

brought forward abundantly shews, security against its occurrence.

The explanation of these facts has been furnished by various writers, and as Mr. Savory has, in his speech during the debate on Pyæmia and at the meeting of the British Medical Association at Cork, summarised the points which are essential for understanding the *modus operandi* of antiseptic surgery, and for showing the necessity for truly aseptic treatment, I may quote what he says: 'We may take a decomposing fluid, inject it into the blood, and produce all those effects which are generally recognised as the effects of pyæmia.' The poison 'is formed during the decomposition of animal fluids, animal fluids in connection with the living human body.' 'Decomposition is unquestionably hastened by exposure' to air. 'Most of all, the introduction of other matter in a state of active decomposition increases vastly the rate of decomposition of the original fluid.' This decomposing fluid 'can, by a syringe, be introduced at once into the blood of an animal, and produce the most terrible forms of blood-poisoning.' 'As we have been already told, the not unhealthy pus, normal pus, may be injected into the circulation, and you do not get as a necessary result, by any means, pyæmia. But pus is an animal fluid, which, of all fluids, is most likely to be found in contact with wounds, and, obeying the law of exposed animal fluids, is exceedingly likely to undergo decomposition; and then pus, undergoing decomposition, will produce pyæmia, as any other fluid will produce pyæmia which is in a state of decomposition.' 'Take pus; you do not want to go to decomposing vegetable and other animal fluids; you may do it with them, but take pus, and with it I could make a case of pyæmia or septicæmia according to order, by the length of time which I kept the pus before I injected it; and I know very well, in experimenting on this subject, one may produce all degrees of the disease, and may say that the chances of getting secondary abscesses are in direct ratio to the length of time an animal lives after it has become inoculated with the poison. When the poison is thoroughly septic, when you have that terrible substance which Dr. Burdon-Sanderson has shown us how to get in the peritoneal cavity of an animal, the blood becomes so poisoned and spoilt that it kills outright, and

there is no time for the secondary effects to supervene.' And then how is it that this fluid can be in contact with granulating surfaces, and yet the patient be free from all symptoms? Simply because the granulations protect the patient against the absorption of the 'terrible substance' in contact with them. There are other reasons which I need not mention here, but the most powerful is that which I have just stated. I again quote Mr. Savory: 'The best work done in late years in this direction are those experiments which Billroth and other persons have performed, showing that where granulations are healthy, when they exist in their integrity, they offer a decided obstacle to the passage of the material from without to within; but when these granulations become destroyed, either mechanically or by other means, whereby they are brought into an unhealthy state, these fluids pass with fatal facility through them and so gain entrance into the blood.' I have already demonstrated that the decomposition of organic fluids and tissues was dependent on the introduction of particles into them from the outer world, and that these particles are bacteria or their spores. The latter point is not absolutely essential for the question at issue, indeed Mr. Savory sums up the essential points as follows in his address at Cork. 'I turn away from any farther inquiry as to the nature of these septic particles. . . It is enough for us that they are septic; that they can produce and promote putrefaction; and further, that fluids so changed by them may provoke those terrible effects which are only too well known as blood-poisoning.'<sup>1</sup>

I do not pledge myself to all Mr. Savory's conclusions, more especially where he states that he can get pyæmia and septicæmia according to the length of time that the decomposing fluid has been kept or that the animal has lived after inoculation; but the statements taken as a whole reflect fairly well the present state of knowledge on this subject, and are sufficient explanation of the results of the different varieties of antiseptic surgery in regard to infective disease. They shew that no precautions which do not entirely prevent the growth of organisms in wounds can be trusted to remove the patient altogether from the risks of blood-poisoning, for if organisms are not entirely

<sup>1</sup> The italics are mine.

excluded from wounds, and if these wounds are not very carefully drained, fluids may be confined in the deeper parts of the wound and there undergo decomposition. The use of a bread and water poultice greatly facilitates the putrefaction of the discharge; and thus it comes about that a patient so treated is practically only protected from the 'terrible poison' in his wound by a thin and delicate layer of granulations. If these remain whole and healthy all may be well,<sup>1</sup> but if from some injudicious movement this layer is ruptured, or if from some other cause the granulations lose their vigour, then the patient is liable at any moment to the entrance of the poison into his circulation, and to the consequent dangers.

