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The Lettsomian Lectures

ON

ASEPTIC SURGERY IN THEORY AND PRACTICE

BY

CHARLES BARRETT LOCKWOOD, F.R.C.S. Eng.,
SURGEON TO ST. BARTHOLOMEW'S HOSPITAL.

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I wish to thank the Council of the Medical Society of London for permission to reprint these Lectures.

C. B. L.

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THE LETTSOMIAN LECTURES ON ASEPTIC SURGERY IN THEORY AND PRACTICE.

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LECTURE I.

Introductory.

I THANK the President and Council of the Medical Society of London for the honour they have done me in inviting me to deliver the Lettsomian Lectures. I propose to try and justify this choice by lecturing upon a subject which must be of interest to every one of the Fellows, whatever line of practice he may pursue.

And, at the outset, it is desirable to say how I intend to proceed. As a matter of fact these lectures will be on the same lines, and a continuation of, the reports on aseptic surgery which I have published at intervals since 1890.* It might be thought that little was left to be said upon such a well-worn topic. But every one knows that although all surgeons aim at asepsis, they endeavour to attain that end by many different and ever-changing methods. Some of these methods I have tested, and you will hear the results. I shall also try to tell you what has been the result of my own methods of treating wounds. To render this of value it will be necessary to lay emphasis upon the unsuccessful cases, and especially upon the circumstances which led to failure. I will not insult your intelligence by talking as though I operate upon the immortals, who die not, nor suppurate. All operators must have a certain percentage of sepsis. When sepsis occurs the cause is to be sought for in the patient, in the environments, in the methods, in the application of the methods. It is instructive to the philosophical

* 'British Medical Journal,' October 25th, 1890; May 28th, 1892; January 27th, 1894; July 11th, 1896; September 17th, 1898; February 24th, 1900.

mind to contemplate the relative importance which is attached to one or other of these sources of failure. I have heard a surgeon vehemently maintain that when a wound suppurated the patient was at fault. I have heard another ask whether there was not a deal of suppuration about as though it were a kind of epidemic. The surgical egotist never admits the possibility of failure, either in his methods or in their application. As a matter of fact, the fault may lie in the patient, in the environments, in the methods, or in their application. If we possessed definite scientific information there could be no room for differences of opinion, and it is singular that better scientific information is not forthcoming. The research is difficult and surrounded with fallacies. But what an advantage it would be if, when sepsis occurred, we knew the exact state of the patient, the bacteriological conditions of the wound, of the atmosphere, of the operating theatres; the cubic capacity of the ward, and the condition of the air in it, the purity of the materials and appliances, and, lastly, the methods of the operator. Most of our great hospitals now possess well equipped bacteriological laboratories and skilled bacteriologists, so that some, at least, of the difficulties have vanished. In a very humble and inadequate way I will endeavour to deal with some of these questions, using, as I proceed, the clinical and bacteriological material which is at my disposal, though I am fully conscious of the crudeness of the attempt.

It is strange that we should be obliged to begin with a definition of the term "aseptic." But whoever reads the medical papers with reasonable diligence will agree that the need exists.* Of course I am aware that there can be no agreement in the definition of general terms. But on this question the disputants are divided into two camps. In one are those who would apply the term aseptic to the *methods* they employ, and in the other are those who apply it to the *end* they achieve. Let us consider the position of those who apply the term aseptic to the methods. They begin by assuming that chemicals are harmful, and therefore endeavour to do without their help. Everything brought in contact with the wound is sterilised by heat; heat-sterilised salt solution is used as a lotion; heat-sterilised cotton swabs are used for sponges; and a heat-

* Correspondence in 'British Medical Journal,' August 6th, 1902; 'Lancet,' February, March, May, and June, 1903; also Watson Cheyne, "Aseptic and Antiseptic Surgery," 'Lancet,' February 7th, 1903, p. 347.

sterilised cotton dressing is applied to the wound. I am at a loss to know how this type of surgeon sterilises his hands or the patient's skin, because if he uses the harmful chemical he ceases to be consistent, and becomes what I suppose would be called an antiseptic surgeon. One who writes somewhat vauntingly about his so-called aseptic surgery nevertheless uses strong chemicals for his ligatures, and, furthermore, transfers the ligatures straight from the chemical into the wound.

The other school is consistent, for it applies the word aseptic to the end, and not to the means. To gain the end both heat and chemicals are utilised. Perhaps in the future science may provide some method of sterilisation as yet undreamt of. This school, to which I belong, will apply it to the end in view—sterility—and continue to speak of aseptic surgery. Should the other school use the new discovery, they will have to invent some new name for their new method. We are, perhaps, living too near the great revolution in surgery to be able to take a dispassionate view of the question. The voices of those who threw doubt upon the teaching of Lord Lister may still be ringing in our ears. But, assuredly, in the future it will be assumed, as a matter of course, that all surgery is aseptic, and then surgeons will cease to speak of "aseptic surgery" or of "antiseptic surgery" as though wishing to imply that they alone dealt in a special brand of superior excellence. But even in that golden age it may be that, after suitable tests, the ultimate result will be called septic or aseptic. For even then sepsis will sometimes occur. All the bacteria will not have died of senile decay.

It may be readily granted that ideal perfection would be reached if asepsis could be attained without the use of chemicals. Nay, I will go further and say, as I have often said before, that the more efficaciously heat is used to sterilise instruments, lotions, materials, and dressings, so much the more can we dispense with the use of chemicals. It is, however, difficult to conceive how they can ever be dispensed with in the disinfection of the skin. To sterilise on a large scale the lotions, sponges, materials, and dressings entails an elaborate equipment and organisation. A special scheme of architecture and system of ventilation are required merely to improve the atmosphere. A reasonable outlay is justifiable to attain these ends. Asepsis must be easier to attain under such conditions, and the proportion of sepsis ought theoretically to be less.

In this country several elaborate and expensive installations have been started with these ends in view. It will be most instructive to have detailed reports of the results. These reports should not be based upon opinion, but should tell us exactly what proportion of sterility was obtained.

The atmosphere, with its swarms of bacteria, must of necessity vitiate the results of the consistent aseptician. Reluctant to bring chemicals into contact with wounds, he is compelled to strive for a germless air. If it were found that the attempt was successful, then the elaborate and expensive precautions would be fully justified. But what if the air showers bacteria into wounds unprotected by either antiseptic or disinfectant? Are we now to put our trust in the assumed harmlessness of atmospheric bacteria, or are we to confide in the germ-killing powers of the tissues and fluids of the body? Obviously, no combination of glass, brass, and marble can ensure a germless atmosphere. So what provision does the consistent aseptician make for the destruction of atmospheric germs? Surely his aim is to keep out all bacteria, or does he pretend to separate the harmful from the harmless, allowing the latter to enter and keeping the former outside? It is impossible for me to conceive that an open wound is germless. When it is closed some bacteria must be imprisoned in its depths, unless some steps be taken to wash them out or compass their destruction. One would imagine that it were easy to be sure whether a wound was septic or aseptic. But even such a straightforward question is difficult to answer. One observer * has tested cases of laparotomy at various stages of the operation. Culture media were inoculated from the wound and from the peritoneum at the beginning, the middle, and the end of the aseptic operation. Bacteria were constantly present. They were most numerous in long operations involving much manipulation. Döderlein opines that most of the bacteria come from the hands and person of the operator, some entering by contact, and some through the air.

It seems to me irrational to make no attempt to get rid of these bacteria, especially when there is a reasonable possibility of washing them out or of killing or attenuating them with dilute chemical solutions. It is true that the wounds which Döderlein tested healed by first intention. But laparotomy wounds are not

* Döderlein, 'Münch. med. Woch.' (Abst., 'British Medical Journal,' June 27th, 1899.)

the most stringent test. The fate of a breast wound in which a haematoma had formed might have been very different. Buried silk sutures, too, might reappear in a mysterious way from these microbe-haunted wounds. To my mind such observations as these are arguments in favour of the rational and moderate use of chemicals.

Pray do not suppose that I wish you to infer that by any use of chemicals all the evils of an infected atmosphere can be overcome. In our cities a large expenditure is justifiable to improve the quality of the air supplied to the wards and operating theatres of our hospitals.

It is so well known that the air of ordinary operating theatres contains bacteria that it is unnecessary to recapitulate the evidence. I should now like to hear what is the condition of the air in those new theatres into which purified air is driven. Perhaps an elaborate bacteriological report has been issued, but, if so, I regret that I have not seen it yet. Such a report would be of great value to those who contemplate the adoption of this system rather than that which relies upon extraction, aided by the occasional introduction of steam.

I wish the results of bacteriological tests could be laid before you in every case, but it has only been practicable to carry them out in hospital practice. Therefore the success or failure of the methods has had to be judged by the way the wound healed. But it will be observed that the slightest amount of suppuration, even of a minute part of a wound or of a stitch, suffices to place it in the septic class. It may be that the sepsis was too slight to injure the result, but that is not the point: the patient ran an unnecessary risk. Some fatal cases of sepsis have very small beginnings.

What constitutes an aseptic case? Our ideal is one in which all the sponges, towels, materials, instruments, skin of the hands, skin of the patient, and the wound itself are all sterile when tested with culture media. This stringent ordeal entirely puts aside the personal idiosyncrasies of the operator. If it were in common use we should not hear of a septic discharge called a little turbid serum, or of such an absurdity as non-purulent pus.

It is our endeavour to have the wound tested with culture media when the dressing is removed. Except when a drain is left in to provide for the oozing of blood, the first dressing is done on the eighth or tenth day. As a rule, a piece of one of the skin sutures

is dropped into the broth. Hitherto a very minute proportion of wounds have withstood this stringent ordeal. Theoretical perfection is exceedingly hard to attain; but the effort to attain it has a most excellent disciplinary effect. When house-surgeons, dressers, and nurses know that their towels, sponges, dressings, silk, catgut, and skin may at any time undergo the stringent test of culture media, they apply themselves with great earnestness to carry out with exactitude the directions of the surgeon. The surgeon, too, does his best to sterilise his own hands when he knows that their state of sepsis or of asepsis will be accurately revealed. I need hardly add that he will avoid introducing infection into the wound with as much care and accuracy as if he were dealing with culture media; in fact, he ought to remember that he is performing a delicate bacteriological experiment.

To my mind this experiment is rendered fallacious by two things: first, the uncertain disinfection of the skin of the patient, of the surgeon, and of his assistants; and secondly, by the condition of the atmosphere in which he works. It has become too much the fashion to ignore the dangers of aërial infection. Perhaps we shall arrive at an explanation of some of our contradictory results when we have accumulated enough scientific information regarding all the conditions under which operations are performed.

