

	Cases	Deaths
At shoulder-joint . . . . .	9	1
Through humerus . . . . .	32	—
„ fore-arm . . . . .	47	—
At wrist-joint . . . . .	4	—
„ hip-joint . . . . .	6	4
Through thigh . . . . .	86	6*
At knee-joint . . . . .	3	—
Through leg . . . . .	69	1†
Partial amputations of foot (including 9 Syme's amputations, 36 Pirogoff's, 15 Chopart's, 1 Lisfranc, 4 of metatarsal bones)	65	2§
Total . . . . .	321	14

A mortality of 4·4 p. c.

\* One of these deaths was due to septicæmia; † from 'habitual erysipelas';  
§ one from 'pyæmia simplex.'

#### Uncomplicated amputations treated by the older methods:—

	Cases	Deaths
At shoulder-joint . . . . .	15	8*
Through humerus . . . . .	41	6†
„ fore-arm . . . . .	42	2
At wrist-joint . . . . .	10	—
„ hip-joint . . . . .	3	2‡
Through thigh . . . . .	105	43§
„ knee-joint . . . . .	7	1
„ leg . . . . .	115	38¶
Partial of foot (8 Syme's amputations, 13 Pirogoff's, 5 Malgaigne's, 9 Chopart's, 1 Lisfranc, 3 of metatarsal bones)	39	10**
Total . . . . .	377	110

A mortality of 29·18 p. c.

\*† All from infective disease; ‡ one from pyæmia; § thirty-eight from  
infective disease; || from pyæmia; ¶ thirty-seven from infective disease;  
\*\* nine from infective disease.

Other tables are given stating the results of double amputations, of amputations with other severe injuries, of amputations in existing septicæmia, pyæmia or tetanus, and of deaths from intercurrent diseases quite unconnected with the operation. I need not, however, go into these, as they would only obscure the point at issue.

Schede tabulates the causes of death in the two preceding tables as follows:—

	In the septic cases	In the aseptic cases
Pyæmia . . . . .	72	0
Septicæmia . . . . .	19	1
Erysipelas . . . . .	2	1
Trismus . . . . .	0	1
Pyæmia simplex . . . . .	6	1
Hæmorrhage . . . . .	3	1
Exhaustion . . . . .	2	1
Shock . . . . .	6	8
Total . . . . .	110	14

Thus, as Schede truly remarks, if the deaths from infective diseases were removed from the list of septic cases, the death-rate in each would be almost the same—about 5 per cent. for the septic cases, as against 4·4 per cent. for the aseptic. In other words, the aseptic method saved this enormous proportion of lives in the main by preventing infective disease.

The last paper to which I shall refer is Reyher's account of his results during the Russo-Turkish war.<sup>1</sup> As I intend to discuss these results later I shall just mention the numbers here.

Eighty-one cases were treated aseptically as soon as possible after the injury, and of these 15 or 18·6 per cent. died. Among these cases were 27 gunshot wounds of joints treated conservatively throughout with 4 deaths; 19 primary resections in cases of gunshot wounds of joints with 2 deaths; 13 primary amputations with 5 deaths; and 22 compound fractures with 4 deaths. Of the 15 deaths, 5 were due to septic diseases (2 to pyæmia, and 3 to septic inflammation and suppuration). With regard to the deaths from septic diseases in these cases, we must remember that here the surgeon had not to deal with an operation performed by himself, in which the problem is to *keep out* the causes of putrefaction, for here the causes were in many instances already present. The deaths occurred in cases where these causes were present and were not destroyed because portions of clothing, &c., were present in recesses of the wounds.

Contrasted with this were 65 compound fractures and 78

<sup>1</sup> Volkmann's *Sammlung*, Nos. 142 and 143; *Die antiseptische Wundbehandlung in der Kriegschirurgie*, 1878.

wounds of joints, in all 143 cases, which did not come under treatment for some time, and in which the generally unsuccessful attempt at purification was made. Where these attempts are unsuccessful the treatment resolves itself into treatment with antiseptics. Of these 143 cases treated with antiseptics, 71 or 49.6 per cent. had already died when the first part of the report was issued, and 2 more died subsequently. Of these at least 46 cases died of septic diseases.

Then contrasted with both these sets of cases there were treated alongside of them 62 wounds of joints, in which no attempt was made to render the wounds aseptic, or even to treat them with antiseptics. Of these, 48 or 77.4 per cent. had died when Reyher wrote, and amputation or resection had been found necessary in most instances.

