearly as possible in specific gravity with the normal serum of the blood. The formula suggested by Dr. Locke of Boston and Dr. H. A. Hare, containing in one quart calcium chlorid 0.25 gm., potassium chlorid 0.1 gm., sodium chlorid 9 gm., is usually employed. It not only gives the heart a better fluid to work upon, but it restores to the blood that coagulable quality which is diminished or lost by hemorrhage. Tablets containing this formula have been devised, and are usually used. One tablet added to one quart of water gives the correct strength. In absence of the tablets one teaspoonful of table salt is added to one pint of water. It is absolutely necessary whatever formula is used that the solution and all the apparatus used be properly sterilized. If the water contains particles that cannot be strained out and there is no filter at hand, the water should stand until the sediment settles, when the fluid can be poured off, resterilized, and used. This solution is placed in an irrigator or a fountain-syringe which has been thoroughly sterilized with hot water and corrosive-sublimate solution, and subsequently rinsed with

boiled water. A long hypodermic needle, which has also been thoroughly sterilized, is fastened to the end of the rubber tube connected with the irrigator or fountain-syringe. The solution may be kept in a pitcher and poured into a glass funnel to which the rubber tube is attached. The temperature of the solution should be about 100° F. The solution is introduced under the skin of either the chest, the abdomen, the thigh, the arm, or between the shoulder-blades. From a pint to two quarts are injected at one time. The part selected for the injection is to be sterilized thoroughly in advance. Saline infusion is also given by the rectum, a long rectal tube being used.

In hospitals it is customary to keep on hand flasks of saline solution. These flasks are sterilized before filling; afterward they are stopped with sterile cotton-plugs and sterilized again by boiling for one hour on three successive days.

Normal salt solution is used for irrigation and for injections in cases of shock, in acute diabetic and uremic coma, hemorrhage, puerperal infection and eclampsia, etc.

Irrigation.—Irrigation, or flushing, is employed to cleanse wounds and wash out cavities, such as the uterus, the abdomen, etc. The solutions employed are various. Many surgeons use sterile salt-solution or plain boiled water. Antiseptic solutions, such as bichlorid solution (1 : 10,000 to 1 : 1000), boric acid solution, etc., are used especially for septic wounds and surfaces. For purposes of irrigation a concial glass vessel, with a tube at the bottom to which a rubber tube is attached, is commonly em-

ployed; a fountain-syringe will also answer the purpose. The irrigating-nozzle is usually of glass. The solution should be warm; when it is desired to check hemorrhage, it is used quite hot (110°–120° F.).

CHAPTER X.

SUTURES AND LIGATURES; SPONGES; DRAINAGE; DRAINAGE-TUBES; GAUZE DRAINS; RUBBER DAM; RUBBER AND COTTON GLOVES.

Sutures, which are used to bring together the edges of a wound, may be of silver wire, silkworm-gut, twisted Chinese silk, kangaroo-tendon, catgut, and horse-hair. Of these, silkworm-gut, catgut, and silk are most commonly used.

Catgut is made from the intestine of the sheep. It is largely used for suture-material within the abdominal cavity or deeper layers of tissues, because it is absorbed by the fluids of the body, and does not remain after the healing of the external wound to constitute a foreign body.

Kangaroo-tendon is prepared from the split sinews of the tail of that animal, and was introduced by Dr. H. O. Marcy of Boston. It is obtainable in any size, and comes in pieces of about twenty inches in length. Its advantage over catgut consists in its greater strength. It is more easily sterilized, and does not lose its strength during perfect sterilization. It is particularly of value in buried sutures and ligatures and continuous sutures at the surface.

To prepare the kangaroo-tendon the following

method may be used: The tendon having been soaked in absolute ether for forty-eight hours, is boiled at a temperature of 100° C. in alcohol for one hour. This temperature is maintained by means of a water-bath. It is then put in mercuric chlorid solution, consisting of mercuric chlorid 40 grains, tartaric acid 200 grains, and alcohol 12 ounces, for ten minutes. It is then placed with sterilized forceps in sterilized glass-stoppered jars containing bichlorid of palladium $\frac{1}{16}$ grain to 1 pint of absolute alcohol.

Silkworm-gut is prepared for use by soaking for forty-eight hours in ether and one hour in 1 : 1000 corrosive sublimate; it is then kept in a long tube of alcohol, though many surgeons prefer it made aseptic by boiling two hours before the operation. It is seldom used as a buried suture, but chiefly in closing wounds with interrupted sutures.

Catgut.—There are various methods of sterilizing catgut, among them the methods of Leavens and Fowler, by which catgut is kept in alcohol in sealed tubes, the preparation by formalin recently proposed by Senn, cumol catgut, etc., all equally effective if judiciously carried out. The gut used should be of the very best quality. The following are the most popular methods of preparation :

1. Six strands of catgut, each fourteen inches long, are wound on glass reels and soaked in ether for twenty-four hours to remove all fatty substances. The spools are then removed with sterilized forceps and dropped into covered glass jars, containing 95 per cent. alcohol, care being taken that the catgut is completely submerged and that allowance is made for evaporation. The mouth of the jar is covered with

absorbent cotton and the jar placed on a water-bath, the water of which is gradually heated until the alcohol boils, when the jar is removed. This operation is repeated on two successive days. On the third day of sterilization the absorbent cotton is removed, and a glass cover, fitted with a rubber protective to prevent evaporation, is screwed on.

2. The catgut is soaked for twelve hours in a corrosive sublimate solution (1 : 1000), and afterward from twenty-four to forty-eight hours in oil of juniper. The spools are then transferred to covered glass jars, containing sufficient absolute alcohol to cover the catgut completely. The alcohol is changed every two weeks.

3. Strands of catgut are soaked for twenty-four hours in oil of juniper, after which they are wound upon glass reels, and placed in covered glass jars containing absolute alcohol.

The method used by Dr. F. W. Johnson, of Boston, Mass., is as follows: The gut is soaked in ether for several days. It is then cut into the desired length, each length being thoroughly stretched (the stretching prevents kinking and twisting). The gut is then soaked for twenty-four hours in absolute alcohol, to take out as much of the water as possible. It is then covered with a solution of bichromate of potassium in absolute alcohol (fifteen grains to the pint), and remains in this twelve hours. Each length is coiled up, wrapped in waxed paper, and put in an envelope, which is sealed. The sealed envelopes are put in a dry oven, and baked for one hour at a temperature of 100° C. This removes all moisture. On the following day the sealed envelopes are

baked three hours at a temperature of 140° C. The gut is now ready for use. The envelopes are kept in a glass jar. An assistant tears open one end of an envelope, undoes the wax paper without touching the catgut, and hands it to the operator. In this way the gut is touched by no one, and touches nothing until picked up by the fingers of the operator. (For preparation of catgut by formalin, see *Formaldehyd*, p. 53.)

Silk is sterilized by being boiled for two hours before the operation. Five yards each of various

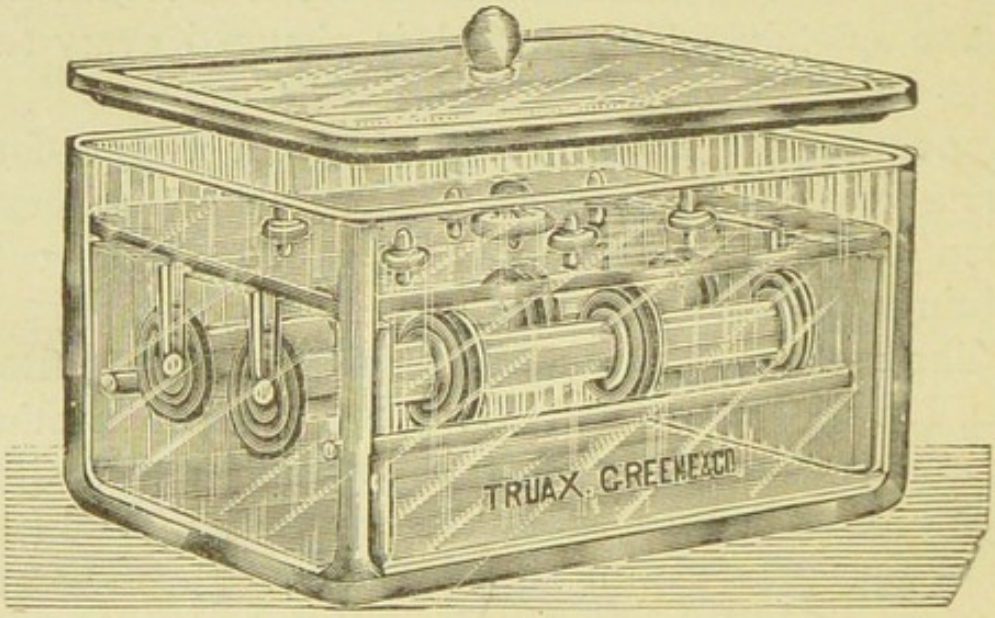


FIG. 18.—All-glass ligature-box, hospital size; six large spools.

sizes of twisted Chinese and pedicle silk are wound on glass spools and allowed to boil for two hours before the operation. When called for by the operator the pan containing the silk is handed to him, and he takes out the required size with sterilized forceps. In this way the sutures and ligatures are touched by no one but the surgeon himself. It is always a good plan to sterilize fresh silk for each

major operation. By so doing we are sure of it being perfectly aseptic.

Silver wire is sterilized by means of dry heat or by boiling in a 1 per cent. soda solution with the instruments. Usually the latter is preferred.

The *interrupted suture* is made by passing catgut or silk through the skin from one side of the wound to the other; then both ends are drawn together and tied in a double knot. The *continuous suture* is the ordinary over-and-over stitch from one end of the wound to the other. The *button suture* is made by passing wire across the bottom of the wound, bringing out the ends about one inch from the edge of the wound, and securing each end with a button. The *shotted suture* is one in which the ends of the suture, after it is introduced, are passed through a perforated shot, which is then clamped.

Stitch abscesses are usually produced by unclean suture-material. They may be caused by tying the stitches too tightly; but as a rule they occur when the sutures are not carefully sterilized. This is the reason why so many operators prefer their silk and silkworm-gut boiled immediately before using.

Sponges.—Sponges are used to wash wound-surfaces and to absorb or soak up fluids. The sponges most commonly employed are in the form of the gauze pads, the cut edges being folded over and loosely hemmed, and of square pieces of gauze, each piece being rolled loosely in the form of a ball, the free end being twisted and tucked in. The marine sponges are not often used at the present time. Gauze sponges are never employed more than once. Those used in operations are afterward destroyed; those not

used are resterilized, placed in sterilized towels, and deposited in covered glass jars, which are not uncovered until called for at an operation.

The great advantage of gauze over a marine sponge is that it can be thoroughly sterilized.

If marine sponges are required for an operation, the dark-colored ones should be bought. They do not look so attractive, but they are the finest sponges; they are "uncut" and "unbleached," and give more service than the clearer-looking ones, which are partly or wholly bleached. The bleached and cheaper sponges have been made by cutting one large sponge into several small ones; or by cutting off portions that were torn in taking the sponges from the ocean.

Marine sponges should be prepared as follows: 1. Lay them in a stout cloth and pound sufficiently to break up grit and lime. 2. Rinse with warm water until it remains clear. 3. Immerse in hydrochloric acid solution (two drams to one quart of water) for twenty-four hours. 4. Immerse in saturated solution of permanganate of potassium, followed with oxalic acid, then pass them through lime-water to take out all the oxalic acid, and rinse well in plain sterile water; after which they are immersed for twenty-four hours in a 1:1000 corrosive sublimate solution. They are preserved until used in a 3 per cent. carbolic acid solution.

When wanted for use the sponges are lifted out of the jar with long dressing-forceps and rinsed in plain sterile water.

Gauze pads for abdominal operations are made of eight thicknesses of gauze about eight inches square,

with the edges tucked in and hemmed to prevent fraying.

Gauze, now considered the most valuable of dressings for wounds, is cut into sections of four thicknesses and folded into dressings. A large number of these are sterilized for two hours, when they are removed with perfectly aseptic hands and placed in sterilized jars.

Absorbent cotton used in dressing cases is prepared in the same way.

Needles of various shapes and sizes required for an operation are sterilized with the instruments. Many operators prefer the needles to be threaded, then attached to a towel, which is folded, enveloped in another towel, and securely fastened. These bundles are sterilized and are not opened until called for by the operator or his assistants. After the operation is completed the sutures and ligaments which have not been used are carefully dried and resterilized. In choosing the needles care must be taken that only sharp needles and strong sutures and ligatures are selected for use.

