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OR

Surgical Cleanliness

A Manual for Physicians, Students and Nurses

BY

L. D. ROGERS, A. M., M. D.

PROFESSOR OF SURGERY IN THE NATIONAL MEDICAL UNIVERSITY, CHICAGO.

CHICAGO
PEOPLES HEALTH JOURNAL CO.,
1900.

PREFACE.

One Sunday morning, some five years ago, a bright, active, robust woman about thirty years of age called on the writer and introduced herself by saying in the most engaging manner: Pardon me, Doctor, for disturbing you upon the Sabbath, but I have come to offer you my services. I am a medical stenographer. I see by your "ad" in this morning's Tribune that you are in need of such a person.

A few moments conversation made it evident that she was a lady of rare intelligence and an expert in her chosen field, being able to spell readily the most difficult medical terms and to write them with the machine almost as rapidly as they could be spoken. Her references showed that she had done special work for many prominent physicians and surgeons.

She was subsequently engaged for the special purpose of taking dictations for this book on Surgical Cleanliness. To our encouragement and delight she entered upon her work with intelligent enthusiasm and seemingly took as much pride in its proper and early completion as the author himself.

However, before the manuscript was half complete she surprised us one day by announcing, that she had an abdominal tumor and had already made arrangements to enter a hospital at once to undergo an operation for its removal. Our suggestion to postpone matters for further deliberation was rejected and we accepted her invitation to be present at the operation, as a spectator. An ovarian cyst, the size of an orange, was removed. On the third day after the operation she had a chill. Her temperature rose, and from that time she suffered horribly until the thirteenth day, when she died. We were also present at the post mortem examination, which revealed a quart of pus in the abdominal cavity, and fully a pint in each pleural cavity.

Such a pronounced case of blood poisoning we never expect to witness again. Why did she have

blood poisoning? Undoubtedly some one was not surgically clean during that operation. It may have been a nurse or an assistant or the operator himself. Possibly, the instruments or dressings were infected by the touch or the breath of an unclean spectator. Perhaps the nurse who prepared the instruments and dressings, or the one which prepared the field of operation, was not conscientious in performing her work thoroughly. Since the life of Lilian Bonner was thus sacrificed by the lack of surgical cleanliness in an established hospital under the hands of a reputable surgeon, we have not deemed it necessary to offer any apology for the publication of this book.

This volume is the outgrowth of a lecture first delivered several years ago before the students of the National Medical University. It has since been revised several times, and repeated to students and nurses with a view of preparing them to enter the operating room and be safe assistants. Few things are more exasperating to a clean surgeon than to have present during an operation officious persons who have no idea of surgical cleanliness.

If spectators possess even a theoretical knowledge of the subject it is a great comfort to the

surgeon and an inmense advantage to the patient. They will know enough to keep out of the way of the operator, the assistants and the nurses. They will stand off at such a distance that they cannot breathe, spit or shake germ laden particles into the wound. They will "touch not, handle not" anything with unclean hands. They will also know, that in order to get the hands surgically clean it requires a good deal more than simply rinsing them off in a basin of water containing a few drops of some antiseptic. They will have learned, that the song of the surgically clean surgeon is "scrub! scrub! scrub! for ten minutes with the scrub brush, scrub! soap and water!"

L. D. R.

441 Dearborn Ave., Chicago, March 1, 1900.

CHAPTER I.

In the dirt under our finger nails, in the creases and folds of the skin, upon the hair, in the secretions from the nose, the mouth, the eyes, the ears, and from all the other orifices of the body there may be found by the aid of the microscope, **germs** which are capable of spoiling the best efforts of the most skillful surgeon.

These germs are the **cause** of pus, the yellow, creamy, or dirty mattery discharge seen in boils, abscesses and all unhealthy wounds. No genuine pus can occur without them. They are always present in pustules, in boils, in abscesses, in felons, in carbuncles, in purulent inflammation, and wherever there is suppuration or maturation. None of these affections can occur **without** them. They are the cause of every one of them. They are **always** the cause of septicemia, pyeamia and blood poisoning in general. Without these germs it would be impossible to have a case of blood poisoning or child-bed fever.

They are the surgeon's most dangerous enemy. They may transform the simplest operation into one of great **gravity.** They have often brought about a fatal result where it was least expected. We have recently seen a young man whose left knee was as stiff as though there had never been any joint. A few years ago he accidentally ran a sewing needle into it. Either by the needle or by the instrument of the doctor who searched for it pus germs were conveyed into the joint. An abscess resulted which entirely destroyed the joint and nearly the life of the boy.

This case reminds me that some thirty years ago when a small boy we were told that if the knee was injured so that the "joint water" escaped, it would always after that be stiff. Now, we know that the cavity of the knee joint, as well as that of any other cavity of the body, may be opened with impunity, provided that pus germs do not gain admittance.

Formerly, it was supposed that the formation of pus in a wound was a natural and necessary step in the process of healing. Now the suppuration of a wound is regarded as an **unnatural,** unnecessary and dangerous complication. Instead of facilitating healing it greatly **retards.**

How the view of surgeons regarding pus has changed during the past quarter of a century is well illustrated by the following two incidents, the truthfulness of which we do not question.

It is related that in the year 1870 one morning as the surgeon-in-chief of a large hospital was making his usual rounds of the surgical wards, he said to the house surgeon :

"How is that amputation case to-day?"

"Doing splendidly," was the reply, "the wound is suppurating beautifully."

"That's good," said the chief, and passed on smiling, evidently satisfied with the condition of the case.

The second incident is said to have occurred in the year 1895, in the same ward of the same hospital, but the surgeons and the patient were different. The surgeon-in-chief one morning asked the same question that his predecessor had asked just twenty-five years before. The answer was :

"Doing badly, sir, the wound is suppurating."

The exclamation of the chief upon hearing this was more emphatic than elegant. It was evident that he was disappointed and chagrined.

The reason for it is easily understood when it is known that the modern surgeon very rightly considers it a positive **disgrace** to have pus occur in a wound of his own making. It is almost conclusive evidence that he or his assistants or his nurses have been **unclean** from a surgical standpoint.

In the light of modern surgical science, avoidable uncleanliness must be classed as **criminal carelessness.**

An old soldier who lost a leg in the Civil war told us that a few days after his thigh was amputated the assistant surgeon ventured the opinion that the wound would heal by first intention, that is, without suppuration. On hearing this the surgeon of the regiment ridiculed the young surgeon unmercifully for entertaining for a moment the absurd idea that an amputation could heal without suppuration. But bacteriology, that science which has practically grown up since 1882, when Dr. Robert Koch discovered the bacillus of tuberculosis, has taught us that any wound which is kept free from pus germs, that is aseptic (surgically clean), will heal without suppuration and even without **inflammation.**

The discovery of this single truth has caused the most astonishing reduction in the mortality of surgical cases. No other discovery in the whole realm of surgery, either ancient or modern, equals in importance the simple fact which may be expressed in a sentence of five words, namely: **Aseptic wounds heal without suppuration.**

A quarter of a century ago, before this golden truth was discovered, the most experienced and skillful surgeons regarded the result of their operations as a matter of chance. If their patients escaped the scourges of surgery, namely: suppuration, purulent edema, hospital gangrene, erysipelas and tetanus, it was considered rare good luck,

and in no way due to their knowledge or skill. In these days he **knows** that he will have no pus if he has been **clean** surgically.

After a bloody operation the surgeon had no more control over the outcome of it than the farmer has over the mighty elements which develop or blast the crops he has planted.

In pre-aseptic times the mortality from amputation reached sixty per cent. In Nussbaum's clinic, at Munich, it is said that eighty per cent. of all wounds were attacked with hospital gangrene. Erysipelas was the **rule** rather than the exception. It was the custom not to suture scalp wounds because they always suppurated. Suturing, by retaining the secretions, seemed to favor the development of erysipelas. During one year in this clinic out of seventeen cases of amputation eleven died of pyæmia. It was a rare occurrence to see a case of open or complicated fracture which was not attacked in a few days with septicæmia or one of its companion diseases and end fatally. The rule was, therefore, to amputate the limb whenever there was an open fracture, that is, one where the air communicated with the bone.

Since writing the foregoing we have visited the hospitals of Munich. We did not see a single case of blood poisoning of any kind. We noticed that the strictest surgical cleanliness was observed in all operations. Before the days of antiseptics the French hospitals showed a death rate of fifty-two

and one-half per cent. after all major operations.

From 1850 to 1851 there were treated in the Pennsylvania hospital at Philadelphia one hundred and sixteen cases of compound fracture. Excluding the cases in which amputation was performed, there were fifty-one deaths—a mortality rate of forty-four per cent.

During the same period in the New York hospitals, one hundred and twenty-six cases of compound or open fracture were treated. Excluding amputation cases, sixty-eight died—a mortality rate exceeding forty-eight per cent.

During the period from 1866 to 1876 there were treated in the surgical clinics of Vienna and Zurich one hundred and eighty cases of open fracture. Excluding amputation cases, the death rate was forty-one per cent. At St. Petersburg one hundred and six cases of open fracture resulted in a mortality of sixty-eight per cent.

During the period from 1841 to 1861, in Guy's hospital, London, there were fifty deaths out of two hundred and eight cases treated—a mortality rate of twenty-four per cent.

The average mortality for these seven hundred and thirty-six cases of open fracture, representing all the great hospitals and surgeons in the world, was **forty-five** per cent.

Upon the introduction of antiseptic methods the mortality rate in open fractures dropped to **four** per cent.

In Volkmann's clinic, at Halle, the mortality rate in open fractures was above forty per cent. His predecessors for a number of generations had had about the same result in such cases.

In the years 1871 and 1872 the death rate was so enormous from pyemia and erysipelas that this distinguished surgeon was on the point of closing his wards. Out of twelve cases of open fracture under his care **all** died. As a last resort, he began the use of the antiseptic methods then being introduced by Sir Joseph Lister. During the succeeding ten years, up to 1881, he had one hundred and thirty-five cases of open fractures and did not lose one from blood poisoning. His mortality rate in all cases dropped to **six** per cent.