Lastly, I would allude to the results obtained in ovariectomy by the leading ovariectomists of this country. Mr. Spencer Wells and Dr. Keith had for years striven to carry out perfect cleanliness and other antiseptic precautions short of complete exclusion of organisms from wounds, and the results of both were very remarkable indeed. And yet, since they have extended their precautions so as to *exclude* the causes of fermentation, their results have still further improved, and they themselves—and they are the best judges—attribute this last improvement solely to the additional antiseptic precautions employed.

Mr. Knowsley Thornton, in his speech at the debate on antiseptic surgery in December, 1879,<sup>1</sup> gave an analysis of more than 300 cases of fatal ovariectomy, and stated that in more than one-third of the cases septicæmia, pyæmia or septic peritonitis were given as the cause of death, and in nearly another one-third the fatal result was attributed to peritonitis. Mr. Thornton pointed out further that the cases of peritonitis were almost entirely due to septic causes, and thus, as he states, two-thirds of the deaths after ovariectomy were due to septic influences, and therefore, if these influences can be eliminated by aseptic surgery, the results ought to improve to a corresponding extent. And he states that this has been his experience, and that the introduction of strict aseptic precau-

<sup>1</sup> MacCormac's *Antiseptic Surgery*.

tions has reduced his mortality by half, and it would have been still less had not putrefaction been present in some of the cases before he operated, owing to previous tapping of cysts by other surgeons without aseptic precautions.

Mr. Spencer Wells, at the same meeting, spoke very strongly in favour of aseptic treatment, and gave the result of the last 168 cases which he had treated in private practice. The first 84 had been treated by his former methods, but yet, he says, 'with all the care I could give to them there were 21 deaths.' On the other hand, the last 84 were treated aseptically, and of these only 6 died, and these deaths occurred among the earlier cases while he was only as yet making acquaintance with the details of the method; and so 'as I went on and became still more accustomed to the method and details of antiseptic treatment, and avoided mistakes, then I obtained the long run of 38 cases without a single death; and, adding to that the 5 more of other important abdominal operations, I can record the gratifying and almost incredible result of 43 cases of these great operations without a death.' In a foot-note he adds: 'The run of 38 cases of successful ovariectomy was afterwards increased to 41, and then a death occurred where septic symptoms had set in before operation.'

Dr. Thomas Keith, who had adopted the aseptic method somewhat earlier, and who had previously been getting the best results of the day, states<sup>1</sup> that his last 76 cases were performed aseptically with only 2 deaths, and these occurred at the commencement, so that the last 68 cases in succession all recovered. Dr. Keith is equally positive in ascribing these good results to the additional precautions which he had taken.<sup>2</sup>

<sup>1</sup> See MacCormac's *Antiseptic Surgery*.

<sup>2</sup> At the recent International Congress held in London, Dr. Keith is said to have stated that he had discontinued the use of the spray. I have not been able to find a report of his statement, but I can quite imagine that the amount of carbolic acid poured into the peritoneum by the spray in a prolonged operation would be injurious both from rendering the patient liable to carbolic acid poisoning, and also from causing an increased amount of fluid in the peritoneal cavity, which, where the details of the aseptic method were not thoroughly carried out, would be liable to undergo putrefaction. Though Dr. Keith has given up the spray, I have not heard that he has given up the practice of aseptic surgery. (See Chapter XVIII. for remarks on ovariectomy.)

Salicylic acid, which was introduced by Professor Thiersch<sup>1</sup> as a substitute for carbolic acid, has been employed in various hospitals, but the results do not seem to be so good as those with carbolic acid. The following is a specimen of Thiersch's earlier results:—

From April 1st, 1874, to May 31st, 1875, 109 cases were treated with salicylic acid dressings, and 51 with carbolic acid. Of the former 7 died, of the latter 2. Among the 109 salicylic acid cases were 21 major amputations, with 5 deaths; also a number of resections, compound fractures, abscesses, excisions of tumours, &c. The deaths among the cases treated with salicylic acid were due to the following causes: In one case from hæmorrhage from the intestine 100 days after primary amputation of one leg and secondary amputation through the other femur; in one case from hydrothorax 123 days after primary amputation of the leg; one patient died on the twenty-third day after amputation of the thigh, pus being found in the shoulder-joint; a case of amputation of the thigh died from exhaustion twenty-eight days later; one case of excision of the head of the femur died from uræmia twenty-five days after the operation; one resection of the wrist-joint, followed by amputation of the fore-arm, died 201 days after the first operation from exhaustion. One of the deaths in the cases treated by carbolic acid was from pyæmia.

Erysipelas attacked the salicylic acid cases seven times, and in one instance proved fatal.