Sheets, gowns, and towels used in operations are all made into convenient bundles and sterilized for two hours prior to an operation. Bundles once opened are not used again for other operations until they are resterilized.

Emergency bundles containing everything necessary for an emergency operation are stored in cases provided for them; but if not used for forty-eight hours, are again sterilized before being used.

Brushes.—Small hand brushes having a strong wooden back and stiff bristles are used for scrubbing

the hands, field of operation, and the instruments. They should be boiled two hours before the operation, then placed in a jar containing a 1 : 1000 corrosive sublimate solution. A separate brush should be reserved for the patient, and should be so marked. A separate brush should also be used for the cleansing of the vagina or rectum. Brushes used in purulent wounds, cancer, etc., should be destroyed after the operation. The same brush should never be used twice by the same person without being resterilized, and no two persons should use the same brush.

Drainage.—The object of drainage is to carry off to the surface the secretions and discharges of wounds and cavities. The retention and accumulation of these would interfere with healing, and, in the case of septic discharge, involves the danger of general infection. Drainage may be secured by means of rubber or glass tubes, or by strands of gauze or silk. In case of abdominal section the glass drainage-tube is usually preferred to gauze drainage, because it gives freer drainage, does not require a large opening in the abdominal walls, and is less likely to cause hernia; a sinus is more apt to follow the use of gauze drainage, and without anesthesia its removal is painful. Gauze soils the dressing and edges of the wound. With the glass drainage-tube, if properly taken care of, the dressings can be kept as sweet and clean as when put on. By bacteriologic examination the secretions in the glass drainage-tube have been found on the third day free from pathogenic bacteria. The chief objections to drainage of dependent pockets in the pelvis or abdomen, as formulated by Dr. J. G. Clark, of the Uni-

versity of Pennsylvania, are, first, that the fluids are frequently not removed, but, on the contrary, are pent up by the gauze drain; and, second, instead of removing infection, the gauze or tube may be the means of introducing it from the outside into the degenerated fluids. To overcome the dangers of dependent pockets and dead spaces in the pelvis, Dr. Clark suggests the elevation of the patient's body after operation to a sufficient height to start the flow of fluids from the pelvis toward the diaphragm, and thus promote the rapid elimination, by the normal channels of exit from the peritoneal cavity, of infectious matter, and of vital fluids that may stagnate in these pockets and form a culture-medium for pyogenic organisms.

The technic of *postural drainage* through the abdomen, which has met with such good results, is very simple. After the operation proper a large quantity of normal saline solution is poured into the abdomen and allowed to remain, and the foot of the patient's bed is raised twenty inches for about thirty-six hours after the operation. The result is that the exudate, if infected, is greatly diluted and may all be absorbed by the peritoneum; if inflammatory, it is kept liquid, and organized exudates are avoided. The pressure of the viscera is removed, intestinal adhesions are avoided, peristalsis does not cause pain by irritation, the patient suffers less distress and discomfort, and convalescence is naturally more rapid.

Care of Drainage-tubes.—If a glass drainage-tube is in the abdomen, the care of it is usually left to the nurse. She must each time, before drainage, thoroughly scrub and sterilize her hands. A syringe is used to withdraw any fluid remaining and for injecting irri-

gating solutions. The syringe must be washed first with boiling water, the water being passed through it several times, then with corrosive-sublimate solution (1 : 1000), followed with boiling water; the syringe is then to be laid in the corrosive solution until the nurse has washed her hands a second time and unpinned the dressing covering the tube. The rubber tube attached to the syringe is passed down the center of the drainage-tube to the bottom, then withdrawn a little, so that only the fluid will be drawn up, and not the tissue of the pelvis. The syringe-piston is to be slowly and steadily drawn up. When removing the syringe the nurse should be careful that blood does not drop on the dressing. The mouth of the tube is to be covered while the syringe is being emptied, and the corrosive and hot water are to be passed through the syringe before again putting it down the tube.

Some surgeons place a piece of twisted gauze into the tube, which sucks up the fluid. This gauze is changed at stated intervals, and the tube is cleaned with a small piece of sterilized cotton or gauze fastened on the end of a pair of long forceps; then a fresh twist of gauze is inserted. The amount of fluid drawn and its character must always be reported by the nurse. When the drainage-tube is to be removed, the nurse should observe the same precautions as she would for a dressing.

Glass drainage-tubes are made aseptic by boiling for two hours before the operation.

Preparation of Rubber Drainage-tubes.—Cut tubing into desired lengths, slip each piece over a glass rod, and scrub with a stiff brush and green soap. Rinse

in sterile water until entirely free from soap. Boil for one hour in a 1 per cent. solution of sodium bicarbonate; rinse again several times in sterile water, and put into sterile jars and cover with alcohol or carbolic

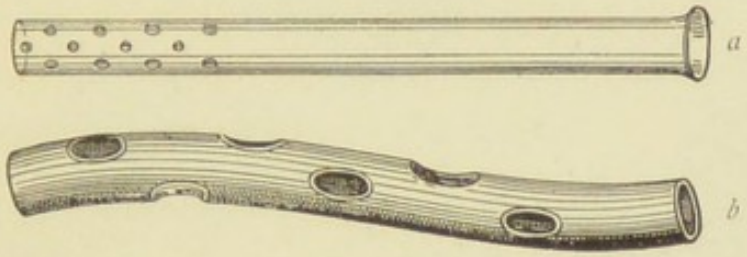


FIG. 19.—Drainage-tubes: *a*, glass; *b*, rubber.

acid, 1 : 20. The jar is kept covered except when the tubes are being put in and taken out by sterilized forceps.

Rubber Dam.—Rubber dam is sterilized by boiling in 1 per cent. soda solution, and is afterward transferred to a glass jar containing 1 : 20 carbolic acid solution.

Gloves.—Rubber and cotton gloves are much employed in surgical work, and with very good results. They prevent infection by the surgeon's and assistants' hands, which even with the greatest care cannot be rendered completely sterile. The cotton gloves are sterilized by dry heat. The rubber gloves are sterilized by boiling one hour in a 1:20 solution of carbolic acid, after which they are transferred to a basin of sterilized water until required for use. To put them on, they are filled with sterile water until the whole glove becomes distended, after which they are easily slipped on. Some surgeons wear the gloves to protect the hands after they have been

sterilized and remove them when all is ready for the operation.

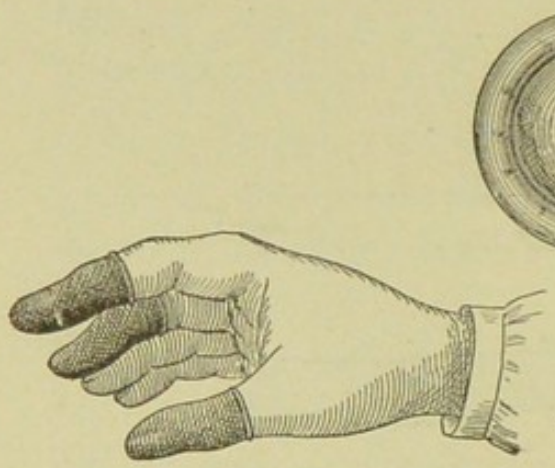


FIG. 20.—Finger cots.

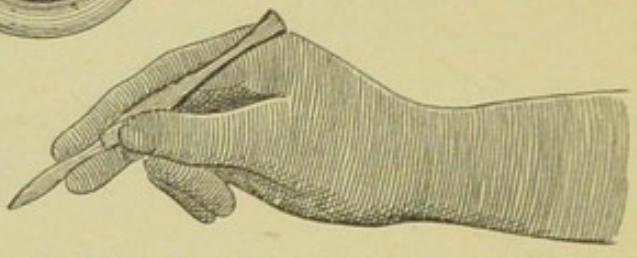


FIG. 21.—Rubber gloves.

Green Soap.—

Caustic potash,	13 ounces.
Linseed oil,	40 "
Alcohol,	4 "

Heat the oil in a vessel to 140° F. or till it is too hot for the fingers. Dissolve the potash in 67 ounces of hot water. Add the alcohol and let it cool. Then add the heated oil, stirring constantly until mixed. Let the mixture stand twelve hours and add alcohol.

CHAPTER XI.

INFLAMMATION.

"INFLAMMATION is that succession of changes which occurs in the living tissue when it is injured, provided the injury is not of such a degree as at once to destroy the structure and vitality of the tissue" (Sanderson).

The changes are, first, changes in the vessels and circulation; second, a passing out of fluids and solids from the vessels; and third, changes in the perivascular tissue—*i. e.*, the tissues about the blood-vessels. These three changes produce the characteristic phenomena of inflammation—heat, redness, swelling, pain, and loss of function.

The first change in an inflamed area is a dilatation of all the vessels—the arterioles, capillaries, and venules. As a result, there is an increased activity in the circulation and an increased flow of blood to the part, a condition known as active hyperemia. After a time the blood-current begins to slacken; then the white cells approach the vessel-wall and begin to pass through it (emigration of white cells). There is also a passing out of plasma or fluid from the blood, and in severe cases of inflammation the red cells may also pass out. If we now examine the inflamed area with a microscope, we find an enormous number of cells, chiefly white blood-cells, in

the tissues about the vessels. Fibrin in the form of delicate granules and fibrils may also be present.

Inflammation is a process which is directed to the removal of an irritant, which may be either a portion of an injured tissue or a foreign body or material. After this result has been accomplished healing or regeneration takes place. If the inflammation was caused by bacteria, suppuration is likely to follow. In that case the tissues will liquefy and the cells will be thrown off suspended in a liquid (liquor puris), the whole being known as *pus*. In suppuration there is always loss of tissue, and healing, if it occurs, is brought about through the formation of a scar. In order to produce healing granulation-tissue is formed. Granulation-tissue consists of new cells and tiny capillary loops. It is sometimes called "proud flesh," and bleeds very easily. The scar has a marked tendency to contract and may cause great deformity.

Among the causes of inflammation are injuries, chemical irritants, heat and cold, and bacteria.

CHAPTER XII.

CATHETERIZATION; DOUCHES; ENEMATA; WASHING OUT THE BLADDER; LAVAGE.

THE use of the catheter is ordinarily very simple, and yet it may truthfully be said that there is no operation which is performed with so little regard for asepsis. Asepsis and antisepsis are as important here as they would be in preparing for an abdominal operation.

Cystitis is often caused by the introduction of germs into the bladder by means of a dirty catheter, or by not cleansing the external genitals, vestibule, and meatus before the operation. Normal urine is to be considered sterile unless there is some disease of the kidneys or bladder; and when infection occurs we may assume that the germs have gained entrance from without. The catheter may be of glass. When a glass catheter is not at hand, a silver or rubber one may be used. When of glass or silver or rubber it should be boiled twenty minutes before being used.

Glass catheters are the best; they are easily rendered aseptic, and show whether they are or are not perfectly clean. Sterilization is most important before using the catheter and immediately afterward. There is no danger of the catheter breaking, as so

many patients fear, if it is not cracked before being introduced. Besides the catheter, which is taken to the bedside in a basin of very hot water, there are needed a basin of corrosive-sublimate solution (1 : 1000), sterilized gauze or cotton, and a vessel to receive the urine. A lubricant of sterilized oil to render the entrance of the instrument as easy as possible is used only when a gum-elastic or rubber catheter is employed. A mixture of carbolic acid solution (1 : 40) and glycerin serves for this purpose.

Introduction of the Catheter.—The patient lies on her back with the knees drawn up and separated, the upper clothing being divided over each knee to guard against unnecessary exposure. The labia are separated with sterilized sponges and the parts washed with the corrosive solution. The catheter is inserted into the urethra, the opening of which is just above the vaginal entrance. If there is any difficulty, the catheter should be withdrawn a little, and gently pointed a little downward or upward, to the right or to the left. If the flow should cease before enough urine has been drawn, the catheter is withdrawn a little or is inserted a little farther than before. Before removing the catheter a finger should be placed over its end, to prevent any drops of urine wetting the bed. After the operation the parts are again washed, and the catheter boiled and placed in a bottle containing a solution of carbolic acid (1 : 20), unless the catheter is of rubber; for carbolic acid ruins rubber.

When the bladder is partially paralyzed from result of an operation, or otherwise, a rectal injection of

very warm water will often cause the bowel and bladder to empty themselves at the same time, thus doing away with the necessity of using a catheter.