It was our privilege to see every case in the wards of this most interesting of all German hospitals. We know that the death rate now is very small.

Lister observed, as had many surgeons before him, that simple fractures—those in which the skin was not broken—were attended with but little risk to life, while **open** fractures had a general mortality rate, as we have already seen, of forty-five per cent.

He reasoned that the atmosphere must contain some deleterious element which decomposed the blood and rendered it a poisonous irritant, causing severe constitutional disturbances and frequently death.

In an article in the London Lancet during September, 1867, he **first published** his theory of antiseptics. Lister discovered no new principle. Heuter had said twenty-five years before: "No germ, no pus." As early as the year 1837, Schawnn had demonstrated the connection between putrefaction and micro-organisms.

But it was the precision and accuracy of **Pasteur,** a quarter of a century later, which convinced the scientific world of this truth and gave Lister the foundation upon which to build his system of antiseptics.

Lister attempted to keep the germs out of the wounds by protective bandages and also to destroy them by a germicide.

On account of its deodorizeng qualities he selected **carbolic acid.** He washed and sprayed wounds with a solution of this agent. Then wrapped them in gauze impregnated with it and over all he placed an air-tight dressing.

During the period from 1864 to 1866, inclusive, Lister operated at Glasgow. His mortality rate for all kinds of operations was nearly **46 per cent.** From 1867 to 1869 he employed his antiseptic methods to a limited extent and his mortality rate sank to **15** per cent. From 1871 to 1876 inclusive, after he had improved details, he treated 553 grave surgical cases with a death rate of thirty-six hundredths of **one** per cent.

Thus it is seen that his death rate before he

employed antiseptic methods was **127 times greater.**

Notwithstanding this immense reduction in the mortality rate obtained through Listerism subsequent knowledge has shown that while the principle upon which he acted was entirely correct his technique or method was imperfect.

He inaugurated a **new era** in the surgical world, which has led to more advancement in surgery during the last twenty years than during the previous two thousand years.

Notwithstanding the unquestioned truth of his theory and superior results achieved by it, time was required for its introduction and adoption into the great surgical clinics and hospitals of the world.

As late as 1876 the famous old surgeon Van Langenbeck said to his students: "A new method has been advanced by an English surgeon who predicates the principle of wound treatment upon the destruction of organic germs which he assumes to be the cause of wound disturbances. The excellent results claimed by him are not in accord with what we obtain. Hence, I can hardly grasp their perfection. Yet, notwithstanding my experience, I feel it incumbent upon me to test them in practice."

The extent of the adoption of Listerism in the United States may be estimated by recalling some facts connected with the treatment of the case of

President Garfield. During the month of June, 1881 he was shot in the back. We were recently told by one of the surgeons who attended him that they each inserted their fingers into the wound without even taking the precaution to **wash** their hands. In the light of surgical science of to-day, it is easily understood why the lamented president had septicæmia, dying three months later of pyæmia a victim of ignorance. He is supposed to have had the best surgical skill the nation could afford at that time. At the present the poorest pauper who attends the free dispensary receives better treatment than our president received **only** eighteen years ago.

CHAPTER II.

While Pasteur had proved that putrefaction was due to germs and Lister had done much toward devising methods to successfully overcome their deleterious effects it remained for Koch to inaugurate a line of scientific investigation, beginning with the discovery of the bacillus of tuberculosis in 1882 and reaching its climax in 1885 by the discovery and complete identification of the more important of the **pus** germs.

Up to the present about twenty different germs have been identified which are capable of producing pus. To all of these the term **pyogenic** is applied, meaning pus producing.

The yellow pus germ is the one of greatest importance to the surgeon. Its scientific name is **staphylococcus pyogenes aureus.** The word **staphylo** is derived from the Greek and signifies a bunch of grapes. **Coccus** is also from the same source and originally meant a pill or kernel. It is now applied to all germs having a glo-

bular shape. The first part of the word **pyogenes** means pus, the second part generating or producing. **Aureus,** of course, indicates golden or yellow, and is used because this germ produces a yellow pus. This long name is applied therefore to globular-shaped germs which are found in clusters resembling bunches of grapes, and which produce pus of a golden yellow. If a small particle of yellow pus be implanted in sterilized gelatine and kept at blood temperature for two or three days the gelatine will become liquified around and about the point of implantation of the pus, and a golden deposit appear. This yellow deposit and the liquefaction of the gelatine are two characteristics which taken together distinguish this germ from all others.

Another way of ascertaining the presence of this germ is to implant upon the cut surface of a boiled potato a minute quantity of material suspected of containing the germ. Place it in a sterilized tea cup or glass jar and cover tightly with a piece of sterilized window glass so that no other germ can come in contact with the contents. If the yellow pus germ is present after two or three days, during which time the potato has been kept in a room at blood temperature, the characteristic **yellow** deposit will be seen at the point of implantation, and a marked softening of the substance of the potato will be observed.

If a small quantity of this yellow deposit from

either the potato or gelatine be transplanted into a fresh wound upon a guinea pig or any other susceptible animal or human being, **suppuration** will occur, amounting in some cases to general blood poisoning and even death.

Garre inoculated a small wound on the end of his finger with a small quantity of pure culture of this germ. An ulcer formed around the margin of the finger nail. From the pus thus formed he made cultures of the germ and then rubbed a considerable quantity upon the unbroken skin of his left forearm. A large carbuncle formed, surrounded by daughter carbuncles, at the point of application of the culture. They ran the usual course, requiring several weeks before healing was complete. Seventeen scars were left to bear testimony to the success of the experiment.

If such results follow the simple rubbing of the germ into the unbroken skin what must be expected when it is conveyed directly into a wound by dirty fingers or dirty instruments?

The **Staphylococcus pyogenes aureus,** the yellow pus germ, is found in greatest abundance upon the **skin** and mucous membranes. Particularly where the skin lies in folds and is moist, as for instance, the arm pits and the groins. It may be found at all the orifices of the body and in all of the secretions. It may be found upon soiled clothing, unwashed instruments, in dust upon the furniture and upon the floor or walls.

It is sometimes found in water and occasionally in the air.

A single yellow pus germ is seven-tenths of a mikron in diameter. It would take 40,000 of them placed in a line to measure one inch. A thousand of them could be packed within a red corpuscle.

The yellow pus germ has been found not only in furuncles or carbuncles, but in pustular affections of the skin and mucous membranes, namely: impetigo, sycosis, phlytenular conjuntivitis, purulent conjuntivitis, acute abscesses of the lymphatic glands, salivary glands, tonsils and mammary glands, and in metastatic abscesses and purulent collections of joints, in acute suppurative osteomyelitis and suppurative endo-carditis.

After the discovery and identification of this pus germ the intensely practical question arose as to what would destroy it or neutralize its deadly ravages.

Numerous experiments have been made with it as well as with all the other important pathogenic germs to determine the **thermal** death point. It has been found that an exposure of 10 minutes in water at a temperature of 143.6 Fahrenheit will completely kill the staphyloccocus pyogenes aureus. Boiling water (212 degrees Fahrenheit) is therefore more than sufficient to destroy it. It becomes then an easy matter to disinfect and make surgically clean any instrument or article which

can be boiled, but the great problem is how to render the skin and catgut or other aninaml substance free from these germs.

A one per cent. solution of carbolic acid will destroy the germ in two hours.

A solution of bi-chloride of mercury of one to one thousand per cent. will kill the germs within eight seconds.

The bin-iodide of mercury has twice the antiseptic power of the bi-chloride of mercury.

Thus far we have described only the staphylococcus pyogenes aureus, the most common and the most important of all the pus producing germs. Before discussing antiseptics in detail we shall enumerate and describe other germs against which the surgeon has to contend.

There are several varieties of the staphylococcus pyogenes. We have fully described one, the aureus. The albus is another. It is found chiefly upon the skin. In every respect, except in color, it closely resembles the aureus—the surface cultures upon nutrient agar or potato have a milk-white color. It lacks the golden hue so characteristic of the aureus. Hence its name, albus, which implies white. It is less virulent than the aureus.

For the purpose of testing the comparative pathogenic properties of the yellow and white pus germs, an instrument infected with the yellow was stuck through the cornea of the eye. Pan-

of the eye developed within thirty hours. When the instrument was infected with the white pus germs, the panophthalmitis did not develop until sixty or seventy-two hours had elapsed.

When the instrument was inserted in a throughly sterilized condition, that is entirely free from all germs, no inflammation of the eye followed. The wound readily healed without causing any trouble whatever.

A bacteriological examination of nineteen cases of panophthalmitis demonstrated the white staphylococcus in ten and the yellow in nine.

There is a variety of the white pus germs, named by Welch, staphylococcus epidermis albus. It is regarded as a regular inhabitant of the normal skin, just as the bacillus coli communis is of the intestinal canal.

It liquifies gelatine and coagulates milk more slowly than the ordinary pus germ. A peculiarity of this germ is that it is very often found in layers of the epidermis deeper than can be reached by any known means of cutaneous disinfection. After sterilization of the surface of the skin so that scrapings develop no germs, the presence of this germ may be demonstrated in a piece of the skin, or on a suture which has passed through the entire thickness of the skin. This skin coccus may often be found in wounds without causing suppuration.

It is likely, however, to cause suppuration if

there is any foreign substance in the wound. It is ,therefore, a common cause of stitch abscesses. It is likely to follow down drainage tubes and cause suppuration. This explains how stitch abscesses may sometimes occur after an operation which has been performed under perfectly aseptic precautions.

Lockwood, of London, has described a diplococcus epidermis albus which closely resembles the ordinary white pus germ. It produces a peculiar odor as it grows, such as is smelled when uncleanly persons remove their chothing.

Incidentally, we would call attention to the fact that the bacillus prodigiosus produces a deep red deposit and this, perhaps, accounts for the blood-red stains seen in the clothing about the armpits of some persons.

