

MORTON (T.G.)

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ON THE ANTISEPTIC TREATMENT OF  
WOUNDS.

BY

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CLINICAL LECTURES

DELIVERED AT THE PENNSYLVANIA HOSPITAL ON  
OCTOBER 2 AND 23, 1886.



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ON THE  
Antiseptic Treatment of Wounds.

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OPENING LECTURE.

DELIVERED OCTOBER 2, 1886.

GENTLEMEN,—I have a few cases to present to you this morning which I think will be of interest, but before doing so wish to refer to the method now pursued in the treatment of wounds in this hospital. When I was a resident physician here, more than twenty-five years ago, and during the succeeding years as attending surgeon, the plans of treatment were very different: they were constantly changing, and varied with the convictions or whims of the surgeon on duty, in the hope of securing better results after surgical operations and in the treatment of wounds generally. Does not the very fact that there has been no one well-defined plan followed here or in any other hospital, or by any surgeon, show that no plan was universally acknowledged to be best and that all were more or less unsatisfactory? I can recall cases that were attended with bad results, and many that ended fatally, which under the present

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mode of wound-treatment would unquestionably have recovered, and lives were lost which should not even have been imperilled.

Within the last few years a great change has occurred. The principles of antiseptic surgery as originated and developed by Lister have now become firmly established, and are revolutionizing wound-treatment. This system, as it may now be called, has been so perfected that it has reached a point which permits me to show you to-day results entirely unattainable by any other method.

Antiseptic surgery had never been thoroughly introduced in this hospital until within a comparatively recent period, and this new departure has been effected chiefly through the great interest in the subject and attention devoted to it by two of our resident physicians,—Dr. Charles B. Penrose and my son, Dr. Thomas S. K. Morton. The results of their careful and scientific work have necessitated the general introduction of antiseptic surgery in dressing wounds, whether accidentally inflicted or made by the knife of the surgeon.

To these gentlemen too much credit for perseverance and skill cannot be given. I believe that you will see as a result of their labor results which will convince you that antiseptic surgery, if properly carried out, is *scientific surgery*, and to my mind *there is none other*. The first case to illustrate my remarks is this patient, aged 46 years, who leaves the hospital to-day perfectly

recovered. He was admitted on the 8th of September last, with a compound, comminuted, depressed fracture of the skull in the right parieto-frontal region. In this case the trephining operation was done under strict antisepsis. The man was up and about the ward on the fourth day; and when the primary dressing was removed on the eighteenth day, it was found that the catgut sutures placed to keep the wound together, as well as the catgut drain, had entirely disappeared, and complete primary union had occurred.

In the second case, one of old ununited fracture of the radius, with considerable absorption of bone, following a simple fracture, where several attempts had been made to obtain bony union, but without success, I was satisfied that there was no use of repeating the old operation, because there was a gap between the ends of the radius. In order to fill this up, I was obliged to resect the ulna. I therefore first removed an inch and a quarter from the lower third of the shaft of the ulna; this brought the ununited ends of the radius together, which were freshened by sawing off the ends of the bone. The ends of the radius and ulna were then united by chromicised catgut ligature. This operation was performed twelve days ago under strict antiseptic precautions, as in the former case. There has been no rise of temperature since the operation, and the wound has not been disturbed since the first dressing was applied. The patient has been about

the wards since the second day, and he is and has been perfectly well in all respects.\*

Cases of amputation, when dressed in the manner described, are allowed to go for two or three weeks before the primary dressing is taken off, when complete union is found to have occurred. In fact, the dressings are usually not disturbed until the patient is considered ready to go out. Curiosity tempts the surgeon to examine these cases, but the first dressing should not be removed unless absolutely demanded by a rise of temperature.

Now, these are facts, and they are circumstances which I have not seen attending the amputations or the operations of surgery of former years. To what must be attributed these wonderful results? Why this contrast with the old practice, often requiring weeks and months in bed, with suppurating wounds and daily dressings, and occasionally hemorrhage and exhaustion and surgical fever? The question is answered when I tell you that it is due to antiseptic surgery and aseptic appliances. But, gentlemen, antiseptic surgery means scientific *antiseptic* surgery, and not partial antiseptic surgery. If you adopt antiseptics as a principle, it must be carried out absolutely. Do not omit in your treatment the minutest precaution which might assist in securing the results which

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\* Dressed on the eighteenth day and complete union of soft parts found; ulna firmly united, radius quite firm.

you desire to obtain, and which you always will obtain if you are not negligent.

Certain facts must be borne in mind. If you could get absolute cleanliness you could get along without antiseptic appliances ; but, as this is not possible, we adopt means which prevent contamination and infection in our wounds. We have often unfortunate surroundings, especially in hospital practice, against the influences of which all our efforts at cleanliness are unavailing. We, therefore, must have agents which will destroy micro-organisms, which are present everywhere, and by their growth breed fermentation and disease.

