

# THE USE OF RUBBER GLOVES IN OPERATIVE SURGERY.<sup>1</sup>

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DURING the last few years the conviction has constantly become deeper and more widely spread among surgeons that the important agents of wound infections are to be sought for among the palpable objects which come in direct contact with the wound. We no longer dread the invisible dust which floats to a greater or lesser degree in every atmosphere;<sup>2</sup> we feel much more indifferent than formerly in regard to the material with which our operating rooms are walled and floored; and most of us do not object to the presence of numerous spectators, dressed in ordinary clothing, and coming from unknown surroundings, provided only that there is no personal contact between them and ourselves, our assistants, our patient, and our armamentarium. What we do insist upon is that the part of the patient which is to be oper-

<sup>1</sup> Read before the New York Surgical Society, March 9, 1898.

<sup>2</sup> The writer does not claim that atmospheric dust is free from harmful germ-life, but he does assert that, clinically, no evidence exists that such dust causes wound infection. If it did, we should never have a continuous series of perfect wound healings, for we make no real provision now against the entrance of dust into wounds. Every exposed object receives dust, and so also does every open wound, but while in a culture medium the germs contained in such dust will develop, similar particles that lodge in a wound fail to cause infection. At the same time, as we do not know the limit of tolerance, all reasonable provision against dust accumulations should be made, by having for operating-rooms smooth, non-absorbent, washable floors and walls, and by excluding dust-laden draughts.

ated upon shall be surgically clean, and that every object which is to come in contact with the wound or its immediate neighborhood, whether it be hand, instrument, sponge, ligature, or dressing, shall be as sterile as is possible. Not only do we insist that these objects shall be sterile at the beginning of our operation, but we make every effort to keep them sterile until its finish. In other words, so far as the wound and its immediate surroundings are concerned, most surgeons to-day endeavor to work aseptically, using antiseptics beforehand only to secure aseptic conditions at the beginning of an operation. No matter what improvements in surgical technique may be made in the future, it is certain that they will always be in the direction of obtaining and preserving more perfect asepsis in the direct handling of the tissues involved in a wound. Not only for the sake of simplicity, but also for the sake of scientific accuracy, is it desirable, in discussing the methods of operating and preserving asepsis, to discard minutiae which are unimportant or even irrelevant, and to concentrate our attention upon those details which actually determine the invasion or exclusion of wound infection. That this has been the tendency of surgeons ever since they became thoroughly familiar with the teachings of Lister is shown by the disappearance of carbolic acid spray, of caustic and irritating douches, of iodoform powder and medicated dressings as applied to clean wounds, and of a host of applications, each of which has had its advocates as being favorable for all cell-growth excepting such as was septic. I should not like to be understood as underrating the importance of paying the closest *intelligent* attention to details, but it should never be forgotten that one of the cardinal principles of good operative surgery is simplicity. For instance, respirators need not be worn by the surgeon, because if his breath is infectious he should not operate. He need not cover his head and his beard to prevent loose particles from falling on the wound, because his hair and his beard should be short and clean. He need not operate in a glass case, because the ordinary atmosphere will not produce infection in the wound. He does not require a

special foot-spigot for his basin, because he can turn an ordinary faucet safely by using a sterilized towel. Sufficiently good nail-cleaners can be made of other material than orange-wood. The impropriety of douching a clean wound with bichloride solution, and of powdering an aseptic suture-line with iodoform, need not be dwelt upon.