The **streptococcus pyogenes** is next in importance to the staphylococcus pyogenes aureus. It is supposed to be identical with the erysipelas germ, known as the streptococcus of erysipelas. This germ is found in chains and not in grape-like bunches, as is the staphylococcus. The word **strepto** refers to a chain. Hence the term streptococcus pyogenes refers to pus-producing, globular germs so arranged as to give a chain-like appearance. It is frequently spoken of as the chain coccus. Usually five to ten of these germs are seen in a string. This arrangement facilitates the passage of a group of them through lymphatic

vessels more readily than the bunched arrangement of the staphylococcus. Probably this accounts for the fact that we more often find the latter in circumscribed, localized suppuration and the former in diffused suppuration, as lymphangitis, cellulitis, and erysipelatoid inflammations.

The spreading nature of erysipelas may be explained by the proneness of this germ to insinuate itself along the lymphatics. It also explains the red streaks which may often be seen extending up an arm or leg after an infected wound of the hand or foot. In the lymphatics the streptococcus pyogenes causes lymphangitis, and when it reaches a lymphatic gland it sets up a suppurative adenitis. This again explains the enlarged and sore glands that may be felt when an infection at an extremis traveling toward the trunk.

The streptococcus pyogenes causes acute suppuration almost as frequently as the staphylococcus pyogenes aureus. Out of thirty-nine cases of acute pus formation it was found to be the sole cause in fifteen of them and in five of the remaining cases it was found associated with the staphylococcus.

It is found almost invariably associated with puerperal or child-bed fever. This fact explains the observation made long before the days of bacteriology, namely: if a physician went from a case of erysipelas to a confinement case the wowas almost certain to have child-bed fever. This

was such a common result that conscientious physicians in former times would not attend an obstetrical case at the same time they were visiting a case of erysipelas.

Since physicians have learned how to disinfect themselves of all pyogenic germs they may now attend at the same time, without jeopardizing the life of the woman, a case of erysipelas and one of obstetrics provided, of course, that they disinfect thoroughly.

In former times it was noticed that if a physician had one case of child-bed fever he generally had several in succession. It was a common occurrence for some certain physician to have so many cases of puerperal fever that he would be compelled to give up obstetric practice for months. While visiting near Ogden, Utah, in 1894, we heard of a country doctor who had lost nine women from child-bed fever in rapid succession. Popular indignation became so great that he was compelled to abandon obstetric practice entirely. It was very evident that he did not understand surgical cleanliness.

It should be remembered that the streptococcus pyogenes is a widely distributed micro-organism. It may be found in almost as many different places as the stapnylococcus. A favorite abode, however, is upon the mucous membrane at all the orifices of the body, even in cases of apparently healthy persons. Its presence in the vagina will

explain why it is commonly, if not always present in child-bed fever.

Its presence in the mouth will account for some of the cases of blood poisoning following a bite by a human being.

How the presence of this germ in the nasal secretions may be the source of serious infection is illustrated by the experience of a Philadelphia physician many years ago. No matter what precautions he took his obstetrical cases usually developed child-bed fever. He had forty-five cases in one year. Other physicians in the same neighborhood, who took far less precaution than he, had little trouble of this kind.

It is related that in order to "rid himself of the mysterious influence which seemed to attend upon his practice he left the city for ten days, and before waiting on the next parturient case he had his hair shaved off and put on a wig, took a hot bath and changed every particle of his apparel, taking nothing with him that to his knowledge he had worn or carried on any former occasion. Mark the result. The lady, notwithstanding that she had an easy parturition, was seized the next day with child-bed fever and died on the eleventh day after the birth of the child. Two years later he made another attempt at purification and the next case fell a victim to the same disease." An exhaustive investigation developed the fact that the unfortunate doctor was afflicted with a persistent,

purulent nasal catarrh which, doubtless, kept his hands infected. The benefits which the practice of obstetrics have derived from bacteriology exceed the most extravagant estimates.

Buchanan, in his valuable little book entitled, "Antisepsis and Antiseptics," says that about thirty years ago the mortality in lying-in hospitals was so great that the International Congress of Physicians and Surgeons, at its session in Brussels recommended the abolishing of such institutions.

Observations in Europe and America, extending over a long period of time, confirm the fact that wherever a large number of lying-in women were congregated puerperal septicemia prevailed, and the death rate was appalling.

In the years 1760, 1768 and 1770, the disease prevailed to such an extent in London that in some of the maternity hospitals nearly all of the patients died. In the Royal Infirmary at Edinburg, in the year 1773, "almost every woman as soon as she was delivered, or perhaps twenty-four hours after, was seized with it and all of them died.

"In the Maison d'Accouchments at Paris during several years the death rate was so high that of every three women who entered the institution one died.

"In the hospitals at Vienna in 1823 nineteen per cent. of the cases died ; in 1842 sixteen per cent.

"In the lying-in hospital at Berlin in 1862 hardly a single patient escaped death from child-bed fever. As a result of this terrible mortality the institution was closed."

Now, conditions are reversed. A woman runs less risk of incurring child-bed fever in a well-regulated lying-in hospital than she does at home.

Now, in many of the large lying-in hospitals, the death rate from puerperal fever is about one-tenth of one per cent., or one in a thousand.

Master Smiley, the chief medical officer of the Rotunda Hospital at Dublin, within whose walls 220,000 women have been delivered within the past 145 years, told us during our recent visit to the famous institution that they scarcely knew what child-bed fever was.

Dr. Griffith, attending physician at the Queen Charlotte Lying-in Hospital, London, where about 1,200 women are confined annually, told us that for several years they had had no deaths from child-bed fever.

In the New York Maternity Hospital, from 1875 to 1883 inclusive, 3,504 women were confined. Of this number 146 died from puerperal fever. Beginning with the year 1884, antiseptic methods were employed. From that time until 1891 inclusive, 3,170 women were delivered with only seven deaths from child-bed fever.

Since the era of antiseptic and aseptic methods, Merman, of Manheim, reports 700 deliveries in

succession before a death occurred, and Braum, of Vienna, reports two deaths in 1,004 cases.

The latest researches indicate conclusively that the streptococcus pyogenes is the usual cause of child-bed fever. In 81 cases of puerperal fever this was found in the discharges from 35 of them, while an examination of the discharges of 57 women who were free from puerperal fever during confinement did not reveal this germ in a single instance. In ten fatal cases of child-bed fever the streptococcus in every case was found in the discharges during life and in the organs after death.

The streptococcus is more easily destroyed than the staphylococcus. The former is destroyed in ten minutes at a temperature of 130°, while the thermal death point of the latter is 144°. The streptococcus is killed within eight seconds in a three per cent solution of carbolic acid.

In the mouth beside the streptococcus already described more than one hundred different germs have been identified. The decay of the teeth is caused no doubt by certain germs. Most of the germs found in the mouth are harmless, and may even serve a useful function.

One of the most important germs commonly found in the mouth is the **pneumococcus**—the pneumonia germ. It is often found in the saliva of an apparently healthy person. The virulency of this germ varies in different persons; and it also

varies in the same person at different times. Saliva containing the pneumococcus injected into susceptible animals—mice, rabbits and guinea pigs—will kill them at one time, while at another it may not. This fact demonstrates the marked variability in the degree of virulence of this germ.

Next to the staphylococci and streptococci, it is the most common cause of inflammation. It is believed to be the sole specific cause of acute lobar pneumonia, and very often the cause of bronchopneumonia, abscess of the ear and meningitis. The list of diseases which it is capable of producing is very long. It may cause inflammation anywhere in mucous or serous membrane. It can cause an abscess in any part of the body. It is the most frequent cause of pus in the pleural cavity, that is, pleural empyemia. This germ is destroyed in ten minutes in water at a temperature of 126° Farhenheit. It may live four months in dried blood or sputum. While it may cause the gravest diseases, it is generally a benign organism in comparison with the streptococcus.

Bacillus coli communis is the name of a germ that is a constant inhabitant of the intestine. It is also found widely distributed outside of the body. It is an important factor in inflammation of the urinary tract and the ducts of the liver. It is found as a rule in appendicitis and peritonitis, but in these conditions it is often associated with other germs. It may be found in inflammations

in any organ of the body. One of its pecularities is to invade tissue already occupied by other bacteria or previously damaged. An idea recently advanced accounting for appendicitis in bicycle riders is that the appendix by the violent contraction of the psoas muscle, causes a fertile soil for this germ to develop appendicitis.

The **gonococcus,** discovered by Neisser during 1879 in gonorrhoeal pus, has been proven to be the specific cause of gonorrhoea. But it was not until 1885 that it was made to grow outside of the human body. Bumm first cultivated it in human blood serum. The germ is found in pairs of biscuit-shaped bodies, with the flattened sides against each other. The peculiar feature of this germ is that it is often found included within the white blood corpuscle cell. It is strictly a human parasite. Pure cultures of it implanted in the healthy human urethra will invariably be followed by a genuine attack of gonorrhoea.

This germ grows readily upon the conjunctiva, the mucous membrane lining the eye and covering the front of the eyeball. The inflammation caused by it in this situation is called gonorrhoeal ophthalmia, and may be so severe as to cause destruction of the eye. New-born infants sometimes have their eyes infected from their mother, the gonorrhoeal discharge from the mother coming in contact with the infant's eyes at birth. Again, nurses caring for infants with gonorrhoeal oph-

thalmia have conveyed the germs to their own eyes through lack of disinfecting their hands after treating the child's eyes. Patients with gonorrhoea have conveyed the disease to their own eyes With their infected hands. The germs live but a very short time outside of the human body, so that the disease is not often, if ever, conveyed through some inanimate object, such as the seat of a water closet.

we recall two cases we have had under our care of little girls, not to exceed five years of age, who contracted the disease while sleeping with their infected mothers.

This germ may cause salpingitis, pyosalpinx and ovarian abscess, also peritonitis. It may even cause inflammation of the joints, and of the covering of the heart. The fact that this germ can cause gonorrhoeal rheumatism has been demonstrated as follows: The contents of the affected joint have been examined; the gonococcus found to be the only germ present; cultures from the contents of the joint have been made and the product injected into the healthy urethra, resulting in a genuine case of gonorrhoea. The so-called gonorrhoeal rheumatism is differentiated from the true by the simple fact that it affects but one joint while the latter affects several in succession.