Mr. Savory considers that the term 'antiseptic surgery' is synonymous with the term 'good surgery.' I would ask, if it is good surgery to leave a patient subject to the risks just mentioned, and dependent for his safety on a number of factors, any one of which may fail to act and upset the remainder; or whether it is not better surgery to keep away altogether from the wound the causes of the formation of this 'terrible substance,' and thus make the patient independent of the numberless accidents which might render him liable to the absorption of the poison, if it were already present. Cleanliness, isolation, ventilation, poultices, drainage with gutta-percha tissue, &c., may be very excellent when suitably combined and carried out, but, as I have already pointed out, this is a system so complex and so impracticable as to be incapable of providing a satisfactory safeguard against infective disease; it is not the simple thing which some hold it to be. The true simplicity, I again say, is where there is only one factor to be considered, as in the aseptic method.

I do not intend to enter in this work into the discussion of the germ theory of infective disease at all. To do so thoroughly would require much more space than I have at my disposal; and further, its discussion might tend to obscure the real principle which is at the basis of antiseptic surgery; for, as I have already pointed out, the tendency in the present day is to bring

<sup>1</sup> This does not by any means always follow, for some forms of micro-organisms may be able to penetrate through healthy granulations, and produce infective disease.

prominently forward the germ theory of infective disease, and thus lose sight of the real points at issue. For my own part, I consider that the evidence in favour of the germ theory of infective disease is overwhelming, and I constantly admire the temerity of those who, often through ignorance of the present state of knowledge on this subject, ridicule it and speak of it as far from proven. It is sufficient, however, for our purpose to recognise that when the precautions taken to exclude micro-organisms are successful, the causes of infective disease are also excluded. This is an absolute rule. Look at any of Mr. Lister's cases which went wrong; they only did so after fermentation had occurred in the wound, after the aseptic method had failed to exclude micro-organisms. And so we may draw this rule, that if organisms are absent from a wound, that wound having been properly examined, the patient is practically safe from the occurrence of infective disease. If, however, organisms are present, he may become liable to these affections from causes depending on a variety of accidents which we cannot consider here. This we may accept without in any way adopting the view that bacteria are the causes of infective disease, for all that we need hold is, that the precautions necessary to exclude bacteria are sufficient also to exclude the causes of infective disease.

That the aseptic system, of all the methods of wound treatment, is the most certain and perfect protector against infective disease, is perhaps even more strikingly shown by the results of operations on healthy joints and bones, which are, under other systems, particularly liable to be followed by infective disease. Such operations have been justly looked on as peculiarly dangerous, and as only warranted under exceptional circumstances, while it is also pretty universally conceded that if they can be performed subcutaneously, *i.e.* more or less aseptically, the danger becomes much less. No other system, however, not even the most scrupulous cleanliness and the most perfect ventilation, has ever enabled the surgeon to cut freely into healthy joints or to operate on healthy bones, and to keep up a communication between the external air and the injured bone or joint, without incurring the greatest danger to the patient, and that danger chiefly from infective disease.

And yet the reader has only to turn to Chapters XVIII. and XIX. to see that such operations can be done with safety under aseptic precautions. As I have already discussed these facts in detail, it would be mere repetition to dwell on them here.

We have thus applied crucial tests to the various systems, with the view of ascertaining to what extent they may be depended on as barriers against infective disease, and we have seen that the aseptic method is the one which has done most in this direction, and, indeed, that under certain circumstances it is the only one which can be depended on at all. It follows from this that, as it protects against pyæmia, even in the worst circumstances, it will be equally certain under more favourable conditions; and as we have seen that no other method of treatment is anything like an absolute safeguard against infective diseases in cases liable to be attacked by it, and as these diseases may occur, as we have just shown, even though rarely, under the most favourable conditions, it follows that unless any sufficient reason exists against its use in any particular instance, Listerism<sup>1</sup> ought to be employed, as far as possible, in all cases, and where it is not applicable the most strenuous attempts ought to be directed to the limitation as far as can be of fermentation in the wounds, and to the avoidance of any disturbance such as movement, or anything which tends to make the granulations unhealthy and thus render the patient liable to the absorption of the products of fermentation.

