

about the last 60 cases, that the fracture and wound behaved as if they were subcutaneous, there was no suppuration nor gangrene of the tissues, but, on the contrary, rapid healing. As a rule, also, necrosis did not occur, though in one or two cases small detached fragments, which had been left at first, were picked out of the wound afterwards. Volkmann describes the course of the cases as follows: 'Gleich von Anfang an tritt keine örtliche Reaction, keine Jauchung, kein Wund-reinigungsstadium auf; das Markgewebe verjaucht nicht in der Umgebung der Bruchspalte; die geöffnete Markhöhle und das blossgelegte spongiöse Gewebe werden sofort wieder durch Blutcoagula verdeckt und abgeschlossen, die so lange liegen bleiben, bis sie durch organisirte Gewebswucherungen ersetzt sind. Es entstehen keine fissuralen (Bruchspalten-) Eiterungen, keine inter-musculären, subperiostealen und parossalen Phlegmonen, keine Eitersenkungen und Eiter-retentionen, keine grösseren Necrosen. Die antiseptische Methode gestattet die Heilung der complicirten Fracturen gewissermassen unter dem feuchten Schorf.' In only three cases did Volkmann fail to eradicate the causes of fermentation.

Max Schede has also treated a number of compound fractures aseptically. There were 37 cases admitted soon after the infliction of the injuries, and only 1 did badly, and that case is said to have suffered in the first few days from fatty embolism and delirium tremens. No patient died. In 4 cases intermediate amputation was necessary, thrice on account of gangrene due to the direct violence of the injury, and once on account of gangrene in the case just alluded to, where the patient moved the limb violently and tore the posterior tibial artery, the anterior tibial having been destroyed by the injury. All these cases were the result of direct violence.

Taken along with Volkmann's 73 cases we have a total of 110 cases treated, in the first instance conservatively, without a death. Of these, 12 required secondary amputation and 5 secondary excision, leaving 93 which recovered without further interference.

Max Schede adds the following interesting facts:—Seven cases came under treatment between the second and the sixteenth day after the injury; these cannot of course be in-

cluded in the same category as those which came under treatment within a few hours after the accident. Of these, 2 died—1 admitted on the ninth day with tetanus and 1 admitted on the sixteenth day with extensive suppuration; 1 underwent secondary amputation, and 4 were treated conservatively. As I have previously pointed out, these cases illustrate the result of treatment by antiseptics, because it is hardly possible to render such a wound aseptic so long after the injury.

Before leaving Volkmann's results I shall refer to the compound fractures made by himself. He has produced 71 compound fractures on 59 patients. One of these cases died. This occurred in the case of a bleeder who died of anæmia about twenty-four hours after the operation—a case of excision of the knee for ankylosis. Leaving out of consideration, then, according to Mr. Holmes' rule, this case which died within forty-eight hours, we have 58 patients on whom compound fractures were produced without any fatal result. After the 70 compound fractures which we have to consider, secondary amputation was only necessary twice; in 1 case a central enchondroma in the tibia was found to be the cause of the deformity, and the limb was therefore amputated; in the other case there was very severe genu valgum in consequence of arthritis deformans, but the exact reason for amputation is not given. As to the bones affected, we have mention of 16 compound fractures produced on the femur and 45 on the bones of the leg. The other operations were for ununited or badly united fractures, but the bones affected are not mentioned.

In comparison with these results Volkmann says, that the journals of the surgical wards at Halle for former years contain notes of 11 compound fractures of the thigh, of which 6 died, and of 64 compound fractures of the leg, of which 26 died. The proportion of cases which required secondary amputation is not mentioned, but it is stated that many of the injuries were very simple and the result of indirect violence.

During the year 1878–79 Bardenheuer, operating aseptically, made 28 compound fractures on healthy bones without bad result. He also performed 53 resections—15 of the hip and 12 of the knee-joints—without a death.

MacCormac gives the results of the aseptic practice in

St. Thomas's Hospital. There were 16 cases of compound fracture treated (2 of the femur, 3 of the upper extremity, and 11 of the tibia) without a death, and in only one instance was secondary amputation necessary. He contrasts these results with those obtained in the former six years during which 54 cases of compound fracture were not treated aseptically, and of these 12 died (4 from pyæmia and 4 from erysipelas); one case required secondary amputation on account of gangrene; and in several there was suppuration or erysipelas and a protracted recovery.

