CHAPTER VII.

ASEPTIC SURGERY—(*concluded*).

Other methods of carrying out Aseptic Surgery. Substitutes for carbolic acid: *Salicylic acid: Thymol: Acetate of Alumina: Eucalyptus oil.* Aseptic surgery by filtration of the air. Subcutaneous surgery.

SUCH are the essential details of aseptic surgery as introduced and practised by Mr. Lister. The disadvantages arising from the irritating and poisonous qualities of carbolic acid have led some to seek other antiseptics as substitutes for carbolic acid. These attempts have not as yet, however, succeeded in producing any substance possessing so many advantages as that acid. The most successful substitute up till quite recently was salicylic acid, which is used on exactly the same principles, but not with the same constant aseptic results.

The use of salicylic acid was first advocated by Professor Thiersch, of Leipzig, and the following is a short abstract of his method of using it.

Salicylic acid is chemically nearly related to carbolic acid. Its formula is $C_7H_6O_3$, differing therefore from that of carbolic acid in containing in addition the atoms of carbonic anhydride. (The formula of carbolic acid is C_6H_6O.) Salicylic acid is not poisonous, but it affects the hands in the same way as carbolic acid. It is absorbed, and may be found in the urine of patients whose wounds are dressed with it.

A lotion of salicylic acid is employed. This is a saturated solution of the acid in water at the ordinary temperature, and its strength is about 1 part of salicylic acid to 300 parts of water.

Two materials are used as dressings—viz., salicylic wool and salicylic jute.

Salicylic wool is cotton wool impregnated with salicylic acid in the proportions of 3 and 10 per cent. by weight.

The 3 per cent. wool is made by dissolving 750 grammes of salicylic acid in 7,500 grammes of spirit (83 sp. gr.). This solution is then diluted with 150 litres of water at the temperature of 70°–80° C. 25 kilogrammes of pure cotton wool are saturated with this mixture.

The 10 per cent. wool is obtained by dissolving one kilogramme of salicylic acid in 10,000 grammes of spirit (83 sp. gr.), the solution being then mixed with 60 litres of water. Ten kilogrammes of pure cotton wool are soaked in this solution.

This soaking is best done in a large wooden vat, in which the layers of cotton wool have plenty of room. It is best to place only small quantities of wool (two to three kilogrammes) in this vat at a time in order to get an equal distribution of the acid. Thin layers of cotton wool are introduced into the salicylic solution under light pressure, fresh layers being added only when the former have been thoroughly soaked. When the whole quantity has been introduced the mass is turned over, so that the undermost layer becomes the uppermost, and then it is left for about ten minutes, so as to have equable distribution of the fluid. The wool is then taken from the vat and spread out in layers. On cooling, the acid crystallises out, and the layers are made up into small parcels, not exceeding two to three kilogrammes each. After twelve hours this wool is spread out to dry in a moderately warm place. It should not be hung up, lest the acid should become unequally distributed.

The 10 per cent. wool is coloured with carmine for the sake of distinction.

It is important to note that Thiersch, in speaking of 3 per cent. and 10 per cent. wool, means wool soaked in the solutions of the strength described. The wool does not contain that per centage of salicylic acid.

This cotton wool does not absorb fluids readily, and therefore Thiersch now uses jute. This is made from the bark of various species of Corchorus grown in Bengal, and is cheaper than cotton wool, and at the same time more absorbent. It is used of two strengths—3 and 10 per cent. prepared in the same way as the salicylic wool.

Glycerine is added to the solution in order to prevent the crystals of salicylic acid from falling out, because they are apt to produce violent sneezing, coughing, &c.

In order to obtain the 3 per cent. jute 2,500 grammes of jute are put into a solution of 75 grammes of salicylic acid, in 500 grammes of glycerine and 4,500 grammes of water at 70°–80° C.

In the glycerine jute the acid is more equally distributed than in the cotton wool. In the case of the latter the cotton is frequently so imperfectly charged that it is necessary to place a layer of 10 per cent. cotton next the wound, and then outside this the 3 per cent. wool. In the case of the glycerine jute a 4 per cent. material is sufficient for the whole dressing.