This germ imbeds itself in the epithelial cells so that it cannot always be reached by disinfectants. The germ may lie dormant a long time and lead

the individual to believe that he is cured. But any undue congestion to the sexual organs causes a reappearance of the disease. It is a common occurrence for a man who supposes himself cured of the disease to marry an innocent, healthy woman, who soon after marriage is attacked with gonorrhoea in the most violent form. The disease in her may end in an ovarian abscess, or an inflammation of the fallopian tubes causing sterility. Still graver trouble may occur. A peritonitis may be set up, causing her death, or a condition be brought about necessitating an operation for the removal of her ovaries, or womb, or all of her sexual organs.

The **bacillus of typhoid** has been recently discovered to have some pyogenic properties. Suppuration of bone following an attack of typhoid fever is often caused by this germ alone. The usual habitat of the typhoid germ is in the intestines, or rather some of the mesenteric glands. It is worth while to incidentally note that there is a chemical difference between it and the bacillus coli communis, another inhabitant of the intestines already described. Cultures of the latter turn blue litmus paper red, showing acid reaction, while the typhoid germ does not.

Speaking of typhoid germs reminds us of the discovery by which typhoid can be diagnosed from a drop of blood.

From the patient a few drops of blood are se-

cured by pricking the finger with a needle and then smearing a drop or two upon a piece of clean glass—a bit of window glass will do—upon which it is allowed to dry. The piece of glass is then sent to a bacteriological laboratory, where they have pure cultures of typhoid germs. The live typhoid germs are in constant motion, which is very striking when seen under the microscope.

Now, if the dried blood on the glass be moistened with a few drops of pure water, and the solution thus formed be poured into a live culture of typhoid germs the characteristic motion of the germs will stop almost instantly if the person from whom the blood was taken has typhoid.

This recent discovery has been tested and found generally reliable. Thus, another triumph for bacteriology, the youngest of the medical sciences, is added.

It will be of invaluable service in making an early diagnosis of typhoid and in differentiating typhoid from other diseases which in their earlier stages may be confounded with it.

The typhoid germ reaches the intestines through the mouth, being usually taken into the stomach with the food or drink. Impure drinking water is the most common source of typhoid. Whenever an epidemic of typhoid occurs in any locality we may at once safely assume that the water or milk supply is contaminated.

Boiling the water and the milk is the most ef-

fective means of preventing the disease. When a case of typhoid occurs in a family it is not unusual for the nurse and other members of the family to take the disease. From this fact it has been supposed that the germs of the disease might be carried in the atmosphere. This may be true, but we are inclined to attribute it to the use of the same infected drinking water, milk or food, possibly from eating from the same dishes or drinking from the same glass used by the patient.

We have no doubt that a careless, ignorant dishwasher may wash the dishes so slovenly and in water insufficiently hot to destroy the germs, It requires water at a temperature of **133** degrees Fahrenheit for ten minutes to destroy or kill typhoid germs.

The typhoid germ is one of the most difficult of disease germs to destroy. Some of the most powerful antiseptics will prove ineffective when added to the intestinal discharges from the typhoid fever patient. It is generally conceded that chloride of lime is the most practical, and should be placed in the vessel before and after receiving the discharges.

Too much care cannot be taken in thoroughly disinfecting all discharges from the typhoid fever patient at once. All soiled clothing and cloths should be burned or immersed in boiling water.

The **bacillus of tuberculosis,** the germ of consumption, more often concerns the surgeon

than that of typhoid. It is estimated that one-fourth of all chronic surgical cases are tubercular. Of the seventy hospitals we visited during our recent trip abroad, we do not remember visiting a single general hospital in which we did not see several tubercular cases.

As stated in the first chapter, the consumptive germ was discovered by Dr. Koch in 1882. Its length is about one-half the diameter of a red blood corpuscle. It requires **boiling** water to kill them, while the most resistant pyogenic germ, the staphylococcus, is destroyed at a temperature of **144** degrees Fahrenheit. On the other hand, the former is destroyed by a three per cent. solution of carbolic acid, while the latter requires **five** per cent.

It may be said without a very great deviation from the truth that the consumptive germ is omnipresent. This certainly is true in all our large cities and in certain districts, while in some of the higher regions of this and other countries it is absent unless transported there by human beings.

While the typhoid germ has never been known to affect animals, especially cattle, tuberculosis may be conveyed to human beings by using milk from a tuberculous cow.

No doubt tuberculosis is most commonly disseminated by the **expectorating** of consumptives upon floors and sidewalks, where the sputa dries and is ground up into dust and blown every-

where to be breathed in by susceptible persons, who sooner or later develop consumption of the lungs or tuberculosis of some gland, joint or bone. A number of cities have already passed ordinances which prohibit expectoration upon the sidewalks and in public buildings and conveyances.

The question of quarantining consumptives is being agitated by the boards of health of some of the western states. In fact, California has already taken steps to prevent consumptives entering the state.

It should be remembered that what was formerly called Scrofula, white swelling, hip joint disease and Potts disease of the spine, are only other names for that disease, which when it attacks the lungs we call consumption or pulmonary tuberculosis. The same germ causes all of these conditions to which in the past different names were given. Bone, joint and glandular tuberculosis come within the domain of the surgeon. Under no other circumstances is surgical cleanliness more necessary than when operating upon any part affected with tuberculosis. If absolute surgical cleanliness is not secured during the operation and maintained after it, the wound is not likely to heal. In no other place do pyogenic germs flourish so readily as in tissues affected with tuberculosis. Iodoform restrains the growth of tubercular germs as well, if not better, than any other agent.

CHAPTER III.

STERILIZING.

Thus far we have explained the importance of Surgical Cleanliness and showed the relation between certain germs and certain diseases. We have also indicated what constitutes Surgical Cleanliness and made a few suggestions as to securing it. We shall now enter into the details.

We have already stated that no germ of disease can survive contact with boiling water. This is absolutely true in case of all pus forming germs, but it is not quite true in the case of spore forming germs. Boiling water will destroy the adult germs, but the spores will sometimes survive even boiling water. This is true of the germs of tuberculosis. In order to kill the **spores** and to render water absolutely sterile, it is necessary to boil the water three times on different days. On the first day the water is raised to the boiling

point for half an hour and then allowed to stand in a warm room, which gives the spores an opportunity to develop into adult germs. On the second day the water is boiled again and allowed to stand in a warm place. On the third day the process of boiling is repeated for the purpose of destroying any spores or germs that may have survived the second boiling.

Water thus treated is spoken of as "thrice boiled" and may be considered absolutely **sterile.** After water is rendered sterile by the three boilings great care must be taken to keep it sterile by putting it into closed vessels, which have been previously sterilized. Every operating room should have two or three large vessels full of sterilized water. A tin wash boiler with a tight fitting cover will answer for a vessel, although large glass jars with ground glass covers are now made for the purpose.

After the hands have been thoroughly sterilized with chemicals, sterilized water may be used to cleanse them from the chemicals. Again, the sterilized water may be used to wash off the chemicals from the field of operation. The greatest use for sterilized water is in washing an aseptic wound. One in which there are no poisonous element, but needs to be washed out for the purpose of clearing away the blood, so that the operator may inspect it thoroughly. However sponging the blood away with pieces of sterile

gauze is more popular now than irrigating with sterile water. During the operation the surgeon has often occasion to wash off the blood from his hands. Here again the sterilized water should be used, provided the hands have not become infected by touching something not surgically clean. In case they have become surgically unclean he must go through the usual process of sterilizing his hands, finally washing them in sterilized water.

This naturally brings us to the question, how can the hands be **sterilized?** If we could immerse them in boiling water and keep them there ten minutes, it would be a simple matter. This being physically impractical we must consider other means. Two or three different methods of sterilizing the hands are in vogue. The most common one is as follows:

Scrub the hands with soap and very warm water for five minutes. The scrubbing should be done thoroughly with a good brush, green soap or old-fashioned lye soap, such as our grandmothers used to make, is the best. Next, the hands should be washed with ether, for the purpose of dissolving any particles of fat or grease that may remain. The finger nails should be thoroughly cleansed while scrubbing with the soap and water. Next, the hand should be immersed for a minute or two in a solution of bi-cloride of **mercury** in the proportion of one to one-thousand, after which the hands

may be rinsed in sterilized water, for the purpose of washing off the extra amount of the chemicals. The laboratory tests show that bi-chloride of mercury is the most powerful antiseptic agent known; yet two facts regarding it should be kept in mind. It will not penetrate grease or fat; and that this chemical does not distribute equally over the surface. In some places there will be a collection of the chemical, while in others there will be none. Ether must be used to remove the fat and grease before it is practical to use the bi-chloride. The second objection may be overcome by immersing the hand just before using the bi-chloride in a solution of ammonia and borax. This will cause the bi-chloride to be equally distributed over the surface of the skin. A common salt solution will do the same.

Another method which is very common and much more practical, is to scrub the hands with soap and water thoroughly for five minutes and then immerse them in a five per cent solution of **carbolic acid** A solution of this strength of carbolic acid gives an unpleasant biting sensation and may be followed by dizziness. While carbolic acid is far less powerful as an antiseptic than bi-chloride of mercury, it is far more practical, because it readily penetrates fatty substances and uniformly distributes itself over the surface of the skin. Carbolic acid was the first surgical antiseptic employed by Lister. The laboratory test

by Koch showed bi-chloride of mercury so much more powerful than carbolic acid that surgeons for a while showed a preference for the bi-chloride. Later the two objections to the bi-chloride which we have mentioned were discovered; besides another, namely, its poisonous effect upon the wound. Cases of general poisoning have resulted from its use; besides death to some of the tissues of the wound. Recently carbolic acid has been more in favor; it is also open to the same objection of sometimes causing destruction of tissues and general poisoning. A New York surgeon states that he has been obliged to amputate several fingers, which were in the beginning slightly injured but dressed with too strong a solution of carbolic acid. The excessively strong solution of the carbolic acid caused gangrene of the fingers.