But death after operations and wounds is not only due to infective disease, it may occur as the result of exhaustion, hectic fever, &c. Among these the most important are the deaths which ensue as the result of prolonged suppurations, most strikingly seen after opening chronic abscesses connected

<sup>1</sup> I need hardly repeat what I hope I have already made sufficiently clear, that there is a difference between the terms 'Listerism' and the 'Listerian method.' Listerism is the great *principle* of wound treatment introduced by Mr. Lister, a principle which may be applied in various ways. The best mode of application of this principle is that worked out by Mr. Lister himself and known as the Listerian method. Some surgeons have introduced various modifications of the method, but they still practice Listerism, though not strictly the Listerian method. That the Listerian method is the best mode at present known of carrying out Listerism cannot be doubted.

with carious vertebræ. In this case we have a chronic disease of the bone, which has led to the formation of an abscess in connection with it. The cause—the chronic disease of the bone—which primarily led to the formation of the abscess, was not very active, and thus the abscess was chronic in its commencement, *i.e.* not attended with any marked symptom of inflammation; the causes—the chronic bone disease and the tension exercised by the pus already formed on the walls of the abscess cavity—which induce the continued formation of pus act very slightly, and thus the abscess increases but slowly, and if the inflammation of the bone cease and the pus be not very tensely confined in a sac, it may become a cheesy mass or even be entirely absorbed. As a rule, however, there is sufficient tension on the walls of the sac to lead to continuance of the pus formation, steady though slow increase of the abscess, and maintenance of the bone disease. So long as the skin remains unbroken this abscess increases very slowly. If now the pus be withdrawn by means of an aspirator or by a trocar and canula, and no causes of fermentation be admitted, it may happen, though in truth very rarely, that there is no reaccumulation of pus, the residue which was not removed by the aspirator is absorbed, the cavity closes, and the disease is cured. In some cases repeated aspirations are necessary to secure this result, but in the majority of instances the abscess steadily increases in size and must at last be opened, or bursts externally. And now if no care be taken to exclude the causes of putrefaction, the state of matters becomes very different from that which existed before the skin was broken. As we have already seen, and as the behaviour of the chronic abscess so long as the skin is unbroken abundantly shews, pus has no inherent tendency to undergo fermentation. We also know that the gases of the air cannot induce fermentation, but that particles in the air and deposited on surrounding objects can. If the abscess is opened without sufficient aseptic precautions, of whatever kind they be, these particles must gain admission into the pus in the abscess cavity, and as there can here be no destructive action of the living tissues on these particles, fermentation occurs. And this fermentation may or may not be putrefactive, but whatever it be, its products are always more or less chemi-

cally irritating; and the effect of the application of irritating chemical substances to granulations is to cause them to suppurate. Further, these irritating chemical substances—the products of this fermentation—are not transiently applied but are constantly present day after day in contact with the granulations, for as we have seen, the ‘vital ferments’ have an indefinite power of multiplication, and thus there is a constantly fresh supply of the irritating products. The result is the profuse suppuration which constantly follows free incisions into these abscesses, and the consequence of this prolonged and free suppuration is hectic fever, exhaustion, waxy infiltration and degeneration of various internal organs, and ultimately, in the great majority of cases, death. On the other hand, prevent the entrance of micro-organisms, as I have shewn can be done by the aseptic method, and the pus remains as unirritating as formerly. There is no more reason for great formation of pus after than before the abscess was opened; indeed, the granulations are relieved from the tension of the pus, and are therefore less irritated than before and secrete less. And then in a few days the greater part of such an abscess cavity closes by adhesion of the granulations, and only a sinus is left leading to the seat of disease. But the granulations lining this sinus do not suppurate because they are not irritated, and hence all that happens is a slight transudation of serum, perhaps not a couple of minims in a week, and this continues till the disease is cured and the sinus can close. Thus, during the treatment the patient is not exhausted by profuse discharge, while he is relieved from the presence of the abscess, which by the tension of its contained pus was keeping up the chronic inflammation of the bone and was a source of constitutional irritation. And thus we constantly see that, where such abscesses are opened aseptically and *kept aseptic*, the patient’s health at once begins to improve.

That these are not mere theoretical speculations, but that they are fair deductions from the facts, will be evident to any one who will carefully weigh the facts brought forward in the history of antiseptic surgery and in Chapter XX. For there we see that the only method of treatment which could be said to be of any service at all in these cases, excepting the Listerian

method, was Abernethy’s mode of puncturing with a trocar and canula, or of making a valvular incision into the abscess. On the other hand, we have the much better results of aseptic treatment, results not obtainable by the so-called simple methods of cleanliness, free ventilation, &c. I need not go into the discussion of these results again; the facts have been sufficiently given in the last chapter.