I show you to-day what I mean by aseptic dressings, which are suitable for every case, and are of universal application. Let me remark, however, that if these statements which I have made to you are true, then the surgeon who does not carry out antiseptic treatment does not give to patients under his care that security against infection, disease, and even death, which modern science has proved to be absolutely sufficient. If the surgeon does not obtain the results which other surgeons who practise antiseptic surgery obtain, then he should be held responsible ; such a surgeon will be known by his results. If his operations are followed by prolonged suppuration, erysipelas, or pyæmia, he would, very likely, be condemned for not adopting the means which are at his command. These surgical complications are due to fermentation dependent upon para-

sitic organisms. The presence in the wound of these micro-organisms can absolutely be prevented by antiseptic dressings.

Certain agents are recognized as germicides,—carbolic acid, salicylic acid, boric acid, resorcin, and iodoform; but the most efficient is the bichloride of mercury. It is odorless, inoffensive, and can be used in such dilute solutions as to be free from danger to the patient while destructive to lower forms of life. We rarely use solutions stronger than one part of the bichloride to a thousand parts of water. A solution one-half this strength is sometimes used externally, and as a douche to wounds while operating, and weaker solutions, down to one part to five or ten thousand parts of water, are employed for dressings. We always wash out the stronger solutions where there is possibility of retention in a cavity with risk of absorption, by much weaker ones. The same precaution may be observed with iodoform when it is brought in contact in bulk with raw surfaces. One of our residents, who was handling the solutions every day, was slightly affected by mercurial poisoning during this year; but with ordinary care such results should not occur to either patient or surgeon, unless through marked susceptibility.

Having shown you some examples of the good effects of these dressings, I will proceed to explain them in detail. In the man with the depressed compound fracture of the skull just presented to you,



as I have already described, we cleaned the entire scalp with soap and water, and shaved it around the wound. The bare surface of the scalp was then washed with the stronger solution of bichloride of mercury, and towels wet with this solution were placed around the field of operation. The knives and instruments, which are always boiled after being used, and, if possible, also before, were carefully cleaned and kept immersed in a tray of three-percent. carbolic acid solution. The bichloride solutions dull the knives, so we use carbolic acid to keep them in instead. A douche of (1-2000) bichloride solution was directed from time to time upon the wound by an assistant during the operation of trephining and while the several pieces of comminuted bone were removed, and while the fragment of bone was elevated which had been depressed. In order to insure freedom from the accumulation of any serous or bloody discharge, we placed several filaments of catgut ligature, which drains by capillarity but will not convey pus, in the bottom of the wound and led them out the angle. This catgut had been rendered aseptic by preparation in a carbolized solution. In from five to seven days it becomes completely absorbed. If it is desired to avoid such rapid absorption, a catgut thread treated with chromic acid may be used, which is harder than the other and requires double the time for absorption. They are made sufficiently pliable to be used for ligatures to bleeding

vessels or for stump-drains. They are cut off short, and never give rise to irritation, and need not give the surgeon a thought after their introduction. The wound is brought together as accurately as possible by interrupted catgut sutures. The wound having been again irrigated, the line of suture was covered by a small strip of protective made of silk treated with varnish and coated with dextrine, and a damp pad of bichloride gauze, thickly sprinkled with iodoform upon its skin surface, then placed on the part, and the whole held in position by a wet bichloride gauze bandage.

After getting the wound thoroughly aseptic, it is not possible for any micro-organisms to live beneath the dressings. The surroundings of the wound were also made clean, and no infection can occur from without.

The gauze which I show you is an admirable material for wound-dressings. It is exceedingly cheap, and has wide interspaces, so that discharges are not pent up around the wound. It is immersed in a solution of one to one-thousand of bichloride of mercury. Over the gauze is usually placed a large pad of dry absorbent cotton which has previously been treated with the 1-1000 solution; the dressings are kept in place by a bandage, which is also made of gauze treated in the same way. After this is in place we do not care how many germs or other micro-organisms are floating in the air, they cannot infect the wound. You see in this patient what

strict antiseptic surgery has accomplished. Such a result could hardly have been achieved without aseptic or antiseptic dressings,—a compound comminuted fracture of the skull, with serious depression, requiring trephining, completely cured by primary union in twenty-four hours, without fever or systemic disturbance whatever. This perfect result is due to antiseptic surgery and its proper application. In all my previous experience in this hospital and elsewhere, I have never seen a case of this kind get well by primary union. The result was obtained by avoiding local irritation, while the ferment of suppuration has been kept away by securing an absolutely aseptic atmosphere.

You will hear some surgeons decry antiseptics in surgery. I have been a sceptic myself. You may hear them laugh about your precautions, and declare that they can get just as good results without them. But go and see their cases, look at their hospital wards, find out the length of time their cases remain under treatment, and whether erysipelas, cellulitis, and pyæmia ever occur in their practice. Observe, compare, and reflect. This is the only practical way to test the merits of treatment.