The Weir method is highly recommended by some. We have found it hard on the hands. After the usual scrubbing with hot water and green soap place in the palm of the hand a scant tablespoonful of commercial cloride of **lime,** than nearly as much washing soda, add water and rub until the mixture resembles thick cream. Rub it into the palms, hands and arms until all particles of lime disappear or until a sense of coolness occurs, which will be felt in usually four minutes. Rinse the hands in sterile water, when they are said to be surgically clean.

There is another method that we like best of all. It has stood the crucial bacteriological test. We mean by this that when this method has been employed, scrapings from the hands placed in a culture medium will not grow germs. The method is as follows: Scrub the hands for five minutes with very warm water and green soap, as in the other methods, then immerse the hands in a saturated solution of **permanganate** of potash, until they are colored to a mahogany brown. Next, immerse them in a saturated solution of oxalic acid until they are decolorized, and lastly in sterilized water, when they may be considered absolutely sterile.

There is still another method of rendering the hands surgically clean. It consists simply in scrubbing the hands very thoroughly with green soap and very warm water, and then bathing them with **alcohol** We know a surgeon who performs perhaps twenty operations a week and uses no other means for cleansing his hands. He tells us that he gets good results. This is certainly the simplest of all the methods we have enumerated. He objects to the frequent use of the bi-chloride of mercury, because it roughens the hands. This last method, however, will not stand the bacterilogical test which should be our guide in choosing a method of sterilizing the hands.

A young medical student, who knew but little about surgical cleanliness, was asked by his pro-

fessor to wash his hands until they appeared to be clean. The professor then scraped off a little of the epidermis from the student's hands and placed it in a culture medium. In about three days there was a luxuriant growth of germs. As already suggested, special care must be given to the finger nails. The nails should be evenly trimmed. The nail cleaner and nail brush should be conscientiously used.

After the hands are once sterilized they will readily become surgically **unclean,** unless great precautions are taken. The tendency is great to touch something unclean. For instance, the scratching of the head, the smoothing back of the hair, taking hold of the table or chair, or the clothing of the patient, or the shaking of hands with a visitor, or rubbing against some one, or against one's own clothing, or wiping the nose with a pocket handkerchief. The latter is an article that is especially filthy from a surgical standpoint. All of these things must be avoided. After the hands are once surgically clean, the motto should be, "Touch not!" A sterilized surgical gown entirely covering the clothing should be put on. This will protect the hands from one's own clothing.

Next in order is the sterilizing of the instruments. So far as the metal instruments are concerned it is an easy matter for they can be boiled, and as already stated, boiling water destroys all

pus germs. If carbonate of soda be added to the boiling water in the proportion of 1 per cent, it will not only increase the disinfecting power of the boiling water, but it will prevent the instruments from **rusting.** This is a valuable point that should not be forgotten, for if instruments are put into cold water without the soda they will often rust within an hour. The common washing soda will answer the purpose. After the instruments have been in the soda solution they are easily polished. Five minutes of boiling will thoroughly sterilize the instuments, provided the water contains soda. After instruments have been boiled some are in the habit of keeping them in a solution of carbolic acid throughout the operation. Instruments should never be put into a solution of bi-chloride of mercury, because it will **corrode** them.

The next link in the technique of performing an aseptic operation is the preparation of the **field** of operation. It is scarcely necessary to state that the skin over the area to be operated on must be thoroughly scrubbed with soap and warm water, washed with ether and then with bi-chloride of mercury, in the proportion of one to one thousand and finally with alcohol. In case of an operation upon the abdomen, a poultice of soap is sometimes placed over the abdomen and allowed to remain for a number of hours. Sometimes a compress wrung out of a carbolized solution ranging from 2

to 5 per cent is bound over the field of the operation and allowed to remain until the surgeon is ready to use the knife. I have seen the skin blistered from using these drugs too strong or leaving compress on too long. The skin should be examined at the end of two hours. If there is any hair over the parts to be operated upon it should be shaved off before the compress is applied. When time permits, it is customary to prepare the field of operation the day before, and then apply one of the compresses we have mentioned and allow it to remain until the patient is upon the operating table. The part is then again thoroughly washed with soap and water, next with ether, then with bi-chloride and finally with alcohol.

What we have said before in regard to **unequal distribution** of the bi-chloride should not be forgotten. This may be prevented by washing the parts with a solution of ammonia and borax before applying the bi-chloride. If the wound made by the surgeon is aseptic, that is, if it is free from germs or other infective substances, it should be irrigated with nothing but sterilized water prepared in the manner stated in the preceding chapter, or sponged with pieces of sterilized gauze. If the wound is septic, then it may be irrigated with a solution of bi-chloride of 1 to 4,000 parts, or a 2 per cent solution of carbolic acid. In this connection we should state the fact that a solution of

bi-chloride as weak as 1 to 10,000 will cause tissue necrosis in a fresh, aseptic wound, that is, it will cause some of the cells in the walls of the wound to die, a condition of things that is not desirable.

A number of other chemicals may be used to irrigate a septic wound. Boric acid, acetate of aluminum and certain preparations of silver. The last are coming into favor and are likely to supercede all others. The antiseptic power of certain products of **silver** is very great. It has the advantage of being less harmful than the bi-chloride of mercury. It is a fact that certain bacteria will not grow in water contained in a silver cup. **Formalin** is increasing in popularity. The claim is made that it is the most powerful of all antiseptics and that it is not poisonous. In cases of aseptic wounds it is best not to irrigate at all. Instead of using a solution to wash away the blood, sponge the wound with dry sterilized gauze until all bleeding is stopped and the wound is free of blood. It seems to us that the washing of a clean wound even with sterilized water must have a deleterious effect upon the tissue cells most exposed. It surely washes away a part of their nutrition.

It is a common poetical statement, "that life sometimes hangs by a single thread." In surgery it is often a reality. The thread or **suture material** may be the factor in determining the fate of a patient. It is scarcely necessary to say, that

whatever substance is used for the stitches it must be surgically clean. If the suture material is silver wire it can be readily sterilized by boiling it. If it is silk thread it may be treated in the same way, but if the suture is made from some animal substance, such as cat gut, silk worm gut or kangaroo tendon, it cannot be boiled without destroying its usefulness. Silver wire is but little used at the present time. The chief objection to it is the fact that it has to be removed. The same objection applies to silk thread, although it is possible for both of these to remain deeply imbedded in the flesh without causing any disturbance. Silver, we have just noted, has great antiseptic power. Therefore, it is not likely to cause stitch abscesses. It is non irritating and has great strength. We saw exhibited in University Hospital, London, an X-Ray picture of a silver wire suture which had been in the knee five years and caused no annoyance.

Cat gut is made from the intestines of sheep. The best cat gut is said to come from Germany in the form of violin, guitar or banjo strings. Cat gut slips easier than silk and requires more care in tying. Cat gut is more irritable and less durable than silk. Chromicized cat gut however does not absorb under ten days. Cat gut prepared with formalin may be weeks in absorbing. Cat gut being an animal substance cannot be boiled in water without destroying its usefulness. It may

be boiled in ether or alcohol to remove the fat it normally contains. It has been stated that cat gut boiled one hour in alcohol is more servicable than when prepared with chemicals. In all methods of preparing it cat gut is usually treated first with ether to remove the fat. Then it is preserved in some germicidal substance or it is subjected to moist or dry heat to such a degree as will destroy all germs which are always found deep in its substance when it comes from the manufacturers. Placing pieces of cat gut about twenty inches long in double envelops and then baking them in an oven heated to about 350 degrees F. is a method that is growing in popularity. The nurse or assistant removes the outer envelop without touching the inner one which is opened by the clean hands of the surgeon. Thus infection of the cat gut is avoided.

Silkworm gut is sterilized by boiling. It is firm, smoothe, and not likely to become infected. It should always be used in closing wounds of skin where the least scar possible is desired, especially upon the face where regard is had for cosmetic results. Stitch abscesses are not likely to follow its use. It does not absorb. **Horse hair** stands next to silk worm in closing cutaneous wounds. It may be sterilized by boiling.

Cat gut ordinarily absorbs within four or five days and for this reason does not have to be removed. This **absorbable quality** makes it

very desirable. The great disadvantage that it has is the difficulty of sterilizing it. Perhaps a hundred different methods have been suggested. Many of them will stand the bacteriological test in the laboratory, but after they have been buried in the living tissues a number of days, suppuration will take place around them and we have stitch abscesses. A single stitch abscess may cause entire failure of an operation. The most approved method at present is to keep the cat gut in a solution consisting of 1 part iodoform, 2 parts ether and 7 parts alcohol. The solution should be in a wide mouth bottle or glass jar with an air tight cover or stopper. The cat gut should be in the solution at least a week before it is used. It may, however, be kept in solution almost indefinitely. Cat gut kept in carbolized oil will not always stand the crucial test.

If drainage tubes are used, they must, of course, be thoroughly sterilized, whether they be of rubber or of glass. This may be accomplished by boiling in a one per cent soda solution. If a gauze drainage is used sterilized iodoform gauze is best and most commonly used. After the wound is sutured the line of incission should be dusted with iodoform powder and over this should be laid iodoform gauze or plain aseptic gauze. Over this may be placed a layer of cotton and again other layers of plain gauze, and finally the roller bandage to retain the dressing in place. Iodoform, however, is being succeeded by less odoriferous agents.

It is essential that all dressings of a wound should be aseptic. **Gauze** and **bandages** are readily sterilized by boiling. But after the boiling it requires a great deal of care to dry them without their becoming re-infected by the germs transported by the dust of the atmosphere or by contact with unclean tables, vessels or hands.

We recently saw on exhibition at the surgical instrument store of Truax & Co., Chicago, an apparatus costing about one hundred and seventy-five dollars which not only boils or steams the gauze but also dries it without removal from the cylinder in which it is placed. Only a few can afford the luxury of such an apparatus. There are however a number of sterilizers on the market costing less than twenty dollars which steam the gauze or linen until it is thoroughly sterile, and finally leaves it dry. New and improved sterilizers are being constantly placed upon the market. The general principle in all is the same. In cases of emergency at a farm house remote in the country we have used the teakettle and dish pan for sterilizers. We have had gauze, linen and towels satisfactorily sterilized many a time by boiling them in an ordinary tin wash boiler.