The urine for examination by the physician is best drawn with the catheter, to prevent contamination from vaginal discharges.

A distended bladder must be emptied gradually, and as the last amount of urine is being drawn the flow should be slowed, to prevent any injury to the mucous membrane of the bladder from drawing it into the eye of the catheter.

Irrigation of the Bladder.—To irrigate the bladder a fountain-syringe, cleansed with boiling water and a disinfectant, is needed ; also a glass catheter, which is sterilized in the same way as for catheterizing. The parts, of course, are cleansed in the manner described. The patient is first catheterized; the catheter is then rinsed with boiling water and attached to the rubber tubing of the syringe which contains the irrigation solution (boric acid or salt solution), the temperature of the latter being about 100° F. The solution must run warm before the catheter is inserted. The rapidity of the flow is regulated by raising or lowering the irrigator. The quantity of solution introduced is governed by the feelings of the patient ; usually 200 c.c. is all that can be tolerated, after which the tube is disconnected and the fluid is drawn off. If a double catheter is used, the tubing is not removed. The irrigation is repeated until the washings come away perfectly clear and clean.

Examination of Stomach-contents. — Many times the nurse is called upon to give a test-break-

fast and to send the stomach-contents to the laboratory for examination.

A test-breakfast usually consists of a cup of tea without milk or sugar, and two soda-crackers; or instead of the crackers a small piece of rare steak or small piece of bread without butter is given. One hour after, the stomach-contents are obtained by passing the stomach-tube. As soon as the tube comes in contact with the walls of the stomach they contract and force out the contents. If vomiting does not occur, it may be excited by pouring down the tube about two drams of lukewarm water. The contents are measured, and placed in a clean bottle labelled with the patient's name, the date, quantity, and hour that the breakfast was given and contents secured; the bottle is then sent immediately to the laboratory.

Douches.—Properly given, the vaginal douche relieves inflammation, checks hemorrhage, acts as a stimulant and cleansing agent, and checks secretion. The amount of water used is from five to six quarts, of a temperature of 110° F. The temperature must always be tested with a bath-thermometer, not with the hand. The Baker douche apparatus is an excellent contrivance. In its absence a fountain-syringe may be used.

When taking a douche the patient should lie on her back, with the thighs flexed on the abdomen and the legs flexed on the thighs. In this position the water comes in contact with the whole vagina.

The pail or fountain-syringe must be hung about four feet above the bed, so that it will take about twenty minutes for the water to run out. Air must be expelled, and the water must run warm before the

tube is inserted into the vagina. The vaginal tube must always be sterilized before and after using, and every patient should have her own tube.

Many patients in private practice object to taking douches, and will neglect them on account of the inconvenience; but this they can overcome by taking the douches in the bath-tub. Half-way across the bottom of the tub a piece of board is placed, on which the patient can lie. The douche-board designed by Prof. Byron Robinson, of Chicago, has proved very beneficial and convenient to patients by giving them a comfortable and simple method of taking a douche. It can be used without legs, on a bath-tub, and with legs (some twelve inches long) may be used in any room.

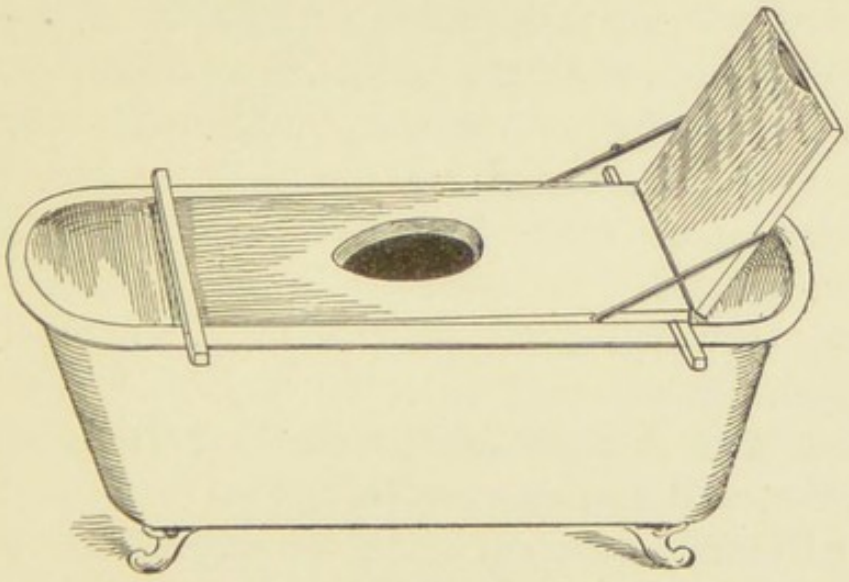


FIG. 22.—Douche-board.

Antiseptic Douches.—Corrosive sublimate, carbolic acid, creolin, and boric acid are used for antiseptic douches; and to prevent absorption and irritation a plain water douche is often given after any of these antiseptics.

A patient should lie quietly for one hour after taking a douche; if only one is used a day, it is best to give it at night, because then the uterus is most congested and needs the hot water most, and the temporary weak feeling which follows a douche will be gone before morning.

Rectal Injections (Enteroclysis) and Irrigation.—The therapeutic range of this procedure is not confined to the treatment of local troubles. It has long been used as a means of cleansing the lower bowel of accumulated feces. In the treatment of rectal ulcers and inflammations it has been employed both to relieve the irritation produced by fecal matter and to apply various medicaments to the parts. For the prevention of shock normal saline solution is injected—one or two pints. This, by filling the blood-vessels, enables the patient to withstand the loss of blood from the nerve-centers. After the operation shock and hemorrhage are counteracted by its use, and at the same time the thirst is relieved and restlessness quieted. In septic conditions, both local and general, by diluting the toxic materials in the circulation and promoting their excretion by the skin, kidneys, and bowels, saline rectal injections play an important part in the treatment.

In patients whose digestive tracts are too weak to hold food or medicine rectal feeding or rectal medication is employed. The rectum should be washed out thoroughly before the injection is given. If the rectum is intolerant and will not retain what is injected, it is well to turn the patient on her left side and raise the hips on a pillow or a folded blanket. A long rectal tube should be used as for a high

enema. The physician will give directions as to the temperature of the solution. In fever patients and in the hemorrhage of typhoid fever great relief and comfort are afforded by using very cold or iced water. In shock or hemorrhage a temperature of 100° F. is usually preferable. In long-continued lavage for local trouble the patient's preference as to the temperature is generally consulted.

A stimulating and nutrient enema, black coffee, or hot saline solution is given when symptoms of shock appear either during or after an operation; it should be injected high up into the colon. The rectum should be thoroughly cleansed at least once daily with warm saline solution, which will also aid the absorption of the nutrient enema. When feeding by rectum in gynecologic cases, it should be remembered that tight tamponing of the vagina may interfere with absorption in the rectum. If the presence of hemorrhoids is a drawback, a 2 per cent. solution of cocain may be used before injecting the fluid.

Stimulating enema:

Whiskey,	2 ounces.
Ammonium carbonate,	15 grains.
Beef-tea,	4 ounces.

Or

Brandy,	2 ounces.
Tincture of digitalis,	20 minims.
Milk,	4 ounces.

For tympanites:

Tincture of asafetida,	2 ounces.
Spirits of turpentine,	1 ounce.
Magnesium sulphate (Epsom salt),	2 ounces.
Warm water,	1 pint.

Purgative enemata:

1. Warm soap-suds, ⅓ pint.

2. Common black molasses, 12 ounces.
   Warm soap-suds, 16 "

3. Molasses, black, 4 ounces.
   Glycerin, 4 "
   Magnesium sulphate, 1 ounce.
   Spirits of turpentine, 1 "
   Warm soap-suds, 8 ounces.

4. Glycerin, 4 ounces.
   Turpentine, 1 ounce.
   Magnesium sulphate (Epsom salt), 2 ounces.

5. Inspissated ox-gall, ½ ounce.
   Warm water, 1 quart.

6. Spirits of turpentine, 10 drops.
   Mucilage of acacia, ½ ounce.

   To be given high.

7. Senna, ½ ounce.
   Magnesium sulphate, ½ "
   Olive oil, 1 "
   Boiling water, 1 pint.

   Infuse the senna in the water. Then dissolve the magnesia, add the oil, and thoroughly mix by stirring.

CHAPTER XIII.

OPERATIONS; PREPARATION OF THE OPERATING-ROOM; THE SURGEON AND HIS ASSISTANTS.

SURGERY has two objects, to prolong life and to relieve suffering. If it accomplishes either of these objects it succeeds. To prolong life or to relieve suffering divides operations into several classes, because they occur with more or less urgency according to the condition the patient is in.

We often hear it said of an operation that it is one of necessity; of another, that it is one of emergency; and of another, that it is one of expediency. For convenience, operations are divided into two classes. First, operations of necessity; second, operations of expediency; and the first class may be subdivided into emergency and elective operations.

Operations of *expediency* are those which it would be well to perform for the health of the patient, as, for instance, the removal of a malignant growth of the breast. If left to itself, the growth will slowly and gradually invade the internal organs and in a very few years will end life; while if removed, the patient will in all probability live a number of years, and there may be immunity for a long period before the disease returns.

Operations of *necessity* are performed to save the life of the patient, as, for example, in cases of intestinal obstruction, in hemorrhage from rupture of an extra-uterine pregnancy, etc.

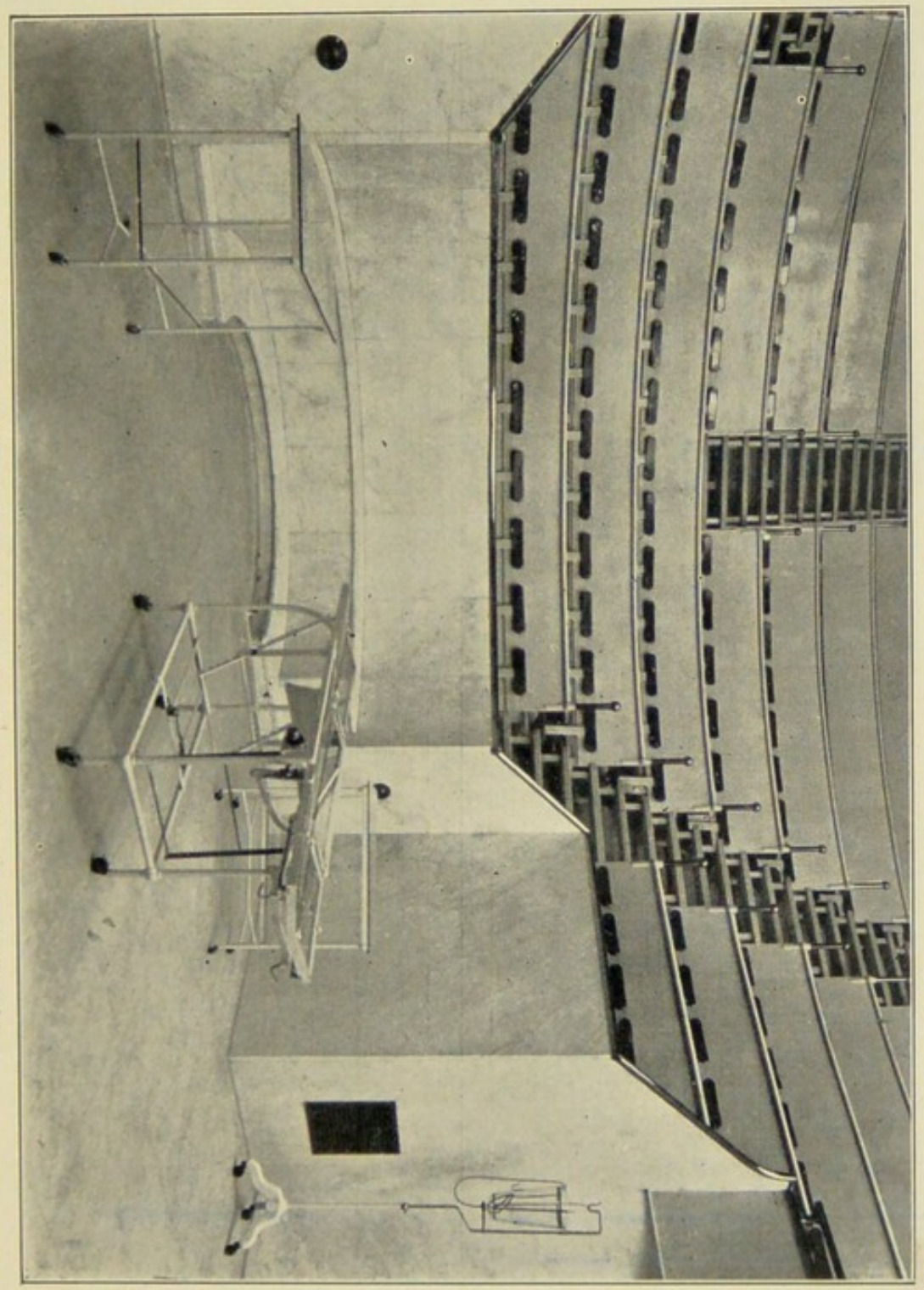
Emergency operations are those which must be performed immediately, without any choice, such as tracheotomy.