I have seen, but years ago, several cases of pyæmia at one time in the wards of this hospital; suppuration after our amputations and ordinary operations was, until comparatively a recent period, the rule and not the exception. In 1867 I was so much impressed with the necessity for

greater cleanliness in the treatment of wounds that I devised this hospital ward-carriage to carry the dressings from patient to patient around the wards; the carriage was also provided with a tank for supplying a douche of fresh water for the wounds; the basins which previously were placed under each bed were discarded, and sponges done away with and oakum substituted. When the basins and sponges were thus abolished, pyæmia greatly diminished in frequency. Forced ventilation was afterwards introduced, and by these combined means pyæmia was lessened, but not entirely eradicated, although for a period of more than five years, owing to scrupulous cleanliness and great care in every direction, not a single case of this dreaded disease occurred in this hospital.

Considered from the economical standpoint, it may strike you that this is not a cheap method of dressing wounds. As regards the first cost this may be true, but if you consider the saving in bandages alone—of one dressing in two or more weeks—over daily dressings, you will see that it is far less expensive than the former plan, to leave out of consideration the time of the surgeon or the feelings of the patient. When the better results are taken into consideration, the greater safety and lessened mortality after operations, I think that you will agree with me that the expense is trifling, and that the antiseptic method is worth all the trouble that it costs to attain such results.

When you see, as you have to-day, that we can even open the skull, and resect a bone, and do this without any inflammatory reaction whatever, you obtain an idea of the possibilities of antiseptic surgery.

In private practice I treat my cases just as I do in the hospital. By means of a douche and a rubber tube you can keep up a stream of bichloride solution upon the field of operation. I carry with me a solution of corrosive sublimate, of the strength sufficient, if half a drachm of it be added to a quart of water, to give me a 1-1000 solution, which I can also use for dressings. The hands and finger-nails of surgeon and assistants are cleansed by scrubbing with soap and water, and then washed in this antiseptic solution. A rubber sheet (previously cleaned) should be placed under the part to be operated upon, in order to carry off the washings and discharges. When the lower extremities are to be operated upon, it is well to elevate the head of the bed by placing bricks under the posts, or by a special apparatus in the operating-table, which I exhibit here; a tray is attached to the foot of this table to catch the waste. In operating you will require something to absorb the discharges and cleanse the parts better than a towel. We use commercial sponges in the hospital, bought by the bale, and put through a bleaching and cleansing process. Thus prepared, they cost about half a cent apiece, and are used but once.

I will now show you two cases which require in each an amputation of the leg, and our method from first to last will be with a view to the strictest antisepsis. The first case is one of crush of the tarsus, in which an unsuccessful attempt has been made by my predecessor to save part of the foot by a Pirogoff amputation. Sloughing of the flaps has occurred, and an amputation of the limb higher up is demanded.

I shall now apply the principles already explained to you in performing this operation and in dressing the stump afterwards. I am partial to the Teale method of amputation of the leg, because it gives the best stump for an artificial limb, the cicatrix being at the side.

[The patient, a man 20 years of age, was then etherized. After the leg was washed with soap, shaved, and cleansed with bichloride solution, an Esmarch bandage (previously disinfected) was placed on the limb. The field of operation was next uncovered and surrounded with towels wet with the same solution. The knives were kept in the tray immersed in a three-per-cent. solution of carbolic acid. The circumference of the limb was taken at the place where it was intended to divide the bones; the long flap was then mapped out, rectangular in shape, one-half the circumference of the limb; the short flap was one-fourth the length of the long flap. The arteries were then tied with carbolized catgut, and the wound

carefully cleansed of all spiculæ of bone or blood-clots ; a few catgut threads were introduced as a drain, the flaps brought together with interrupted sutures of catgut, the protective placed over the sutures, and iodoform and bichloride gauze was applied. The whole stump was finally covered with dry absorbent cotton (previously treated with a solution of bichloride), kept in place with a wet gauze bandage similarly treated with the mercurial solution. The patient was then covered up warm and a bottle of hot water placed to the remaining foot.]

These dressings will remain undisturbed probably for three weeks or longer, unless some unexpected symptoms appear calling for earlier interference.

The second case I show you has just been admitted : he is 37 years of age, and has sustained a severe crush of the right leg, has a simple fracture of the right clavicle, and several ribs on the same side have been also fractured, and he has a crush of the left tarsus. His condition is serious, but with antiseptic precautions he ought to do well. The right limb requires amputation, for bones, muscles, nerves, and blood-vessels are concerned in the crush ; the left foot will probably be saved ; we shall at least make the attempt.

[Amputation of the upper third of the leg was performed by lateral skin-flaps and circular division of the muscles, with the same precautions in regard to antiseptic dressings.]

## SECOND LECTURE.

DELIVERED OCTOBER 23, 1886.