Though this is the most striking instance in which profuse suppuration leads to loss of life, yet in many other cases great danger is caused by its occurrence. Thus in many injuries of bone, such as compound fractures, very profuse and prolonged suppuration often follows which may endanger the life of a weakly patient, or may even in the case of a healthy patient lead to amyloid infiltration and degeneration of the internal organs. This is chiefly the case where necrosis of portions of the fractured bone occurs; the necrosis may be due to the injury directly, a portion of bone being deprived of vitality or separated from its vascular connections at the time of the accident, but more frequently it is the result of acute inflammation of the bone, acute suppurative osteitis, which supervenes on the injury, and which is due, as is at once evident from comparison with the behaviour of a simple fracture, to the existence of a communication between the injured bone and the external air, and the consequent occurrence of fermentation and formation of irritating products in the wound. But, if the wound is kept aseptic the fracture behaves exactly as if it were a simple one, the danger which results from the external wound being completely avoided. There is therefore no acute inflammation either of the soft parts or of the bone, and hence no necrosis from this cause; the process of repair at once commences. And, just as in the simple fracture, in the way which will be described more minutely presently, portions of bone detached from their vascular supply do not therefore give rise to suppuration, and indeed, by no means require removal, but become encroached on and removed by the surrounding new tissue. Here also this result depends on the asepticity of the wound, however brought about, whether by the aseptic method, or in rare cases by absolute immobilisation or the formation of a crust. If once fermentation occurs

in the wound, suppuration takes place, detached portions of bone are always separated, and frequently necrosis of living bone results. An abundance of facts which prove these views have also been brought forward. The same remarks apply to lacerated wounds, though in these cases the suppuration is not often so great, or at least so long continued, as to endanger life.

Wounds of joints also, though perhaps most frequently fatal in the first instance from sapræmia, septicæmia or pyæmia, yet when these dangers have become slight, are still serious from the prolonged suppuration which follows. We have fully demonstrated that these dangers are all avoidable by taking measures to prevent the occurrence of fermentation in the joints (see Chapter XVIII.)

There are many other cases, which I need not consider, in which the avoidance of profuse and prolonged suppuration is a matter of the greatest importance, sometimes even of life and death. I shall just mention one example more—acute osteomyelitis. In this disease, if the patient escapes the primary dangers from infective diseases (see definition of the term in Chapter XVII.), he is certain to suffer from prolonged and very profuse suppuration, on account of the death of the bone to a greater or less extent. To avoid these risks amputation is frequently resorted to, but recently Mr. Spence has recommended the excision of the inflamed bone, and has had some good results from this procedure. Neither of these operations are, however, necessary if the case be treated aseptically. It is generally merely requisite to open the abscess freely, with the necessary aseptic precautions, and to attend to free drainage, and as a consequence suppuration ceases at once or is very slight, and sometimes the wound heals up without any separation of dead bone whatever, or if this occurs it is generally merely a superficial exfoliation. Mr. Lister has had several excellent cases treated in this way. The case of osteomyelitis is of course by no means so typical as the other instances which I have mentioned, because, as we have seen, micro-organisms are always present in the pus of the abscess in connection with the bone; but nevertheless its course, if treated aseptically, is often markedly different from that which it follows when treated otherwise, and this, and the fact that some cases do better than

others, may be explained by the other fact previously mentioned (p. 256), that in many acute abscesses the micro-organisms are probably dead when the pus is evacuated.

Then again, if we consider the case of necessary operations on weak or diseased individuals, we shall find that the aseptic method more than any other has diminished their risks, and indeed, with regard to many, alone renders their performance possible. The good health of the patient is one of the many conditions necessary in the sort of treatment which we have just been considering under the head of cleanliness, free ventilation, &c. If the patient be in a weak state, his resisting power to septic influences is less, and the protecting layer of granulations is less potent to resist the entrance into the system of the 'terrible substance' in contact with it. Let the patient be weak, and he can, for a shorter time, endure the exhausting suppuration which may follow the operation, a time too short, it may be, to permit of recovery from it.<sup>1</sup> This is a point of view from which the subject has been regarded by most surgeons who have adopted the aseptic method thoroughly. Thus Mr. Wood, at the meeting of the British Medical Association at Cambridge in 1879,<sup>2</sup> said of the aseptic method, that one great reason for employing the Listerian method was 'that it saved a considerable percentage of weakly constitutions, upon whom it was absolutely necessary to operate, and who would die unless for its precautions.' Among these instances may be mentioned cases of amputation in patients suffering from phthisis. The difference of opinion which exists on this subject is of course well known, and many surgeons refuse to operate where marked