After gauze is sterile and dry it should be placed in some absolutely clean vessel so that it will not become re-infected. In most hospitals large glass jars having tightly fitting covers are commonly used. In taking the gauze from these it is more

convenient and more cleanly to use a long pair of sterilized forceps than the hands. The linen **operating gowns** worn by the surgeons and his assistants should be sterilized by boiling. After which they should be dried and kept wrapped up in sterilized linen until they are needed.

To prepare **iodoform gauze** several methods are in use, but the simplest way known to us is to thoroughly saturate sterilized gauze with a mixture of ether and iodoform, in which the iodoform is present in the proportion of ten per cent. The gauze is then placed in an open shallow vessel or on a large clean plate and covered with a layer of sterilized gauze to protect it from the dust of the atmosphere. In a short time the ether will evaporate and leave the iodoform evenly deposited upon the fibres of the gauze. When it has become dry it should be preserved in clean and tightly closed vessels. Before it is stored away it may be rendered still more antiseptic by immersing it in a solution of bichloride of mercury in the proportion of one to one thousand. It should never be forgotten, however, that this last agent is a powerful poison. We have no doubt but that it will soon be supplanted in surgery by formalin or some of the other newly discovered antiseptics which are equally or more effective as an antiseptic and less poisonous.

To prepare a 10 per cent iodoform gauze, the following has come to our notice since writing the

preceding: Take by weight 50 parts gauze, 40 parts glycerine, and 10 parts iodoform, add 200 parts of alcohol, and 100 parts water, mix well. The alcohol and water will evaporate. The glycerine and iodoform will remain in the gauze. This method is accurate and the iodoform is not changed by the presence of ether as in the preceding method. The most suitable gauze weighs one ounce to the square yard.

Boric acid, carbolic acid and other agents may be incorporated into gauze by saturating sterilized gauze with a solution of any one of them and then allowing the liquid portion to evaporate. As already stated, iodoform gauze is more commonly used at present. Its germicidal power is small, its **drying** quality however is great. This accounts for the fact that while pus germs may continue to live in iodoform they do not thrive. The biniodide of mercury has several advantages over the bi-chloride of mercury. It is said to be less poisonous, less likely to precipitate and more powerful as a germicide.

If our surgical operations could always be absolutely free of all pus germs then there would be no occasion to use antiseptic gauze or any antiseptics. In fact many surgeons now use but little if any antiseptics, but they are **scrupulously** clean. Simple, plain aseptic gauze would answer all purposes and would be idealy consistent with our theory of perfect aseptic surgery. So long as

it is practically impossible to do an absolutely aseptic operation, that is an operation in which not a single germ remains in the wound or in the dressings, it will be more satisfactory to use antiseptic gauze, that is gauze which has been impregnated with one or more of the various antiseptic agents.

CHAPTER IV.

REDRESSING.

If a wound is aseptic, if the sutures are aseptic, if the dressings are aseptic, a **redressing** will not be necessary under ten days. The symptoms calling for a change of dressing is a rise of **temperature,** increase of **pain,** an increase of **moisture** and **odor.** So long as there are none of these no change of dressing is needed, and no change should be made at least within **nine** days, the time required for wounds to heal under the most favorable conditions.

In case a wound is not clean as shown by the symptoms just mentioned, the sooner it is dressed the better. It must be redressed at least once a day thereafter. In some cases it is imperative to dress an infected wound two or three times a day. This is especially true where pus is burrowing into the neighboring parts and destroying tissue that should be saved. After the dressing

is removed and as much matter as possible is wiped away by means of dry sterilized gauze, the wound should be washed with a warm sterilized normal salt solution, that is, warm sterilized water with about one teaspoonful of salt in each pint of water. We have just read, that recent investigators find that the blood serum contains nearly one per cent salt instead of seven parts to the thousand, as we have been taught heretofore. If this be true, we should make a normal salt solution nearly one per cent salt; that would require almost a teaspoonful and a quarter to the pint. The normal salt solution is rapidly superceding solutions of carbolic acid, bi-chloride of mercury and other chemicals for irrigating and douching purposes. Yet, there are cases where we may resort to these poisonous agents with satisfaction.

While speaking of normal salt solution we must digress long enough to call attention to the great value of this agent in case of shock and excessive hemorrhage. Many a person well nigh pulseless from loss of blood and death seemingly inevitable, has been revived speedily by simply injecting under the skin from one to two quarts of normal saline solution. The method of introducing it is as follows. In the end of the tube of a fountain syringe tie a large hypodermic needle. Fill the syringe bag with normal salt solution at temperature of 100. Insert the needle in the loose folds of skin, particularly under the breast. Avoid in-

jecting air. Unless surgical cleanliness is observed troublesome abscess may follow where the needle entered.

We can recall a number of cases of surgical shock, hemorrhage, congestive chill, blood poisoning, revived and in all probability saved by injecting normal salt solution. This agent is used by many surgeons in washing out the abdominal cavity after it has become infected by the rupture of an internal abscess, or in case of purulent peritonitis. A distinguished surgeon has just reported the recovery of an apparently hopeless case of purulent peritonitis. He attributes her recovery to the fact that during the first seventy-two hours after the operation in which he opened the abdomen, he caused three hundred gallons of warm normal salt solution to run into and out of the abdominal cavity, thus keeping its contents bathed continually with it.

One of the most useful agents in cleaning a wound of pus is **peroxide** of **hydrogen.** It is not poisonous. As soon as it comes in contact with pus it sets up an efferversence resembling the foam on soda water. The pus corpuscles are actually consumed by the peroxide of hydrogen. A chemical union occurs which disintegrates the pus. If there is any objection to the use of peroxide of hydrogen it is the quality of being slightly irritating. We can remember when this agent was introduced into surgery about fifteen

years ago. Before that its only commercial use was to bleach the hair of actresses.

While speaking of the abdominal cavity and its contents we will here digress again a little to state a most important caution. The medical journals are just now discussing the case of a distinguished surgeon who has been sued for $10,000 damages, because a sponge was overlooked and sewed up in the abdomen, causing the death of the patient. It may be surprising to our readers, but nevertheless this is a very common mistake. Not only sponges, but scissors, forceps and other instruments have been employed during an abdominal operation and left inside by mistake. We attended a convention of gynecological surgeons once during which this oversight was discussed. More than twenty-five of such mistakes were confessed then and there. The unfortunate surgeon who has recently been sued defends himself by stating, that it was the duty of the surgical nurse to count the sponges, and that when he was ready to close up the abdomen he asked the nurse the usual questions. Have you counted the sponges? Are they all out? She answered in the affirmative and he closed the wound. The trial of this case will probably determine to what extent the nurse is responsible. Must she bear a part of it or must the surgeon bear all the blame?

There are several **places** upon the body where special attention to surgical cleanliness is of very

great importance. For instance, an infection of the eye requires prompt and constant attention to make it surgically clean. The **eyes** of a large per centage of new born infants become infected during the first or second week after birth. If they are not treated promptly with a view to secure surgical cleanliness the sight of one or both eyes are often lost. A thorough knowledge of this subject would have made blind asylums hardly necessary. In some countries stringent laws have been passed in regard to the care of the eyes of the new born. One advanced practitioner tells us that he washes out the eyes of every infant soon after birth with a two per cent solution of nitrate of silver. It is a safe practice for the nurse or mother to wash out the infants eyes with a two or three per cent solution of boric acid. Especially should this be done upon the slightest appearance of a discharge from the eye.

A discharge from the **ear** is often followed by serious concequences if surgical cleanliness is not observed. The cleaning of the ear is not an easy matter. Some are opposed to throwing any kind of a solution forcibly into the ear. If the head be placed on the side with the affected ear upward there cannot be any very great risk in pouring into the ear a warm medicated solution of glycerine. Pure or medicated glycerine being heavy will cause the pus to rise to the surface and float out. Incidentally we would say that one of the most

effective applications for relief of acute earache is to pour into the ear a solution consisting of one part carbolic acid and nine parts glycerine. Boric acid powder is often blown into the ear to dry up a discharge. This is open to the serious objection that the powder sometimes forms a crust and blocks the escape of the pus. Instead of aiding the egress of the matter the result is the opposite. The pus is forced to burrow in some direction that may cause serious complications, for instance into the brain.

It is a frequent occurrence for an abscess to form at the root of a **tooth** and spread into the neighboring tissue, causing much damage. It is safe to say that if the mouth could be kept always surgically clean we would have no such abscesses which often follow down the lymphatic channels into some gland of the neck, causing it to swell up and break down from suppuration.

The **tonsil** is often the seat of an abscess which is called suppurating tonsillitis or "quinsy." Pus germs lodge in the crypts of the tonsils. A chilling of the neck or whole body is followed by a congestion, which puts the tonsils in a favorable condition for the development of abscess and other troubles far more serious. Suppurative endocarditis and death have followed abscess of tonsil. Many troubles called rheumatism have started with suppurative tonsilitis. It is now believed, that the pus from the tonsil gets into the lym-

phatic channels and is carried into the blood vessels and heart. Sudden death during diphtheria is a common occurrence. It is credited to heart failure. The cause no doubt is the absorption of the germs or their toxins into the circulation.

A disinfecting of the throat becomes an important matter. Many agents have been used. Alcohol and water in equal parts is a simple and convenient gargle. It is believed to possess great merit. Seilers tablets make a good, mild gargle. A grain of permanganate of potash in a glass of water is a very excellent disinfecting gargle. It possesses much merit and has stood the test of long usage. A combination of salt, water and vinegar is a domestic gargle which stands well the light of modern science. We have already discussed the value of salt water in surgery.