A culture tube of nutrient broth is a very delicate test. If we were working without chemicals it might be absolutely relied upon. No chemical need be introduced with silk, towel, or silkworm gut, for they can be conveyed straight from the steriliser into the broth. But a certain quantity of antiseptic clings to the bits of skin removed from the fingers of the surgeon and of his assistant and from the margins of the wound, and some clings to the sponge. The catgut probably contains a relatively large quantity. The presence of a minute trace of a diluted chemical does not render the tests absolutely valueless. In spite of its presence a percentage of test objects infects the broth. Being very dilute, and in exceedingly minute quantities, it probably cannot exert more than a retarding influence upon bacterial growth. Inasmuch as the tubes are incubated for a week at body temperature, there is time for the bacteria to grow in spite of the presence of the minute trace of chemical. For some time we tried to neutralise the biniodide of mercury upon the test object by dipping the bits of skin or of sponge into a solution of ammonium sulphide. There was no increase in

the proportion of infected broth, and therefore the unpleasant sulphide was discontinued. I think most will concede that although our present tests may not be perfect, nevertheless they are infinitely better than none at all. At all events, since they have been instituted there has been a marked improvement in results. I am endeavouring to get our bacteriological department to undertake independent and stringent tests of their own. Further, may we not reason thus? If the chemical which clings to the skin prevents the skin from infecting culture media, may it not also prevent the skin from infecting the wound? Surely it is reasonable to suppose that skin saturated with the antiseptic is less likely to infect than skin which is not. Chemicals will kill spores or bacteria in time, but in surgical practice they are used under the most disadvantageous conditions. Sublimate, for instance, is rendered inert by the albumen and salts with which it comes in contact. I am quite sceptical as to the possibility of disinfecting an infected wound. Indeed, it is hard to imagine any one more helpless than a surgeon confronted with a septic wound. He cannot cure, and his best efforts may not alleviate. If the septic wound could with certainty be made aseptic, surgery would have made another vast advance. On the other hand, although we cannot disinfect with chemicals, yet we possess several which, even in extreme dilution, act as antiseptics, and can be relied upon to protect the hands, the wound, the instruments, and materials from aërial infection. I cannot myself observe that the dilute antiseptic solutions have the slightest appreciable malign influence upon the tissues. Therefore it seems to me irrational to leave bacteria within a wound when there is a possibility of washing them out with a weak and harmless chemical solution.

The search for the ideal chemical antiseptic and disinfectant is as arduous as the quest of the Holy Grail. It is easy, as I have said, to find a chemical which, in weak and harmless solutions, acts as an antiseptic, but it is quite another matter to find a chemical disinfectant. The task would be easier if our knowledge of the action of chemicals upon bacteria was more scientific. It is useless to beg the question by saying that the bacteria are poisoned. I confess a deep ignorance as to how a chemical like sublimate kills bacteria. It may, and probably does, enter into chemical combination with the micro-protein. But this cannot be the whole truth, because the quantity of the chemical varies according to the species of bacterium and not according to the quantity. Some

species of micrococci are more quickly killed by a given quantity of sublimate than others, and even the age and vigour of the growth may make a difference. We begin to know something about the antiseptic and disinfectant properties of chemicals. Quite a romance might be written about the vicissitudes of some. The experiments of Koch placed sublimate upon the highest pedestal only to be laid low by the experiments of Geppert. Kanthack and Drysdale gave the palm to biniodide of mercury, and said it was twice as strong as sublimate. Andrewes * and Krönig and Paul † throw doubt on this and exalt sublimate; but, as a matter of fact, a chemical which is the best in the laboratory is not necessarily the best in surgical practice.

The other day a friend showed me his hands covered with an angry rash. He had been trying a skin disinfectant on the recommendation of a bacteriologist. The disinfectant had, I believe, given wonderful results in the laboratory, but evidently it did not agree with that particular skin. Nevertheless another individual might have found it non-irritating; so much depends upon personal idiosyncrasy. Whilst working with a colleague who used sublimate my own hands were in a continual state of irritation and yet his seemed always to be smooth and comfortable. Now the biniodide of mercury which I habitually use never causes me discomfort and seldom roughens the skin of my hands. Others, owing to some peculiarity, may not have had such a fortunate experience. Again, a chemical which gives bad results in the laboratory may give good ones in surgical practice. Iodoform is one of these. It cannot be called a disinfectant and its antiseptic properties are exceedingly feeble; nevertheless it is of great value in the treatment of wounds about the rectum and for some forms of tuberculous ulceration.

The truth is that different kinds of infection have to be fought with different kinds of chemicals used in different ways. Experience has a great part to play in the choice, and doubtless we have all much to learn. Here are a few examples, selected because they illustrate some sources of infection which are sometimes overlooked.

* 'Lessons in Disinfection and Sterilization,' by F. W. Andrewes, London, 1903, p. 91.

† "Die Chemischen Grundlagen der Lehre von der Giftwirkung und Desinfection," 'Zeits. f. Hyg. u. Infectionskrank,' Leipzig, 1897, pp. 1–112.

The importance of using the right chemical disinfectant in the right way is, I think, well shown in the treatment of chronic sepsis of the bladder and urethra. These dangerous forms of sepsis are often overlooked, and the strange symptoms they produce are attributed to wrong causes. For instance, an officer was affected with a series of abscesses in the subcutaneous tissues of the face, neck, buttocks, and thighs. The abscesses left discharging sinuses, which did not heal. Although the tubercle bacillus was not seen, or its presence demonstrated by inoculations, the abscesses were attributed to tuberculosis. Whenever a patient has mysterious suppuration, the source of infection should be looked for, though it may be very difficult to find. In this instance it was discovered by making the patient pass urine into a glass, when numerous flakes of lymph were seen. The bladder could not be disinfected until a stricture of the urethra, about which nothing had hitherto been said, had been divided. Recovery was rapid, complete, and permanent.

When bladder sepsis is overlooked, its effects may be attributed to mere abstractions, such as "rheumatism." A gentleman who was supposed to have "gouty arthritis of the ankle" was speedily cured by disinfecting the infected bladder and urethra with nitrate of silver. A lady with "rheumatic arthritis of the knee" was cured and remarkably improved in health after a gynæcological colleague had curetted and disinfected the septic interior of the uterus. Some chemicals can hardly be used on conscious patients, because they are so painful even in extreme dilution. This is especially noticeable when they are applied to some of the mucous membranes. For instance, a gentleman's bladder was being disinfected with a solution of nitrate of silver, the strength of which had been gradually increased until it had reached 1 grain in 1 ounce of distilled water. This could be retained in the bladder for five minutes without much discomfort. One day no nitrate of silver was available, so 4 ounces of 1 in 10,000 solution of sublimate was introduced. The patient immediately complained of intense pain, and was obliged to eject the lotion as quickly as possible.

I have found solutions of hydrogen peroxide far more efficacious than mercurials in the treatment of those horribly fetid appendicular abscesses, and for similar ones about the middle ear. The effects of about three applications of the pharmacopœial solution of hydrogen peroxide were most striking in the case of an elderly lady. A large

localised appendicular abscess was opened, with relief of pain and a diminution in the height of the temperature and in the rapidity of the pulse. Two days afterwards the abscess cavity became abominably fetid, with gangrene of the edges of the abdominal wound. The gangrene attacked the muscles more than the skin and fat. The patient became critically ill, with a rapid pulse and heightened temperature. The gangrene was arrested and the fetor removed by two or three applications of the solution of hydrogen peroxide, and the patient got well. The usual mercurial disinfectant had been used, but without any result.

It is not without interest to note how iodoform has fallen from its high repute. Less than five years ago many of us thought a dusting of iodoform an indispensable part of the dressing of a wound. I myself have quite given iodoform up, and seldom use it except in the form of 10 per cent. iodoform gauze for septic wounds such as those about the rectum, fetid appendicular abscesses, or those in connection with middle-ear disease. In such cases as these it seems to be of value, but in what way I know not. It is also useful in the treatment of tuberculous ulcers of the skin or mucous membranes.

It is sometimes asserted that the iodoform is decomposed in septic wounds, and gives off free iodine, a powerful disinfectant. But I have tested mixtures of putrid pus and iodoform, and also septic wounds, with the delicate starch reaction, without seeing a trace of blue discolouration, so that that explanation seems open to doubt. Perhaps iodoform does neutralise ptomaines, but we are still groping in the dark, and obviously must continue to do so until provided with scientific information. There are other reasons for relinquishing the use of iodoform. Some patients object strongly to its peculiar odour, others are very susceptible to its poisonous effects, and speedily begin to smell and taste it. Occasionally iodoform causes acute local inflammation. A lady had several operations performed upon her face after a severe horse accident. A little finely-powdered iodoform was dusted upon the wound and produced an acute dermatitis with abundant vesication. Had this occurred but once I might not have thought much about it, but it happened after a second operation and not after others in which iodoform was omitted. It is only fair to say that iodoform has not infrequently been blamed for the effects of septic infection. Doubtless the layer of iodoform dusted upon a wound served a

good purpose by excluding the air, but a layer of silver foil is more efficacious and perfectly harmless.

We all devote much time and attention to methods of operating, but I am inclined to think that all do not give the same thought to what may be called "the organisation of operations." I should imagine that the organisation of an operation bears the same relation to methods of operating as strategy in war bears to tactics In an aseptic operation every detail must be perfect and all engaged in it consistent. Not least amongst the details should be included an exhaustive diagnosis and a complete knowledge of human anatomy and pathology. To get the very best results in hospital practice each surgeon ought to have his own wards, theatres, instruments, nurses, and assistants. It is most undesirable for septic cases to be introduced into the wards or theatres used for the aseptic, and separate septic wards and theatres ought to be provided. It is necessary to make provision so that septic cases arising in the wards can be removed. Obviously to carry out these requirements necessitates a much larger provision of isolation wards for septic cases as well as a theatre for septic operations. Moreover, the theatres at present used for aseptic operations often leave much to be desired, especially as regards the intrusion of the audience into the area of operation. The present organisation, buildings, and equipment of our old hospitals cannot be made to meet such requirements as these; but I do not doubt that evolution will continue and that our ancient hospitals will be replaced by modern. Hospitals built on modern lines require for their construction a spacious area of land. Imagine for a moment a spacious ward containing 25 beds, all in view of the night nurse. Then project from one end the sanitary towers cut off by cross-ventilation, and perhaps a balcony too; at the other end put the sisters' room, kitchen, day room for convalescents, clinical room, four separation rooms, linen rooms, clothes room, and such like conveniences. Lastly, remember that in proximity must be operating theatres with anæsthetic rooms, recovery rooms, instrument rooms, and dressing rooms. What a space all these require, without mentioning the accommodation of the resident medical and surgical staff, or of the medical school, or of the sterilising rooms, or machinery for heating and ventilating. A medical school is a great aid to efficiency and to that perfection of organisation which aseptic surgery demands. Further, it is to be remarked that all

this tends to the humane and considerate treatment of those who are so helpless from disease or injury. To my mind it is barbarous to compel those who are convalescent to sit about in wards surrounded by those who are undergoing the painful ordeals from which they themselves have just emerged, and to pass their time—

'Mongst horrid shapes, and shrieks, and sights unholy.

Day rooms should be provided for them, and separate rooms for those who are maimed, and whose lives are ebbing away. As a profession we are far too callous about these things.

It is also probable that the system of assistants will require modification. It is of importance that the surgeon should be assisted by one who is a convinced aseptician, and who is thoroughly conversant with his methods. In nearly all our hospitals the house surgeons and dressers are appointed for limited periods. Those gentlemen do their work remarkably well, and with great devotion, but unfortunately their period of office comes to an end just as they are beginning to be efficient.

Obviously our present system must increase the percentage of sepsis even among the cases of the most consistent aseptic surgeon; but the system is of great educational value, and it is difficult to say which is best—a system which sends out into the world numbers of men well educated in the requirements of aseptic surgery, or one which helps one surgeon to obtain a minimum percentage of suppuration. I myself have no doubt as to the right answer: the greatest good of the greatest number ought to prevail. I believe that the inhabitants of the British Isles, even in remote parts, have at their disposal one of the best medical services that exists.