An *elective* operation is at the choice of the patient; if it is done at all, it can only be done as a last chance and forlorn hope.

Preparation of the Operating-room.—The operating-room should be made as aseptic as possible; the walls and floor should be washed with corrosive-sublimate solution (1 : 2000). The operating-table, stands, chairs, and other furniture, which are usually of glass and iron, should be washed with the sublimate solution. The sterilizer, which has been packed with the dressings, blankets (2), sheets (2), towels, caps, suits, and gowns for the operator, assistants, and nurses, should be started two hours before the operation. The instruments should boil half an hour before the operation in a 1 per cent. soda solution. Everything that will be needed for the operation and for possible accidents must be in the operating-room, and within easy reach. The solutions used should be quite warm, both for the surgeons and patient. We often come across a nurse who when she has filled the basins will put in her dirty hand to see if the water is too hot or too cold. We can readily tell from the outside of the basin if the water is of the proper temperature.

At all major operations four nurses are necessary—the head nurse, who has charge of the instruments;

PLATE 3.



Clinical Amphitheater, Medico-Chirurgical Hospital, Philadelphia.

a second nurse, to take charge of the sponges; a third nurse, to keep ready for the operator a basin of sterile water to enable him at any time to quickly rinse his hands to remove septic fluid or to free his fingers from blood and clots, and attend to the irrigation, etc.; a fourth nurse, to handle unsterilized articles. Each nurse should have a clear idea of her duties, and discharge them without undertaking the duties belonging to another. If the dry technic is used, the head nurse can hand the sponges as well as the instruments, and this gives a nurse to wait on her exclusively. Under no consideration should the head nurse be left alone for a single moment, as the operator might call for something which she, being "surgically clean," could not touch, and so cause a probable delay in the operation.

The duties of the nurses in the operating-room are the same for all operations. The dress must be of washable material, preferably white; it should be fresh for the operation and as far as possible sterilized. A dress that has been through the wards is not clean; neither is one that has been worn a day or half a day. The dress-sleeves should be unbuttoned, so that they can be rolled up above the elbow, to allow the arms to be made as sterile as possible, and so that the sleeves may not come in contact with anything used in the operation itself. The finger-nails must be cut short. On first going to the operating-room the hands and forearms should be scrubbed with a brush and green soap and running water as hot as can be borne for ten minutes by the clock. The cleaning of the finger-nails is very important, as many of us would be surprised to find the large number of germs

taken from under the finger-nails as the result of one cleansing.

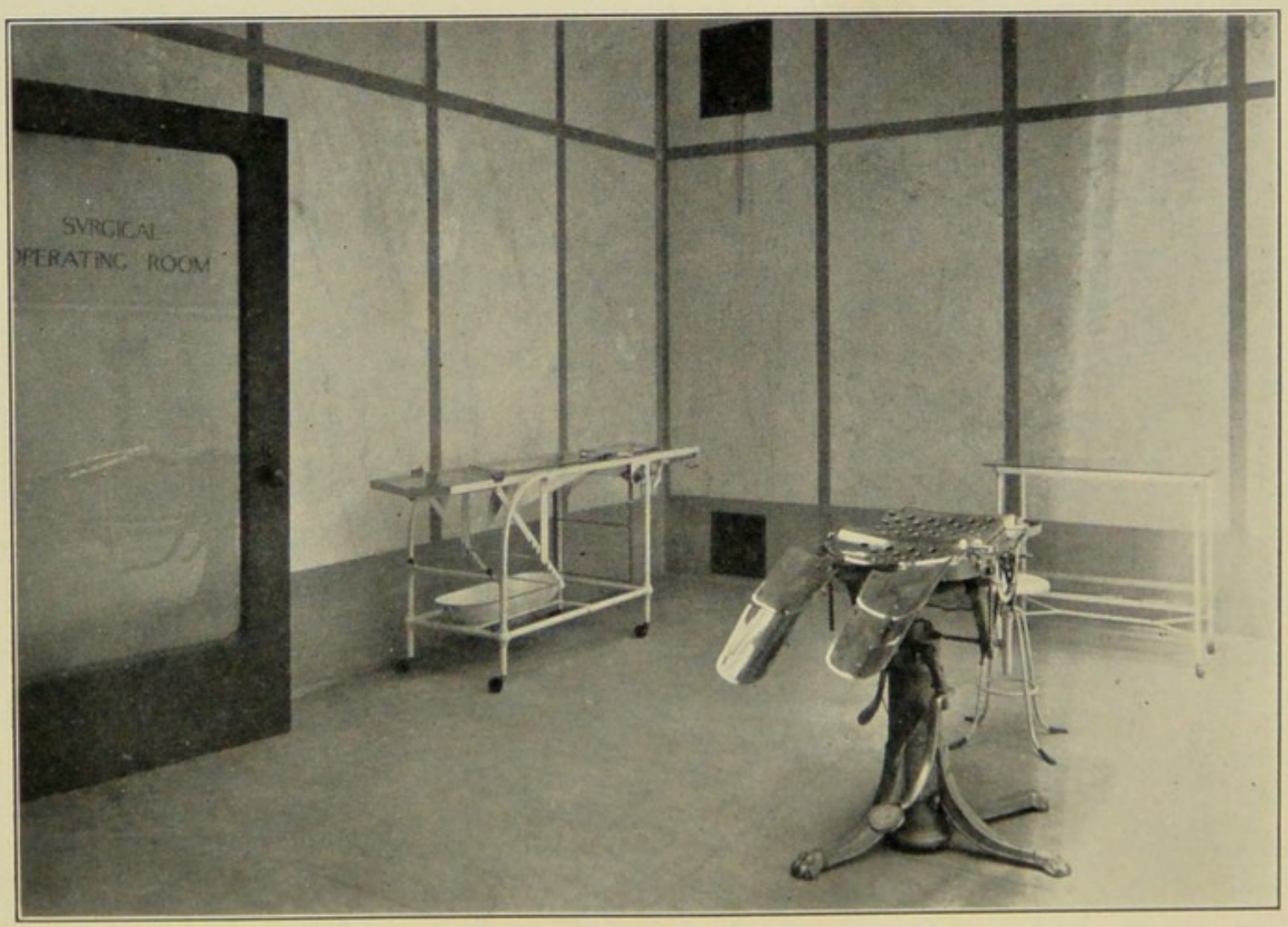
The hands and forearms are then rendered absolutely sterile by putting them first into a saturated solution of permanganate of potassium until they are of a deep-brown color from the tips of the fingers to the elbow, then into a hot saturated solution of oxalic acid until all the permanganate stain has been removed; they are then washed in sterilized hot water, and finally are soaked for three minutes in a solution of corrosive sublimate (1 : 1000). The solutions reach those corners and crevices in the finger-nails that cannot be reached by the brush.

Some surgeons prefer ether and alcohol for cleansing the skin. After the hands have been scrubbed thoroughly in hot soap-suds and the finger-nails cleaned, the hands are washed in ether, which removes from the skin all oily and fatty substances; they are next washed in pure alcohol for one minute, and finally soaked for three minutes in a solution of corrosive sublimate (1 : 1000). The field of operation is cleansed in the same manner with ether, alcohol, and the sublimate solution.

The nail-brushes used should be absolutely sterile. They must be new, and need to be boiled for two hours on the day before the operation, and then put into a glass jar containing corrosive sublimate (1 : 1000). A dirty nail-brush is the haven of myriads of germs and their spores, and by using such a one we place more germs on our hands than were there before they were touched.

In some hospitals it is the custom to put on sterilized rubber gloves, to protect the hands from con-

PLATE 4.



Surgical Operating Room, Medico-Chirurgical Hospital, Philadelphia.

tamination until the operation begins. The nurses next put on sterile caps and gowns. After making the hands aseptic it is essential that they do not come in contact with anything that has not been made aseptic before the operation is commenced, for such is very easy to occur unless the nurse is constantly on her guard against it.

The surgeon and his assistants prepare for the operation very much the same as does the nurse. Many surgeons before operating take a corrosive-sublimate bath (1:5000), after which they put on clean linen suits or long gowns and prepare their hands and forearms, after which they put on sterilized suits. The suits, which have been sterilized in bags or folded in a sheet, are taken from the sterilizer by the head nurse, and placed in the dressing-room about one hour before the arrival of the surgeons, so that they may be perfectly dry when required for use. They should not be hung over the back of a chair, or laid over a table for dust to collect upon them. We must bear in mind that after sterilization there is always the danger of contamination, and the articles must be carefully protected as soon as they are removed from the sterilizer. To avoid confusion, each suit and bag should be distinctly marked with the owner's name, as should also the white canvas shoes which some surgeons wear. The caps must be laid in the dressing-room, together with long strips of sterilized gauze to cover the beard and mustache.

Spectators should remove their coats and wear long linen gowns. The nurses should not leave the operating-room unless it is absolutely necessary, and there should be no unnecessary opening of doors,

which allows cold air to enter. Constant moving also causes dust to become stirred up. The temperature of the operating-room should be 80° F., and the air kept perfectly pure by thorough ventilation, which should be so arranged that draughts will be avoided.

With the kind permission of Dr. F. W. Johnston, of Boston, I extract the following from his paper on "Two Years' Work with the Sprague Sterilizer in the Gynecologic Department at St. Elizabeth's Hospital, Boston, Mass.," which shows the great necessity of absolute cleanliness and how easily infection takes place from dust in the room:

"I was especially anxious to ascertain if any pus-producing organisms should be found in the dust.

"The operating-room is kept as clean as soap and water and corrosive sublimate can effect the cleanliness of its floor and walls.

"The following is the report of E. A. Darling, Assistant in Bacteriology, Harvard Medical School:

"Four Petri double dishes containing films of sterilized and coagulated blood-serum were exposed in various parts of the operating-room during a celiotomy, the period of exposure varying from one hour and twenty minutes to one hour and fifty minutes.

"The plates were exposed during the middle of the forenoon of December 28, 1897.

"One dish was placed on the floor, where we supposed the dust would be kept in the most active motion by our feet and the nurse's dress; one was placed on the stand holding the sponge-pails; one was placed on the patient's knees raised in the Trendelenburg position; and one was placed on the table

beside the instrument-tray. The dishes were uncovered just as the knife went through the skin.

"At the conclusion of the operation the dishes were covered, conveyed to the bacteriologic laboratory, and placed in the incubator at 37° C. for several days.

"After twenty-four to seventy-two hours the plates were opened and the colonies counted.

"At the same time an attempt was made to determine the varieties of bacteria present, and particularly to demonstrate the presence or absence of the pyogenic forms.

"Cover-glass preparations and cultures were made from as many different kinds of colonies as could be distinguished.

"The results are, in brief, as follows:

"Plate A. *Sponge-table*, exposed 1 hour 50 minutes: after 24 hours showed 216 colonies; 72 hours, 296 colonies.

"Plate B. *Knees of patient*, exposed 1 hour 20 minutes: after 24 hours showed 156 colonies; 72 hours, 280 colonies.

"Plate C. *Floor*, exposed 1 hour 50 minutes: after 24 hours showed 296 colonies; 72 hours, 428 colonies.

"Plate D. *Instrument-table*, exposed 1 hour 40 minutes: after 24 hours showed 216 colonies; 72 hours, 256 colonies.

"The varieties of bacteria present were studied minutely on Plate B (the one on the patient's knee), less carefully on Plate D (the one on the instrument-tray). Of the recognized pyogenic cocci, two varieties were found—the Staphylococcus albus (15 colo-

nies on Plate B, 20 colonies on Plate D) and the Staphylococcus aureus (3 colonies on Plate B, 4 colonies on Plate D).