MacCormac also referred to 45 compound fractures made by the surgeon (since the address the number has risen to 57), without a death. Thirty of these involved the knee-joint, and though the wound in the soft parts was comparatively small, yet it was 'quite large enough in many instances to allow serious inflammation and putrefactive changes to take place in it.' In no single instance did any serious result follow.

If, now, we sum up the facts already obtained and, following Mr. Holmes' suggestion, exclude all cases of primary amputation, and of death within forty-eight hours after the injury, we get the following remarkable results:—

I. Accidental Compound Fractures.

Adding together the results of Lister, Volkmann, Schede, and MacCormac, we find that there were 164 cases of compound fracture treated conservatively, in which an attempt was made to purify the wound,¹ and of these 2 died, giving a mortality, after accidental compound fractures, of 1.2 per cent. But then one death certainly, and the other probably, was independent of the injury. Among these are included a few cases of compound fracture of the skull, but if we take limbs alone, we find that 158 limbs were affected with compound fracture, and among these secondary amputation was performed in 15 cases and secondary excision in 5, leaving 138 limbs which were cured without operative interference.

¹ The numbers would be larger now, see note on p. 506.

II. Intentional Compound Fractures.

Adding together the results of Lister, Volkmann, MacEwen, Bardenheuer and MacCormac, we have 530 patients affected with 1,072 compound fractures, and of these only 3 died, giving a mortality of .56 per cent., the causes of death being in each case quite independent of the operation. Looking at the results to the limbs, we find that 766 limbs had 1,068 compound fractures, and that among these secondary amputation was only necessary in 4 instances, or .51 per cent.

Adding together the cases of accidental and intentional compound fractures, we find that 694 patients were affected with 1,239 compound fractures treated aseptically, and of these 5, or .72 per cent., died.

Or looking at the results as regards the limbs, we find that 924 limbs were affected with 1,226 compound fractures, and of these 902 recovered without further operation, while 19 required secondary amputation and 5 required secondary excision.

In contrast with these results we have the following facts:—

Volkmann and Fränckel¹ found a record of 885 compound fractures of the leg in the reports of the German and English hospitals, and, of these, 339, or 38.5 per cent., died. In the above 694 cases treated aseptically, I have not been able to give the exact numbers as regards the bones affected, but by far the greatest number of bones injured were those of the lower extremity, the injuries of the thigh and leg being about equal in frequency, the femur being perhaps most often affected. However, as the mortality after compound fracture of the femur is greater under ordinary circumstances than the mortality after compound fracture of the bones of the leg, the comparative value of these statistics is increased.

		p. c.	after compound fracture of the leg.
Baum in Göttingen ²	lost 38		
Billroth in Zürich ²	38.7	"	"
In Breslau ²	40.5	"	"
In Halle ²	40.6	"	"
In Bonn ²	41.8	"	"

¹ Volkmann's *Sammlung*, 117-118.

² *Ibid.*

Mr. Holmes¹ states that in St. George's Hospital, from 1865 till 1878 inclusive, after excluding cases of primary amputation and deaths within forty-eight hours, there were treated by the ordinary methods 162 cases of compound fracture of the leg, of which 40, or 24·6 per cent., died. A considerable proportion of these cases was treated during a period in which cleanliness, good ventilation, &c., were greatly in vogue, and by surgeons who were much impressed with their necessity. Among these 40 deaths were 21 from pyæmia alone, and several of the remaining deaths were due to other septic diseases.

I have previously, at p. 510, given the results in St. Thomas's Hospital, the mortality there being 22·2 per cent.

These records correspond with the expressed views of surgeons of all ages as to the dangers of compound fractures produced accidentally or of operations in which compound fractures are made. On the other hand we have also the generally acknowledged fact that *subcutaneous* osteotomies are practically free from danger, and the subcutaneous method is, as we have previously seen, a form of aseptic treatment. The foregoing facts show that it is not necessary to have recourse to subcutaneous operations to ensure safety, but that the Listerian method is equally, if not more efficacious, while the free access to the bone is in many cases a great advantage, indeed in some an absolute necessity.

