

formerly alluded to; and it is also possible that they may enter from fault in the aseptic precautions, though I think this must be exceedingly rare. For it is difficult to imagine that in the latter case only micrococci would get in; indeed, in faulty experiments with cultivating fluids, it is almost invariably some form of rod-shaped organism which appears.

## CHAPTER XIII.

## ANTISEPTIC SURGERY.

Complete definition of antiseptic surgery. Varieties of antiseptic surgery. TREATMENT BY ANTISEPTICS: Carbolic acid—objections to it: Chloride of zinc: Boracic acid: Sulphurous acid: Chlorinated Soda: Alcohol—Hutchinson's method: Terebene and Sanitas—Bilguer's method—Neudörfer's salicylic powder. FREE DRAINAGE AS AN ANTISEPTIC METHOD. IRRIGATION AND IMMERSION. OPEN METHOD: Modes in which it acts antiseptically: Bartscher and Vezin's method: Burow's method: Rose's modification. HEALING BY SCABBING: Methods of forming a crust: Bouisson's ventilation method: other modes. GUÉRIN'S COTTON-WOOL DRESSING. MODES IN WHICH THE DESTRUCTIVE ACTION OF THE TISSUES ON BACTERIA IS ASSISTED. Why does not fermentation always occur in the blood in wounds in which organisms are present? Best practical methods. Conclusions.

We have now arrived at the end of our discussion as to what are the particles which cause putrefaction; what are the exact enemies with which we have to contend in attempting to prevent putrefaction. We have seen that it is from particles falling into fluids or on tissues that organisms develop. We have seen that it is only after the access of particles from the outer world to such fluids and tissues that fermentations occur, and we have satisfactorily demonstrated that the particles which cause fermentations and those which give rise to organisms, are one and the same—in other words, fermentations are due to the growth of organisms in fluids or tissues. We have also seen that these same laws, with one exception, to be presently mentioned, hold good when the fluids or tissues are confined in the living body, just as when they are in flasks, viz., that the particles which cause putrefaction and other fermentations only rarely enter such substances through the circulation, but generally reach them directly from the air or from surrounding objects; that so long as an animal is healthy, dead

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fluids or tissues may remain unfermented in closed cavities in the body, and may even entirely disappear, but that as soon as atmospheric air with its dust is admitted, organisms develop, and fermentations occur. We are now therefore able to take a much wider view of the meaning of the term 'Antiseptic Surgery' than is generally done. It is no longer surgery which only *excludes* the causes of putrefaction; we may now include under the term *all those methods of wound treatment in which, wittingly or otherwise, the growth and fermentative action of the lower forms of organisms (bacteria) are more or less impeded.*

When we come to look at the numerous methods of wound treatment from this point of view, we shall see that there is perhaps none at present employed, with the exception of the poultice dressing so much lauded by Mr. Savory, which does not in some way or other, however imperfectly, interfere with the growth and fermentative action of bacteria, and which does not owe its chief virtues to that cause.

I shall not enter into details on all these methods, for their number is legion, but I shall discuss the modes in which this interference with bacteric action may be carried out under several headings, and indicate briefly the principles which ought to guide the surgeon in carrying out one or other method.

The antiseptic methods which merely *interfere* with the development and fermentative action of organisms on the fluids and tissues in wounds, and which do not aim at their total exclusion, may act on various principles.

1. By the addition of various antiseptics to the discharge, either in the wound, or after it flows out, this discharge may be rendered an unfit soil for the development of organisms.—*Use of antiseptics.*

2. The discharge may be allowed to flow away so rapidly as not to have time to undergo fermentation to any extent in the wound itself.—*Free drainage.*

3. This removal of the discharge may be facilitated by washing it away constantly with water alone, or with water containing antiseptics.—*Treatment by irrigation or by water bath.*

4. By freely exposing the discharge to air evaporation takes place, and the fluid becomes too concentrated to permit the growth of bacteria, while, at the same time, by supplying these organisms with plenty of oxygen, they have no necessity to break up the albuminous compounds in their search for oxygen, and thus, as shown by Pasteur, their fermenting power is diminished.—*Open treatment.*

5. By keeping the parts at perfect rest and by operating only when the patient is in good health, the tissues and the blood are in such a state as to resist the development of bacteria in the thin layer of lymph between the cut surfaces, and union by first intention thus occurs. This is best carried out by *perfect rest and accurate apposition of the cut surfaces.*

*Healing by scabbing* acts on the last two principles.