"The remaining colonies on both plates were sarcinæ of several kinds, yellow, orange, and white moulds, and several varieties of unrecognized bacilli and cocci.

"As would be expected, the plate from the floor showed the largest number of colonies. Plate B (the one on the patient's knee) most interested me.

"The finding by Dr. Darling of fifteen colonies of the Staphylococcus albus and three colonies of the Staphylococcus aureus on this small plate within a few inches of the opened abdominal cavity was certainly a grand object-lesson, and has given lots of food for reflection."

CHAPTER XIV.

PREPARATION OF PATIENT FOR OPERATION; CARE OF PATIENT DURING AND AFTER OPERATION.

THE methods given here for preparing the patient for abdominal operations may serve as a reliable guide to the nurse, who is more or less responsible for preparatory treatment. The methods of preparation of all kinds are subject to change in detail, because surgical methods are constantly advancing and changing, though the general principles remain. It should be remembered that patients rally much better from an operation when they have been properly prepared both externally and internally.

Day Before Operation.—The patient receives a full bath and the hair is washed. A cathartic is given—castor oil, citrate of magnesium, or salts. The diet should be nourishing and light. Milk is not given before an abdominal operation, because the stomach may not digest it thoroughly, and its curds may remain in the intestines and act as an irritant. Gruel is nourishing and easily digested. No food is given after midnight.

PREPARATION OF FIELD OF OPERATION.

1. Scrub the parts with green soap and stiff brush.
2. Shave from nipples to rectum.

3. Scrub again and rinse thoroughly with sterile water.

4. Rub well with alcohol, followed with ether, to remove fats.

5. Wash with corrosive sublimate (1 : 1000), and put on an antiseptic dressing, consisting of five dressing-pads, one layer of common cotton, one dressing over that, then abdominal binder. The patient must be instructed not to put her fingers underneath the dressing nor to disturb it in any way.

Prepare the vaginal canal by giving a warm douche (lysol, 1 per cent.), and cover the vulva with a dressing. Use perineal straps to keep the dressing and abdominal binder in position. See that the dressings are kept wet with the antiseptic ordered until the patient is taken to the operating-room. This preparation should be made twelve hours before an operation.

Some surgeons will direct the application of a *poultice of green soap*, which is removed early on the morning of the operation, the part being scrubbed with hot water and a brush to remove the soap, a warm corrosive-sublimate poultice (1 : 1000) being then applied. A green-soap poultice is a thin layer of green soap spread over a pad of gauze, absorbent cotton, or a towel, and covered with a dry towel and a bandage. The antiseptic pad, or the poultice, thoroughly softens the scarf-skin, which in about twelve hours can be scrubbed off, leaving the true skin.

Biniodid of mercury is sometimes dissolved in the ether, making a solution of 1 : 1000, which, besides removing all fatty substances from the skin, is

also a disinfectant. When the skin is very dirty it is scrubbed with turpentine, then with alcohol, and then with the biniodid solution. The nose and mouth should be thoroughly sprayed with a saturated solution of boric acid every three hours.

Day of Operation.—Flush out the colon and give a bath; take off all flannels, put on a gown open at the back, and cotton-flannel stockings. Cleanse teeth, mouth, nose, and throat with a boric-acid solution and brush. Catheterize just before sending the patient to the anesthetizing-room if the operation is on the uterus or its appendages. Always catheterize in other operations if the patient is unable to urinate. Envelop the hair in a sterilized towel.

Remove all rings and ear-rings; also false teeth, whether a whole or a partial set, as there is danger of their being swallowed, and put them in a tumbler of cold water. Envelop feet and lower limbs in a warm blanket securely pinned around the hips with safety-pins. Besides preserving the heat, this arrangement will prevent the patient from tossing the limbs about while taking the anesthetic. Many operators give morphin (grain $\frac{1}{4}$) and atropin ($\frac{1}{100}$ of a grain), hypodermically, half an hour before the operation, to stimulate the heart and prevent vomiting.

Arranging the Patient for the Operation.—The patient having been placed on the operating-table, the clothes are removed from the part to be operated upon, and sterilized blankets are tucked about the chest, the edges being tucked under the back to reduce as far as possible the loss of body-heat, and the bandage and pad are removed from

the field of operation, which is again thoroughly cleansed with soap and water and disinfectants. An assistant nurse hands the sterilized water, green soap, and scrubbing-brush to the assistant surgeon. The soap-suds are rinsed off with sterile water, after which the part is sponged with permanganate of potassium, oxalic acid, lime-water, and sterile water, or with ether, alcohol, and bichlorid solution. This final scrubbing should be done in the anesthetizing-room if possible, while the patient is being anesthetized, to avoid delay in the operating-room. A sterilized sheet, having an oval opening in the center through which the section is made, and towels are then arranged around the field of operation. One towel is laid along the side, turned over and fastened with clamps to the sheet, so as to form a pocket in which the surgeon places the instruments he needs to have close at hand. The instruments are taken from the sterilizer and laid in trays containing sterile water or laid upon dry sterile towels.

Some surgeons use the prepared sponges. These must be reliably counted before the operation by the operator and assistants, and the number written down, so as not to trust to memory. Sponges must be squeezed almost dry before they are handed to the surgeon, because it is only in an almost dry condition that they are of service. The nurse should not, while waiting to hand a fresh sponge, rest her hands or forearms on the pail. She should count the sponges before the surgeon begins to sew up the wound, and should be very sure that she has the exact number employed in the operation. The large square sponges used for covering the intestines, or

walling off small areas, should have a long piece of silk attached, and to this a forceps, so that if one should slip out of sight it can be readily located and recovered without undue handling of the bowel. After being used, the sponges are put into a pan or basin, and should not be disposed of until they have been accounted for before the abdomen is closed.

Whatever has been removed from the body must be placed in a basin and laid aside in a safe place until the surgeon gives his directions as to whether or not he wishes it to be sent to the laboratory for examination to make sure of its character, with a view to clearing up some obscure point about the nature of the disease.

The head nurse attends to the instruments, sutures, and ligatures. If the dry technic is used, a basin of dry gauze sponges is placed on a table within easy reach of the operator's assistants.

The assistant nurses must be on the alert to change the hand solutions when necessary, and to wipe the moisture from the face of the operator and his assistant with a sterilized towel, to prevent drops falling into the wound, and this must be done at a moment when the surgeons are not bending over the wound. They must move about the room very quietly but quickly. If asked to do anything that they do not understand, they should always inform the head nurse, who will make the duty clear. When emergencies arise and the operator is dealing with exceptional difficulties, the nurses must be on the alert to do quickly anything they may be called upon to do, each nurse discharging her duties without undertaking those belonging to another. It is absolutely

necessary on such occasions to exercise self-control, and to follow the directions given without excitement or confusion.

Just before the wound is closed the soiled towels are removed and replaced by fresh ones. After the dressing has been applied the patient is raised, wiped perfectly dry, and a bandage put on. While the patient is waiting to be transferred to bed, hot-water bottles, well covered, should be applied to all parts of the body. The blankets used to cover the feet and chest of the patient during the operation should be tucked closely about the body and underneath, and not merely be thrown over.

Pneumonia and pleurisy after operation may follow as the result of chilling when in the operating-room, or exposure during the removal from the operating-room to the patient's room.

When the patient is replaced in bed, which has been thoroughly warmed during the operation, the nurse should be present to take charge. The pillow should be removed, and a towel placed for the head to rest upon. The foot of the bed is elevated, this posture being maintained for twenty-four hours, after which the bed is lowered. The heaters are placed about the patient's body, one thing being kept constantly in mind—not to burn the patient. A towel should be placed under the chin of the patient, and a small basin should be at hand to receive the vomited mucus, and this should be removed during quiet intervals. Postanesthetic retching and vomiting may be relieved by saturating a towel with fresh, strong vinegar and holding it a few inches from the patient's face, laying it over the nostrils, or hanging it from

the bedstead so that it will be near the patient's head. Oxygen hastens the recovery of consciousness and lessens the nausea. If administered with the anesthetic, there is almost complete absence of nausea—usually none as soon as the patient is fully conscious.

Dryness of the mouth and lips, and thirst (which is often a troublesome feature), may be relieved by placing wet cloths on the lips, by allowing the patient to rinse out the mouth with cool water, and by frequent bathing of the hands and face with alcohol and tepid water or with plain water. If thirst is extreme, an enema of saline solution (one pint) is given slowly.

The patient should not be left alone for a single moment during the first thirty-six hours after an abdominal section if it can be avoided. The patient can do nothing for herself, and every want should be instantly supplied. I have known patients so eager to allay their thirst that they would get out of bed and drink water from the water-pitcher on the wash-stand and reach down for the hot-water bottle at the feet and drink part of the contents. One ward patient drank the water from an irrigator standing by the side of the next bed; another patient while in a semiconscious condition took the drainage-tube out of the abdomen, and when found by the nurse after a moment's absence from the room was sitting up on the edge of the bed. Watching a patient recover from anesthesia is often monotonous; but if this duty is closely attended to, many dreadful accidents will be avoided.

A roll should be placed under the knees, so as to relax the abdominal muscles and also to remove the

strain the patient would have to make in order to keep up the knees. A small flat pillow placed under the hollow of the back will relieve the backache of which so many patients complain.

Bladder and Bowels.—The catheter should be passed every six or eight hours if necessary, according to directions, the most rigid aseptic precautions being taken. Flatulence may be very distressing; consequently passage of gas by the rectum is of good omen, as it shows that the bowels have regained their normal tone and there is no obstruction. After an abdominal operation the muscular walls of the intestines share in the weakness of the patient, and are not strong enough to overcome the contraction of the sphincter muscle. The accumulation of gas distends the muscular fiber of the intestines, and, if not relieved, would soon result in paralysis of the intestines. To prevent this a rectal tube is inserted to keep the sphincter dilated and to allow the gas to escape when it reaches that point. Purgatives, such as calomel (grain 1 every hour until 10 grains have been taken), are usually given as soon as possible after the patient has recovered from the anesthetic, to stimulate the intestines, and keep up peristaltic action.

Much fluid is not given for a certain number of hours after the operation, as it might cause vomiting, and also because, as we have seen, bacteria require heat and moisture for their development. If they can lie in a small pool of fluid, they will develop rapidly. We cannot deprive them of warmth unless we almost freeze the patient, but we can deprive them of moisture. Should any bacteria

have found their way during the operation into the abdominal cavity, they will be rendered inert by the absence of moisture, and will be taken by the leukocytes into the lymphatic vessels and glands and be devoured.

After twelve hours, if there is no vomiting, very hot water, or toast-water is given in teaspoonful doses every fifteen or twenty minutes, the quantity being gradually increased and the intervals lengthened. The familiar cup of freshly made tea is sometimes the best drink to begin with; it is always a pleasure under the circumstances to see the patient enjoy it, since it is not only refreshing but stimulating. If the stomach behaves well, tablespoonful doses of gruel or beef-essence may be given every half hour. Milk is not given as a rule, as the curd may pass along the intestines and act as an irritant. For the first three days, and if there is no vomiting, nothing but liquids is given; and after the third day soft and easily digestible food, which is gradually changed to a more solid diet.

The external genitals should be kept perfectly clean, the body bathed, the bed and body-linen kept sweet and clean, the teeth brushed, and the hair combed. Every want of the patient should be anticipated, and she should be made as comfortable as possible. Sponging the palms of the hands, the arms, and the legs will add to the comfort of the patient. The luxury of a change into a fresh bed will often secure a good night's rest. Under no consideration should morphin be given except by the surgeon's directions, and every moral influence should

be exerted to induce the patient to endure pain rather than resort to the drug.

The nurse should not ascertain whether the patient is comfortable by continual questioning, but by unobtrusive observation. Questioning may alarm a patient and lead her to think too much about herself.

No visitors should be admitted without the surgeon's consent. The mind of the patient is to be kept perfectly free from worry and excitement, and the whole atmosphere of the room should be bright, pleasant, and cheerful, no matter what trouble is going on outside.

A slight rise of temperature the day following operation usually marks reaction from shock. On the eighth day the dressings are removed and the stitches taken out. The following week the patient sits up, and at the end of the third week she goes home.

The following diet-list dating from the third day will be of assistance in varying the food.

FIRST DAY.

Breakfast.—Mutton-broth with bread-crumbs.

Lunch.—Milk-punch.

Dinner.—Raw oysters, thin bread (with crust removed) and butter, sherry wine.

Lunch.—Cup of hot beef-tea.