Fortunately, most of the objects that come in direct contact with wounds made by the surgeon can be rendered perfectly sterile, and not only sterile, but also non-irritating to the tissues. The use of heat, our most reliable disinfectant, has favored the attainment of this object more than any other improvement that has been made, and our instruments, ligatures, towels, and dressings can all be made perfectly sterile. It is but rarely now that a wound infection is attributed to catgut, although a few years ago that accusation was common. I use catgut as much to-day as I ever did and have no fault to find with it. But I can remember cases of wound infection the cause of which, I felt confident at the time, was imperfect catgut. This conclusion was reached by a process of exclusion, and yet careful examination proved the catgut to be sterile. In former years I have often heard it said that a wound had become infected through some one's carelessness at the first change of dressings. My conviction to-day is that operation wounds are *never* infected at the first change of dressings, unless, indeed, some actually soiled implement or material be thrust into them. I am entirely certain that a dozen men, all of whom have on the same day attended very septic cases, may, without causing the least infection, be present at the performance of any operation, if they do not come in actual contact with any person or object directly concerned in the work. I believe it is not too much to say that floors, walls, ordinary dust floating in the air, spectators and distant objects in general, *never* cause infection of operation wounds. If this statement is accepted, it is not difficult to reach a definite conclusion in regard to the guilt or innocence of the individual objects which *are* liable to cause wound infection, for most

of them can be tested accurately, and their sterility or their infectious condition determined. There is no difficulty today in having absolutely sterile clothing, water, sponges, towels, ligatures, sutures, instruments, and other utensils. If these sterile objects are manipulated with a proper regard for aseptic technique they never in themselves cause disturbance of healing. My conclusion is that the real source of infection of a wound deliberately made by a careful surgeon, who uses perfect materials and handles them perfectly, is to be sought either in the skin of the patient or in the hands of those directly concerned in the operation. I think there are good reasons, of a purely clinical character, for believing that the skin of the patient is seldom the source of operative wound infection. In the first place, many operations of emergency, when prolonged preparation of the patient's skin cannot be made, furnish us with perfect results, if in other respects the surgical technique is perfect. Then, in every operation at which the skin is incised, its deepest layers, its hair-follicles, and sweat-glands are laid bare and brought into direct and indirect contact with the rest of the wound. The cut edges of skin are frequently squeezed and contused with forceps, and are at the last pierced through and through with needles and sutures, and often enough partially strangulated by too tightly tied silk or catgut. Surely, if the skin of the patient were a very guilty party, we should rarely, with such provocation, see a perfect wound healing. It is also well known that such operations as can be done without having the fingers touch the wound at all give very clean results, and yet even in such operations the patient's skin is cut and squeezed with instruments and penetrated with sutures at many different points, and the forceps which pick up the skin also pick up the deeper tissues. It is very probable, at least, judging by clinical experience, that the patient's skin is seldom an active factor in determining the infection of operation wounds. In fact, the hand is left nearly alone to prove its innocence. To convict it we have only to call the witnesses, and they are numerous. If we had no other evi-

dence, the unceasing active discussion, both by surgeons and bacteriologists, in regard to the best method of sterilizing the hands in preparation for an operation would be nearly enough. And yet even to-day there is no unanimity in regard to the best method, the directions which are given varying from the simple use of soap and warm water up to eight different applications, calling for an expenditure of from fifteen to thirty minutes. It is not necessary for me to refer here in detail to the evidence in regard to the hands, which is given by the bacteriologist. We are all familiar with the list of organisms to be found upon the fingers, and with the difficulty of so cleansing them that they will stand the test of bacteriological examination. Even after a hand has been brought to the condition of surface sterility, we know that deeper layers of epidermis, such as may readily be opened during the maceration accompanying any large operation with frequent washings, still contain many bacteria. I think it remains to be shown that a hand which is, on the surface, sterile at the beginning of an operation remains in that perfect condition up to the end. When one considers the number of hands employed in large operations, often as many as ten or twelve, each one of which may be a source of infection; when one considers also the different qualities of the skin, the different characters and habits of the individuals, the different things which they have handled, and even the diseases they may be the subjects of, the problem of providing perfectly sterile hands at every operation becomes appalling. Moreover, in hospital practice, and often, too, in private work, the hands employed in operations are frequently changing, and every few months new hands are introduced, the possessors of which have only just begun to learn the method of cleansing them. Some of these hands come in daily contact with old wounds and with various discharges, and are necessarily more difficult to sterilize than others. And I cannot resist the conviction that the hands of some individuals are much more likely to convey infection than those of others, perhaps not continuously so, but often