The general description of the course of these cases is not so good as that of cases treated with carbolic acid, and Volkmann and others have tried salicylic acid, but have not found it so trustworthy as carbolic acid.

Thymol, though at first much praised,<sup>2</sup> also soon failed to give satisfaction. The explanation of this probably was that in the first instance the thymol was used in wards free from infective diseases, and therefore good results were at first obtained. But these wards had a great tendency to become unhealthy on account of the bad hygienic conditions, and the

<sup>1</sup> 'Klinische Ergebnisse der Lister'schen Wundbehandlung und über den Ersatz der Carbolsäure durch Salicylsäure'—*Volkman's Sammlung*, Nos. 84 and 85, 1875.

<sup>2</sup> *Ueber das Thymol und seine Benutzung bei der antiseptischen Behandlung der Wunden*, von Hans Ranke, *Volkman's Sammlung*, No. 128.

thymol was unable to prevent this in the same way as carbolic acid had done. Thus bad results were very soon obtained, and carbolic acid had to be reinstated.

Here is another strong argument against the idea that cleanliness alone is a sufficient safeguard. In this instance there was of course the same amount of cleanliness when thymol was used as when carbolic acid was employed, but a powerful antiseptic was required in addition to the cleanliness, and, as the experience before the introduction of Listerism into these wards had shown, it was necessary to use this antiseptic on aseptic principles in order to attain the desired object.

#### THE RELATION OF OTHER FORMS OF ANTISEPTIC SURGERY TO INFECTIVE DISEASES.

I have found the greatest difficulty in getting records of any value as to the results of treatment with antiseptics not employed aseptically. I have described Bilguer's method and results (see p. 302), and these may be taken as a very fair specimen of the results obtainable by treatment with antiseptics alone, though it must be observed that in many instances his cases were no doubt treated aseptically. I have also, at p. 401, referred to Reyher's paper giving details of the different results obtained by aseptic treatment and treatment with antiseptics, and this is perhaps one of the best contrasts which could be given. Several of the results which have been published as having been obtained by strict aseptic treatment are in reality nothing of the kind, but are merely the results of treatment by antiseptics and they might very fairly be used as such. And it would be seen from these that though infective diseases are often much diminished in frequency, yet they are by no means entirely abolished. Indeed, the rapid manner in which carbolic acid began to fall out of use before Mr. Lister published, shows that it was found to be inefficient when used as an antiseptic only and not aseptically. I believe that, employed as an antiseptic only, carbolic acid is inferior to various other substances, for it combines with albumen, and in doing so apparently loses in part its antiseptic virtues (see p. 260); and therefore, in order to be efficient, it would require to be added to the discharges of the wound in large quantities. At the same time its in-

efficiency is increased, because carbolic acid is very irritating, and causes an increased amount of discharge liable to undergo fermentation. And also, as Hack<sup>1</sup> has shown, wounds treated with carbolic acid have greater absorbing power than those treated with other substances.

The best comparison between aseptic treatment and treatment with antiseptics is that furnished by Mr. Lister's own results (see p. 376). The cases which were not treated aseptically were, as far as possible, treated with antiseptics. They were frequently syringed with antiseptic lotions and dressed with antiseptic ointments and dressings, and yet it will be seen, that the proportion of deaths avoidable by methods of wound treatment, and especially of deaths from blood-poisoning, was much greater than in the aseptic cases, although the nature of the injuries was much less severe.

At p. 348 I have referred to the results obtained by the use of alcohol in Nélaton's practice, and I stated that in Chedevergne's paper<sup>2</sup> mention is made of 48 cases treated in this way, of which only 1 died of pyæmia.

The cases were, however, not very severe. Thus, there was 1 case of tumour of the lower jaw; 3 cases of epithelioma of the lip; 10 partial excisions of the mamma; 2 amputations of the leg; 5 cases of removal of fatty tumours, and a number of isolated minor operations. There were also 2 cases of wound of the knee-joint and 1 of the elbow-joint, all of which recovered. No details of these cases are given.

Rochard<sup>3</sup> extends these statistics, and states that 97 patients had been treated in this way, and that among these there had only been 2 cases of pyæmia and 5 of erysipelas.

Chedevergne states with reference to the first part of these statistics that the results obtained were not merely accidental, for two cases which had not been treated with alcohol died of pyæmia. He attributes the fatal case from pyæmia, mentioned in his paper, to imperfect application of the dressing, pus having been allowed to accumulate in the wound.

<sup>1</sup> *Ueber das Resorptionsvermögen granulirender Flächen*, Leipzig, 1879.