GENTLEMEN,—The case of amputation of the right leg, which was performed three weeks ago in your presence, has had the original dressing disturbed but twice since you saw him, and simply for the purpose of removing the drainage-tubes. His temperature has been normal since the sixth day, and never rose above  $100\frac{1}{5}^{\circ}$ . He had likewise a crush of the left tarsus, which I made an attempt to save, and fortunately this has been successful; he had also a fracture of the right clavicle and a fracture of several ribs of the same side, which he suffered from when he received the graver injury for which the amputation was performed. He is doing well in every respect. In future I shall rarely use the rubber drainage-tube, which is a foreign substance, and cannot, like gut, be absorbed, but I will substitute catgut for drains, for I find the tubes are usually not necessary and require the dressing to be opened earlier than desirable.\*

The first case I now show you is a man upon whom I performed a Teale amputation of

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\* Clinic November 13, 1886.—He has had no dressing on the amputation since the lecture. A small ulcer still remains over the crushed tarsus of the other foot. He is up and walking about on crutches and ready for discharge.



the leg, in your presence, three weeks ago to-day. The dressings then applied before you have not been removed. The object of the treatment by the antiseptic method is to avoid suppuration and to get immediate union, which when bone has been divided is particularly desirable. This I am satisfied has occurred in the case before us, but we shall see. Upon removing the dressings, you observe that they are perfectly dry; they are discolored in the immediate vicinity of the wound by some leakage of bloody serum, which occurred probably immediately after the operation; this, however, has been so trifling in quantity that the gauze dressing is hardly soiled: no more beautiful illustration of the results you may expect in using strict antiseptics can possibly be found than in the case before you. You remember that I told you that the rule in making the long flap in a Teale amputation was to take the circumference of the limb at the point where you decide to divide the bone: the long flap then is to be made one-half the circumference of the limb. For instance, if this should be ten inches, then the length of the long flap ought to be five inches, and its breadth the same; the short flap is to be made one-fourth the length of the long flap. All the tissues are dissected free from bone, which is then divided at the point previously determined upon, and the vessels having been secured with catgut cut close, the flaps are brought together with the interrupted sutures of the

same material. The ends of the bones by this form of flap are well covered, and the cicatrix is upon one side, where it will be free from pressure. This makes the most satisfactory stump for the adjustment of an artificial limb. The wound has entirely and absolutely united, and the patient is ready for his discharge. Upon the surface of the dressings, lying in contact with the stump, are the remains of the catgut ligatures and the catgut drains. Those portions of the catgut which were in the stump have been absorbed, those outside or external are these which I show you, and they are shrivelled and quite dry, and readily brushed off; all the catgut included within the flaps—sutures and drainage—has been completely absorbed.

Now, here has been division of bone, of nerves, of blood-vessels, of muscles, and the other structures of the leg, followed by union without a drop of pus,—in other words, union by first intention. When you reflect upon this result, which is simply a union of all the parts just as a piece of broken furniture can be glued together, is it not indeed remarkable?\*

In 1804 there was in this hospital an instance of primary union after an amputation of an index-finger, and it was an occurrence so unusual that the fact was recorded as a “curious circumstance attending the healing of a wound.” “No inflammation came on after the operation,” the record

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\* He was discharged a few days afterwards.

states, "and nothing like pus was observed during the healing of the wound. Granulations did not arise, neither was a cicatrix formed, but the stump was healed by an extension of the old skin." What was then a marked exception has now become the rule.

The character of the dressings which we apply after amputation in order to secure union without suppuration will be demonstrated before you, as has already been done at my former clinics, and will now be done again in connection with another case upon which I intend to perform a Teale or rectangular flap-method upon the right leg, on account of deformity following an injury of the foot.

But first let me show you the patient before you,—a young man, who was admitted on account of a serious injury, which required a partial amputation of the hand. The operation was done more than three weeks ago, and the wound has not been dressed since; he has not had a single unfavorable symptom since the operation; he is well, and would have been discharged yesterday, but was detained until to-day in order that you might see the dressings taken off and the result.

The operation was performed by my son, Dr. Morton, Jr.; it was done with the usual antiseptic precautions. The hand was badly crushed, so that amputation was required, leaving only the thumb and part of the little finger. On removing this, the first dressing, you see the wound

entirely healed, and there has been no suppuration.