I have pointed out many details in which my own organisation may be imperfect. The disinfection of the skin of the patient and of the operator's hands leaves much to be desired, and much of my work has to be done amidst surroundings which are out of date. But one who is alive to deficiencies is more likely to supply them than one who is wrapt in complacent optimism. I am an advocate for simplicity and uniformity in the organisation of operations. It has been well and truly remarked by the celebrated Desault "that the simplicity of an operation is the measure of its perfection."* In organising the operation it would be hard to improve upon these

* Robert Liston, 'Practical Surgery,' 3rd edition, London, 1843, p. 1.

words of Desault, quoted with approval by one of his peers. Now that we are so alive to the dangers of infection simplicity is more needed than ever before. The elimination of each unnecessary pair of hands lessens the dangers of infection. Therefore the surgeon alone handles the instruments, ligatures, sutures, and dressings. The single assistant has little to do and his fingers ought to be kept out of the wound. A garrulous assistant is particularly objectionable. A passage of infective particles from the nose and mouth ought to be a well-recognised danger. Simplicity should govern the choice of instruments and of materials. Instruments should be few and simple, materials uniform and simple. Thus it would be safer to use a single reel of silk throughout than several sizes, with perhaps some fishing gut or catgut and kangaroo tendon in addition. Obviously diversity of materials multiplies the chances of infection. The same applies to dressings. The chances of error must be less when one kind of dressing is chosen and adhered to. As our hospital organisation is at present I find it difficult to adhere to one dressing, and those who watched my practice might naturally suppose that I was extremely inconsistent.

LECTURE II.

Disinfection of the Skin.

The literature of skin disinfection has already reached large proportions. One author has published an excellent volume of two hundred and odd pages upon the subject.* So far as can be judged no one can yet claim that his method is perfect. Much depends upon the stringency of the test applied. It seems clear that the use of soap and mechanical means cannot disinfect the skin. † It merely diminishes the amount of infection. ‡ This is an important point, because some surgeons seem to rely solely upon mechanical methods and soap and water for the disinfection of

* Carl S. Haegler, Basel, 1900, 'Handereinigung, Handesdesinfection, und Handeschutz,' gives a complete bibliography up to date.

† *See* Haegler, p. 27. Also a valuable essay by Kronig and Blumberg. 'Beiträge zur Handesdesinfection," Leipzig, 1900. Also Poten, 'Die chirurgische Asepsis der Hände,' Berlin, 1897.

‡ Sarwey and Paul, 'Arch. f. klin. Chir.,' 1900, p. 463, &c.

their hands. There is no room for doubt that when the mechanical scrubbing with brushes and pumice stone and abundant soap and water is followed by absolute alcohol or rectified spirit the chances of sterility are greatly increased. Next when, as in Fürbringer's method, these are followed by immersion in sublimate lotion, 1 in 500, a still further improvement ensues. However, both of these are forbidden to the consistent aseptician.

Fürbringer's method consists in—

(1) Cleansing the nails.
(2) One minute, scrubbing with soap.
(3) One minute, alcohol.
(4) One minute, 1 in 500 sublimate lotion.

I find, personally, that sublimate makes the hands rough and inflamed. Alcohol is undoubtedly one of the most valuable aids to disinfecting the skin. After the work of Fürbringer, Ahlfeld, Schaeffer, Leedham-Green,* and of many others, its most valuable qualities, when used as an adjunct, are fully established. Alcohol has the great virtue of overcoming the fatty matter which impermeats the skin. The alcohol may be used by itself, or in a solution with soap, or in conjunction with chemical disinfectants.

In order to simplify the process and render disinfection easier, I have for some years used a mixture of alcohol, water, and biniodide of mercury for disinfecting the skin; presently the results will be given. I have always been accustomed to test the disinfection of the hands by snipping off a scrap of skin down to the dermis and placing the scrap in broth. Several other methods can be used such as (1) scraping with bits of wood, bone, or toothpick; (2) rubbing upon sterilised material such as silk; (3) dabbling upon culture media.† My own way seems quickest and easiest. A small quantity of disinfectant clings to the skin, and this I hope in the future to be able to get neutralised.

I have tried to get this done with the help of Mr. Rose, and so far our attempts at neutralisation have not revealed any serious error in the past.

We assume at present that skin which does not infect culture

* This excellent paper is in the 'British Medical Journal,' October 17th, 1896, p. 1109. *See* also Lauerstein, 'Munch. med. Woch.,' July 29th, 1902; Abst., 'Epitome of British Medical Journal,' October 25th, 1902, par. 253.

† *See* Sarwey, p. 465.

media will not infect wounds. But as asepsis is our aim we ought some day to learn how to disinfect the skin with absolute certainty. Sometimes the question is asked whether, when a scrap of the skin of the hand is sterile, the whole hand is sterile. Here we are face to face with a much-debated point, the possibility of a perfect induction. Personally I cannot conceive a perfect induction when bacteriological problems are concerned, and it is to be doubted whether any one will be so self-sacrificing as to offer the whole of the skin of the whole of both of his hands for bacteriological examination. Fürbringer's is perhaps the most stringent test. He scrapes the backs and palms of the hands, the fingers, and about the nails with pieces of sterilised wood. These are then put into the culture media. I myself could not afford the time which this method demands. Thus absolute certainty being out of the question, we must content ourselves with relative certainty. The method of hand disinfection by the spirit and biniodide of mercury method has of late given a proportion of three septic tests in a total of 111.*

It is interesting to note that in each case it was the surgeon's own skin which was septic. Once it was some form of micrococcus, once staphylococcus pyogenes albus, once the exact nature of the growth was unknown. This marks an advance upon previous results. In 1898 the skin of the hands was septic seven times in 70. In 1900 it was septic twice in 30.† So that there has been a continuous and marked improvement from 1 in 10 to 1 in 15, and then to 1 in 37. I attributed this improvement to the efficiency of the spirit and biniodide of mercury lotion, and also to the additional care and precision with which it is applied. This continuous improvement in results may also be advanced as evidence in favour of the method of testing. It is most difficult to get any human being to keep looking at the clock, but, nevertheless, the hands must be soaked in the lotion for not less than two minutes by the clock. Also it is not at all easy to get the hands properly prepared for disinfection. Some are reluctant to trim their nails quite close. Hot soap and water and a soft scrubbing brush should be used for at least three minutes before the spirit and biniodide.

* The house surgeons were Messrs. Jennings, Pinker, Scott, Farncombe, Rose, and Wenham. I am much indebted to these gentlemen for their help.

† *See* reports in 'British Medical Journal.'

There seems to be some misconception abroad as to the composition of spirit lotion. For instance, my colleague, Dr. F. W. Andrewes, says*: "It is a common practice to use the perchloride or biniodide of mercury dissolved in spirit instead of in water, as, for example, in the sterilisation of the skin or of ligatures." But at his own hospital the lotion consists of biniodide of mercury in methylated spirit (one part in 500), 75 per cent., and water 25 per cent.† The latter has to be added because, as we all know and have known for years, disinfectants are inert in solution in pure alcohol. Some of the methods of hand disinfection are so elaborate and take so long that they are impracticable for ordinary surgical work. If the short and simple spirit and biniodide method proves the best after extended trials surgical work will be simplified.

During the course of an operation the hands are frequently rinsed with biniodide of mercury lotion to free them from blood and atmospheric germs. The usual strength of the lotion is now 1 in 4,000. For operations about the face and eyes the strength is usually 1 in 10,000, for if it were stronger the eyes might suffer, and I am inclined to think that keloid is likelier to grow after strong lotions have been used. Doubtless in the near future an isosmotic antiseptic lotion will be found to take the place of biniodide. In addition the hands of the surgeon and of his assistant are continually bathed in lotion whilst the sponges are being rinsed out. For no one is allowed to touch them except the surgeon or his assistant.

It is probable that these measures are efficacious because the skin of the hands was tested eight times at the end of the operation, and was sterile on each occasion. I am anxious to use sterilised salt solution instead of the dilute antiseptic solution, but I am doubtful whether the experiment is justifiable amidst the present surroundings and organisation.

Gloves.

Those who are distrustful of the disinfection of the hands advocate the use of cotton, leather, or indiarubber gloves. I suppose we may dismiss cotton and leather gloves from the question; of leather gloves I have no experience. Whilst assisting I have had experience of sterilised cotton gloves. It seems very

* 'Lessons in Disinfection and Sterilization,' p. 93.

† As given in 'Aseptic Surgery,' 2nd ed., p. 177.

difficult to see how they can be expected to protect the wound from contaminated hands, but thin rubber gloves come in a different category, and I have given them a fair trial, and, to begin with, found, as might have been expected, that rubber gloves are easily sterilised with heat. They were tested on seven occasions, and were always sterile. No chemicals were used before this test. But, like Mr. Lynn Thomas* and others, I have found it practically impossible to complete an operation without tearing or puncturing the fingers of the gloves. This, of course, entirely vitiates the experiment, but in our case it did not matter much so far as any danger to the wound was concerned. Before the gloves were put on the hands were sterilised with the usual precautions, and on five occasions the skin was sterile when the gloves were taken off at the end of the operation in spite of the numerous holes in the thin rubber. But in addition to their vulnerability, the gloves seriously impair the sense of touch. Indeed this, to my mind, is one of the chief objections to their use. Probably we all place a varying degree of reliance upon our sense of touch, but I myself am accustomed to place great reliance upon the sense of touch, especially in the performance of abdominal operations, such as those for the removal of the vermiform appendix or uterine appendages. These I could not do to my own satisfaction if the sense of touch were hampered with gloves. For radical cure of hernia, or removal of the breast, and such like, they can be worn without any real inconvenience; but for operations upon septic cases gloves ought to be worn, especially if other operations are impending. I have seen very severe cellulitis follow an operation when, a few hours before, the surgeon had had to operate upon a very septic case. He did not wear gloves, but took every precaution to disinfect his hands. There were other circumstances in the case which suggested that the cellulitis might have been a coincidence, as before the operation the patient had had an occasional rise of temperature. Had the operator worn gloves at the septic operation, he could at all events have claimed to have taken every possible precaution. If someone could invent gloves which (1) could be sterilised by heat, (2) which did not tear, and (3) which did not impair the sense of touch, the objections to their use would fall to the ground.

* J. Lynn Thomas, "On the Value of Gloves in Operative Work," 'British Medical Journal,' January 21st, 1899, p. 140.

The Disinfection of the Patient's Skin.

During the operation a piece of the skin of the patient is snipped off and dropped into broth. The piece includes the whole depth of the skin, and in most regions has in it many hair follicles and also sudoriferous and sebaceous glands. These, together with the epidermis, as is now well known, harbour all sorts of bacteria, and in considerable numbers. Some of these bacteria have very peculiar characters, and give rise to pigments and to bodies with strange and penetrating odours. I ascertained some years ago that they had lethal effects on mice and rabbits,* and without any doubt some of them are the cause of the slighter forms of sepis and suppuration, not always of the kind to make the patient ill, but almost certain to lead to the extrusion of buried sutures. Now, it is to be imagined that the skin bacteria must be most difficult to dislodge from their hiding places in the ducts of the sweat glands, in the sebaceous glands, and in the hair follicles. But their removal and destruction are rendered still more difficult by the presence of the cutaneous grease and oil. Any method of skin disinfection must aim at the removal and penetration of the cutaneous grease. We have attempted to accomplish this by mechanical efforts, aided by soap, turpentine, ether, and alcohol, and by using spirit and biniodide of mercury lotion. I wish to say at once that I am exceedingly dissatisfied with the result of our efforts. The skin was tested 55 times, and infected the broth on 14 occasions. But two of the infections were due to bacillus subtilis, and may have been accidental. In one of these tests the skin was from the abdomen, in the other from the pubes.