As to the spray Thiersch does not care whether it is 1–50 carbolic acid or 1–300 salicylic acid. Carbolic acid is to be preferred, because it causes less coughing and sneezing, and it does not adhere to the clothes.

Salicylic acid is best in some cases, as it irritates the wound less than the carbolic.

For disinfecting the hands and skin, carbolic acid or salicylic acid may be used, but for the instruments carbolic acid must be employed, because the steel becomes oxidised in a solution of salicylic acid.

The sponges are washed in carbolic acid.

No protective is required, because the salicylic acid is but little irritating.

Macintosh is also unnecessary.

In order to enable the dressing to peel off and to let the discharge get away more easily a layer of gutta-percha tissue or of oiled silk riddled with holes and covered with a piece of gauze is applied next the wound.

This treatment may be illustrated by a case of amputation.

The patient having been chloroformed and Esmarch's elastic bandage applied, the part is shaved, washed with soap and water, spirit and turpentine oil, and then with salicylic acid lotion, or with the 1–20 carbolic acid solution. It is also scrubbed with a nail-brush for a few minutes (quite unnecessary). The operation is carried out with the usual aseptic precautions. After arresting the hæmorrhage the wound is

closed with deep and superficial stitches. A drainage tube is then introduced into each angle, and the wound is washed out with salicylic acid solution till the fluid which comes out is clear (unnecessary). Three finger-breadths of perforated gutta-percha and of carbolic gauze is then applied; over this one finger's thickness of the strong salicylic wool, and outside this two fingers' thickness of the weak wool. The whole is then fastened on with a bandage.

If the patient complains of pain the dressing is changed and the wound examined. If not, it is left till the eighth or tenth day, when it is changed, in order to remove the drainage tube. If any discharge comes through in the first instance fresh wool is put outside the dressing. The second dressing is left till healing is complete.

Large compound fractures are treated at first by irrigation with salicylic acid. In order to protect the skin from maceration by the fluid it is from time to time rubbed with palm oil. After all risk of abscess formation has passed off and the wound is granulating well, one may apply dry salicylic dressing as before described.

Where there is a tendency to inflammation, more especially where there is imperfect drainage with progressive abscess formation, wet salicylic dressing should be applied. This is ordinary salicylic dressing, which is from time to time soaked with salicylic lotion.

Thymol as an antiseptic application to wounds was introduced some years ago by Ranke of Halle, and was much lauded on account of its non-poisonous and non-irritating qualities.

The thymol gauze was made on the same principles as the carbolic gauze, spermaceti being, however, employed. A thymol solution of the strength of 1–1000 is made by the addition of alcohol and glycerine.

This antiseptic has not answered the expectations entertained at first. It does not prevent putrefaction, and has been justly abandoned in aseptic work.

Acetate of alumina has been lately used by Maas. He applies lint dipped in the solution ($2\frac{1}{2}$ per cent.) to the wounds,

and covers this with macintosh. The strength of the spray is also $2\frac{1}{2}$ per cent.

He says that this is a powerful antiseptic, and that with it he gets typical aseptic results. The substance is unirritating, and very few dressings are required.

Eucalyptus oil has recently been strongly advocated by Dr. Schulz of Bonn.[1] Its antiseptic properties were shown by Bucholtz in his paper on antiseptics. He found that it was three times as strong as carbolic acid, for while carbolic acid prevented putrefaction when present in the proportion of 1 in 200 parts, the eucalyptus oil only required to be present in the proportion of 1 to 666·6 parts to produce the same effect.

Siegen also showed that eucalyptus oil prevents putrefaction and alcoholic fermentation better than carbolic acid. He found that blood to which $\frac{1}{3}$ per cent. of eucalyptus oil had been added was quite odourless ten days later. Bing states further that it hinders the passage of white corpuscles out of the vessels, and that therefore, on Cohnheim's theory, it is an agent capable of arresting suppuration.

With regard to its usefulness, its smell is more pleasant than that of carbolic acid. It dissolves readily in alcohol or in oil, and mixes perfectly with pure paraffin.