for prolonged periods. At least I am familiar with more than one instance which to me demonstrates the truth of this observation. Certainly the handling of infected tissues, and any method of hand-cleansing which roughens or cracks the skin, render *perfect* hand sterilization exceedingly difficult or impossible. Many careful observers claim that it is totally impossible to render any hand perfectly sterile, and in this opinion I heartily concur. It seems to me that the real difficulty is that, in all our attempts to sterilize the hands, we are naturally prevented from utilizing our most powerful sterilizing agent,—namely, wet heat. Why not then cover the hands with a material that can be boiled? This process of reasoning led me, about a year ago, to look carefully into the use of India-rubber gloves. I was well aware that they had been used previously for special reasons, or on special occasions, by others, and I had myself used them and had had one or more assistants use them at different times when the hands had been cracked or fissured, or especially infected.<sup>1</sup> But it was only in April last that I determined to use them systematically. My experience in the matter of wound infection had been similar to that of many others. A most satisfactory series of perfect wound healings would be broken in a totally inexplicable manner by a positive wound infection. Or a number of wound infections would sometimes follow one another much too closely to be excused as unavoidable accidents. At the same time, I had made use of the best known methods of hand sterilization, and had tested the various materials made use of at my operations. These were all found to be sterile, but the hands were certainly not uniformly and continuously perfect. In

<sup>1</sup> My friend, Dr. Halsted, chief surgeon to the Johns Hopkins Hospital, tells me, in a personal communication received very recently, that since 1891 all assistants at his operations have been expected to wear gloves. He has a high opinion of their value as a means of avoiding wound infection.

In the *Centralblatt für Chirurgie*, May 22, 1897, is a communication from W. Zoega von Manteuffel, of Dorpat. This writer highly recommends the use of India-rubber gloves in special classes of cases.

April last I began the *constant* use of rubber gloves, and had my first assistant, whose hands especially came in contact with the operation wounds, also use them. At first I thought that the difficulty had been solved, for the wound-healing was remarkably perfect. But in the course of three months there were several imperfect wounds; not serious or dangerous, but positively imperfect. I then made up my mind that my system was not sufficiently complete, for, while my first assistant and I both wore gloves, my other assistants, who handled instruments, ligatures, etc., did not. Since the middle of October, immediately on my return from my summer vacation, I and all my assistants have worn rubber gloves at *every operation of every kind*, and the service has been a daily one of great activity. In private practice I have followed the same plan. The result has been most gratifying. The list of operations includes a large variety, such as for gall-stones, operations upon the intestines, hernias, nephrectomies, extensive breast amputations, thyroidectomies, amputations, resections, for hæmorrhoids, harelip, cleft palate, urethral strictures, appendicitis, etc. That is to say, a set of operations such as test the value of methods for avoiding sepsis, and test also the use of the hands and the sensitiveness of the fingers in palpation. All of the cases operated upon, both in hospital and private practice, from October 19 up to the present date, have been carefully observed with a view to the detection of the slightest infection. A large number of the wounds have been immediately closed without other drainage than a small bit of thin rubber tissue inserted at one or at two angles. Solutions of bichloride have not been used in any case, and iodoform has been applied only to wounds already infected before operation and in operations about the rectum. The only douche used has been sterilized salt solution of the strength of  $\frac{6}{100}$  of 1 per cent. Excepting that rubber gloves have been worn at every operation, and that the hands have been merely washed in soap and water, *no* change in any of the methods or details in connection with operations have been made within a year. During the period