As for **vinegar** it has been shown to possess considerable antiseptic power. One eminent anthority has gone so far as to say that it is as powerful as bi-chloride of mercury. It is related that once upon a time during a cholora epidemic two men robbed the clothing of the dead with impunity, so far as taking the disease. The secret of their immunity was said to have been due to the fact that each morning before going out upon their ghoulish expedition they bathed their entire bodies with vinegar.

A one per cent solution of carbolic acid makes a useful gargle. One of the most effective and at

the same time one of the most dangerous to use as a gargle, is a solution of bi-chloride of mercury. It should not be used in the throat stronger than **one** part in **ten** thousand. We have known nurses to use it successfully to gargle their own throats, while nursing cases of diphtheria.

The disinfecting of the **stomach** does not conform to the usual rules of disinfection. A normal stomach disinfects itself. The free **hydrochloric** acid which is normally present in the gastric juice is a natural antiseptic, and when the stomach is in a healthy condition it keeps the stomach in pure condition. When the stomach becomes over loaded or when by disease the gastric juice becomes abnormal, disease germs may exist in the stomach. It is at once apparent that poisonous chemicals cannot be used to cleanse the stomach. Much can be done towards cleaning the stomach by washing it out with plain water, or water containing a small quantity of boric acid or bicarbonate of soda. The stomach tube consists of a rubber tube, about three eight of an inch in diameter and about two feet long. The upper end of the tube is expanded into a funnel so that water can be readily poured into the tube. The tube is lubricated; the best substance for this purpose being the white of an egg. The small end of tube is placed far back into the patients mouth and told to swallow it rapidly. This is usually accomplished after a little urging on the part of the physician or nurse. As

soon as it is inserted, the fluid is poured into the funnel end of the tube. When it is desired to evacuate the stomach after it is filled with the washing fluid, the funnel end of the stomach tube is lowered beneath the level of the stomach. Thereupon the contents of the stomach is at once siphoned out.

Strong antiseptics should not be used in the **rectum,** because they are likely to be absorbed and cause general poisoning. We saw one case and have read of others, where a strong carbolized solution injected into the rectum was followed by a sort of a convulsion and unconsciousness.

Stronger antiseptics may be used in the **vagina.** Yet some persons are very sensitive to chemical poisons used in a vaginal douche. We recall a case where a solution of bi-chloride in the proportion of 1 to 4000 was followed by salivation, or at least marked ptyalism. A solution of 1 to 8000 of bi-chloride of mercury is sufficiently strong to use in a vaginal douche. Boric acid, carbolic acid, permanganate of potash as well as many other antiseptics may be used in the vaginal douche. In case of genorrhæal infection the permanganate of potash solution in the proportion of one grain to the pint, or a little stronger, gives good satisfaction.

There is one antiseptic which we have neglected to emphasize and that is **mustard** flour. It has the advantage of being a vegetable instead of a

mineral, as nearly all other antiseptics are. It is not poisonous. It is said to be nearly as powerful as bi-chloride of mercury. It can be mixed in water and used to wash the hands, or it can be used as a douche. It could be used in the stomach. In fact, it is the only powerful antiseptic that we could safely use in the stomach. A number of successful surgeons use nothing else but mustard flour water in which to sterilize their hands.

Speaking of **vegetable** antiseptics reminds us of another one, and that is **turpentine.** It has really great antiseptic power. The late Mr. Tait, the world's most famous gynecological surgeon, condemned antiseptics but we recall the fact, that he used turpentine quite freely in washing his hands and for other purposes.

The disinfection of the **bladder** is often necessary. It can be disinfected by giving the patient four times a day a cup of warm water to drink in which is dissolved from five to ten grains of boric acid. This way is very easy and generally satisfactory. It is surprising how quickly the foul ammoniacal odor of the urine disappears after this treatment is begun. The boric acid escapes through the kidneys.

There are cases in which it is necessary to wash out the bladder. Here again, a solution of boric acid is about the only antiseptic we can safely employ in washing out the bladder. Three teaspoons ful of boric acid may be dissolved in a quart of

water. This will make approximately a one per cent solution. A weak solution of iodine may be used in some conditions of the bladder, especially tuberculosis.

There remains still another place upon the body where surgical cleanliness will save a vast amount of suffering. We refer to the **nipples** of nursing women. Abscess of the breast is always caused by an infection. The pus germs find entrance through some abrasion or irritation about the nipple. If the breast is left surgically clean it will be impossible for a woman to have a "broken breast," one of the most painful affections known to women. Before and after the child nurses the nipples should be cleansed. **Before** the child is ever put to the breast, the nipples should be cleansed with soap and water. Then washed with a boric acid solution and finally washed with alcohol.

The wearing of thin **rubber gloves** while operating is gaining favor with surgeons. If the gloves are thoroughly sterilized, which can be readily done by boiling, no infection can possibly occur to the wound from the operators hands. We know of one very successful surgeon, who will not operate without gloves and will not permit any one to assist him who does not wear them. Knowing how difficult it is to sterilize the hands and how much labor it takes to teach assistants how to sterilize their hands, we must endorse the

position this surgeon has taken, but gloves are not always at hand and they are expensive. Besides they are likely to be ruptured in the midst of an operation. The **finger nails** should receive great attention as to cleanliness. They should be manicured often. In the debris under the finger nails is a favorable place for pus germs. It is scarcely necessary to say, that the **operating room** should be clean and free from dust. It is a fact that pus germs are not very abundant in the dust of the atmosphere. If the floor is washed with an antiseptic solution a half hour before the operation there cannot be much dust stirred up, and the dust previously in the atmosphere will be largely precipitated to the floor and held there by the moisture.

Laughing, coughing, sneezing and unnecessary talking should be avoided in the operating room. There are very few persons whose mouths are so clean as not to have some decayed teeth with ulcerating roots and abscesses of the gums. Unless care is taken a small particle of saliva laden with pus germs might easily be thrown from the mouth into the wound. The operator and his assistants should avoid breathing into the wound. Few surgeons can perform a major operation without **perspiring** freely. Care should be taken that the perspiration does not drop from the surgeons face into the wound. A watchful nurse will see that the perspiration is wiped away

as often as necessary. It is well to cover the hair and beard with gauze to guard against infected particles falling from them into the wound.

It seems almost unnecessary to state that spectators with unsterilized hands and unclean clothing should keep away from the operator and his assistants. Yet this caution is necessary. We have seen intelligent persons who would be supposed to know better rub up against the surgeon or his assistants wholly unmindful that they were risking the success of the operation.

The Sterilization of Catheters and Bougies.

Nicoll gives the following directions for the sterilization of catheters and bougies:

Bougies.— Gum-elastic bougies will not bear heating to a temperature sufficient for sterilization. Soaking for fifteen minutes in carbolic acid solution 1 in 20, for half an hour in 1 in 40, or for an hour in perchloride of mercury 1 in 1000, renders the surface so sticky that the towel adheres in the process of drying, and the bougie becomes covered with fluff. After several soakings the surface becomes permanently dull and sticky and unfit for use. Dr. Schimmelbusch says that "a smooth bougie or catheter can mechanically be made externally free from germs by rubbing it with a piece of sterilized gauze and warm water."

To test this, series of six gum-elastic bougies in use from six to eighteen months, after being employed in cases of stricture, were washed with tepid water and soap, rinsed in cold running water, and dried by thorough light friction with sterilized gauze. They were then rubbed on the surface of acid and alkaline agar tubes. In one case colonies of an unidentified coccus appeared, in another a patch of penicillium. The other ten tubes remained sterile. Six bougies soiled with pus were similarly treated; all the tubes remained sterile. In other experiments instead of the gauze an ordinary towel fresh from the laundry was used, and similar results were obtained. It appears, therefore, that antiseptic solutions which rapidly destroy instruments are unnecessary for sterilization.

Catheters—Red rubber catheters (Jacques) may be sterilized by boiling or steaming, or may be soaked for months in carbolic solution, 1 in 20, or perchloride of mercury, 1 in 1000, without damage. A rubber catheter may be used daily for six months without becoming unfit for use, if washed every day with hot water and soap and put to soak in carbolic lotion for the remainder of the twenty-four hours. But there are certain red rubber catheters which rapidly deteriorate under repeated boiling, and all rubber catheters ultimately do so. Prolonged and repeated soaking in antiseptics has little effect. By experiments the

writer has proved that rubber catheters, boiled, steamed or soaked for four hours in the lotions mentioned, are rendered sterile internally and externally. But gum-elastic catheters, like bougies, will not stand the lengthened and repeated soaking necessary for sterilization. There is no entirely reliable method. For practice the writer has formulated the following rules:

1. Avoid as far as possible the employment of catheters. In cases of stricture it can only be very exceptionally that a catheter is called for. Bougies, which are readily sterilized, will do all that is necessary. 2. Where a catheter must be employed, use where possible a red rubber Jacques catheter in preference to a gum-elastic. In retention from atony, spinal paralysis, reflex nervous effects and other causes, and in many cases of prostatic retention, the former answers as well, and is as readily sterilized by boiling or immersion in an antiseptic solution as is a metal catheter. 3. Where the red rubber fails to pass, the use of metal catheters, especially by the patient, does not commend itself as free from risk of injury.

Gum-elastic catheters must therefore be used. If the urine is very septic the writer destroys the catheters used. If the urine is not very purulent or offensive, he washes the catheters externally with soap and water, and then with antiseptic solutions, which is followed by internal steaming. Those that survive he retains. When the regular

use of a gum-elastic catheter is necessary, the patient is supplied with a catheter with a well-finished interior. After use he thoroughly washes it, holds it under the tap for a few minutes and lays it aside in boric acid, weak perchloride, or other weak antiseptic. This only offers a reasonable chance of asepsis, but it is useless to expect an average patient to carry out more elaborate plans. The writer has had glass tubes constructed, which are filled with the antiseptic solution, in which the catheter is placed after use. The solution varies in strength according to the kind of catheter; for gum-elastic catheters it must be weak, red rubber catheters will stand anything.

Preparation of the Abdomen for Operation.