The degree of certainty with which the skin of the patient can be disinfected depends upon the region. I would put them in the following order, beginning with that which is most certain:—(1) Limbs, (2) abdomen, (3) breast, (4) neck, (5) the back, (6) the groin and axilla, (7) scrotum, and (8) scalp.

The patient's skin is much more difficult to disinfect than the hands of the surgeon or of his assistants. Many of the regions upon which we have to operate are furnished with sebaceous and sweat glands both large and numerous. Moreover, the piece of skin which is cut off the patient and put into the broth is larger than that from the hand, and includes the whole depth of the skin.

* 'British Medical Journal,' May 28th, 1892.

It affords, therefore, a more stringent test. In previous years the skin of the limbs has shown very high proportion of sterility. Recently we have only tested it twice, and found it sterile both times. The skin of the abdomen was tested 21 times, and was septic thrice; the skin of the breast six times, and was septic once; the skin of the groin 22 times, and was septic eight times; the skin of the neck and of the axilla were each sterile when tested once; and the skin of the pubes and of the scrotum were each septic when tested once.

Perhaps, when more stringent tests are tried, the proportion of sepsis may be greater, but the results of skin-testing throughout all these years have been so uniform and consistent that I do not think the above order will need revision. Certainly wounds made in the extremities heal remarkably well, and better at a distance from the groin and axilla than near to those localities. The high proportion of sterile abdominal skin is also reassuring. Working with sterile skin and upon peritoneum which fraternises with silk, the abdominal surgeon ought to get good results.

Now, taking these results as a whole, they show that the methods of skin disinfection are still far from perfect. Probably as much depends upon the application of the methods as upon the methods themselves. This is clearly shown by the records of the different house surgeons by whom the skin was prepared. One gentleman had five septic out of eight; another, five septic out of 14; whilst another had only one septic in 10.

In hospital practice the skin of the patient is usually prepared the night before the operation. This is now mainly done for convenience, and the spirit and biniodide of mercury methods probably give the same results when efficiently applied immediately before the operation. This is a great advantage, especially when children and nervous women are concerned. We tested the patient's skin after it had been prepared on the table on three occasions and on each it was sterile. The skin was taken twice from the groin and once from the abdomen. It seems reasonable to suppose that if one can disinfect the skin of the hands 108 times out of 111, the same methods ought to give good results with the skin of other regions. Outside the hospital I always prepare the skin myself after the patient has been anæsthetised and, judged from a clinical point of view, the results are better than in hospital practice.

Silk.

On the whole there is no better material than twisted silk for buried sutures and ligatures. Twisted silk is very tough and does not break at the knot. Formerly it was used too thick, but most of us have now learned that 00 is sufficient for ordinary ligatures, and that No. 3 or 4 is seldom necessary.

The boldness with which a surgeon buries silk is a very good indication of his proficency in asepsis. Those who are distrustful fall back on catgut and kangaroo tendon, both of which are most difficult to sterilise and do not hold long enough for the security of some wounds. For instance, when laparotomy has to be done upon a very stout person the wound is nearly always extensive. Owing to the thick layer of subcataneous fat it is almost impossible to close the abdomen with a single row of sutures, and absorbent ones might disappear prematurely. In such a case buried silk is an invaluable aid, and is, in my experience, tolerated exceedingly well by the tissues of the very stout. And here I would interject that the very stout do not always get such prompt and satisfactory surgical aid as the spare. Although healthy stout patients bear operations well and recover quickly some surgeons seem rather afraid of operating upon them. Provided that diabetes is not present the stoutness adds to the difficulties, but not to the immediate dangers. But even the difficulties disappear when the incision is a large one. A large incision is made without hesitation when it can be securely closed again with rows of buried silk. Fine silk, too, is the best material I know for peritoneal sutures. Indeed, the peritoneum tolerates silk in a remarkable way. The behaviour of the different tissues to suture materials, such as silk, is almost an unwritten page in surgical literature. Judged from the clinical standpoint I should say that the peritoneum tolerates silk sutures better than any other tissue; that tendon, aponeurosis, ligament, and the fibrous tissues come next in tolerance, but with nerve as good, if not better; whilst muscle is most intolerant.

The tolerance of the peritoneum for silk is shown by the behaviour of the omentum. For in 25 consecutive cases of inguinal and femoral epiplocele * the omentum was ligatured with from one to nine silk ligatures. None of them had the slightest trouble from the presence of the silk, and I cannot recall any instance out

* From March, 1900, to December, 1903.

of a very large number in which there has ever been the slightest trouble. In the earlier days of antiseptic surgery the possibility of sepsis about omental ligatures had to be taken into consideration.* Minute precautions are necessary in both the preparation and the application of the silk. To begin with it is to be wished that manufacturers would wind their silk upon plain, uncoloured bobbins. They are addicted to the use of black bobbins, which impart their colour to the silk after a few hours' soaking in lotion.

The processes of manufacture tend to render the silk sterile, but before use the reel is boiled in water for half an hour. After this it is either used forthwith or preserved in 2·5 per cent. carbolic acid lotion. Now, I have noticed that this carbolic-acid silk has a very irritating effect upon the skin. When it is used for skin sutures each needle hole is surrounded by a ring of inflammation, and it is to be supposed that when used for buried sutures it has the same effect upon deeper structures. This effect is explained by the experiments of von Zeignek,† who discovered that when silk was kept in sublimate solution it attracted to itself nearly all the chemical, so that at last the lotion contained nothing but a faint trace of mercury. Rubber drainage tube and catgut had similar effects upon sublimate solution. But I have found that after immersion in carbolic acid lotion the sterile silk must be boiled in water for not less than 15 minutes, otherwise it still inflames the skin. Generally it is easy to have the silk boiled just before use, and I carry about with me for this purpose a small metal vessel and spirit lamp.

My own attempts to bury silk in the abdominal wall are not without instruction. The last time that I gave the results ‡ 10 appendectomy wounds had been closed with silk, and three of these had suppurated with extrusion of some if not all of the buried sutures. Rather disconcerted by 30 per cent. of failure, I ceased for a time to use buried silk. But to my mind there is something thoroughly unsatisfactory in the closure of the oblique appendectomy wound with a single row of silkworm-gut sutures. Inasmuch as the

* Lucas-Championnière, 'Cure Radicale des Hernies,' Paris, 1892.

† 'Wien. klin. Woch.,' October 1st, 1896. Abst., *see* 'Epitome of British Medical Journal,' December 5th, 1896, par. 460.

‡ "An Address on the Organisation of Aseptic Operations and some of the Causes of Failure," 'British Medical Journal,' February 24th, 1900, p. 429.

muscles are all split in the direction of their fibres a single row cannot bring them properly together. The only accurate way is by a row of sutures in the peritoneum, another in the internal oblique and transversalis, another in the external oblique, and another in the skin.

A great deal depends upon the way in which the silk is tied. I can remember being taught to tie sutures with enough tightness to bring the cut together without strangulating the tissues. This was in the early days of antisepsis. Now we oftentimes see sutures pulled very tight without harm of any kind. Theoretically one would suppose that the tightness of the ligature could not matter in an aseptic wound. But when we consider the atmosphere of rooms and operating theatres and the ever-present risk of skin infection, it is difficult to believe that no bacteria enter; and, if this be conceded, one cannot imagine that all that enter are killed by the antiseptics. So that the tightly-tied suture and the tissues which it strangulates are a suitable soil for the germs to grow in. But this not all. As I have already said, the different tissues behave differently to silk sutures. However tightly a sterile silk suture is tied in the peritoneum, it will be tolerated; but this is not the case with muscular tisuses. I am quite sure that my ill-results in my early cases of buried silk suture after appendectomy were mainly attributable to the tightness with which I pulled the sutures that held together the muscular fibres of the internal oblique and transversalis. It is probable that these tight sutures not only strangulated and killed some of the muscle, but were also constantly pulled upon by the contracting fibres.

Now, in the operation of appendectomy, by selecting the cases and by rejecting those in which pus was seen or in which septic appendix contents came in contact with the wound, 52 consecutive cases healed by first intention. But one of these, which was tuberculous, afterwards had suppuration and parted with some sutures; and another subsequently parted with some sutures weeks after a small haematoma had subsided. In this case the wound was, as I suspected at the time, probably infected by appendicular contents. Each of those 52 wounds was closed with four sets of silk sutures; in (1) the peritoneum; (2) the internal oblique and transversalis; (3) the aponeurosis of the external oblique; (4) the skin. The skin suture was continuous, and so oftentimes was that in the peritoneum; the rest were interrupted.

A great deal of silk is buried in the radical cure of hernia. In fact, the repair of the abdominal wall in the radical cure of hernia is guided by the same principle as in other abdominal wounds, namely, the closure of the wound in layers. Thus the peritoneal sac is first tied, then the arching fibres of the internal oblique and transversalis are fastened to Poupart's ligament; then the aponeurosis of the external oblique is sewn together; and lastly, the skin. Out of 89 cases of inguinal hernia, inguinal varicocele (a similar proceeding), and of femoral hernia, 84 healed by first intention and five had suppuration. In four cases the suppuration was of the most mild type, and only led to the extrusion of one or two pieces of silk. Once (for case see Lecture III) the suppuration caused anxiety, but, oddly enough, none of the silk sutures were ever seen in the pus. I propose hereafter to refer to these cases when the question of environment is discussed.

Now it will be conceded that about 5 per cent. of mild suppuration is not very high, but it ought to be less. The septicity of the silk, of the hands, of the skin, of the sponges, and the germ-laden atmosphere, are more than enough to account for it. It is quite clear to my mind in what direction improvement can be looked for.

In my own very limited experience silk ligatures and buried silk sutures are well tolerated by the thyroid body. In nine cases the cavity left by the enucleation of an adeno-cystoma was closed with from three to six buried silk sutures, and all healed by first intention. Another was closed with catgut and healed in the same way, as did also two cases of excision of parenchymatous goître in which a very large number of silk ligatures were applied. The tissues of the mammary glands likewise tolerate buried sutures of fine silk, for I habitually use them for the obliteration of the cavity left after the removal of cysts and adenomata, and have never seen them reappear.

The tests of the silk can hardly be said to be vitiated by the presence of chemicals. The silk is boiled in water for at least half an hour, and then a bit is cut off and put into nutrient broth. At times the silk may have been immersed for a few minutes in carbolic lotion 1 part in 60. On a previous occasion the silk was sterile 18 times before and 10 times after use. I have now to report that it was sterile 44 times out of 50. Three out of the six septic pieces of silk had been prepared by the same house-surgeon.

Some of the tests—I know not exactly how many—were made at the end of the operation. Once the infection was due to moulds and cocci, and probably came from the air. In the others some variety of white staphylococcus grew in subcultures, some of these cocci without doubt came from the skin of the surgeons or of the patient. I am not here to throw a gloss over our results, and therefore confess that these are extremely bad.

Catgut and Silkworm Gut.