Although these various methods may be described as acting on these different principles, yet there is no hard and fast line between one and the other. Indeed, at the present day advantage is now constantly gained from the use of the various principles combined—as, for instance, by the employment of free drainage, antiseptic irrigation, &c., in the open method. As these methods are so very numerous, and as they are generally modified by every surgeon who employs them, few indeed using them on the true principle, I think it will be best merely to make a few remarks under each heading, and then when we come to the historical part we shall be able to fill up blanks in the following description.

I.—*Methods by which various Antiseptics are added to the Discharge, so as to hinder the Development of Organisms in it.*

What are the best antiseptics to use for this purpose?

*Carbolic acid* is the one most frequently employed, but, in my opinion, it is by no means the best in this instance. We have already seen that in vegetable infusions, where carbolic acid is present in the proportions of 1–200 to 1–250 all further growth of organisms is prevented, but that in such fluids as serum, milk, pus, &c., the acid forms a compound with the albumen, and a much larger proportion is required. Thus, in

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milk, carbolic acid in the proportion of 1-54 is just enough to prevent development. In accordance with this fact, a very strong solution would be required in the case of wounds, or it must be added in large quantities, in order to prevent the development of micro-organisms.

And so my own experience of carbolic acid as a disinfectant in the form of a 1-40 watery solution in putrid cases is unfavourable, while, on the other hand, if 1-20 carbolic acid be used, it is very irritating, and interferes with healing. Injected once or twice a day, the latter destroys the superficial granulation cells, and produces a thin slough in which bacteria develop, and from which it is very difficult to dislodge them. Then its poisonous qualities are objectionable, and are of course much more evident when the acid is injected into wounds or abscess cavities than when used in the manner described in the chapters on aseptic surgery.

Further, Dr. Wilhelm Hack,<sup>1</sup> in a paper on the power of absorption by granulations, has demonstrated that granulations treated with carbolic acid possess many of the qualities of a recent wound as regards absorption. For instance, apomorphia, which was only absorbed by wounds treated with water dressing during the first twelve hours, was readily absorbed at any time by granulating wounds treated with carbolic acid; and therefore in the absence of information to the contrary, I should fear that some of the poisonous products of putrefaction might be absorbed with like avidity. Hence, I do not like carbolic acid unless it is used aseptically.

*Chloride of zinc* applied to the cut surface has been already alluded to. A single application has the remarkable property of preventing putrefaction in a wound for some time after an operation; sometimes, indeed, till granulation is nearly complete. It is further useful, according to Hack's experiments, in that the slough caused by it does not permit the absorption of substances from the wound. When used in the treatment of wounds, a dilute solution (1 or 2 grs. to the ounce of water) is employed.

*Boracic acid* is too weak an antiseptic to be of much service

<sup>1</sup> Ueber das Resorptionsvermögen granulirender Flächen. L.ipzig, 1879.

as an injection, but the boracic ointment and the boracic lint act well as dressings.

One of the best antiseptic lotions is made with *sulphurous acid*. This is a powerful germicide. It is also non-irritating and perfectly free from any poisonous qualities. It is used as a solution which is made by mixing together equal parts of the sulphurous acid of the pharmacopœia and water or glycerine. This may be still further diluted if necessary.

The *chlorinated soda* solution is mentioned by Dr. Cabot as standing next to 1-20 carbolic lotion in rapidity of action on bacteria. The strength generally employed is ʒss. to ʒj of water.

*Alcohol* is not a bad antiseptic, but in order to be effectual, it must be used strong. It has a further advantage, for Dr. Hack has shown that granulations treated with alcohol do not absorb at all or only very slightly; and to this may be attributed, to some extent, the favourable course of the cases in which wounds are simply washed out with an alcoholic solution, and a rag, dipped in the same solution, applied outside.