referred to, of about five months, the only instances of even slight wound infection were the following: In each of three cases, one in private practice and two in the hospital, a single drop of pus was found at one suture puncture at the *second* change of dressings. This was wiped away, and at the third dressing no sign of the incident remained. In a fourth case, a child, from whom I had removed a small tuberculous gland in the neck, a small quantity of clear serum escaped on the fifth day. A few days later this was slightly turbid, and I then discovered, just inside the opening, a bit of rubber tissue which had broken off of the piece of tissue used for drainage. In a fifth case, a very debilitated elderly patient, for whom I did a laparotomy and intestinal anastomosis, and who had an actively discharging artificial anus at the time, a distinct cold mural abscess without rise of temperature developed on the tenth day. This was the only case which required even partial separation of the sutured skin wound. When I say that no infection occurred, I mean that no reddened wound edges, no œdematous tissue, no delayed union or unhealthy discharge, with the exceptions referred to above, occurred in a single instance. In a number of cases already infected, such as suppurating and discharging glands of the neck, requiring the use of both knife and curette, the wounds have been completely sutured and closed like originally clean operations. All of these wounds have healed primarily, and in no one of them has any part of the suture line given way or any discharge occurred. Even actively suppurating spaces, such as occur about a diseased appendix, have seemed to me to invariably heal, although of course, by granulation, in a much more perfect manner than usual. Of course, the observations of men in regard to what constitutes wound infection may be different according to the standard of measurement. I have made use of the highest clinical standard that I know of, and I can truthfully say that I have never before seen such uniformly perfect wound healing of such a high grade. Even "primary unions" differ in quality. I do not mean to assert that similar perfection has not been reached by others while



operating with naked hands, but I personally have never been able before to achieve such results. On this comparatively limited experience, I feel justified in saying that, for my own work, no change of methods has ever been so completely and delightfully satisfactory as the use of India-rubber gloves while operating. The advantages of the method are these:

The gloves can be boiled, and so, when the operation begins, they are absolutely sterile. To demonstrate the possibility of having an absolutely sterile hand I have subjected specimens of rubber gloves, such as I use in operating, to the following test. The gloves were sterilized in the usual way, two of them by boiling and one of them in the dressing sterilizer at the Roosevelt Hospital. Dr. T. M. Cheesman was kind enough to prepare jars of sterilized beef broth and to superintend the preparation of the specimens. The jars were opened, and the gloves immersed, in the instrument room at the hospital. Two of the specimens are three weeks old, and have been kept at a uniform temperature of 80° F.; one of them is eight days old and has stood in a temperature of from 65° to 75°. The jars are all perfectly free from bacterial growth. Such a test as this is, of course, a very severe one. The condition of the hand is determined by taking a number of scrapings from its surface. But if it were to be tested as thoroughly as these gloves have been, it would be necessary at least to immerse a large part of the hand in the culture fluid for hours. What method of sterilizing the hands would permit such a test to be successfully made? As the gloves are non-absorbent, they must, if they touch no infected object, remain sterile *throughout* every clean operation. In the course of the operation blood can be rapidly and completely washed off from their smooth surface with a sterile solution.

No matter to what previous use the operator's hands may have been put, he may begin his operation without dread that they may cause infection. The same protection may be secured in the case of assistants and nurses, even when these are inexperienced. Although having a suppurating lesion on

his own hand, the surgeon may operate with impunity on his patient.

The rubber gloves add very greatly to the operator's comfort. In the first place, he avoids the loss of time and the annoyance caused by a prolonged effort to sterilize his hands. He simply washes his hands and puts on the sterile gloves.<sup>1</sup> When he removes his gloves his hands are perfectly clean and soft and his nails free from discoloration and cracking. No matter how septic the case he is obliged to operate upon, he is protected against infection. Not once during this past winter have I suffered from a crack in the skin of my hands. I have been frequently asked if it is not very difficult to manipulate instruments, ligatures, etc., with gloves on the hands. At first it is rather difficult, and at first one is liable to tear or prick the gloves. But like most of the things we do, what is difficult at first soon becomes easy through habit. Needles can be threaded, instruments can be used, ligatures can be tied just as well and certainly nearly as rapidly with gloves on as without them. I have also been often asked if the sense of touch is not so blunted, when the hands are gloved, as to interfere with accurate palpation. I do not find this to be the case. I have had no difficulty from that source in any instance. One can feel a very feeble pulse perfectly well while wearing a well-fitting rubber glove. The same is true of adhesions, slight differences of consistency, irregularities of surface, etc. One reason for this is that the hands of the operator who wears gloves are never hard and callous or roughened by contact with irritating disinfectants, and the sense of touch is therefore more acute.