In spite of the efforts of numerous investigators and inventors catgut still remains an object of suspicion. This is to be deplored, because it is an admirable substance for a variety of surgical purposes. I invariably use catgut for septic wounds. To my mind it is invaluable for operations about the rectum and perineum. Likewise it is best to use catgut when there is reason to suppose that the wound is tuberculous. When tuberculous pus or caseous material escapes into the wound silk ligatures are apt to become infected and keep open the wound until withdrawn or extruded. In operations for the removal of growths from the urinary bladder catgut can be safely applied to bleeding vessels and for the closure of wounds in the mucous coat. I habitually use it in cases of appendectomy when pus is met with or the wound is obviously septic. For certain wounds in infants and children—such as circumcision—it makes excellent material for ligatures and sutures. The removal of cutaneous sutures from a nervous frightened child is a troublesome business.

Speaking generally it is advisable to use catgut for the control of hæmorrhage in all septic wounds in preference to materials which do not speedily soften and disappear. Who has not seen a sinus persist for months because it had a septic silk ligature in its depths? A scrap of silk has not infrequently formed the nucleus of a vesical calculus. One would hardly think it necessary to lay any stress upon the propriety of using catgut for septic wounds and silk for aseptic if one did not occasionally see the reverse put into practice.

But there are probably other reasons why catgut is looked at askance. Although some specimens may contain no infective organisms, they may contain ptomaines which set up a localised suppuration. Besides, catgut is not particularly good material to

work with. It may have irregularities upon it which render it difficult to thread through the eyes of small needles; next, it is sometimes rather brittle; and, lastly, when tied upon a bleeding point is apt to slip off. This last difficulty can be overcome by the usual simple device of encircling the bleeding vessel with a stitch, or by transfixing the pedicle if there be one; the others can probably be overcome in the process of preparation. Mr. Scott kindly made xylol catgut for me to use. Our tests showed that it did not infect culture media, but it was decidedly brittle, and the strong odour of the xylol was most unpleasant.

We have a simple method of preparing raw catgut. First, it is well scrubbed with soap and water; next, it is soaked for 48 hours in methylated ether; and, lastly, it is put into a solution of biniodide of mercury in water—1 part in 250. It may remain for months in this solution without any apparent alteration, but it is not used until it has soaked for 72 hours. The methylated ether removes quite a quantity of oil and fat from the catgut. Pieces of the catgut were put into broth on 14 occasions, and did not infect. Obviously this catgut was full of a potent antiseptic when it was placed in the broth, but are we to assume that catgut which does not infect the broth does not infect the wound? It is possible that spores or bacteria do actually pass from the catgut into the broth, but are unable to grow in the presence of the minute trace of biniodide which the catgut has given up to the broth. But if this be so the same process must go on in wounds with possibly this difference, that the antiseptic which escapes from the catgut does not stop in its vicinity, but passes away into the lymph spaces and vessels. All this is quite speculative, but, judged from the clinical standpoint, this biniodide catgut is excellent and reliable material for ligatures and for some kinds of sutures. I should doubt whether ordinary raw catgut can be relied upon to hold much longer than five days; at all events, that is about the time when skin sutures begin to loosen, therefore it has to be used with circumspection in places where the strain of sudden and violent muscular contraction has to be met. I sometimes insert catgut sutures after laparotomies in which pus is encountered, but care is taken to put in reinforcing sutures of silkworm gut.

Mr. Moullin has recently published the results of a brilliant series of operations upon the stomach. His remarkably low mortality would have been lower had not the xylol catgut failed

to hold one of the abdominal incisions.* I also used xylol catgut for a case of appendectomy which was done during the acute stage. The appendix and the omentum which enveloped it were acutely inflamed and septic. There was slight suppuration of the wound. This case is omitted from the St. Bartholomew's statistics because it was known to be septic at the operation, and because it was being used as a test for xylol catgut.

The more frequent use of buried silk sutures has led to the partial abandonment of silkworm gut. This smooth, supple, strong material has very great advantages for abdominal wounds which have to be brought together with a single row of removable sutures. I have occasionally seen silkworm gut used for buried sutures. For this purpose it has certain disadvantages; owing to its thinness it probably cuts through the tissues in its grasp; next, the ends of the suture stick out, and being rather bristly can be felt by the patient who complains that they prick; and lastly, silkworm gut is not very easy material to sterilise, in spite of the fact that it bears boiling well. On more than one occasion I have been called upon to remove buried fishing-gut sutures because they were painful. Some time ago† silkworm gut which had been boiled for over 20 minutes was sterile 35 times out of 37. This is rather a high proportion of sepsis for a material which bears boiling so well. Latterly 19 pieces which had been boiled for less than half-an-hour were all sterile. It is obviously very important to recognise that silkworm gut is difficult to sterilise, and ought to be boiled for at least half-an-hour.

Silver Wire.

Allured by the account given by Dr. Jos. C. Bloodgood‡ of the use of silver wire and silver foil in the radical cure of hernia I tried those substances in 15 cases. Metallic substances had already been tried by others and found wanting, but they had not been tried in quite the same way. The following is Dr. Bloodgood's succinct statement§:—

"Clinically, the results in the healing of the wounds have been much better since the introduction of silver wire and silver foil. Before the introduction of silver wire 116 cases of hernia had been closed with silk; in 28 of these cases (24 per cent.) there was more

* 'Lancet,' January 9th, 1904, case v, p. 93.

† 'British Medical Journal,' September 17th, 1898, p. 802.

‡ 'Johns Hopkins Hospital Reports,' vol. vii, Nos. 5–9, Baltimore, 1899.

§ *Loc. cit.*, p. 225.

or less suppuration. Since silver wire was first used (June 2nd, 1894, Case 74, Group 1) there have been 330 operations, with 14 suppurations (4·2 per cent.).

"Since the wearing of rubber gloves in hernia operations by both operator and assistants in February, 1897 (over two years), there have been 226 cases of hernia (including recent cases), with only four suppurations (1·8 per cent.)."

Clearly methods which gave these results were worth a trial.

I myself could hardly look for such a striking alteration because, although working with silk, I had had about 4 per cent. of suppuration.* The 15 cases which I did with silver wire and silver foil were in no sense considered a test of any particular kind of operation, but only of the materials. Thin rubber gloves were worn throughout the operations by both surgeon and assistant. The inguinal canal was opened, and the neck of the sac secured with a piece of twisted wire; then the back of the inguinal canal was restored by fastening the arciform fibres of the internal oblique and transversalis to the inner edge of Poupart's ligament, after the manner of Bassini; and, next, the aponeurosis of the external oblique was sewn together again so as to close the canal, leaving the external abdominal ring the right size. By this time about nine pieces of silver wire had been buried. The skin was closed by a silver suture, which began at one end and then ran subcutaneously from one side of the wound to the other. This suture gave a great deal of trouble. If the two ends were left exposed we found the pain was considerable when it had to be pulled out. Then we buried the wire altogether to see whether or not the tissues would retain it. The silver leaf or foil is the kind which is used for gilding things like picture frames. It is put into a flat metal box and sterilised with dry heat until the thin paper between the leaves is slightly charred. We ceased the use of silver wire after 15 cases of inguinal hernia had been done with it, because it proved to be troublesome and inconvenient. Whatever pains we took to cut the ends of the wire short, and turn them down, nevertheless they altered their position and hurt the patient.

The first case was that of a youth who had an inguinal hernia of the right side, complicated with retention of the testis in the inguinal

* 'The Radical Cure of Hernia, Hydrocele, and Varicocele.' by C. B. Lockwood, Edinburgh and London, 1898, p. 158.

canal. Two pairs of rubber gloves were spoilt over the operation by the wire and needles piercing the fingers. This was a real aseptic operation, for our tests showed that everything brought in contact with the wound was sterile, and likewise the wound itself when dressed on the ninth day. Close upon a year afterwards the youth returned with a small superficial abscess, and the house-surgeon opened it and pulled out the skin suture. In four others the wire is known to have caused trouble and had to be removed.

The results as regards immediate union were fair, but one youth had slight suppuration, which was caused by necrosis of the skin edge. The suppuration, however, was slight, for my note says that the wound was healed on the fourteenth day.

The trouble taken to make this essay with silver was not thrown away. I was much impressed with the character of the wounds, which were singularly devoid of any trace of inflammation, and their course was with difficulty traced. It seemed clear that this was attributable to the layer of silver foil. According to Bloodgood the silver foil has germicidal properties, although not to the same degree as copper or brass. But however this may be it seemed an ideal substance for the exclusion of air and for protecting the wound from the layers of dry antiseptic gauze which I was then in the habit of using. Hence I have continued to use the silver foil in conjunction with silk and have been most gratified with the dryness of the wounds and the entire absence of any trace of redness or of œdema.

The Sponge Question.

Ought we to continue to use sponges? Many have already answered this question in the negative, and resort to sterilised swabs of cotton wool. But swabs are not very satisfactory for cleansing the wound of blood. Besides one hears of cases in which they have been left in the abdomen. Clearly there is more danger of losing one swab out of many than one sponge out of three or four. No one seems to dispute the superiority of marine sponges in all respects save that of asepticity. This is a fundamental objection, and if marine sponges cannot be sterilised they must be discarded.

I have hitherto thought that because our sponges did not seem to infect broth that therefore they could be relied upon. But here again what Lord Bacon would have called the "idol of the chemical" has to be reckoned with. It is probable that in each test

enough chemical is conveyed into the broth to render it antiseptic; but when we treated sponge with sulphide of ammonium we still saw nothing grow. I am by no means convinced that sponges prepared by the sulphurous acid method* are infective.

Our last series of fifty sponges treated in this way were all sterile with the exception of one which grew some moulds and bacilli, supposed to have originated from the atmosphere. A sponge tested at the end of an operation was infected with skin bacteria. These results are the same as those which have gone before. We greatly need a thorough investigation of disinfected sponges by the most rigorous and recent bacteriological methods. The sponges which we use are either new ones recently prepared or sponges which have been used for aseptic cases. A sponge which has touched anything infective is at once destroyed. Attempts have been made to obtain artificial sponges which could be sterilised by heat. But those which have been tried have been hard and harsh and deficient in absorptive properties.

LECTURE III.

On the Accurate Closure of Wounds.—Skin Flaps.—Skin Sliding.—Environment and Results.

When the cut edges of the skin are brought together with perfect accuracy, they adhere at once and are an effectual barrier against air infection. In respect to this rapid adherence the skin is comparable to the peritoneum. But to secure this advantage the apposition must be perfect and exact. This point is well understood, but perhaps a word may be said with regard to another aid to asepsis which will in the future have an extensive use. I refer to the complete and accurate closure of the largest wounds by the transposition of flaps of skin by undercutting, and by the gliding of extensive portions at the boundaries of the wound.

Many of us can remember the time when an amputation wound was sewn together with discontinuous sutures about an inch

* New sponges are (1) shaken and beaten to get rid of sand; (2) soaked in solution of hydrochloric acid and water to remove shell and coral (1 drachm of strong hydrochloric acid to 1 pint of water); (3) washed out in alkaline water (1 drachm of washing soda to 1 pint of water), and subsequently in sterile warm water; (4) twelve hours in cold solution of sulphurous acid (1 in 5), which is washed out with sterile water.

apart, and can recall the little area of raw surface which was left between the sutures. Nowadays this would be considered very poor workmanship. A number of discontinuous sutures might be used to adjust the flaps and obliterate the space between them, but every vestige of the raw surface would now be covered in by running a continuous suture of the finest twisted silk along the whole of the edges of the wound. The skin adheres with great rapidity, and is probably firmly united before any bacteria which may have survived in the sweat glands, sebaceous glands, or hair follicles could have had time to multiply and invade the deeper parts of the wound. We know how rare a perfect disinfection of the skin must be. When we come to consider the matter it would but a short time ago have been rather rash to have aimed at such accurate apposition, because then in all probability it would have led to the retention of septic fluids within the wound, and to such a series of disasters as can be occasionally found recorded in the older works on surgery.