The following procedures are carried out in the John Hopkins Hospital in the preparation of the abdomen for operation:

On the day before the operation the ward nurse, using a gauze mop, washes the skin with green soap and water. With disinfected hands she then washes the area with alcohol, ether and mercuric bichloride solution (1: 1000). A large sterile gauze shield is then laid over the cleansed part, this being held on with tapes. In the operating-room, after the patient is anesthetized and on the table, the preparation is continued in two stages. The first

stage is done by an assistant whose hands are not necessarily completely sterile. The second stage is done by the assistant with clean hands. The first stage consists in removing the ward dressing, lathering with green soap and water, shaving and flushing; washing with green soap and water, employing a gauze wash-ball; flushing with ether, washing off with sterilized water. The second stage consists in washing thoroughly with green soap and water, using a wash-ball; flushing with ether, flushing with alcohol, and flushing with mercuric bicloride (1: 1000). In those cases with old scarred skins or slight dermatitis, potassium permanganate and oxalic acid are also used. There is then a final flushing with sterile water. This whole process is done in from ten to twelve minutes.

CHAPTER V.

Current Opinions on Disinfection.

At a meeting of the Chicago Medical Society, Jan. 17, 1900, the subject of disinfection was discussed. The following is the essence of the conclusions and present opinions of several eminent surgeons who took part in the discussion:

For mental, physical and antiseptic reasons the patient should enter the hospital 24 to 48 hours before the operation. The preliminary steps in disinfection is **mechanical,** consisting largely of rubbing away masses of loose epidermal scales to which germs are attached. This is best accomplished by soap and warm water applied with a stiff nail brush. All agreed that too much confidence is placed in so called antiseptics. All of which are more or less poisonous, and if used in sufficient strength to kill germs, will injure the tissues. A general bath should be the first step in preparing a patient for the operation. Schleich's

marble dust soap was recommended as better than green soap. It should be used with a piece of sterilized gauze and not with a brush.

Rubber gloves were recommended. They should be prepared as follows: Wash in- and outside with a 10 per cent solution of sodium carbonate. Rinse in sterilized water, dry for one minute over a gas flame, reversing. Dust inside liberally with sterilized soap, shoe powder. Wrapp in double layer of sterilized gauze and put in a formaldehyde sterilizer for two hours. Then lay away wrapped in sterilized towels labeled with size and date of sterilization. This method of sterilizing gloves has been found to be superior to all others. Repeated and numerous tests for germs even two weeks after this method has been employed has revealed no germs in the gloves.

In dry operations woven gloves have a place. **Cotton** is safer than **silk,** but neither compares with rubber. Cotton gloves are cheaper than rubber. Cotton gloves may be used in both aseptic and septic operations. In the former to protect the patient from being infected by unclean hands, and in the latter condition to protect the operators from being inocculated with septic matter. Numerous bacteriological tests of the inside and of the outside of cotton gloves, after operations, showed that the operator's gloves were infected on the inside in two thirds of the cases, while the inside of the gloves worn by the nurse, who handed

instruments, ligatures, sponges and dressings to the operator, were not infected at all. Illustrating the fact that the exertions and perspiring of the operator brought the germs to the surface through the sweat glands, which was not the case with the hands of the nurse who was comparatively inactive.

Theoretically it is well nigh impossible to thoroughly and absolutely sterilize the skin of the patient or that of the operator. Practically it is an easy matter to secure a degree of surgical cleanliness that will insure healing by first intention. Theoretically strong chemical disinfectants are required for the purpose of sterilizing the hands, but practically careful washing with the mildest soap and water, following with a rinsing with alcohol is absolutely sufficient and very much safer for the patient, because hands roughened by the use of strong antiseptics are much more likely to become hopelessly septic, than those that are covered with smoother, healthy skin. It is easy to keep the hands sterile, after they have once been rendered aseptic. And yet, no task is more difficult in a surgical clinic than to keep all hands interested clean.

Deep stitches through the skin make a direct communication for the germs in the skin to pass into the deeper aseptic tissues. But such stitches never cause infection, so long as they are not drawn too tight. Tension causes pressure necrosis,

that is, the nutrition is cut off by pressure, and death of the part follows, making a fertile soil for the development of the germs, to result in stitch abscesses or something more serious. Cat gut stitches are safe if not drawn too tightly. Theoretically a surgeon may sterilize his hands after dressing pus cases and operate immediately upon clean cases, but practically such a custom is followed by bad results through accidental infection. In spite of the greatest care, something that was used in connection with the unclean cases will accidentally come in contact with the skin. It is better therefore to operate upon clean cases first, and dress or operate upon the unclean ones last. The surgeon and his assistant should be careful not to breathe or speak into the wounds.

Whenever drainage is used in clean wounds it should be removed within twenty-four hours. If it is done this early, infection is not likely to occur from drainage. The peritoneum is rarely if ever infected from the air. In some cases of peritoneal infection the abdomen may be filled with normal salt solution, and so dilute the poisons as to tide the patient over the danger point. The peritoneum is more likely to be infected from the surgeon's hands or the patient's skin. Blood clots can be removed from the peritoneum better by a dry aseptic sponge than by an irrigating fluid. Intra-venous injection of normal salt solution is the best method of treating shock.

Puerperal Sepsis.

We can think of no more fitting way to close this volume on Surgical Cleanliness than by a brief survey of the steps that have led up to the discovery of the fact that puerperal sepsis and surgical fever or blood poisoning are one and the same. More than fifty years ago, a few medical writers intimated this truth, but they were severely ridiculed and abused by the authorities and leading men of their time. What was hinted at forty years ago has become universally recognized as truth during the last five or ten years.

Dr. Oliver Wendell Holmes's article on "The Contagiousness of Puerperal Fever," in 1843 must ever remain a Classic. The closing paragraph of Holmes's paper was as follows:

"I have no wish to express any harsh feeling with regard to the painful subject which has come before us. If there are any so far excited by the story of these dreadful events that they ask for some word of indignant remonstrance to show that science does not turn the hearts of its followers into ice or stone, let me remind them that such words have been uttered by those who speak with an authority I could not claim. It is as a lesson rather than a reproach that I call up the memory of these irreparable errors and wrongs. No tongue can tell the heart-breaking calamity they have caused; they have closed the eyes just

opened upon a new world of love and happiness; they have bowed the strength of manhood into the dust; they have cast the helplessness of infancy into the strangers arms, or bequeathed it, with less cruelty, the death of its dying parents. There is no tone deep enough for regret, and no voice loud enough for warning.

"The woman about to become a mother, or with her new-born infant on her bosom, should be the object of trembling care and sympathy wherever she bears her tender burden or stretches her aching period. The very outcast of the street has pity upon her sister in degradation, when the seal of promised maternity is placed upon her. The remorseless vengeance of the law brought down upon its victim by a machinery as sure as destiny, is arrested in its fall at a word which reveals her transient claim for mercy. The solemn prayer of the liturgy singles out her sorrows from the multiplied trials of life, to plead for her in the hour of peril. God forbid that any member of the profession to which she trusts her life, doubly precious at that eventful period, should hazard it negligently, unadvisedly, or selfishly."

Holmes's theory that child-bed fever was contagious, and his appeal for surgical cleanliness brought down upon him the severest ridicule of the most brilliant minds of his age. Notwithstanding this abuse, the doctrine of "The Contagiousness of Puerperal Fever" grew. To Hirst

in his excellent work upon Obstetrics we are indebted for the following remarkable narrative:

"In 1846 a young assistant in the Maternity Department of the General Hospital of Vienna, named Semmelweiss, was struck with the frightful mortality in one of the Maternity Wards of the General Hospital, while in a neighboring ward the death-rate was scarecely one-tenth as great. He discovered that in the first ward the women were attended by students who were in the habit of coming fresh from post-mortem examinations in the Pathological Department to the bed-sides of the parturient patients. In the second ward the women were attended solely by midwives.

"Semmelweiss conceived the idea that the students carried on their hands putrid products from the post-mortem table to the lying-in women whom they examined. And that these products were responsible for the large number of fatal inflammations and fevers that followed the student's work. He consequently ordered that no student should examine a woman until he had washed his hands in chlorin-water. The results of his regulation were fairly startling, as is shown in the accompanying table:

	Confinements.	Deaths.	Per Cent.
1846	4010	459	11·4
1847	3490	176	5
1848	3556	45	1·27

"It should be stated that the rule compelling the students to wash their hands in an antiseptic solution was put into effect in the middle of the year 1847.

"Semmelweiss recognized the transcendent importance of his discovery. He foresaw something of the lives preserved, the homes kept from bereavement, the mothers saved to their children, the wives to their husbands, in millions of families; the incalculable diminution of human suffering which his discovery promised to the world; but his was not the calm and confident soul of a Harvey, wise enough to know that the truth is mighty and shall prevail: sure that mankind must accept it some day, and content to bide his time. Semmelweiss' nature was not great enough for such patience. He fumed and fretted his life away in vain efforts to obtain recognition for his great principle of chemical disinfection. He preached his new doctrine in season and out of season, endeavoring to impress it upon his immediate colleagues, and upon the medical societies and periodical medical literature of the time in Europe. During the latter days of his professorship in Buda-Pesth he would even stop aquaintances upon the street to importune them with his views. But he got for his pains nothing but ridicule, contumely, opposition, or indifference. He finally lost his mind entirely, from chagrin and disappointment, ending his life in a lunatic

asylum in Vienna, where he died, strangely enough, from a septic wound on his finger, received during an operation performed just before his commitment to the asylum.

"More than twenty years after Semmelweiss' discovery, the mortality of many lying-in hospitals in Europe remained as high as ten per cent. Then came the brilliant work of Pasteur in the field of bacteriology, the acceptance of the germ theory in disease, the application of antisepsis to surgery by Lister, and the adoption of the system almost immediately by obstetricans. From that day to this there has been a steady and increasingly rapid acquisition of knowledge of the etiology of septic infection, and of its most successful preventive and curative treatment.

"It is to be hoped that the medical world of today and of the future can never again be deaf and blind to such an appeal as that of Holmes, or to such a demonstration as that of Semmelweiss."