Supper.—Milk-toast, jelly.

SECOND DAY.

Breakfast.—Oatmeal with sugar and cream, cup of cocoa.

Lunch.—Soft custard.

Dinner.—Small piece of tenderloin steak, chewed but not swallowed, baked potato.

Lunch.—Glass of milk.

Supper.—Buttered milk-toast (crust removed), jelly, cocoa.

THIRD DAY.

Breakfast.—Soft-boiled egg, bread and butter, coffee.

Lunch.—Milk-punch.

Dinner.—Chicken-soup, tender sweetbreads, Bavarian cream, light wine.

Lunch.—An egg-nog.

Supper.—Tea, raw oysters, bread and butter.

FOURTH DAY.

Breakfast.—Oatmeal with sugar and cream, a tender sweetbread, creamed potatoes, coffee, graham bread and butter.

Lunch.—Glass of milk.

Dinner.—Chicken panada, baked potato, bread, tapioca-cream.

Lunch.—Cup of hot chicken-broth.

Supper.—Buttered dry toast (crust removed), wine jelly, banquet crackers, tea.

FIFTH DAY.

Breakfast.—An orange, scrambled egg, oatmeal with sugar and cream, soft buttered toast, coffee.

Lunch.—Milk-punch.

Dinner.—Cream of celery soup, a small piece of tenderloin steak, baked potato, snow pudding, wine, bread.

Lunch.—An egg-nog.

Supper.—Calf's foot jelly, soft-boiled egg, bread and butter, cocoa.

Sixth Day.

Breakfast.—Oatmeal, poached eggs on toast, coffee.

Lunch.—Cup of chicken-broth.

Dinner.—Chicken-soup, small slice of tender roast beef, baked potato, rice-pudding, bread.

Lunch.—Glass of milk.

Supper.—Baked apples, raw oysters, bread and butter, orange-jelly, tea.

Seventh Day.

Breakfast.—Orange, mush and milk, scrambled eggs, cream-toast, coffee.

Lunch.—Cup of soft custard.

Dinner.—Mutton-soup, small piece of tender beef-steak, creamed potatoes, sago-pudding, bread, wine.

Lunch.—Cup of beef-tea.

Supper.—Sponge-cake with cream, buttered dry toast, wine-jelly, cocoa.

Eighth Day.

Breakfast.—Broiled fresh fish, oatmeal, graham bread, coffee.

Lunch.—Chicken-broth.

Dinner.—Potato-soup, breast of roasted chicken, mashed potatoes, macaroni, blanc mange.

Lunch.—Cup of mulled wine.

Supper.—Cream-toast, lemon-jelly, chocolate.

The diet for other days may be selected from previous ones. The change of diet may cause a temporary rise in the temperature and pulse.

CHAPTER XV.

SEQUELÆ OF OPERATIONS; SHOCK, HEMORRHAGE, SEPTIC PERITONITIS, ACCIDENTS DURING OPERATION, ETC.

As a rule, the average abdominal case passes into convalescence, especially when the case is in skilled hands and the operation has been performed in a finished surgical way. Complications, however, are liable to arise in the simplest case, and throw great responsibility on both surgeon and nurse. It is in these cases that the knowledge and skill of the nurse mean so much, and where the greatest triumphs of surgery are scored.

A nurse has no moral right to take charge of a surgical case unless she has at her finger-ends the complications liable to arise, their symptoms and the various means of meeting them until the arrival of the surgeon.

Shock is great depression of the vital functions of the body brought on by injury or surgical operation. It is produced through the agency of the nervous system. The greater the injury, the longer the anesthesia, the greater the shock. The anesthetic enables the patient to undergo the operation without consciousness, but it does not prevent shock coming on afterward from the opening of the abdomen, the uncovering of the viscera, the handling of the intestines, and the exposure of the delicate sympathetic

nerves in that part to the air and to touch. If to all this is added a long anesthesia, then the prostration produced by the anesthetic is added to the effects of the operation.

Different individuals are differently affected: most persons are more susceptible to shock after months of hard work, or when the system is run down after an illness. Invalids stand shock very well, and indifferent persons stand it better than those who are despondent. The mental influence is very great: anything that depresses the mind aggravates shock. It is here that the offices of the Church have such an effect on some patients, in quieting apprehension and in adding fortitude.

Age modifies shock. In old people shock is usually more severe and prolonged, especially if there is any organic disease. Children recover readily from shock if there has been very little loss of blood. Shock is combated to a certain extent by the patient's drinking a large amount of fluid for forty-eight hours before the operation, so that the blood-vessels of the vital organs will be well supplied with fluid during the operation. Experiments have been made which show that when the abdomen is opened the abdominal veins dilate, and as a consequence a large amount of the blood in the body flows into them, thus leaving the heart and the vessels conveying blood to the important nerve-centers at the base of the brain with very little fluid to work upon, and shock ensues. The output of the heart, as we know, is in proportion to the venous pressure, and if this is lowered the heart and the important nerve-centers at the base of the brain will be supplied

with a diminished amount of blood. The intravenous injection of saline solution causes a rise in the venous pressure and an increase in the output of the heart. The signs of shock may be and have been mistaken for those of hemorrhage on account of the two presenting so many points of likeness; but in shock the symptoms are present from the first, while in hemorrhage they do not come on for some hours after the operation.

Two very important points to be considered in case of shock or of hemorrhage are the temperature and the condition of the patient's mind. In shock the temperature at first is normal or very little below normal, and the senses are dull in proportion to the degree of shock present; in hemorrhage the temperature is subnormal, the mind is bright, keen, and alert, and there is an anxious expression on the face, as if the patient were anticipating danger.

The *symptoms of shock* are a weak, rapid, and irregular pulse; sighing, rapid, irregular, and shallow respiration; a normal or slightly subnormal temperature; a pale face with a pinched look; a cold, clammy skin, and dulness of the mind. There may be involuntary movements of the bowels and urine as a result of loss of muscular power; nausea and vomiting may also be present.

The *treatment of shock* consists in lowering the patient's head and raising the foot of the bed, to increase the supply of blood to the vital centers; in the application of heat to all parts of the body, particularly the sides, between the legs, and to the feet; in placing a mustard-plaster over the heart; in administering whiskey, brandy, or nitroglycerin

hypodermically; in giving hot black coffee by the rectum, or saline solution hypodermically or by the rectum. Strychnin is a powerful stimulant, and should be given in doses of $\frac{1}{20}$ grain every half hour for four doses. Tincture of digitalis in 15-minim doses may be given every half hour for four doses. As a rule, in cases of shock there is a disposition on the part of nurses to do too much. Everything must be done in a prompt, quiet manner. For immediate stimulation in threatened collapse nitroglycerin is valuable. It is used for quick effect only, and not for prolonged stimulation of the heart's action. Stimulants must be given carefully, and time allowed to observe the effects produced, other measures being determined accordingly. An enema of one-half ounce of turpentine, a well-beaten raw egg, and three ounces of warm water constitutes a powerful stimulant.

It must be remembered that in severe shock the function of absorption by the stomach and intestines is almost wholly suspended, and anything given by the rectum must be introduced high up. When the respiration of the patient is fast failing, everything depends on maintaining the heart's action. To this end artificial respiration must be persistently practised. A serious danger in performing artificial respiration is that in our hurry we may make the motions too rapidly and not give the lungs time to fill thoroughly nor allow the air to be expelled before filling the lungs again. The motions should not be more frequent than sixteen to eighteen in the minute, so as to imitate as nearly as possible the natural rhythm of respiration. External heat is a most

powerful heart-stimulant, and often when the heart's action fails it may be restored by heat over the heart and by hot fluids taken into the stomach.

Recovery may be rapid or very slow; it is manifested by "reaction"—the pulse becomes more full, slow, and regular, the temperature rises, the body becomes warm, and a general improvement takes place. In rare cases the reaction becomes excessive and develops into *traumatic delirium*, which may be mild, low, and muttering, or of the wildest character. The skin is hot and flushed, the pulse full and regular, and the temperature above normal. This condition may subside and recovery take place, or it may be followed by collapse.

Hemorrhage may be caused by the slipping of a ligature or by the displacement of clots, as the result of restlessness or reaction of the circulation, and generally occurs within the first twenty-four hours after the operation. The hemorrhage which comes from torn adhesions and bleeding surfaces is a free oozing, and seldom affects the pulse. When a drainage-tube has been used, it will usually indicate that there is hemorrhage by a flow of blood through the tube. This, however, cannot be relied upon, as only a moderate quantity of blood may flow through the tube, the abdomen being filled with clots.

The *symptoms* of internal hemorrhage are restlessness, thirst, faintness, an anxious expression, pale face, dilated pupils, cold skin, frequent and irregular or sighing respiration, subnormal temperature, and a weak, rapid pulse (120–140). In rare cases the pulse is not greatly accelerated.

Treatment.—The patient must be kept perfectly quiet on her back, the head being lowered and the foot of the bed elevated. If symptoms of shock supervene, heat is to be applied to all parts of the body by warm blankets and hot-water bottles. Stimulants are given only when the pulse is failing, as they excite the heart's action and increase the hemorrhage. When the hemorrhage has been excessive, infusion of saline solution is resorted to, the fluid that the body has lost being thus replaced. Bandaging the limbs from their extremities upward is sometimes of use in keeping the blood in the vital organs. When the hemorrhage comes from a slipped ligature with large vessels pouring blood into the abdominal cavity, the abdomen is reopened and the vessel ligated. Everything should be ready for operative interference when the surgeon arrives, the same aseptic precautions being observed as in the original operation. For the free oozing from torn adhesions the tube is emptied frequently—every ten minutes. The drier the pelvic cavity is kept, the sooner will the hemorrhage cease.

A noted surgeon has said that if an abdominal case escapes shock or hemorrhage, there is still a third danger to which the patient is liable, that of septic peritonitis. This is due to the entrance of germs into the peritoneal cavity, either from without or from ruptured abscesses or wounds. It may set in at any time from a few hours to six days after operation. The symptoms are pain in the abdomen and exquisite tenderness, distention, vomiting, constipation, icterus, restlessness, sleeplessness.

The temperature rises a little, rarely going for a

few days above 100° or 101° F.; but the pulse creeps up rapidly to 115, 120, or 130 beats per minute, and is weak and thready; although sometimes it is hard and "wiry" in the beginning. Then the temperature rises to 103° F. or above. The rectal or vaginal temperature may show a much higher rise than that of the mouth or axilla. In one typical instance the temperature taken in the mouth ranged between 101° and 102° F., the skin was cold and clammy, and the patient complained of intense thirst and a "burning up" feeling. The vaginal temperature was 108° F. In some of the worst cases the writer has seen the temperature was below normal, but the prostration was severe. The abdomen is distended, due to distention of the transverse colon by gas. There are nausea and vomiting. First the contents of the stomach are vomited, then bile, then a dark coffee-colored fluid which becomes more and more fecal in odor; a cold perspiration appears; the patient has a very anxious, pinched expression, and is restless and talkative; the eyes are unusually bright, and there is a faint yellowish look about the skin and conjunctivæ. As the disease continues the general system becomes poisoned.

The *treatment* consists in ridding the system of the poison through the skin, bowels, and kidneys. High enemata of turpentine, glycerin, oil, salts, or molasses are usually given until the bowels are thoroughly moved or large quantities of gas are passed, because it is by putting the bowels into an active state that the threatened paralysis of the intestines can be overcome, and they can take up from the peritoneal cavity the poisonous materials that

are causing the disturbance. It is only when the intestines are so paralyzed that they cannot be moved that a fatal result ensues. Strychnin, being a powerful heart-stimulant, is given in doses of grain $\frac{1}{25}$ every hour until its physiologic effects are produced. It must be stopped at the first appearance of twitching of the muscles of the face or of the limbs and stiffness of the neck. Vomiting may be relieved by washing out the stomach, by the application of a mustard-plaster over the region of the stomach, or by cocain in ¼-grain doses for four doses. If improvement does not follow, the surface of the body becomes cold and clammy; the face pinched and sunken and of a dusky hue; the restlessness increases, also the thirst, which becomes very great, and to the last the patient calls for water, which is vomited immediately after being taken, but which it is cruel to withhold. The mind usually remains clear to the end.

Antistreptococcic serum has been used with fairly good results. It comes in glass tubes, sealed hermetically, and is injected hypodermically with antiseptic precautions into the thigh or the side of the breast, where there is considerable loose subcutaneous connective tissue. Another procedure of value is infusion of normal saline solution for the purpose of diluting the toxins in the blood and of removing them by the increased flow of urine which infusion brings about.