<sup>1</sup> Dr. Halsted writes me as follows: "We boil our gloves now, of course, and from the boiler they are dropped into large basins of corrosive sublimate solution (1 to 1000), filled with this solution by the surgeon who is to wear them, and, while full, drawn on his hands, which have been as carefully disinfected as if no gloves were to be used."

Clinically I have found it to be perfectly satisfactory to simply wash the hands in soap and water and put on the sterile gloves. One learns to avoid cutting and tearing the gloves, which accidents would expose an unsterilized hand.

When tissue, as a portion of intestine, is very slippery, a piece of sterile gauze renders it at once manageable. If thick pedicles have to be tied with force, a piece of gauze prevents the ligature from cutting the gloves. If a glove finger is accidentally cut or pricked, the wound is at once closed by putting over it an extra glove finger. The gloves are not expensive, and they last, with daily operating, from four to six weeks. The method of preparation that I formerly made use of was this:

The gloves were boiled for one-half hour in a 1-per-cent. solution of soda. They were then washed off in hot sterile salt solution to remove any remnants of sulphur which showed after the boiling. Lightly packed with sterile gauze to dry the interior, and, wrapped in a sterile towel, they were ready for use at any time. My gloves are now prepared as follows: They are first thoroughly washed with soap and hot water, to which a little aqua ammoniæ has been added. They are then boiled for fifteen minutes in a 1-per-cent. soda solution. Being carefully removed by means of sterile forceps from the hot soda solution, the gloves are laid in the centre of a sterilized towel, which is folded over them. This enveloping towel is not opened until the individual who is to wear the gloves is to put them on. Operator, assistants, and nurses put on a fresh pair of gloves for every operation. I have given up trying to dry the interior of the gloves by packing with gauze, as this process is laborious, requires some handling, and seems to be unnecessary. If the hands are quite dry, and are then well rubbed with dry sterilized starch, the gloves can be drawn on quite easily even when their interior is moist. If the hands are moistened with glycerine, or with a material called *lubrichondrin* (made from sea moss), wet gloves can be easily put on. Oily lubricants are damaging to India rubber. Filled with any sterile fluid the gloves permit the hands to enter readily. If this last method is made use of, the hands should be first sterilized, as the fluid which filled the glove flows out and over its outer surface as the hand enters. Before putting the gloves on, the

hands are rapidly washed in an ordinary way with soap and water and dried. To remove any starch which may have fallen on the outside, the gloved hands are washed off with sterile salt solution. During the operation, blood and other fluids can be very rapidly washed off as often as one chooses, or a fresh pair of gloves can be put on at any moment in case of accidental contamination. During active military and naval service India-rubber gloves would be of the highest value. When rolled up they occupy a very small compass, and can be rapidly sterilized over and over again in any small vessel which can serve as a boiler. The best methods of sterilizing the hands would be totally impracticable in a rapidly filling army hospital, but provided with a few pair of gloves, the army or navy surgeon need never dread that he may infect the wounds, which he treats and makes, with his hands. The gloves may be prolonged into gauntlets, and in order that for certain cases the whole forearm may be covered, I have had armlets made which extend from the wrist to the elbow. The presentation which I have made of this subject is based almost entirely on clinical experience. I find that with the aid of "boiled hands" I can obtain in my own work such uniformly perfect wound healing as I did not believe before was possible. Those surgeons who already, with naked hands, have entirely satisfactory success, certainly do not need rubber gloves. But I am sure that they will be useful to those who too frequently meet with imperfect results. If some of the latter will give the method a fair trial, its level as an addition to our defences against wound infection will soon be properly estimated.