Schulz also states from Siegen's experiments and from his own that the eucalyptus oil is not poisonous. The tree from which the oil is obtained grows in large numbers in Australia, and the oil can be obtained in large quantities and very cheap.

Schulz recommends that for the spray the glass bottle should be filled with the pure oil or with oil dissolved in alcohol. The steam would then pick this up and make an emulsion.

As a lotion it might be used in the form of an emulsion.

Schulz proposes that the wounds should be dressed with lint saturated with a 10 per cent. solution of eucalyptus or olive oil. Outside this, or instead of it, may be used Lister's gauze dressing containing eucalyptus oil instead of carbolic acid. A gauze which contains even 50 per cent. of eucalyptus oil may be made with paraffin. Dr. Schulz has not himself, however, used this method.

[1] *Centralblatt für Chirurgie*, January 24, 1880.

Quite recently Mr. Lister has been making an extensive trial of eucalyptus oil in the treatment of wounds. A gauze has been prepared similar to the ordinary gauze, but containing eucalyptus oil instead of carbolic acid. Dammar has also been substituted for the ordinary resin. So far this has proved very satisfactory. It seems to be trustworthy as an antiseptic, and can be used under circumstances where carbolic acid is apt to cause irritation, as in dressings on the scrotum, or in patients whose skins are liable to be irritated by carbolic acid. Being non-poisonous, it may also be substituted for carbolic acid in cases where constitutional effects are apt to follow the absorption of the latter.

It has also been employed as an ointment in the proportion of 1 part by measure of the oil to 4 parts by weight of the same base as is used for the boracic and salicylic ointments (p. 65). This ointment is employed in the cases for which boracic and salicylic ointments have up to the present been used, and it possesses the advantage over the latter in that the oil not only renders the discharge pure as it passes over it, but also on account of its volatility bathes the parts in an antiseptic vapour. Hence it will probably be especially useful in the treatment of burns (see p. 116). Its non-poisonous qualities are also a great point. As yet no experiments have been made with the view of substituting it for carbolic acid in the lotions used in the spray, in washing wounds, purifying instruments, &c., and indeed the whole matter is only for the present under trial.

So far we have been considering modes of preventing putrefaction in wounds based on the fact that the septic particles in the air and on surrounding objects may be deprived of their power of causing fermentation by contact with some suitable chemical substance. But we also saw in the preliminary considerations that it sufficed for the avoidance of fermentation in flasks to keep the dust out mechanically, as, for instance, by means of cotton wool. This fact was made use of by Mr. Lister some years ago in the following manner. I may quote his remarks, which are given in a foot-note to his article on Amputations in Holmes' 'Surgery,' vol. v. p. 619, published in 1871.

'Among recent contributions of fact to the elucidation of this question (the germ theory) may be mentioned Professor Tyndall's simple but beautiful proof of the existence of organic particles of dust of excessive minuteness in the air by means of a condensed beam of light, and the equally clear ocular demonstration afforded by the same method, that even the finest particles are capable of being removed from the air by causes which Pasteur, in some of his experiments, inferred must clear it of suspended organisms, such as the action of gravity and filtration by cotton wool. The fact last named seemed to promise valuable results in antiseptic surgery, and experiments made with this view have afforded further evidence in favour of the germ theory which it may be well to mention here. I found that if cotton wool impregnated with either chlorine or sulphurous acid gas or with the vapour of benzine or carbolic acid, was placed upon a wound or granulating sore, after washing the surface with a solution containing the same agent, *although the volatile antiseptic left the cotton in about a day*, the blood or pus still effused beneath the cotton remained free from putrefaction for an indefinite time, provided that the discharge was not sufficiently copious to soak through the cotton and appear at the surface, in which case the meshes between the fibres affording ample space for microscopic organisms to develop in, putrefaction spread within a few hours throughout the moistened part of the mass. This circumstance greatly interfered with the practical utility of the dressing, and it has since been superseded by the antiseptic gauze to be described in the text, but the facts seem to me important with regard to the germ theory. The cotton wool, though it loses all chemical antiseptic virtue in a day, yet will keep out putrefaction for a month or more. It cannot possibly keep out any atmospheric gas, which is necessarily diffused freely between its fibres, and gets in for the same reason that the volatile antiseptic gets out. That which it does exclude can only be suspended particles of dust. It follows, therefore, as a matter of certainty, that the cause of putrefaction through atmospheric influence of blood or pus, or, in other words, such materials as the surgeon has to deal with in treating wounds,