<sup>2</sup> 'Du traitement des plaies chirurgicales et traumatiques par les pansements à l'alcool,' *Bulletin général de thérapeutique*, vol. 67, 1864.

<sup>3</sup> *Histoire de la Chirurgie Française au XIX<sup>e</sup> Siècle*, Paris, 1875.

In London most excellent results have been obtained by Mr. Hutchinson by the use of a spirit and lead lotion (see p. 269); and in his speech at St. Thomas's Hospital, at the debate on antiseptic surgery,<sup>1</sup> he referred to his results, and stated that they were as good as those obtained by a colleague who practised aseptic surgery, but he added that he himself had abstained from operations which involved peculiar risk.

There can be no doubt of the excellence of alcohol as a dressing, and the good results are to some extent explained by Hack's<sup>2</sup> experiments, which show that absorption takes place with the greatest difficulty from wounds treated with alcohol. No doubt, also, as Mr. Hutchinson uses it, many of the cases are treated aseptically.

With regard to these and other results from the use of antiseptics, I cannot give any tables; for few surgeons have employed one antiseptic or one particular method of applying them, and in London more especially, where almost every surgeon uses one or other form of antiseptic treatment, the results from the various methods of treatment are grouped together, and are thus almost absolutely useless for the point at issue.

Among the best of these mixed results—results obtained no doubt in the main by the use of antiseptics—are the cases of major amputations performed at St. Bartholomew's Hospital for the last ten years (1870-79).<sup>3</sup> There were 467 major amputations, of which 71, or 15.2 per cent., died. These results include, however, the practice of two surgeons who treated their cases in the main aseptically.

We have already seen in the historical part that the various methods of occlusion, acting on the principle of excluding the gases of the air, have failed to exclude infective diseases. I need only refer to Jules Guérin's experience during the siege of Paris, p. 325, and to his refusal to apply his method in a particular hospital because the atmosphere was '*aussi profondément infecté.*'

The only method of occlusion which has been of permanent

<sup>1</sup> See MacCormac's *Antiseptic Surgery*.

<sup>2</sup> *Loc. cit.*

<sup>3</sup> *St. Bartholomew's Hospital Reports*, 1880.

service is Alphonse Guérin's 'Pansement ouaté' (see pp. 280 and 325). As we have seen, marked improvement followed its introduction during the siege of Paris, and good results are still obtained in some of the less healthy Paris hospitals. This method no doubt acts mainly by keeping the layer of granulations at perfect rest, and thus avoiding its laceration and the consequent passage of the putrid material—that 'terrible poison,' as Mr. Savory has called it—into the blood. However good its results may have been in some cases, I cannot think that a method of treatment in which fluids, undergoing decomposition to a greater or less extent, are retained in contact with the surface of the wound, and in which the patient is only protected from the effects of the absorption of these fluids by maintaining the parts at perfect rest, is one which can be recommended when better means are obtainable.

The method which perhaps stands next to the aseptic method in its power of preventing infective disease is treatment by irrigation or the water-bath. Here also definite statistics fail, but I may refer to Langenbeck's statement (see p. 344), made in 1855, to the effect that during the preceding five or six years no case of pyæmia had occurred among the cases treated by the continuous water-bath. No results are given as to the other infective diseases, but from what I know and have seen of this method, I should think that where the water is frequently changed, especially if an antiseptic is added to it, and where the wound is not complicated, and there is no retention of discharges, these diseases would be more or less completely absent. Langenbeck mentions that during the five years to which I have just referred, in which he had no case of pyæmia among the cases treated by the water-bath, pyæmia was, nevertheless, prevalent in other wards, and attacked cases treated in other ways in the same wards.

I referred, also, on p. 345, to Valette's success. He employed antiseptics to a much greater extent than Langenbeck.

I now come to the consideration of the results obtained by the use of the open method.

I have already mentioned (p. 332) Bartscher and Vezin's results. They had 28 cases of amputation (26 of these being

major amputations), with 3 deaths. The causes of death are not given.

I have also mentioned (p. 333), Burow's results up till 1866. He had 94 amputations (87 of these being major operations), with 5 deaths. The causes of death are not stated. In a later paper (1877), Burow (junior),<sup>1</sup> gives the results of all the amputations performed up to that time by his father and himself. Since 1866, 29 major amputations had been performed with 4 deaths, thus giving a total of 123 amputations with 9 deaths, or more properly 116 major amputations with 9 deaths, or a mortality of 7.7 per cent. Of the 4 last deaths 2 were due to gangrene of the stump and 2 to pyæmia. How many, if any, of the other deaths were due to septic causes we do not know.