Two weeks ago last Thursday this man, aged 22, was brought in suffering with a compound, comminuted, depressed fracture of the parietal bone. I trephined the skull so as to allow the elevation of the depressed portion. The wound was cleaned and dressed in the same manner as the preceding cases. The dressings have not been removed since they were first applied. His temperature did not go above  $100^{\circ}$  after the operation, and on the second day was normal and has remained so. In forty-eight hours after the dressings were applied he was allowed to get out of bed; he was without any symptoms whatever after this severe operation, which formerly often required a treatment of weeks and sometimes months in the house. It is now sixteen days since the injury, and the primary dressing is now taken off. Here is the gauze pad slightly discolored with dry blood; the sutures—that is to say, the portion of them lying external to the wound—are left free upon the dressing, and I pick them off and ask you to examine them; there is no pus, and there has been none. The wound has entirely healed; the line of the incision, which was three inches long, has united throughout its entire extent by primary union so that the direction of the incision can scarcely be defined; the few catgut drain-threads have disappeared. You will remember at my first clinical lecture I presented a pre-

cisely similar case to this one. There is an especial advantage in these head-injuries from this method of treatment. Fungus cerebri, as you know, is due to inflammation of the brain-tissues, which push out granulations through the softened meningeal structures; cerebral matter may also protrude owing to pus-accumulation in the hemisphere below. The way to escape hernia cerebri is to prevent suppuration: it is scarcely possible for it to occur where there has been primary union. Having the results of antiseptic methods, as illustrated in this case, in mind, would we be justified, think you, in treating other cases of this kind in any other manner and have suppuration, with the risk of fungus cerebri, when we have the means of almost certainly if not absolutely preventing it?\*

Here is another amputation. This boy was admitted on the 10th instant, with a crush of the fore part of the foot requiring a Hey amputation. The operation was done by my son. I was present and assisted in the dressing, which was applied just as you have already seen, and it has not been disturbed since.

You are all aware of the seriousness of a foot amputation where the tarsal joint is involved, and where, as in this case, muscles, nerves, and blood-vessels were crushed or torn. The result in this case you see before you: this is the original dressing, and has not been removed. You

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\* He was then given his discharge.

see we have an absolutely perfect union ; and I have never seen a handsomer stump than this. There has not been a drop of pus.\*

Gentlemen, these are not picked cases that I bring before you this morning : they are the ordinary cases from the wards. What an advantage this method of surgical dressing should be to the physician who practises in the country, where, owing to the distance, patients cannot be visited as often as in the city or in a hospital ! What a relief to the surgeon's mind when he knows that the primary dressing need not be disturbed for, in many cases, weeks, or indeed until the patient is well ! What an advantage to the surgeon it must be for him to be able generally to prevent suppurative fever after operations, for by this means the patient has no interruption to his nutrition and repair must be greatly facilitated.

I will now show you the result of an operation which I was able to perform with the aid of these dressings, one which without antiseptics, I would not have been so confident of success. This man sustained a rupture of the long tendon of the biceps muscle of the right arm. He was at work in a pit ten feet in depth, standing at the bottom and throwing shovelfuls of dirt out of the top, when suddenly he experienced a sharp pain in his shoulder and was unable to con-

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\* Discharged without any dressing, the same day.

tinue at his work. I found upon examination of his arm that the long tendon of the biceps had been ruptured. The muscle was firmly contracted and in a state of spasm. I cut down upon the muscle and found its tendon coiled up upon it like a worm. I cut off the frayed end of the tendon, and, replacing it in a deep groove that I had cut in the deltoid (which I had exposed to the acromion), I stitched it deeply into the tissues of this muscle with catgut interrupted sutures. The usual dressings were applied, and the arm kept in a sling. That was sixteen days ago. The dressings have not been disturbed since; they will now be removed. You see the line of the incision, which has perfectly united. Some remnants of catgut sutures are lying upon the dressings, which are perfectly dry. Although the wound has healed, we will not allow the man to use his arm yet; he should not go to work again for another fortnight, but there is no need of keeping him in the hospital. He can report at the Out-Patient Department, and carry his arm in a sling until the tendon has united firmly in its new location.\*

Two cases came in on last Thursday afternoon which I regard as crucial tests of aseptic surgery: they will now be brought before you.

The first man was shot thirty hours before his admission, while in the mining regions, and received a wound in the

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\* No further dressing was required.

popliteal space, which at the time was accompanied by excessive hemorrhage: the pistol-bullet had not been removed from the wound. Upon examination I came to the conclusion that the ball must have injured the important deep structures, since the wound was directly in line with the large blood-vessels and nerves, and that it had possibly entered the joint. Sensation in the parts below was preserved, but there was no pulsation in the anterior tibial artery or its branches in the foot.

With antiseptic precautions, I opened the popliteal region, and found the ball lying some distance beyond the artery, it having also injured the knee-joint. The bullet, which was from a Smith & Wesson revolver of .32 calibre, had completely divided the popliteal artery, and had wounded but had not opened the accompanying veins. The divided ends of the torn artery were carefully isolated; the proximal end was filled with clot, the other end was patulous. Both ends were securely tied, in order to prevent secondary hemorrhage. I used catgut ligatures, which were cut short, and the wound was then closed in the usual way and a rubber drainage-tube was inserted. The patient, since the operation, has been perfectly comfortable.\* An injury of this kind, involving a divided main artery and a joint involved, has always been considered very grave, and one which

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\* Clinic November 13, 1886.—He is up and about the ward. A small ulcer marks the former exit of the drain.



under other forms of treatment might, and probably would, demand an amputation. I need not now stop to point out the great difference between the results of treatment by former methods in these grave cases and those which we have obtained here by strict antisepsis.