I must now again refer to Carl Reyher's results in the Russo-Turkish war (see p. 401, *et seq.*) During this war he treated 22 cases of compound fracture of the extremities aseptically (by 'primary antiseptics,' as he terms it), and of these 4 or 18 p.c. died, secondary amputation being only necessary in one instance. The following list shows the cases and the results:—

Part injured	No. of cases	Died	Secondary amputation	Healed with retention of limb
Humerus	4	—	—	4
Fore-arm	3	1	—	2
Thigh	3	3	1	—
Leg	12	—	—	12
Total	22	4	1	18*

*Or 81·8 p. c.

¹ *St. George's Hospital Reports*, vol. ix.

During the same time he had 62 fractures of the long bones treated with antiseptics or, as he calls it, with 'secondary antiseptics,' and of these 23, or 35·3 p.c., died. The following is the table:

Part injured	No. of cases	Died	Secondary amputation	Healed with retention of limb
Humerus	12	5	3	5
Fore-arm	3	—	—	3
Thigh	25	13	5	12
Leg	22	5	2	17
Total	62	23	10	37*

*Or 69·6 p. c.

He also refers to 27 similar fractures not treated antiseptically at all, but he gives no details of them, and only states that up to the time of writing 8 had died of pyæmia.

The following are the fatal cases where aseptic treatment was attempted:—

One compound fracture of the thigh died of fatty embolism; it is not mentioned how long after the injury the patient died: in this case the femur was completely shattered throughout its whole extent, the wound of entrance being near the pubis. One compound fracture of the thigh died from exhaustion, the result of profuse suppuration. One compound fracture of the thigh died from septic suppuration. One compound fracture of the forearm—a shell injury—died of pyæmia.

With regard to these cases I need merely point out the extreme difficulty of thoroughly disinfecting the wound and of removing all portions of clothing from the wound. Reyher refers to this point, and it seems that in 3 of the 4 fatal cases in which the aseptic method was tried, disinfection was not successful. This is of course only what might be expected. There is nothing magical about the injection of an antiseptic into wounds, and unless the fluid reaches all the recesses of the wound, and destroys all the causes of fermentation which have been introduced into it, the wound cannot be expected to follow an aseptic course; it is not an aseptic but a septic wound, and the consequences of such a wound will be those of a septic not of an aseptic one.

In considering the results of other forms of antiseptic treatment, the only detailed account to which I can refer is Krönlein's report of the results of the open method in Zürich (see p. 410). Krönlein states that between 1860 and 1867, 160 cases of compound fracture were treated, and of these 67 died; 86 of them being treated conservatively with 21 deaths. Between 1867 and 1871, 102 compound fractures were treated, of which 27 died; 65 of these being treated conservatively with 14 deaths.

Though Krönlein tells us the number of cases amputated, and the number treated conservatively to the end, he does not tell us the number of primary and secondary amputations. Now, of course, in considering the results of compound fractures, we must divide them into those amputated primarily, and those in which conservative treatment was tried; the latter group being subdivided into those which required secondary amputation and those which were treated conservatively to the end. Of course the cases treated conservatively to the end are the most favourable class, because they did not require secondary operation. But in judging of the success of conservative treatment, it is necessary to know in what proportion of cases that treatment failed and secondary operation was required. Now it is only of the former—the successful cases—that Krönlein gives us information. With the view of getting a correct impression on this point, I have gone over his statements, and the following are the facts, so far as I have been able to gather them.

Of the 160 cases treated between 1860–67, 38 were amputated primarily, with 19 deaths; 21 were amputated secondarily with 17 deaths; and 15 were amputated, but whether primarily or secondarily, I have not been able to ascertain; of these 9 died. 86 were treated to the end conservatively with 22 deaths. Now according to our rule the primary cases are omitted. As to the 15 amputations with 9 deaths, I don't know what they are, and therefore we shall put them in a group by themselves. This leaves us with 107 cases in which we are certain that conservative treatment was attempted, and of these 39, or 30·4 per cent., died. The result then, so far as we know it, is—

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No. of cases	Deaths	Secondary amputation	Recovered without mutilation
107 (certain)	39	21 (certain)	64 (or 59·8 p. c.)