The following is the detailed list:—

	Cases	Deaths
Amputations through thigh . . . . .	33	6*
"    "    leg . . . . .	25	3
"    "    humerus . . . . .	25	0
"    "    fore-arm . . . . .	29	0
"    of foot . . . . .	9	0
Partial of hand . . . . .	2	0
Total . . . . .	123	9

\* 2 certainly from pyæmia.

These results are certainly remarkably good. The cases extended over a period of something like forty years, and were treated in a small hospital composed of four rooms containing altogether sixteen beds. These rooms were small and the quantity of air for each patient was not very great. A number of operations other than amputations were also performed. Thus, during the last ten years given in the paper to which I refer (1866-76), there were treated, besides the 26 amputations, 53 excisions of the mamma, 30 cases of fistula in ano, 4 amputations of the penis, 14 excisions of large tumours, 5 excisions of the upper jaw, 8 excisions of the lower jaw, 6 herniotomies, 6 tracheotomies, 5 lithotomies, &c. Thus the conditions were not so favourable as might at first sight be supposed. We are not told what the results were in these latter cases, either as to the occurrence of infective disease or otherwise. Burow

<sup>1</sup> *Archiv für klinische Chirurgie.*

took the most scrupulous precautions as to cleanliness, more especially of hands and instruments; for example, he never employed sponges which had been used before. Then in many of his cases, notably in the excisions of the mamma, he used acetate of alumina—a very powerful antiseptic—and he specially praises its property of keeping down smell.

Much more important facts are published by Krönlein<sup>1</sup> in his report of the results of the open treatment at Zürich from 1867–71. The method employed was chiefly that of Bartscher and Vezin, but it was combined with frequent irrigation of the wound with antiseptic solutions, so that we have here, not the open method pure and simple, but a combination of it with irrigation and treatment by antiseptics.

Krönlein gives details of the cases of amputation, excision of the mamma and compound fracture conservatively treated, and contrasts the results obtained between 1867 and 1871 with those of the previous 7 years (1860–67). During these 7 years all sorts of methods of treatment were employed. In some cases the edges of the wound were brought together by strips of plaster or by stitches, and covered with compresses and bandages; in others the wound was left open for several hours, &c.

Krönlein discusses from various points of view the causes of the difference in the results in the two periods, and at length comes to the conclusion that it is in the main owing to the different methods of treatment employed. I need not enter into all his arguments: I quite agree with his conclusion.

During the first period (1860–67), 260 important cases were treated, and of these 105 died. These cases included 140 amputations, 34 excisions of the mamma, and 86 compound fractures treated conservatively. Of the 105 deaths 59 occurred from pyæmia and septicæmia alone.

During the second period (1867–71), 172 similar cases were treated with 34 deaths. These consisted of 85 amputations, 22 excisions of the mamma, and 65 compound fractures. Of the 34 deaths 12 were from pyæmia and septicæmia alone. I may just quote his tables:—

<sup>1</sup> *Die offene Wundbehandlung.* Zürich, 1872.

*Amputations.*

1860–67.			
	Cases	Deaths	From pyæmia and septicæmia
Thigh . . . . .	36	31	16
Leg . . . . .	36	21	12
Humerus . . . . .	18	10	8
Fore-arm . . . . .	24	4	2
Hand . . . . .	9	—	—
Foot . . . . .	17	6	4
Total . . . . .	140	72*	42†

\* Or a mortality of 51·4 p. c.

† Or 30 p. c.

1867–71.			
	Cases	Deaths	From pyæmia and septicæmia
Thigh . . . . .	28	10	2
Leg . . . . .	11	2	1
Humerus . . . . .	14	2	2
Fore-arm . . . . .	10	—	—
Hand . . . . .	7	—	—
Foot . . . . .	15	3	1
Total . . . . .	85	17*	6†

\* Or a mortality of 20 p. c.

† Or 7 p. c.

*Excisions of the Mamma.*

1860–67.		
Cases	Deaths	From pyæmia and septicæmia
34	11*	4†

\* Or a mortality of 32·3 p. c. † 11·7 p. c.

1867–71.		
Cases	Deaths	From pyæmia and septicæmia
22	3*	1†

\* Or a mortality of 13·6 p. c. † 4·5 p. c.

*Compound Fractures treated conservatively to the end.*

1860–67.			
	Cases	Deaths	From pyæmia and septicæmia
Thigh . . . . .	7	2	0
Leg . . . . .	62	13	7
Humerus . . . . .	7	3	3
Fore-arm . . . . .	10	4	3
Total . . . . .	86	22*	13†

\* Or a mortality of 25·5 p. c. † 15·1 p. c.