The second case is one in which the knee-joint was entirely exposed by a fall, which ruptured the old inflammatory adhesions that had been thrown out in nature's attempt to unite by new tissue a ruptured quadriceps more than a year ago. The skin and deep tissues were so torn as to expose the condyles of the femur and the articular surface of the tibia, the lateral and crucial ligaments were torn, and the wound of the soft parts around the joint was so extensive that the leg was held only by a posterior flap, in which, however, the vessels and nerves were preserved intact. I made lateral vertical incisions upward four inches in length on either side, just as if I were going to perform an amputation, and so was enabled to lift up the tissues and to clean out the knee-joint and adjacent wound with a douche of one to one thousand solution of corrosive sublimate: all clots were carefully removed, and the wound-surfaces thoroughly curetted. I then brought the parts together with about twenty interrupted catgut stitches, and dressed the wound antiseptically as already described. His temperature this morning, forty hours after the operation,

is only  $100\frac{1}{5}^{\circ}$ , and his general condition is good. When you consider the character of the case,—that he was in a bad condition, that he has been a drinking man, and that he was under the influence of liquor when he received the injury,—I think you will agree with me that the result thus far has been remarkable. The object of the treatment was to seal up the joint and to prevent the occurrence of irritation and suppuration by the exclusion of all micro-organisms.\*

The next case is one of contusion of the upper part of the thigh, with a very large hæmatocele, just above the knee, of one week's duration. I shave the part thoroughly, wash it clean with bichloride solution, and cut open this sac from one end to the other, and my incision is five inches in length. I turn out the clot and wash the wound with a one to one thousand solution of corrosive sublimate: with a sharp spoon I am now scraping the walls of the cavity, so as to remove all disorganized shreds of tissue and blood-clots. This having been done, I unite the edges of my incision with interrupted catgut sutures, and apply a compress of gauze wet with the same solution. Iodoform is thickly dusted over the wound, and absorbent cotton, previously washed with

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\* Clinic November 13, 1886.—First dressed on sixteenth day, and complete union found, save a very superficial ulcer where the drain came out. Was kept in bed with posterior splint for another week. A plaster bandage has since been applied, and he will be allowed to walk about with crutches.

the mercuric-chloride solution, is next applied, and retained in place with a bandage wet in the chloride solution. A few strands of catgut ligature are placed in one angle of the wound so as to admit of drainage, and a straight splint is placed on the back of the limb to insure rest.\*

The next case is a man from the mining regions upon whom I will perform a Teale amputation. About a year ago he was injured by a falling mass of coal, which crushed his right heel. This accident was followed by prolonged suppuration and ulceration. As a result there is contraction of the plantar fascia and of the gastrocnemius muscle to such an extent that he has an acquired talipes equinus; the foot is permanently extended, so that he walks upon the base of the big toe; ankylosis of the tarsus and ankle-joint has taken place; the sole of the foot is covered only by a thin skin or scar-tissue, which is adherent to the bone beneath.

The only remedy for this state of affairs is amputation and an artificial limb.

It is always best before making a Teale operation to measure carefully the size of the flaps and mark their outlines with iodine or the point of the knife. You should never trust simply to your eye.

Proceeding now to the operation, the limb is first washed with soap and water and carefully shaved. It is next bathed

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\* Complete union found when he was first dressed on fourteenth day.

with the one to one thousand solution, and towels wet with the same are placed around the limb above and below the line of operation. The hands of the surgeon and assistants are also disinfected, likewise the Esmarch bandage. The knives and other instruments for the operation have been boiled in water, and are kept in a tray under a weak solution of carbolic acid, because the corrosive chloride would act upon the steel and dull them.

The limb at the point of amputation measures ten inches exactly. The long flap then will be five inches in length and breadth. I will take it from the outside external aspect of the limb, because there is more healthy tissue here. The short flap I will now mark, one and one-fourth inches in length and five in breadth. All the soft parts help to make up the flaps, which are now separated from the bones and the tibia and fibula divided; the wound is washed with the same solution of bichloride, and the vessels are secured with catgut ligatures, which are cut short. Some strands of catgut, instead of rubber tubes, are placed in the lower angle of the wound, and the flaps are brought together with catgut sutures.

The same dressing, of bichloride gauze thickly dusted with iodoform, is applied as in our other cases,—first having placed a strip of silk protective over the sutures, then a layer of absorbent cotton, which has also been treated with the one to one thousand corrosive-sublimate solution; the

dressings are kept in place with a wet bichloride bandage. Unless something unusual occurs, indicated by a rise in temperature (which shall be carefully recorded morning and evening each day), this dressing shall not be disturbed for three weeks. I will then bring him before you again and show you the result.\*

In case a rise of temperature occurs, first find out if this is due to some intercurrent malady. In September last, forty-eight hours after a serious operation, the temperature of one of my patients rose to  $103^{\circ}$ . An examination showed a sharp attack of diphtheritic tonsillitis, from which the patient soon recovered, but which in no wise affected the wound, which was not dressed for several weeks, when it was found quite united, as in those you have seen.