In many operations, especially in those for mammary carcinoma, a very large area of skin has to be removed, as it is now recognised that the skin over the cancerous growth cannot be saved with safety because its lymphatics are frequently the seat of cancerous infection.

The excision of the suspected skin often leaves a huge gap which can only be closed by the exercise of considerable ingenuity. When the wound is aseptic flaps of skin and subcutaneous tissue 6 or 7 inches long, and attached by a narrow base, can be dissected up and turned into the wound. These flaps hardly possess proper blood supply of their own and only survive, because owing to the asepticity of the wound, they immediately adhere to the chest wall to which they are applied. From that source they do not at first acquire new blood vessels, but are probably kept alive by the absorption of plasma. It is remarkable to observe how tight these huge skin flaps may be, and how livid they may become, and yet preserve their vitality. At the end of a few days they may appear to be upon the point of perishing, but nevertheless recover and unite firmly with all their surroundings. I have used similar skin flaps to close gaps in the chest wall. About 18 months ago in removing a recurrent carcinoma portions of three ribs and a large piece of pleura had to be excised. A large area of the diaphragm and of the lung was exposed to view. Four or five sponges were stuffed into

the gap, whilst a large thick flap was brought up from the chest and abdomen. The patient recovered without a single bad symptom. Without the aid of the flap this operation could not have been undertaken, and without asepsis the flap could not have been made.

The principles which govern the fashioning of these flaps cannot be entered upon now. The theory is simple, the practice difficult. I shall content myself with saying that there is room for a whole lecture upon this subject, which, by the bye, has been almost entirely neglected by surgical writers.

For the complete closure of gaping wounds asepsis allows us to use a further device. Besides being able to convert the surrounding skin into flaps, we can also undercut it so as to allow large pieces to slide in the direction of the wound. Doubtless the undercutting destroys in part the blood and nerve supply of the skin, but so long as the wound is aseptic no harm results.

In bringing together the wound and adjusting the edges of skin flaps a continuous suture of twisted silk is used. This has one great advantage after a protracted operation such as that for removal of the mammary gland, pectoral muscles, and the lymphatic area—it is very rapid. But the continuous suture has a disadvantage, for it often strangulates the strip of skin within its grasp. As a rule, when this occurs the loss is trifling; but it is to be doubted whether the wound ever remains aseptic, and at times the ultimate healing is delayed. For this reason I have found it difficult to classify as "septic" or "aseptic" some of the amputations of the breast and operations for cancer of the lymphatics of the neck. Without an explanation it would lead to misconception if they were called septic, and yet they cannot truthfully be called aseptic. Some day, when our knowledge is more precise, we shall perhaps include them in a class labelled "secondary skin infection after necrosis of skin."

In spite of these occasional drawbacks, the complete closure of wounds by means of skin sliding and skin flaps is an enormous gain, and, when boldly resorted to, does away with the necessity for skin grafting by Thiersch's or other methods. It is a very great happiness to patients to be told, on the removal of the dressing, that the wound is entirely healed, and they seem to think less of scars which are all in one place.

Drainage.

Some years ago I remember reading a paper before this Society entitled "The Abuse of Drainage of Wounds."* About that time (1890) nearly every wound was drained. It is not unlikely but that the pendulum afterwards swung too far in the other direction. I suppose that to-day all septic wounds are drained with gauze, or tubes, or some other efficient device; also all wounds in which blood is liable to collect. I myself always drain wounds of the scrotum, and nearly always those of the axilla, merely to prevent blood collecting. Rubber tubes are the most comfortable for the patient, and can be sterilised with heat. Glass tubes are apt to hurt, and on more than one occasion have been known to break within the abdomen; but nevertheless they are so efficient, and so easily sterilised, that I occasionally employ them. Gauze has advantages, but is painful to remove, even with the help of hydrogen peroxide solution. The introduction of a drainage tube increases the risks of infection. Doubtless infection from the skin—which, as we know, is septic in 25 per cent. of cases—can more easily enter when the lips of the wound are kept apart by a drainage tube than when they are allowed to adhere by immediate union. In addition, the wound has to be dressed for the removal of the tube. These considerations have led to the immediate closure of wounds made to empty psoas, lumbar, and iliac abscesses. At the worst, if the operation be aseptic, some pus may collect again and call for removal; but at this stage the abscess cavity is much smaller, and the dangers of sepsis are less. For the successful performance of this operation for emptying and then closing again these large tuberculous abscesses it is of the greatest importance to be gentle and restrained, so as not to start hæmorrhage into the abscess cavity. The neglect of this is likely to bring an excellent operation into disrepute.

In aseptic wounds, then, drainage is unnecessary unless oozing and accumulation of blood are anticipated; but in septic wounds drainage is almost invariably required. This bald statement, however, ought to be amplified, for septic *cavities* ought also to be drained. This is very clear in the case of the urinary bladder. On more than one occasion I have closed the cystotomy wound at once,

* 'Trans. Med. Soc. Lond.,' vol. xiv, 1891, p. 40 *et seq.*

being guided by the absence of bleeding and of sepsis. It is a vast gain to the patients if the suprapubic wound heals by first intention, and that they should be able to walk about at the end of the third week. But when the bladder is septic, the immediate closure of the cystotomy wound is fraught with danger. Whenever the bladder is septic I insert a Guyon's drainage tube. This admirable device has robbed this class of case of a great many of its dangers and discomforts.

Also, when the bladder is septic I perform external urethrotomy in preference to internal, in order to provide adequate drainage. The dangers of an incised wound far from the surface of the body, and frequently bathed in septic urine, are too obvious to need pointing out. The perineal wound drains well, and merely needs the insertion of a strip of gauze. When the urine is aseptic, the perineal wound may be closed forthwith, with a good chance of immediate union.

The treatment of the gall bladder is ruled by similar principles. If, after cholecystotomy, it were known that the gall bladder was aseptic and was destined to remain so it might be judicious to suture the opening into it and drop it back into the abdomen. But one must always be doubtful about the asepticity of a cavity which communicates with the intestinal tract by a comparatively short canal. No doubt so long as the cystic duct and the common bile duct are undilated and are lined with healthy epithelium they prevent the intestinal bacteria from invading the gall bladder, the biliary ducts and canals, and the liver substance. But cholecystotomy is usually done when the gall bladder and the ducts have been altered by disease. It is probable that sepsis of the gall bladder is present in every case of gall stones. Acting upon this assumption I have never yet ventured to suture and return the gall bladder after cholecystotomy, or in other words to perform what has been called the "ideal operation." The systematic drainage of another cavity—the rectum—after the removal of tumours, hæmorrhoids, and for operations for fistula, has done much to diminish both the dangers and the miseries of this class of operation. A small ($\frac{1}{3}$ inch) rubber tube with a packing of iodoform gauze is all that is needed. The gauze supports the drainage tube and stops the bleeding.

Dressings.

To my mind the essential qualities in the dressing are sterility and dryness. Working at St. Bartholomew's and elsewhere with a number of different assistants and sisters I use plain sterilised gauze, double cyanide gauze, iodoform gauze, and alembroth. For many aseptic cases plain sterilised gauze is now being used. Double cyanide gauze and wool are used for a proportion of aseptic cases as well as for the septic. For some of the latter iodoform gauze is used. But, as regards the various dressings, I cannot detect any difference in the healing of the wounds provided a layer of silver foil is put next to the skin. If silver foil were not at hand I should prefer to use plain sterilised gauze and a layer of plain sterilised wool.

This layer of silver foil is supposed to retard the growth of the skin bacteria; next, it helps to exclude air infection; and, lastly, it separates the antiseptic dressing, if such a one be used, from the wound. It is exceedingly hard to trace the line of a wound which has been covered with silver foil because the skin edges are so entirely devoid of redness.

The original Listerian dressing was completed with an outside dressing, which consisted of a layer of waterproof jaconet and eight layers of gauze. The purpose of this outside dressing need not be referred to, but there can be no question but that it has of late fallen into disuse. At some nursing homes I have been told that I am the only surgeon who uses an outside dressing. Now, it may be conceded that the dryness of aseptic wounds has done away with one of the main objects of the outside dressing. Moreover, a large layer of impervious jaconet may be hot and uncomfortable, and by preventing evaporation be calculated to favour the collection of perspiration and the growth of skin bacteria. But in some cases these disadvantages are far outweighed by some very solid advantages. For instance, the triangular scrotal dressing which I first described to this Society in 1896 * is not only comfortable but likewise secure, and since its use a suppurating scrotal wound has been almost unknown. It is true that this result has been attained with the aid of systematic drainage, but that would be risky unless an outside dressing was used to prevent the escaping blood from becoming infected from the exterior. In the radical

* 'Trans. Med. Soc. Lond.,' vol. xix, p. 26, Fig. 2.

cure of hernia, especially inguinal, it is difficult to prevent the exposure of the wound, and I should despair of doing so without the aid of a very well fitted and securely fixed outside dressing. It would be easy to adduce a number of inguinal and scrotal wounds in which the outside dressing had prevented the wound from being soaked with urine.

After laparotomy another danger has to be guarded against. Owing to the anæsthetic and the nature of the operation vomiting is a frequent complication. During vomiting the contractions of the abdominal muscles are extraordinarily violent and special precautions are needed to prevent the access of air to the wound, and hence an accurately-fitted and fastened outside dressing becomes a wise precaution. In hot weather it can if necessary be easily dispensed with after the first 48 hours. But nowadays it is unusual to hear any complaints of discomfort, and the skin is hardly ever found reddened, much less blistered. For similar reasons an outside dressing is of use in amputations of the breast and about the root of the neck. During vomiting, coughing, and breathing there is a strong probability of the entrance of air into the wound unless special precautions in the shape of an outside dressing be taken. Those which I use are all cut to pattern and carefully fitted and fastened with straps and buckles. They are afterwards secured with bandages which are sewn on or reinforced with strapping.

The Influence of Environment and Results.

It is probable that much has to be learnt about the influence of environment upon the results of operations. The term environment is rather loose and ambiguous, but we all have a general notion that it comprises the surroundings of the patient before, during, and after the operation. The surroundings during the operation have already been discussed, and likewise some of those which are requisite before and after the operation.

In this metropolis surgeons operate in public hospitals, private hospitals or nursing homes, and in private dwellings. It is exceedingly difficult to ascertain how far these three different environments influence the results as tested clinically by the mode of healing. I possess, however, a small amount of information which will now be placed before you. The series begins March, 1900, and ends July, 1903.

I do not intend to weary you with a recital of the precautions which are taken in the organisation of operations in private houses. Briefly the objects aimed at are accuracy and simplicity. Accuracy is attained by close personal supervision. I suspect that in order of danger come sponges, ligatures, and instruments, although the hands of the surgeon and of his assistants and the patient's skin are almost as dangerous. Now, every one of these is, and ought to be, under the immediate control of the operator. The utensils and towels may be left to others, and are easily sterilised with heat. But it is always advisable to make precise inquiry into the manner of their disinfection before allowing them to be used. Care is likewise taken to see that the room in which the operation is performed is light, clean, and airy, and that the sanitation is perfect. The room is cleared out and prepared the day before and its air left to settle.