are not the atmospheric gases, but dust, and the fact that this dust is deprived of its putrefactive energy by agents which are chemically so unlike as chlorine, sulphurous acid, benzine, and carbolic acid, but which agree in having a common hostility to animal or vegetable life (I used benzine because I knew that the entomologist employs its vapour to kill insects), this fact confirms the view that the putrefactive particles are really organisms. I commend these simple experiments with cotton wool to the candid judgment of the reader, because, whatever may be thought of their bearing upon the allied subject of spontaneous generation, they must be allowed to afford absolute demonstration of the truth which is the foundation of the antiseptic system, viz., that the putrefaction of blood or pus under atmospheric influences is caused not by the gases of the air, but by suspended particles, which can be deprived entirely of their septic energy by the vapour of an agent like carbolic acid.'

It will thus be seen, that what Mr. Lister used here was not an antiseptic application but an aseptic one, and that the only mode in which this dressing acted was by mechanically preventing the particles from reaching the wound. For the reasons quoted, this method has not been turned to practical account, though, as we have seen, it is still used in cases of gangrene in order to protect the weak parts from all sources of irritation.

Mr. Barker, assistant surgeon to University College Hospital, has tried a similar method in one or two cases. He purified cotton wool by heat, and applied between it and the wound a layer of lint dipped in carbolic oil. This method, however, seems to be impracticable, for after the wool has been heated, but before it is applied, dust would very probably gain access to it unless very complicated precautions were taken. I believe that if pure cotton wool is used Mr. Lister's method is the only practicable one.

I have mentioned these experiments more as confirming the flask experiments described before than for the purpose of recommending the method for adoption. I believe that thoroughly satisfactory and indeed the best results may be obtained by the use of suitable chemical means.

Subcutaneous surgery is another way in which the aseptic principle may be carried out. Here the wound is made under the skin and away from the air dust altogether. This method will be better understood when we come to trace the history of antiseptic surgery.

CHAPTER VIII.

THEORIES OF SPONTANEOUS GENERATION, HETEROGENESIS AND ABIOGENESIS.

Principles on which other methods of antiseptic surgery act. Organisms are always present in fermenting liquids: their significance. Theory of the origin of organisms independently of a parent. Theories of Needham and Buffon: Needham's proofs. Spallanzani's experiments: Needham's objections: Spallanzani's replies. Schulze's experiments. Schwann—Schroeder and Dusch—Schroeder—Doctrine of Heterogenesis. Pouchet's work: his method of testing the matter: proofs that the source of the organisms in infusions is neither the air, water, nor the putrescible substances: modes of repeating Schulze's and Schwann's experiments: examination of dust. Criticism of his results. Pasteur's experiments: results with ordinary fluids: introduction of dust into sterilised fluids: results with milk and alkaline fluids: the cause in the air which gives rise to the growth of organisms is particulate: Pasteur's cultivating fluid: estimate of Pasteur's work. Pouchet's reply: New experiments—Criticism of these.

Such are the methods by which that form of antiseptic surgery which aims at the total *exclusion* of septic ferments may be best carried out. But 'Antiseptic Surgery' in its broad sense includes another class of methods of treatment acting on a totally distinct principle, and interfering more or less perfectly with the occurrence of fermentations. These all act on the principle of *rendering inert the causes of putrefaction after their entrance into the wound, of offering obstacles, more or less complete to the fermentation which these particles would otherwise occasion.* In order to understand these methods, to see on what principles they act, to decide which are the best, and to carry them out with the greatest success, it is necessary to take up our discussion of the causes of putrefaction at the point which we have already reached, and to consider what is *the nature of the particles* which we found to be the causes of