Looking at the results of the open method from 1867 to 1871, we find that 102 cases in all were admitted, and of these 27 died. Of these 19 were amputated primarily with 5 deaths; 9 were amputated secondarily with 4 deaths; 9 were amputated, but whether primarily or secondarily I do not know, with 4 deaths; 65 were treated conservatively to the end with 14 deaths. Treating these cases like the former, we may say that 74 cases were certainly treated conservatively, and of these 18, or 24·3 per cent., died. Thus—

No. of cases	Deaths	Secondary amputation	Recovered without mutilation
74 (certain)	18	9 (certain)	51 (or 68·9 p. c.)

It is to be remembered in both cases that some of the doubtful amputations were probably secondary, so that these results are the most favourable. I may give further details of the cases which we know about according to the limbs affected.

Cases treated Conservatively.

(1860–67.)

Part affected	No. of cases	Percentage of cases treated conservatively	Deaths	Secondary amputations	Recovered without mutilation
Femur . . .	8	61·5	3	1	5
Leg . . .	77	81	26	15	49
Humerus . .	9	47·3	4	2	4
Fore-arm . .	13	39·3	6	3	6
Total . . .	107	66·8	39	21	64

Cases treated Conservatively.

(OPEN METHOD 1867–71.)

Part affected	No. of cases	Percentage of cases treated conservatively	Deaths	Secondary amputation	Recovered without mutilation
Femur . . .	12	70·5	3	1	9
Leg . . .	38	84·4	12	7	22
Humerus . .	14	51·3	2	1	11
Fore-arm . .	10	62·5	1	—	9
Total . . .	74	69·1	18	9	51

It will thus be seen that some improvement followed the introduction of the open method, but this in no way corresponds to that effected by the aseptic method.

The causes of death are not given, but of the 39 deaths of the first period, at least 27 were from pyæmia and septicæmia (14 of the cases treated to the end conservatively and 13 of the secondary amputations). Of the 18 deaths of the second period at least 8 were from pyæmia and septicæmia (5 of the cases treated conservatively and 3 of those amputated secondarily). As I have said, this is the most favourable statement possible, and it does not include those which died of other septic diseases.

I do not find any facts of statistical value, with regard to the results with other forms of antiseptic treatment, but the good results of irrigation and the water bath and of crust formation are well known, and have already been alluded to in the history of the subject. The whole tendency of the facts published in recent times is, however, to show that success increases according as the method adopted fulfils more and more the requirements of the aseptic principle; and the same is evident if we look at the history of the subject and see the successes obtained by the use of balsams, of crust formation, of irrigation and the water bath, and of subcutaneous surgery.

CHAPTER XX.

RESULTS OF ANTISEPTIC SURGERY—(*continued*).

Abscesses connected with disease of the vertebræ. Best situation for opening psoas abscesses: best time for opening them: after-treatment and after-progress. Table of Mr. Lister's results: general summary and remarks on these cases. Comparative statistics are wanting. Sir James Paget's views.

BEFORE discussing these results, I think that it will be most convenient to consider the last group of cases to which I intend to refer, viz. cases of abscesses connected with disease of the vertebræ. The cases which I give here were treated by Mr. Lister between the end of 1871 and 1879; and I will mention all the cases which occurred during that period. I have been careful to take only those abscesses which were unmistakably connected with disease of the vertebræ, as indicated by curvature, by the history of the case and the symptoms present, and, in several instances, by the presence of pieces of bone in the pus. Of course this list, like the others, does not represent all the cases which Mr. Lister has ever treated aseptically, for he had several cases under his care before this period, and both before and during it, he has treated a number of similar abscesses in private practice. Here, as in other instances, his results have been better in private practice than in hospital, because the cases were attended to either by himself or by skilled assistants, while in hospital it was often necessary to leave the changing of the dressings to students.

In the treatment of these abscesses the general principles of aseptic surgery are carried out in the manner before described, and I need not recapitulate the points here. I must, however, say a few words as to the best situation for opening psoas abscesses. An abscess which has passed into the thigh,