We may begin with 58 wounds inflicted in private houses, hotels, or flats. As regards severity these are not all comparable to those in St. Bartholomew's Hospital or in nursing homes. A very critical operation has usually, in case of some sudden emergency arising, to be done in a nursing home close at hand. The list includes cases of amputation of the breast, amputation of the breast with removal of the pectoral muscles and axillary lymphatics, radical cure of hernia, arthrotomy, appendectomy, laminectomy, one of ligature of superficial femoral artery, removal of tumours, and so forth. I have omitted from this list cases in which pus was present and wounds communicating with septic gall bladders or the urinary bladder.

A case which died of shock after a long and difficult operation for the removal of a broad ligament tumour has been omitted, and also a death from shock after amputation of the thigh for diabetic gangrene. In malignant disease of the breast the ultimate safety of the patient often necessitates the removal of very large areas of skin. I am accustomed to close the whole of the huge wound by turning up long flaps of skin from the flank, or abdomen, or chest. When the wound is apparently aseptic these flaps preserve their vitality in a very remarkable manner, but the pointed tip sometimes dies and a small part of the wound has to heal by granulation. Under these circumstances it would be impossible to include the wound amongst the aseptic, although nearly the whole had healed by first intention, and the temperature and pulse had fallen to normal after the shock and reaction had passed away. In three

breast amputations some part of the flap necrosed, and a portion of the wound had to heal by granulation.

Of the remaining 55, one had slight hæmorrhage and hæmatoma after a very severe operation for the removal a malignant mass from beneath the clavicle. The growth was adherent to the subclavian vein, so that part of that vessel had to be excised. The patient made a good recovery, and, I am informed, without suppuration. Arthrotomy was performed upon a young lady for the exploration of the knee, with removal of a slipping internal semilunar fibro-cartilage. After the operation the course of events was uneventful until the fifth day, when the temperature rose, the fauces became inflamed, and a red skin eruption appeared. The knee then became more painful, and some blood-stained fluid was removed with an aspirator. This was examined by my colleague, Dr. E. W. Andrewes, and pronounced to be sterile. A small drainage tube was inserted, and slight suppuration occurred along its track and in the superficial part of the original wound. There followed a slight outbreak of eczema in the head and limbs, which prevented the use of antiseptics other than lead and spirit lotion. Although this case was attended with great anxiety, the joint escaped without damage, and now possesses its full range of movement.

This is the only one out of numerous arthrotomies which has given me anxiety. The sanitation of the house was modern and seemed to be without a flaw, and the suppuration may have been, and probably was, caused by infection from the skin, for the patient was eczematous; but, on the other hand, the high temperature, the inflammation of the fauces, and the cutaneous eruption seemed to indicate the onset of one of the exanthemata. One would like to offer this to you as an explanation of the septic infection, but candour compels me to say that I have seen attacks of measles and of chicken-pox produce no ill effects upon operation wounds. I can believe that sepsis might be conveyed by the blood-stream from the ulcerated fauces of scarlet fever or diphtheria, but not in cases devoid of ulceration or suppuration. The rest of the cases healed by first intention. This gives a proportion of one case of suppuration and one of healing by granulation in 55, or, including both, 3·63 per cent. of sepsis.

In London and its suburbs small private hospitals or nursing homes have multiplied in a remarkable manner. As yet, so far as

I am aware, none has been built for the actual purposes of a hospital. All those with which I am acquainted have been started in private houses which have been altered and adapted to serve the new purpose. That they serve the purpose exceedingly well will be acknowledged on every hand, and those in charge having been, as a rule, nurses or sisters at large hospitals, are thoroughly acquainted with and devoted to their duties. A new building planned for the special purposes of a private hospital would probably be quieter and more convenient, but could hardly possess better operating theatres or better rooms and appliances than are now available in some of these nursing homes.

The operations performed in nursing homes are not strictly comparable to those performed in private houses. Amongst them were some of great severity, and therefore requiring to be within range of prompt attention. The operations included radical cure of hernia, appendectomy, ovariotomy, amputation of the breast, amputation of the breast with removal of pectoral muscles and of the axillary glands, nephrectomy, nephrorraphy, excision of varicose veins, laparotomy, and so forth. Two of the patients had double operations performed on them.

Eighty-two out of 92 wounds had healed by first intention when the patients left the nursing home. The wound made for the removal of an exostosis of the tibia was slightly pulled apart by premature walking. Twice after removal of the breast, pectoral muscles, and axillary lymphatics, a very small portion of the edge of the skin necrosed so that a small part healed by granulation, the rest *per primam*. Seven wounds were septic, about 7·6 per cent. So far as I can tell, the causes of sepsis were as follows :—

1. After castration the dressing was disturbed, with exposure of the upper part of the wound; there was slight suppuration along the course of the drainage tube, but the silk sutures upon the spermatic cord and in the aponeurosis of the external oblique did not come out, and the rest of the wound healed by first intention. The inguinal canal had to be opened because a malignant growth had spread up the spermatic cord. The prevention of such an accident as the exposure of the wound ought not to be a difficult problem to either the surgeon or the nurse.

2. Laparotomy was performed to ascertain the nature of a tumour near the greater curve of the stomach. It proved to be a carcinoma involving the transverse colon, great omentum, great

curve of the stomach, and the anterior abdominal wall. Some of the adhesions had to be separated. Ten days after the operation the pulse became quicker, the temperature rose, and a little pus escaped from the lower end of the wound. After this a rapid recovery ensued. The pus had a fæcal odour, and I thought that its formation may have been in some way due to the separation of the adhesions. This is rendered likelier from the fact that nine months after the wound had healed I was told that another abscess formed and became a fæcal leak. This is one of the perils in intra-abdominal malignant disease.

3. The wound suppurated after the removal of a very adherent vermiform appendix. The appendix burst, and a quantity of fæcal contents escaped into the wound. The patient made a rapid recovery, as no buried sutures had been inserted. As a rule, an accident of this kind can be avoided; but, should it occur, it is better to drain the iliac fossa for the first two or three days after the operation.

4. A bursal tumour was removed from beneath the gluteus maximus, the latter being separated in the course of its fibres. The wound seemed so dry that no drain was inserted. A huge hæmatoma formed and had to be drained. The blood which escaped was septic, the pulse-rate was slightly increased, and the temperatare was raised. After the aeptic clot had escaped recovery was rapid and perfect.

5. A large lipoma was removed from the back. No drain was inserted. A hæmatoma formed and was removed. The wound healed in part by granulation.

6. Radical cure of inguinal hernia was performed on both sides. The right side healed by first intention. A small hæmatoma formed on the left, followed by very slight suppuration and the extrusion of one of the deep sutures.

7. Suppuration occurred under the following circumstances after the radical cure of inguinal hernia in a patient weighing 17 stone. On the right side he had an enormous scrotal hernia, which was irreducible and liable to attacks of obstruction. It also prevented him from following his occupation, and rendered his life a misery. The hernial sac contained a part of the transverse colon, nearly the whole of the great omentum, the cæcum and vermiform appendix, most of the right colon, and some part of ileum. The right colon was adherent to the posterior wall of the sac, and was difficult to

reduce. The great omentum was excised, and found to weigh $2\frac{3}{4}$ lbs. The abdominal wall was repaired with silk and fishing gut, and a drain inserted into the wound, which was large and deep. Next day the scrotum was distended, and the right testicle was very tender and inflamed. When this had subsided the wound, which had apparently healed, became painful, and some very fœtid pus escaped. This was not followed by the loss of any of the buried sutures. I cannot help suspecting that the right colon may have been pierced by one of the deep sutures. The ultimate result of this formidable operation has been highly satisfactory.

You will have noted that I said that 82 patients left the nursing homes with their wounds healed, but I know that two of these afterwards each developed a small sinus and lost some buried sutures. These cases have both been mentioned before when speaking about the fate of buried silk.

In one a very small hæmatoma formed beneath the skin of an appendectomy wound. The blood was let out, and the wound healed. The patient returned home within three weeks, but, as I have just said, a small sinus formed and some of the silk escaped. In the other case, also of appendectomy, the disease was tuberculous, and although the wound healed, and remained healed for some time, nevertheless a small sinus with some fungating granulation tissues formed, and I believe some silk was extruded. In this case some of the silk ligatures were placed upon tissue which was tuberculous, and it is most doubtful whether this ought ever to be done. In future I shall use biniodide catgut for tuberculous tissues. Obviously, these operations performed in nursing homes do not compare favourably with those in private houses, but, as I have already said, they are not strictly comparable.

The hospital operations were performed in St. Bartholomew's. The wards of that institution are more than 150 years old. Efforts have at various time been made to improve them by building sanitary towers, by reflooring, and by heating and ventilating. But the effort to alter and modernise old hospital buildings is hopeless, and the St. Bartholomew's wards remain exceedingly inconvenient when judged by modern standards. But the time is approaching when they will be replaced by modern structures supplied with ample air space, light, and ventilation. Out of 175 wounds inflicted in the hospital, 153 healed by first intention, 10

had some suppuration, and 12 others had necrosis of some portion of a skin flap, so that a portion of the wound healed by granulation; also a laparotomy wound which had its sutures removed too soon. Omitting these the percentage of suppuration is approximately 6.

Amongst the wounds which healed by first intention are included two amputations of the thigh for gangrene of the leg. The circumstances were rather unusual.

An elderly woman was afflicted with a large uterine fibroid, and her left leg threatened to become gangrenous. At the request of my colleague, Dr. Griffith, I performed hysterectomy. Although this operation was followed by a good recovery, gangrene of the leg progressed, and the thigh had to be amputated. The wound healed by first intention, but convalescence was slow, owing to a mental illness which supervened. The second case was that of a boy who had the knee flexed acutely after old arthritis. He came to have amputation performed, but I thought it reasonable to see whether resection could not be done. The limb was straightened with extreme difficulty, and soon the foot became gangrenous, and amputation had to be performed.

Thus we have a case in which hysterectomy wound healed perfectly in spite of the presence of a gangrenous limb, and two wounds which healed perfectly after the removal of a gangrenous limb. The explanation is simple. The limbs were dead, but not infective. The amputations were done before the dead tissues were teeming with bacteria.

It would be misleading to say that 5·84 per cent. of suppuration had occurred without giving brief details of the cases. Suppuration varies in quality as well as in quantity. Not a little also depends upon the selection of cases. I have only rejected operations in which pus, a septic sinus, or a septic cavity was present at the time of the operation. I venture to think that something is to be learnt from the brief details of these cases. They are as follows:—

1. The elbow was resected for advanced tuberculous disease, with much destruction of the articular cartilages, and of the humerus and ulna. It is believed that the whole of the tuberculous synovial membrane and bone was taken away. The case did exceedingly well, although a little pus was discharged from the wound. The patient had had tuberculous caries of the spine and a psoas abscess.

Cases of this kind raise the important question of the incidence of suppuration after operations for tuberculous disease. I believe that these cases would not be more liable than others to suppurate, provided that every vestige of the tuberculous disease had been removed, and that no tuberculous material had been smeared over or rubbed into the freshly-cut tissues. But in most instances it is impracticable to fulfil one or both of those requirements, and, therefore, the chances of suppuration are increased. Should suppuration occur, as it did in this case of resection, its onset is insidious and unaccompanied by marked alterations in the pulse-rate or temperature. Clearly, a wound in which there is reason to suspect the presence of tuberculous infection must be treated with special precautions. And, first, I use a drainage tube more frequently than for other cases. Next, it is injudicious to use silk for ligatures or buried sutures; prepared catgut is safest. Should catgut become infected with tubercle it does not stay long in the wound. And, lastly, I believe in the virtues of iodoform as an application and as a dressing. A little finely-powdered crystals of iodoform is rubbed into the wound, and an iodoform gauze dressing is applied. Iodoform has to be used with great discretion, and it might be injudicious to put it into the cavity of a psoas abscess, although it may be used with safety in smaller cavities or wounds.