Tympanites is often one of the earliest signs of septicemia, and when accompanied with a high temperature is usually a cause for anxiety, though it may be due to constipation, and in such cases is usually

without significance. The treatment consists in the application of turpentine stupes, the use of brisk purgatives or high enemata, and the insertion of the rectal tube for about ten inches.

Fermentation-fever is due to the absorption of fibrin-ferment and the products of aseptic tissue-necrosis. It causes a slight rise in temperature which need occasion no anxiety.

Intestinal obstruction may be due to strangulation of a knuckle of intestine beneath inflammatory bands, or to its enclosure between the sutures in the wound. There is usually distention of the abdomen. Note should always be made if gas is heard rumbling in the intestines, and also if gas is passed and how often; also the result of the enemata which are administered to relieve the distention.

Hernia is a sequel rather than a complication of abdominal operations, and is due to a failure of union between the cut edges of the muscles and fasciæ. As a rule, it does not occur until some weeks after the patient has returned home. It is to prevent this accident that such stress is laid upon not allowing the patients to help themselves in any way without the surgeon's permission, so that the abdominal muscles may have sufficient time to become firmly united. This is also the reason why patients should wear an abdominal supporter for some months after their discharge. If hernia occurs, it is usually treated by a secondary operation.

A **sinus** is often caused by imperfectly sterilized ligatures, which may cause an abscess around the point of ligation. This abscess may discharge itself into the intestine or vagina, or into the tract occupied by

the drainage-tube through the abdominal wall. The sinus keeps open until the ligature is discharged or removed by another operation.

Accidents during Operation.—Many times in difficult abdominal or vaginal operations the walls of the bladder may be torn, or one of the ureters or the intestine may be injured. When the ureter or bladder is injured, the urine sometimes passes through the incision to the dressing. This is called a urinary fistula. When the intestines are injured, fecal matter is discharged through the wound. This is a fecal fistula.

Vaginal hysterectomy is the most serious of vaginal operations, but the nursing is the same as every operative case requires. If clamps are used, they usually remain attached for forty-eight hours. The handles are usually supported on a pad of absorbent cotton. In the handling of the clamps great care must be used, as, for instance, when the patient is lifted on the bed-pan one nurse should lift the clamps.

Hysterectomy is the complete removal of the uterus and ovaries, either through the vagina (vaginal hysterectomy) or through the abdomen. Regarding the question of insanity which may follow a hysterectomy or the removal of a large fibroid tumor, one must know that a large amount of blood is taken from the body ; that the cutting and tying of the large blood-vessels alter the circulation ; and that the operation is also more or less a shock to the nervous system, and may affect the brain. Insanity is *not* a complication of this operation, the recovery from which is usually rapid ; but when insanity does set in, this is commonly the cause, and the patient generally recovers.

CHAPTER XVI.

OPERATIONS IN PRIVATE PRACTICE.

In private practice the preparation of the patient is just the same and should be carried out as thoroughly as in a hospital. If it is not possible within twenty-four or thirty-six hours to make the preparation, then we cannot say that our attempts to obtain asepsis approach perfection. In emergency cases when there is not sufficient time to permit a thorough cleansing, freedom from sepsis is not so certain, and these cases do not cause the same anxiety as those that are sent to a hospital, where every effort to obtain complete asepsis is made. We must remember, in making the preparations, to make as little bustle and noise as possible, and to carry on the preparations in a quiet and cheerful manner, so as not to frighten the patient and family. When the surgeon and his assistants arrive they must be shown to a room in which they can change their clothing. The patient is not anesthetized until everything is in readiness.

One difficulty which a nurse will have to encounter in private practice is likely to trouble her a great deal, inasmuch as she will find surgeons who conduct details of cases in a way to which she is not accustomed, and which may appear to her wrong, and which indeed may very often be crude and unscien-

tific. In these cases she should not be too ready to show her superior wisdom and instruct the surgeon, and inform him under whom she received her training, because there is not the slightest likelihood that he will act upon her suggestions, but will naturally be offended.

The directions for preparing for the operation will be given by the surgeon in charge. In some houses there may be a separate room for the operation, while in others the nurse will have to prepare the patient's bedroom. In the latter case the brightest end of the room must be selected for the operation, to afford the surgeons plenty of light. A screen must be put up before the bed, so that the patient will not see the preparations. The nurse should remove from the room all movable furniture; lay oilcloths or newspapers covered with a damp sheet on the carpet, and pin them securely to it, and fasten a curtain across the window, so that the operation cannot be viewed from the opposite side of the street. The remaining furniture and window-frames should be washed with carbolic-acid solution (1 : 60), and on the morning of the operation should be mopped with a cloth wrung out of the solution. The articles necessary for the operation can be placed on the operating-table, covered with a sterile sheet, and be left outside the room until the patient is partly etherized, when they may be carried in.

If a separate room can be had, one with a northern light is to be preferred; and if possible it should be near the bath-room. Unless the nurse has twenty-four hours' notice in which to prepare the room

for operation, it should not be disturbed, because if swept and dusted immediately before the operation dust is stirred up and the air is so filled with germs that it would not be safe to open the abdomen in the room. If the nurse has a few days in which to prepare for the operation, all unnecessary furniture should be removed, the hangings taken down, the room thoroughly swept, and the walls and remaining furniture washed with carbolic-acid solution (1:60) and exposed to the action of the sun and air for about twelve hours, when the windows are to be closed, the room thoroughly dusted with a damp cloth and not again disturbed. The *kitchen*, if not too remote, makes the best operating-room; it is warm, hot and cold water are close at hand, and there is no danger of soiling carpets or hangings.

A word regarding the bed. If possible, it should be an iron bedstead with a fresh horsehair mattress and pillow. The tall wooden bedsteads which we so often find are perhaps heirlooms which have witnessed every illness that has visited the family, and also the deaths. They cannot be disinfected so thoroughly as can iron bedsteads.

The operating-table should not be wider than twenty-five inches nor higher than thirty-seven inches, because if low and wide the surgeon will have to stoop and bend forward. A kitchen-table, or a dining-room table with the leaves hanging, and a small table at one end for the patient's head, or two dressing-tables, one placed across the head of the other, will make a good narrow operating-table; or three chairs, with two planks, a leaf from an exten-

sion-table, or an ironing-board laid across them, may suffice.

The table may be covered with rubber cloth, oil-cloth, two sheets, and a blanket. A word of caution here: the nurse should not use any old blanket or comforter to cover the operating-table, for it is likely to be filled with germs.

Two wooden chairs should be at hand in case the Trendelenburg position is necessary, and two wooden boxes for the surgeons to stand upon when using this position.

The evening before the operation the nurse should boil a washboiler full of water and then fill covered pitchers, the washboiler and pitchers having first been made thoroughly aseptic. The water is conveyed from the boiler to the pitchers by means of a perfectly clean pitcher or tin ladle.

On the morning of the operation there should be sterilized in the boiler or in an oven six sheets, two blankets, twelve towels (not new). The heat should be kept up for fully one hour before the operation. The dry technic, by which is meant the use of dry sponges and gauze, is usually employed in private practice, especially when the water-supply is at all questionable.

There will be needed several clean recently boiled basins for the various solutions, etc. Two tables will be needed—one for the instruments, the other for the assistant. They should be covered with freshly washed and ironed sheets or towels. There will also be needed a pail or a washtub for the soiled water, a tin dish or a flat bake-pan for the instruments,

brandy, a hypodermic syringe filled with the required solution, usually strychnin sulphate ($\frac{1}{25}$ grain), a small tumbler, a Davidson or a fountain syringe, table-salt for salt-solution, safety-pins, two new nail-brushes, ready for use in a 1:40 carbolic acid solution, castile soap, green soap, a razor, hot-water bottles, two blankets, alcohol, vinegar, and matches. The surgeon will bring the necessary dressings with the instruments, which must be sterilized in the same way as in the hospital.

The instruments are to be wrapped in a towel and allowed to boil for ten minutes in a saucepan, tin pail, or a fish-kettle of boiling water, to which have been added two teaspoonfuls of washing-soda to each pint of water, to prevent rusting. One end of the towel must be left hanging out of the kettle as a handle by which to lift out the instruments. The pail of water should be on the fire and the water boiling when the surgeon arrives, so that the instruments can be put in at once.

If the nurse is asked to give the anesthetic, she should not attempt anything else. None but novices give the anesthetic and watch the operation. The experienced anesthetizer constantly watches the patient. If the nurse is asked to assist the surgeon, she must be neither too enthusiastic, nor too quick, nor too slow. When the operation is over her duties will have nothing peculiar about them. She must see the patient safely out of the anesthetic influence, and carry the case along as she would any other.

Sometimes a nurse is called to an emergency operation in a very poor family, where there are no con-

veniences. In such instances the kitchen can be cleaned and prepared as an operating-room in a few minutes. If she is called in the night and goes to the case with the surgeon, she should, while the surgeon is making his examination of the patient, start a fire and put on the washboiler, to make sure of plenty of boiling water. She should then get six sheets and twelve towels, if possible. There may be no clean towels, and the nurse will have to wash some dirty ones. The sheets and towels can be soaked first in boiling water and afterward placed in corrosive-sublimate solution (1:1000), until the surgeon is ready to use them. Boiling water is one of the best antiseptics, as it kills germs on contact. Unfortunately it cannot be used in rendering our hands and the field of operation aseptic, but it can be used in the preparation of the sheets, towels, sponges, and instruments.

The kitchen should be rendered as clean as possible. The kitchen-table should be prepared for the operating-table, and there should be two small tables, one for the instrument-tray and one for the sponges. If small tables cannot be had, chairs covered with a sheet or towels wrung out of the corrosive solution will answer the purpose. If there is no gaslight, as many lamps as can be obtained should be arranged near the surgeon, but not too near the ether, because ether is inflammable.

After the surgeon has made the examination the part must be shaved, washed, and a towel wrung out of corrosive sublimate solution applied, an enema given to clear the bowels, and the urine drawn.

While the patient is being anesthetized the nurse may arrange the tables and wash a flat bake-pan or meat-pan for the instruments. If sponges have been forgotten, a clean sheet can be torn up and folded into flat sponges. China basins can be used for the antiseptics, the sponges, and the surgeon's hands; china pitchers for hot and cold water; a washtub for the soiled water; and hot bricks, plates, or beer bottles for heaters.

CHAPTER XVII.

GYNECOLOGIC EXAMINATIONS AND OPERATIONS.

PERFECT asepsis is of special importance in gynecologic examinations and operations, because in many instances the peritoneal cavity, which is highly susceptible to septic influences, is invaded by them. We must bear in mind that the whole genital tract communicates directly with the peritoneum, and infection at any point may cause peritoneal sepsis. Infection has taken place through the introduction of a dirty sound, and fatal peritonitis has followed perineorrhaphy and trachelorrhaphy.

The technic for major operations is usually perfect, but for minor operations carelessness is liable to creep in. We have no right to expose a patient to danger no matter how small the operation to be performed; and if our technic is not as perfect as we can make it with the means at our command, then we expose the patient to the greatest of all dangers, that of peritoneal sepsis, which usually means death. Success in surgery is due to minute attention to a careful technic, and a careless nurse may be the means of introducing sepsis, which may result in death after a most brilliant and skilfully performed operation. The most skilful surgeon is dependent upon his assistants for the perfection of his technic, and only those nurses

who have been thoroughly instructed in the practice of asepsis and antisepsis should be allowed to assist at an operation or examination, however small.

GYNECOLOGIC EXAMINATIONS.

The positions which a patient may occupy when undergoing an examination are the knee-chest, dorsal, Sims, and the upright.

The **upright,** or the erect, position is rarely used for the purpose of making a diagnosis, but is sometimes preferred in verifying a diagnosis, especially that of uterine displacement, previously made with the patient in another position. Around the waist is pinned a sheet, which extends to the floor, under which the clothing of the patient is drawn up. The patient stands with limbs separated, one foot resting on a stool or the rung of a chair.

Dorsal Position.—The patient lies on her back with the knees drawn up and separated; the hips are brought down near the edge of the table, leaving sufficient room for the heels to rest together comfortably, eight or ten inches apart, without slipping from the table. A sheet having an oval slit in the centre long and wide enough to expose the parts is thrown over the patient. In this position there is naturally a certain amount of flexion of the pelvis upon the trunk, and almost complete relaxation of the abdominal muscles is secured.