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In presenting to the reader my two lectures which were delivered at the hospital on October 2 and 23, I endeavored to give to the class in as terse a manner as possible the essential points in regard to antiseptic surgery as it is now conducted in the Pennsylvania Hospital.

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\* Clinic November 13, 1886.—Dressed for first time to-day before the class. Complete and solid union found throughout. Will be discharged in a few days.

My son, Dr. Thomas S. K. Morton, Senior Resident Surgeon at the Hospital, has presented me with the following details, which I regard as so important that I have concluded to add them to the report of my lecture.

The antiseptic *dressing* is only the ending of a series of manipulations upon, and applications to, a part before, during, and after an operation. *Per se*, it is almost valueless unless all the necessary details leading up to its application are thoroughly carried out.

Entirely disregarding theory, what is aimed at is to have the field of an operation, upon its completion, free from any substance which can become an irritant or develop fermentation; then to apply some form of dressing which will entirely prevent access of such material to the wound.

Since its first introduction by Lister, the term antiseptic has been made to embrace every procedure likely to prevent such wound-complication, and its range of applicability is rapidly on the increase.

No one dressing or system of antiseptics can yet be spoken of as best: their name is almost legion. The object which it is essential that we shall keep in view is the antiseptic principle: its details of application may be varied.

Hospitals are the only places where comparative tests of such details can be made, and I present below a list of those in present use in the Pennsylvania Hospital. These are the result of much comparative

work, experimentation, and investigation, and it is hard to conceive how our wounds could do better than they do.

*Cleansing of Parts.* — Carefully shave the field of operation and its surroundings ; hair grows everywhere except on the palms and soles,—an exception to the above rule,—and is very tenacious of dirt. Then rub well with turpentine or ether, then soap, and a final wash with the one to one thousand bichloride solution. Special pains should be taken to cleanse such parts as the ear, umbilicus, toes, axilla, and groin. If the operation be in the auricular region, wash the pinna of the ear as thoroughly as possible, sprinkle the canal full of iodoform, and put in a small wad of bichloride cotton on top ; the cotton, if it become soiled, can be removed before the dressing is applied.

For special occasions, the operative field and its surroundings can be cleansed beforehand and then wrapped in either an antiseptic dressing or in towels wrung out of one to one thousand sublimate solution. A simple irrigation of one to one thousand solution will only be required at the time of operation after this preliminary cleansing. An oil-cloth should be placed under the part to be operated upon and wet with the one to one thousand douche. So also towels wrung out of the same solution should surround the field and cover any part which the operator is liable to touch or lay instruments upon.

*Arrest of Hemorrhage.* — Great care must be exercised in the ligation of bleed-

ing points. Invariably the catgut ligature should be used for this purpose, unless the vessels are very near the surface and can be stopped by running a stitch through or under them. The catgut which we use is procured either from wholesale dealers in musical supplies, or from importers. Five sizes, running from the finest made to the largest cello string, are all that can be needed for any surgical purpose. To prepare this material properly, the commercial gut should be soaked in oil of juniper for forty-eight hours, then washed and stored in alcohol. The oil of juniper removes the animal oil, so that it becomes quickly pliable in aqueous solution, antiseptic, and will be absorbed in from seven to ten days, according to size.

Stronger and more durable catgut can be made, if desired, by means of chromic acid. The formula is as follows: Take twenty parts of water, one part of carbolic acid,  $\frac{1}{200}$  part of chromic acid, and to this mixture add one part of catgut as prepared above. Let it stand for forty-eight hours, wash in alcohol, and preserve in the same. This gut, according to size, will resist absorption from ten to thirty days. In tying catgut, all difficulty will be overcome if the first tie be made as in a surgeon's knot.

*Drainage.*—If care has been taken to arrest bleeding properly, there should be very little material poured into even the largest wounds after their closure, for bi-



chloride, unlike carbolic acid, produces very little tendency in a wound to ooze.

In a properly-managed wound, all possible discharge should be over by, at most, the third day. Various means are employed to accomplish the drainage of this actual, or possible, discharge of bloody serum into wounds. Principal among these are bunches of fine catgut and perforated tubes of rubber, decalcified bone, or parchment. I cannot yet speak with positiveness of more than the first two mentioned. The latter and others are still under trial. Catgut in hanks of from three to twelve strands can be depended upon to drain most wounds which are expected to heal by primary union, even the largest. But if the surgeon has not sufficient confidence in it, the rubber drains may be used, but should be early withdrawn. This is their worst objection, as to accomplish it the whole dressing has to be removed at the most critical time in a wound's healing. Catgut will not, as a rule, drain pus, as it operates by capillarity: hence rubber tubes must be used for the drainage of antiseptically-treated in-eradicable abscesses, etc.