2. Another tuberculons wound suppurated and healed by granulation. A number of tuberculous glands, together with a large piece of tuberculous skin, were removed from a man's neck, the wound was brought together, but with a considerable strain upon the sutures, and in the end it tore apart and the wound had to heal by granulation.

3. The radical cure of femoral hernia was followed by slight suppuration and the loss of a buried suture.

4. Radical cure of hernia was performed on both sides for a man with double inguinal hernia. The right side was a simple operation, and the wound healed by first intention. The left side was much more difficult as the sac contained omentum which was adherent at its neck. After the adhesions had been separated and the omentum ligatured and removed some blood welled out of the abdomen. The abdominal wall was freely divided, and the omentum again secured, although it had ceased to bleed. The peritoneal, muscular, aponeurotic, and cutaneous layers of the abdominal wall were fastened together with silk sutures. The whole operation lasted two hours

and twenty minutes. Ultimately there was slight subacute suppuration on the right side and two deep sutures were lost. The things which predisposed to this sepsis were probably: (*a*) The prolonged exposure to the atmosphere; (*b*) the bleeding; (*c*) the insertion of silk sutures into the muscular stratum.

5 and 6. Laminectomy is not a frequent operation in my experience, but the small number that I have attempted have been followed by a very unusual and disconcerting amount of sepsis.

A youth * fell from a height of 30 feet upon his back, and became completely paralysed below the level of the seventh intercostal space. Three weeks after the accident the spines and laminæ of the third, fourth, and fifth dorsal vertabræ were removed, and an epidural hæmorrhage was found. After being in the hospital for over a year he was discharged much improved, with partial return of sensation and voluntary control of the bladder and rectum and spastic condition of the muscles of the lower extremities, all of which reacted normally, though weakly, to electric excitation. Such is the report of my colleague, Mr. Bailey, who was then surgical registrar, but he omits to say that when the dressings were removed there was slight suppuration at one or two of the skin sutures. Fortunately this did not spread, but I certainly felt very anxious when I saw it. I think it is much to be regretted that all cases of suppuration are not recorded in the statistical tables of all of our hospitals.

Laminectomy was also performed to try and find a tumour of the spinal cord. The theca of the cord was bulged at the point where the tumour was supposed to be, but when the theca was opened no tumour could be seen. The cord was displaced after division of nerve roots, but still no tumour was in sight. The operation was followed by slight temporary improvement, although there was some suppuration in the superficial part of the wound and at some of the stitch holes. This patient died a month later of ascending pyelo-nephritis and with a parotid abscess. The wound was healed except at one stitch hole. The theca was healed, and there was no sepsis about or within it. After the spinal cord had been taken out and cut across a long narrow tumour was found in the anterior fissure, and at the exact level at which my colleague, Dr. Lewis Jones, had diagnosed it.

* "Report of Surgical Registrar," 'Statistical Tables of St. Bartholomew's Hospital, 1902, p. 194.

In the first case I doubt not that the skin of the back was the source of infection, as it may also have been in the second case. The skin of the back is exceedingly thick, almost the thickest in the whole body. Moreover, it abounds in large sebaceous glands and sweet glands. Owing to the recumbent position of the patient the wound and dressings become bathed in perspiration. In a recent case of laminectomy I did my best to avoid these pitfalls, and the wound healed by first intention in spite of the presence of a septic bedsore over the sacrum.

I have heard it said that these paralysed patients are more predisposed to sepsis than the ordinary run, but I doubt whether this be true as regards wounds. The idea probably arises from the liability of the paralysed to suffer from retention of urine, with subsequent infection of the bladder, ureter, and kidneys.

7. An operation for ventrifixation of the uterus was followed by suppuration, but, rather to my surprise, I was told that no deep sutures had come out. Before performing this operation I was aware that there had been severe sepsis amongst the cases operated upon in the same theatre and ward. This did not deter me from operating, because I was then firm in the belief that wounds only became infected by contact, and that the methods I employed were an efficient safeguard against that danger. I am beginning to attach more importance to environment.

8. The mammary gland, pectoral muscles, and axillary lymphatics were excised for carcinoma. A portion of the skin flap sloughed and there was slight suppuration beneath it. The patient was 67 years old, and suffered from asthma and bronchitis. A severe cough is a troublesome complication when the wound involves the chest wall, as the entrance of air is prevented with difficulty.

9 and 10. Double radical cure of inguinal hernia was performed upon a porter. Small hæmatomata formed on both sides and became septic. None of the deep stitches were extruded, and the wound speedily healed. Stitches from the wound infected culture media, but unfortunately no cultures were made at the time of operation.

It is rather difficult to classify some cases. For instance, in carcinoma of the lymphatic glands of the neck secondary to carcinoma of the tongue I have imitated Mr. Butlin, and begun by turning the whole of the skin from off the anterior triangle of the neck by a large flap.

In four consecutive cases a small portion of the flap died, and a part of the wound had to heal by granulation. Now it might be said that the death of a small portion of a flap under such circumstances was not a very great misfortune. But this, to my mind, is not the right way of thinking. The operation is not a perfect success unless all the flap survives and all the wound heals by first intention. I have tried turning the flap backwards with its attached base along the anterior edge of the sterno-mastoid muscle, and I have tried turning it forward with its base along the middle line of the neck. On the whole, I think it is best to turn the flap back. But, unfortunately, the skin of the neck is very thin, and it seems difficult to include the platysma and deep fascia in the thickness of the flap. But the survival of these long skin flaps is, as I have already remarked, not altogether a question of blood supply. When the wound is asceptic, long thin nonvascular flaps adhere and survive, whereas in the presence of infection they would inevitably have perished. The asceptic process is more akin to Thiersch's skin grafting than to any ordinary skin-flap operation.

In six cases of removal of the breast, pectoral muscles, and axillary lymphatics a small portion of the edge or tip of the extensive skin flap necrosed, and a very small part had to heal by granulation. Healing by granulation occurred in the superficial part of a laparotomy wound for gastro-enterostomy. A hasty house-surgeon removed the sutures prematurely.

Mr. Scott, to whom I am much obliged, has quite independently tabulated the results of the operations which I did during his house-surgeoncy. It is interesting to note how his estimate accords with my own, provided that the case with a pre-existing septic sinus be omitted, and, be it noted, that one of Mr. Scott's patients had two suppurating wounds.

Total wounds,* 36; healed by first intention, 29 (80·5 per cent.); remaining, 7.

Of these seven cases, three had some necrosis of flap without sepsis; one had necrosis of flap with sepsis, but in this case there was a septic sinus at the time of operation; one suppurated with loss of sutures; and two suppurated without loss of sutures, or time, one of them being a case of double radical cure in which both

* Wounds of usual character, and including radical cure of hernia appendectomy, intestinal anastomosis, amputation of breast and thigh, excision of knee, and so forth.

sides suppurated. Mr. Scott estimates the suppuration at 8·3 per cent., including the case with pre-existing septic sinus.

Some of the operations which were followed by suppuration took a very long time to perform. What influence has the duration of an operation upon the chances of infection? Assuming that the atmospheric bacteria are harmless (an assumption which cannot for one moment be granted), then there is no reason why the wound should be infected either at the beginning, the middle, or the end of the operation. But a surgical operation is a bacteriological experiment, and what bacteriologist would expose his culture media to the atmosphere for a couple of hours, and during all that time keep stirring them up? To ensure success, bacteriological experiments must be done quickly and quietly, and so must surgical operations.

I can recall a few operations which have taken more than 90 minutes, and they have been followed by a larger proportion of sepsis than those of shorter duration.

Of course, the long exposure to atmospheric infection is not the only reason for this sepsis. I have already mentioned a case of radical cure of hernia in a very stout subject. Owing to his depth of fat a very big incision was required, and during the operation the loose and oily fat became bruised and full of clotted blood. Another very stout patient* had an inguinal hernia full of inflamed and adherent omentum. The hæmorrhage from the omentum was very free in spite of chain sutures of stout silk. Ultimately the wound had to be enlarged. The operation lasted two hours and a quarter. The patient made good progress, and left the nursing home at the end of three weeks with the wound soundly healed. Afterwards some pus formed beneath the scar, and after it had been let out some of the buried silk separated. Here, again, the thick layer of subcutaneous fat was bruised and infiltrated with clotted blood. As no drain was inserted some blood may have collected in the depths of the wound.

Some wounds are easier than others to protect against atmospheric infection. Most abdominal wounds are of this nature. In the removal of the mammary gland, pectoral muscles, and axillary lymphatics, it is easy to protect the greater part of the huge wound with layers of antiseptic gauze.

* Operated upon after July, 1903, V.A., p. 39.

It is difficult to see what effect any change in environment could have had upon this series of cases. In them the escape of blood into the wound and tissues around was the usual precursor of sepsis. The human blood is a most troublesome fluid; I sometimes wonder why the vessels should be filled with so strange a mixture. I often ask—but have never yet been told why—our own blood should clot and cause our own tissues to inflame? How often we meet with a sequence of events such as this: Blood shed into a serous cavity, into a joint, or amongst the tissues; clotting of the blood, and then inflammation of the tissues in contact with the clot; and, perchance, infection of the clot followed by its conversion into matter; for, although the infection usually comes from without it may come from within, being carried by the blood stream or by the lymphatics.

These phenomena are clearly displayed in cases of subcutaneous injury, such, for instance, as a fracture of the patella. Some would ascribe the inflammation which ensues to the breaking of the bone and the tearing of the tissues, but I should ascribe it mainly to the extravasation of the blood. And, acting on this belief, I take the greatest pains when wiring the patella to remove every particle of clot. In the subcutaneous operations which have been devised for fractured patella the clot is, of course, not taken away. But this is a trifling objection to that method of operation compared with another, for subcutaneous methods do not take away the piece of dorsal aponeurosis which always falls between the fragments.

The inflammatory effects of extravasated blood are very marked when it is in contact with that sensitive membrane, the peritoneum. Twice I have been requested to operate for appendicitis and found instead a hæmatosalpinx. To my mind the error was venial. At the operation I saw the area of inflamed, engorged, and swollen peritoneum around the clots; and clinically the pain, elevation of temperature, and acceleration of the pulse had all seemed to justify the diagnosis. I suppose a physiologist could tell us exactly which element in the blood clot excited the inflammation, which raised the temperature, and which accelerated the pulse.

I have on three occasions seen the omental vessels bleed into the abdomen after radical cure of hernia. The signs of peritonitis were very marked, and once they were of the most septic type. The infection may have been introduced at the operation, but the operator had had no other cases of peritonitis. I am sure that had no bleeding occurred the fatal case would not have been recorded.

But when blood clot is close to the intestines it may be infected from their interior, the intestinal bacteria finding their way through the coats of the intestines when the latter are inflamed or infiltrated with blood.

Although I have not had to tell you of a single instance of general septic infection, or even a single one of progressive suppuration, I am not contented, and fervently hope that better results may in future be obtained.

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