Mr. Jonathan Hutchinson, more especially, has had remarkably good results from the use of alcohol. His method is as follows:—Having carefully arrested all hæmorrhage, chiefly by torsion, he washes out the wound with pure spirit. He then carefully arranges drainage tubes at the most dependent parts, and stitches up the rest of the wound. Thin compresses soaked in a lotion composed of 6 parts of absolute alcohol, a half part of liquor plumbi, and 16 parts of distilled water, are now applied. These compresses are kept constantly moist, either by a nurse or by means of a drop irrigator. The lint is changed daily. In the treatment of important cases, such as compound fractures and dislocations the rule observed is, never to allow the skin to become warmer than natural. His wounds generally heal by first intention, and septic poisoning is very infrequent.

In some of these cases no doubt the wound may be aseptic from first to last. To apply an antiseptic to a wound, to stitch up immediately, and then keep an antiseptic dressing constantly applied, is really to operate more or less aseptically, and I believe, with regard to Mr. Hutchinson's cases, that this

partly explains the good results—the wound being aseptic, at least for a time. Then Hack's results have a strong bearing on these cases, for absorption does not take place readily. Mr. Hutchinson is also very particular to have free drainage, which powerfully helps to maintain the aseptic condition; and lastly, he carefully selects the cases for operation, only operating, unless in cases of necessity, where the patient is in good health. This selection of cases is a thing not necessary and not done where complete aseptic treatment is employed.

The method which I should think was the best, acting on this principle, is the following; it is practically what Mr. Lister employs with excellent results, only I would reject the carbolic acid. After the wound has been made, and before any stitches are inserted, the raw surface ought to be thoroughly sponged over with chloride of zinc solution (40 grs. to the oz. of water). In the case of operations on the extremities, this is best done before the tourniquet is relaxed, so as to ensure its thorough application, for otherwise the blood would wash away the solution or dilute it before it has had time to act. Silver wire stitches are then inserted—special care being taken to ensure free drainage, by the use of large drainage tubes. As a dressing in the first instance, till the bleeding has stopped, several layers of wet boracic lint (wet in boracic lotion) are applied.

On the day following the operation, the lint is removed, the surface of the wound is thoroughly cleaned with sulphurous acid or chlorinated soda lotions, or with Hutchinson's lotion, and the drainage tubes are washed out with the same, though not removed. The dressing is now a narrow strip of the salicylic, eucalyptus or full strength boracic ointments, thinly but evenly spread on calico, and outside this, overlapping it in all directions, one or more broad layers of boracic lint.

On the second or third day, the drainage tube is removed, and is washed in 1-20 carbolic lotion, the wound being then syringed out with the sulphurous acid or other lotion. After a day or two the ointment over the line of incision is changed to the half-strength boracic, or if salicylic or eucalyptus ointment was used, they are retained. These dressings are changed daily

at first, but when the discharge diminishes, they may be left for two days.

*Terebene* and *sanitas* are remarkably good applications where the smell is bad.

The results of this treatment are of course not so perfect as those of the aseptic method, for, however carefully one washes out the wound, there are pouches in it into which the fluid does not enter, and pieces of slough cannot of course be disinfected. Thus, prolonged suppurations may occur, caries may continue without tendency to cure, and even accidental wound diseases (pyæmia, &c.) attack the patient.

With regard to the use of chloride of zinc, I ought to say that it is well not to apply it to wounds which must, if possible, heal by first intention, as, for instance, in incisions about the lips or face.

It was on this principle, as we shall see, that Lemaire employed carbolic acid and coal tar; and his results, though very good, by no means correspond to those obtained by strict aseptic treatment.

It was also on this principle that good results followed the use of balsams of various kinds in olden times. The most remarkable example of the success of such attempts at rendering the wound secretions incapable of putrefaction by the use of balsams, was that of Bilguer in the last century. No doubt where the wound is shallow, and possesses few recesses, and where the balsam or other antiseptic employed fills up these recesses, we have really an aseptic treatment and an aseptic result.

By sprinkling powdered salicylic acid on wounds till no more fluid passes out, Neudörfer manufactures a paste under which he says that healing may occur without suppuration.

## II. On Free Drainage as an Antiseptic Method.

I have already discussed the main principles of drainage under the head of aseptic surgery. It is quite clear that, if discharge flows away as fast as it is formed, there can be no marked development of bacteria or of their products. The free drainage

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