Sims' Position (*also called the Latero-abdominal Position*).—In the Sims position the patient lies on the left side of her chest, with her head and left cheek resting on a low pillow, and the left arm is

drawn behind the body or hangs over the edge of the table. The hips are brought down to the left-hand corner of the table, so that her body lies diagonally across it, the head and shoulders being at the right-hand side, with the right hand and arm hanging over the table-edge. The thighs are flexed upon the abdomen, the right thigh being so flexed that it lies just above the left knee, and the feet rest upon a board extending from the right-hand corner of the table. This position is one in which there is a tendency for the intestines to ascend, and this causes the vagina to be filled with air and thus brings the uterine cervix within easy reach.

The **knee-chest,** or *genupectoral*, position is much used for inspection of the rectum, bladder, vagina, and cervix of the uterus. In some cases of displacement of the uterus the patient may have to take this position many times daily. The patient first kneels on the edge of the table, then bends forward and rests her chest on a low pillow, her head lying just beyond, so that her back slopes down evenly, her arms clasping the sides of the table. In this position the abdominal organs are thrown toward the diaphragm; the air enters the vagina and balloons it out, so to speak, so that there is an unobstructed view of the canal and the cervix.

Examination of the Rectum.—The patient is usually placed in the knee-chest position. Either the rectal speculum, or in its absence a Sims speculum (small blade), is used. When the instrument is introduced the rectum becomes distended with air so that its walls are well exposed. If the patient is not in

such a position that the buttocks are in a good light, a head-mirror, or an electric headlight may be needed. It is well to have these at hand in case they should be called for.

For an examination of the bladder the knee-chest position is sometimes used; though, as a rule, the dorsal position is chosen, with the hips elevated high above the abdomen by means of cushions or pillows, which allows the intestines to gravitate toward the chest; and when the urethra is opened the bladder becomes distended with air and its interior is thus easily seen. Sometimes the patient is anesthetized for the examination, since it is usually very painful; but local anesthesia of the urethra is often sufficient.

Preparation for Gynecologic Examination.— To prepare a patient for examination the genital parts should be cleansed, so that there will be no danger of carrying septic material to the upper part of the genital tract; the bladder and bowels should be emptied. The uterus lies between the bladder and the rectum, and the distention of either of these organs will alter the position of the uterus. As a rule, no douche should be given before the examination, since the surgeon may want to see the character of the discharge. All bands around the waist must be loosened, also the corsets; a single tight band around the waist will crowd down the contents of the abdomen and displace the uterus. Around the patient is thrown a sheet, beneath which she can raise her clothing above the waist, and then step upon a chair and thence to the operating-table without there being the slightest exposure.

For examination in private practice the patient may lie on a small table covered with a shawl, a comforter, or blanket. There must be at hand a table, covered with a towel, on which are placed two bowls, one containing corrosive-sublimate solution (1 : 1000), and the other containing warm water, green soap, vaselin, and towels.

The speculum should be warmed by placing it in the warm sterile water. The same aseptic precautions are used during an examination as during an operation. The instruments should be sterilized. Sometimes a cleansing douche of corrosive sublimate (1 : 2000) is administered after an examination.

PREPARATION FOR OPERATION.

The preparation for gynecologic operations, such as perineorrhaphy, etc., are the same as for an abdominal operation, excepting the difference of the field of operation to be prepared. In case the operation is a minor one upon the uterus or vagina, the preparations may be somewhat modified according to the individual preference of the operator; but the general rules of asepsis are always the same; and they must be the more strictly observed in these operations because the dangers of infection are increased by our inability to get the genital tract thoroughly clean. In abdominal surgery there is not this difficulty.

The preparation of a patient in a private house for a minor gynecologic operation should be as thorough as in a hospital. If the operation is to be performed with the patient in bed, there will be needed a wide board or an ironing-board for insertion between the

mattress and sheet, thus making a hard surface for the patient to lie upon.

A piece of rubber cloth or oilcloth will serve for the pad. The material used is folded at the top and sides, covered with a towel, and the unfolded end draped into a pail or wash-tub. When the patient is anesthetized the bed is turned toward the window to afford the surgeon a good light—a northern light if possible. A bay window should be avoided, because it gives cross-lights.

The limbs are flexed, the hips brought to the edge of the bed, and the pad placed under them, so that the water used in bathing the external parts is conducted by the cloth into the pail or tub. When holding the patient's limbs the nurse should let the heel of one foot rest in the palm of her hand; the knee of the patient will then rest against the chest of the nurse, whose free hand is passed over and holds the other limb in position at the knee. If the nurse is asked to hold the speculum, she should grasp the handle from below with her right hand; the angle of the speculum will thus lie in the hollow between the thumb and forefinger, and the convexity of the blade will rest on the dorsum of the hand. The upper labia and buttocks are raised by the left hand. If the speculum or regular retractors cannot be obtained in the emergency, retractors can be improvised by bending the handles of four large spoons to the appropriate angle. Two are used to retract the lateral walls, the other two being applied to the anterior and posterior parts of the vagina.

After-care.—After a vaginal operation, trachelor-

rhaphy, etc., the patient will probably be catheterized for a few days. We must always remember the risk of cystitis. Many patients have fully recovered from the operation proper, but convalescence has been delayed by this complication.

After passing the catheter the nurse should be careful that when removing it the urine does not drop on the stitches; the parts are afterward sprayed with the ordered solution and dried. When giving douches the nurse must insert the tube carefully away from the stitches; and after the douche is over she should separate the labia and wipe the vagina dry with sterilized cotton or gauze held in dressing-forceps. The same care must be used when giving enemas, in order that the rectal and vaginal stitches be not broken by the tube. The patient must be instructed not to strain when the bowels are moved, or the stitches may break. When dressings are applied, they may require frequent changing in order to keep them clean and free from discharges. Strict antisepsis must be observed, the genital parts must be kept perfectly clean, otherwise septic material will readily find access and probably result in infection of the wound and suppuration, or a stitch-abscess. If the uterus is packed with gauze, the pulse and temperature are usually taken every two hours; and should the temperature rise to 101° F. the packing is removed.

Diet.—A liquid diet is usually ordered until after the third day, when the bowels will have been moved; after which, if all is well, the amount of food is increased until it attains its customary proportions.

The patient is generally kept in bed two weeks,

and the sutures removed on the ninth day in the order in which they were introduced. After the removal of the stitches many operators order a vaginal douche two or three times a day, the amount of water varying from four to six quarts. This treatment is successful only when the douches are given at the proper time and temperature.

CHAPTER XVIII.

SIGNS OF DEATH; AUTOPSIES.

WINSLOW, one of the professors at the University of Paris, and who had twice been taken for dead, was the first to make a scientific investigation of the signs of death. After Winslow came Louis, and since their time eminent men, especially in countries prescribing rapid burial, have endeavored to find certain and reliable signs of death before decomposition begins.

SIGNS OF DEATH.

Absence of respiration is not a sure sign of death, as it may be due to syncope or to the person being in a trance; nor is absence of the heart-beat, unless determined by means of a stethoscope in experienced hands. Coldness and rigidity may be due to collapse or catalepsy or in persons who are frozen stiff.

In doubtful cases of apparent death which occur suddenly or from external violence the following tests are usually applied:

1. The absence of the heart's action is carefully determined by a stethoscope or phonendoscope.

2. Absence of the circulation is ascertained by tying a string tightly around a finger or a toe; if the tip becomes blue, life is not extinct, though this may occur in cases where there has been great loss of

blood, and in other cases where the heart is too weak to send the arterial blood into the capillaries of the fingers.

3. Absence of respiration is determined by placing the surface of a mirror before the mouth; if the surface becomes moist, respiration has not ceased.

4. If a subcutaneous injection of aqua ammonia is given a red or purple spot will form if life still exists.

5. If a needle is inserted into the flesh of a living person blood will escape, but not if life is extinct; still, if there has been a large loss of blood, there will be no escape of blood in the living.

Rigor mortis (post-mortem rigidity or stiffness of death) begins in the upper part of the body, usually in the maxillary muscles, and spreads gradually from above downward. It disappears in the same order. It comes and goes quickly after great muscular effort or excitement, and when once it has been broken up it does not return. The time it sets in after death varies from ten minutes to twelve or even twenty-four hours. Rigor mortis is considered the most positive sign of death, because it indicates death of the muscle itself.

Death of the body as a whole takes place first, and at intervals of an hour or even several hours death of one or other of the involuntary muscles follows.

Hypostasis, or congestion of blood in the capillaries, which forms in all the dependent parts of the body, is considered a valuable sign of death, but this purple color may be due to contusion, and has been seen in cholera patients before death.

The body-temperature at and from one to two

hours after death may be very high, 107° or 112° F. Patients dying from cholera and yellow fever have high temperatures for several hours after death; but, as a rule, the body is cold to the touch in from six to ten hours.

AUTOPSIES.

Every nurse should do all in her power to assist the physician or surgeon to obtain autopsies, and with a little tact the necessary permission can usually be obtained. Every well-conducted autopsy adds more or less to medical knowledge. It verifies the diagnosis of the illness, and in many cases it explains or shows the cause of symptoms the explanation of which could not be determined before death. In surgical work, when a patient dies in less than twelve or fourteen hours after an operation, the autopsy, when made by a competent bacteriologist and pathologist, will show whether death was due to sepsis or to some organic disease over which the surgeon had no control.

In a private house the autopsy should be held in the room giving the best light, and if possible in the daytime in order to obtain the correct color-interpretation; for if made in artificial light the observations will not be entirely trustworthy.

At the present time an autopsy is perferably held almost immediately after death, and before putrefactive changes have taken place. The undertaker should always be warned not to inject the body, because the fluids usually employed, which contain among other things corrosive sublimate and arsenic in large quantities, change the color and consistency

of the organs to such an extent that it is difficult to recognize the pathologic processes. Then, again, the punctures made during the embalming process may open an abscess or other cavity, and thus distribute the contained pus or exudates. Embalming-fluid has been poured into the mouth, and having found its way into the lungs and stomach, has greatly changed the appearance of those organs.

The clothing on the body should be removed and a large sheet spread over it; or if preferred, a night-dress or skirt open down the middle may be put on.

The things a nurse should provide are:

1. Large rubber sheet, old oil-cloth, old quilts, or papers to put under trestle to protect the floor.

2. Small table for instruments, a marble-top table if possible, unless there is a marble-top stationary bowl in the room.

3. Three washbowls: one for corrosive sublimate, one for dirty instruments, and one for organs removed.

4. Two pails for dirty water.

5. Old towels and a number of old sponges.

6. Plenty of hot and cold water.

7. About four quarts of fine sawdust, or oakum, or excelsior packing, absorbent cotton, or common cotton for filling up cavities, any one of which will prevent fluid oozing through the incisions. When these are not obtainable, bran, cloth, or newspapers may be used. Fine sawdust is the best material, as it packs easily, does not interfere with the sewing by getting into the stitches, and keeps the needle dry.

8. Six wide-mouthed bottles in which to place specimens from the various organs, and which can be securely corked.

9. Mucilage and labels on which to write the history of each specimen in the bottle.

10. About three yards of fine twine or carpet-thread, and a large darning-needle or a large curved needle.

Should the autopsy take place in a house where there are no conveniences, the body can be left lying on the undertaker's stretcher covered with a sheet, the clothing removed, and a large napkin put on. There should be several old newspapers to protect the floor, and on which to place the dirty instruments and organs removed; an old sheet, a pail, a wash-bowl, and a pitcher of warm water can always be obtained.

The sheet is torn into four pieces. Two pieces are used, one for each side of the neck and trunk, covering the arms, leaving the chest and abdomen free for the surgeon to operate; the third piece is placed beneath the head; and the fourth piece is tucked in below the genitals, thus covering the lower extremities. The bowl contains the large dampened sponge, and, together with the pail, should be placed within convenient reach.

Absolute cleanliness is essential at a private autopsy. Blood-stains must be washed from the walls, floor, dishes, the rubber or oil-cloth; the papers, old sponges, and cloths should be burned, and the body must be washed perfectly clean. The room must be left in perfect order—just as it was before the post-

mortem. Ground coffee thrown on a few live coals will remove all odor from the room.

For removing the odor from the hands, turpentine will be found serviceable, or a solution of permanganate of potassium and oxalic acid, or a dilute solution of formaldehyd. The result of the autopsy must be kept secret and revealed to no one.

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