The catgut drains, which are made up of fine threads of that material, are absorbed in from seven to ten days.

The rubber tubes are kept in three-percent. carbolic acid solution.

*Irrigation.*—This is kept up from time to time during an operation where anti-sepsis is possible; it will do no harm in

any operation, and probably some good even where cleanliness is impossible. It is accomplished by a small stream of the one to two thousand solution directed from any of the various forms of douche apparatus.

One to two thousand is our standard solution for this purpose, and multiplications or divisions of that strength are made up for special occasion. For example: one to one thousand for wounds filled with dirt; one to twenty-five for poison-wounds, such as dog-bites; one to five thousand or ten thousand for abdominal work. Of course, the stronger solutions are washed out by much weaker solutions or by distilled water *ad libitum*.

*Sponges* are used but once, and then destroyed. We buy them in twenty-five-pound bales, and bleach and purify them by the following process.

Soak in ten-per-cent. hydrochloric acid solution for twenty-four hours, wash thoroughly, and place for an hour in a solution of permanganate of potash, one hundred and eighty grains to five pints of water. Take out, squeeze, and drop into this mixture: dissolve ten ounces hyposulphite of sodium in sixty-eight ounces of water. To this add five ounces hydrochloric acid and filter. Put in sponges, and leave until thoroughly bleached; then wash them *most thoroughly*, and store in one to one thousand  $\text{HgCl}_2$ .\*

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\* These formulas as used in the Pennsylvania Hospital, together with a record of our antiseptic cases of the past summer, have been published by Dr Chas. B. Penrose in the *Medical News* for October 16, 1886.

When ready for use, they cost about three-fourths of a cent each.

*Instruments and Apparatus.*—Our instruments are invariably boiled after an operation, and, if possible, before. When the latter is done, they can safely be used directly from the water as it cools. Usually they are kept immersed in a three-per-cent. solution of carbolic acid.

Needles, also pins liable to penetrate deeply into the dressings, should be kept in three-per-cent. solution of carbolic acid in glycerin. Instruments can be permanently kept in this solution without damage. Nail-brush and soap should be used on all instruments both before and after operation. All apparatus, such as tourniquets, etc., which may come in contact with the wound or its unprotected vicinity must be previously soaked in either corrosive sublimate or carbolic solution.

*Closure of Wound.*—The details of this usually neglected proceeding are of great importance. Wash thoroughly with the mercury solution. Remove the larger clots; the smaller will organize or be absorbed. Adjust an appropriate drain, and suture with catgut of the proper absorbability. If the wound be deep, it should be sewn structure to structure from the bottom upward. The skin and immediately subcutaneous tissues sew with very closely placed interrupted or continuous sutures of the same material, taking care to leave sufficient room at the drain-exit for its proper working.

*Protective* is a substance employed to keep the irritating dressing from direct contact with the newly-formed repair-cells. It is simply fine oiled silk, coated with a preparation of copal varnish, dextrine, and carbolic acid. This is merely to prevent its shedding water, etc., as ordinary oiled silk does. It is laid in a narrow strip along the suture-line, overlapping it about one-half inch on either side. It is of much more importance where the edges of the wound do not approximate. In that case, if the area to be covered is large, a series of narrow strips is better than one large piece, as it allows of immediate drainage into the antiseptic materials of the dressing. The protective should cover in the ends of the catgut drains, so as to keep them moist and in working order. In removal of the dressing it prevents drawing upon the stitches, etc. It is kept in air-tight glass jars and dry. When wanted, cut off a sufficient amount and place in corrosive or carbolic solution.

*Dressings.*—Our principal dressing consists of the gauze of Lister (cheese-cloth impregnated with this mixture while hot: carbolic acid, one part; resin and paraffine, each four parts) wrung out of one to one thousand bichloride solution, in which it is kept. It is cut so as to overlap the wound considerably, and its skin-surface thickly covered with iodoform sprinkled on with a salt- or sugar-duster. Bandages which are to be put on wet with this so-

lution are made from the same gauze. In a small wound eight layers of the moist gauze bound on with a gauze or ordinary roller is all that will be required. If the wound be large or liable to ooze, a considerable pad of bichloride (one to one thousand) dry absorbent cotton is superimposed, and the gauze-bandage placed over all.

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Realizing that one hindrance to the more universal use of this method is the trouble, and sometimes impossibility, of the surgeon himself preparing or obtaining properly prepared the many little matters which are necessary to the thorough and satisfactory—and it will be satisfactory only when thorough—following of this treatment, I have suggested to Mr. McKelway, apothecary, 1410 Chestnut Street, that he prepare complete outfits, comprising every detail of every article desirable or necessary therefor.

Mr. McKelway informs me that he has ready such complete outfits, and he can be corresponded with or seen about either entire outfits or any parts thereof.

These outfits are sufficiently large in quantity of material to meet the need of most hospitals and of any surgeon.