<sup>1</sup> Operations on patients suffering from albuminuria seem to be less dangerous if treated aseptically than a wound is when treated in other ways. This is easily intelligible, for when not treated aseptically there is frequently absorption of products of fermentation from the wound. In a healthy person this may not be of much consequence, the poisonous materials being probably got rid of in great part by the kidneys. Where, however, the kidneys are diseased this material may not be got rid of, but may accumulate in the blood and poison the patient, or may act on the kidneys and cause them to stop working and lead to the patient's death from uræmic poisoning. Both these dangers are avoided if the case is treated aseptically, for in that case this material is not formed in the wound.

<sup>2</sup> *British Medical Journal*, vol. ii. 1879.

phthisis is present. Of course, where a wound is not treated aseptically, and where healing does not occur by first intention, suppuration takes place, and where the patient is weak this reduces him still further, and, if the wound is large, may only hasten his death. In these cases also the irritative fever which occurs is particularly dangerous. Where, however, union by first intention occurs, irritative fever and suppuration are absent, and the removal of the disease is a relief to the patient. As the aseptic system not only favours union by first intention, but also prevents the occurrence of fever and suppuration in cases where union by first intention cannot take place, amputation in cases of phthisis is a much more hopeful procedure than formerly. Several of Mr. Lister's cases have been striking examples of this.

And further, operations can now be performed which may be necessary for the recovery of the patient, but which would have been almost certainly fatal under the former methods of treatment, and which were therefore considered unjustifiable. This of course follows from the facts narrated in the three preceding chapters, for if an operation such as the incision of a healthy joint may be safely performed for the removal of an inconvenience, it must be equally safe when performed for the removal of something which, if left, would imperil the patient's life. I may quote two facts from Professor Volkmann's speech at the recent International Medical Congress.<sup>1</sup> 'For a large enchondroma in the costal pleura that occupied the left wall of the thorax, Professor Fischer removed a large piece of the chest wall and ribs, so that the heart and lungs were exposed and an opening as large as a child's head was made, and yet the patient was able to be discharged from the hospital after four weeks.' 'In the case of a large echinococcus of the liver, which in front and at the side was covered with thick layers of liver tissue, and which projected into the thoracic cavity, after resection of the seventh rib, I opened the healthy pleural cavity, which was free from adhesions. The thorax was freely opened, the thinned diaphragm cut into, the echinococcus sac opened, the animal bladder extracted *in toto*, and the patient recovered without complication. A similar operation with like results was conducted by Mr. Israel of Berlin.' On this point

<sup>1</sup> See *Lancet*, August 13, 1881.

also Mr. Wood says: <sup>1</sup> 'And another point from which he' (Mr. Wood) 'had been in the habit of considering it' (the aseptic system) 'was this: that it extended the aim and scope and value to the community of surgical skill in cases on which it would be too risky to operate without the extreme precautions which antiseptic surgery affords. There were a great many operations which they were doing at the present time which would have been considered wild, and which were now by many considered unjustifiable, otherwise than with their improved means.'

There are, however, a great many other points which have to be attended to in the treatment of wounds besides the saving of life; we have to look to what Sir James Paget calls the 'well-doing' of the patient. Now as the aseptic method allows the performance of operations which would otherwise be considered unjustifiable, it is evident that it must in many cases enable the surgeon to render the patient a more useful member of society than he would otherwise be. Take, for instance, any interference with the movement of joints from some cause (say the presence of an exostosis) which would involve the opening of a great articulation in its rectification; here the aseptic method permits an operation which would not otherwise be possible. Look at Mr. Lister's list of joint cases, and see whether or not some of the patients have been rendered more useful members of society by the aseptic method.

Take the simple operation of tenotomy. How impossible it was till the subcutaneous method was introduced; but as soon as a method was found by means of which the causes of fermentation were excluded from the wound, these operations became frequent, and they certainly daily increase the usefulness of many patients. And what was impossible in this department in former days by means of free incision, is possible now; and if for any reason one wishes to see the tendon to be divided, it may be exposed aseptically without fear of the result. And further, in cases of ruptured tendons, cases so apt to leave impaired power behind, one may cut down and sew the ends of the tendon together with catgut and in this way get perfect

<sup>1</sup> *Loc. cit.*