method is employed. If we search the surgical text-books we find that there is throughout a fear of such operations or injuries. Thus, Mr. Spence, in his 'Lectures on Surgery,' says,[1] 'There is no class of operations that I have a greater dread of than the apparently simple one of removing a loose cartilage.'

I have no statistics of septic cases, comparable to the aseptic ones, in which wounds of joints have been kept open for some days; but, as will be seen in the history of this subject, experience has up till recently led surgeons to the conclusion that the safety of the limb and of the patient depends on rapid healing of the wound. And yet, as all the facts quoted show, these operations, when aseptically performed, are really devoid of danger. Sir James Paget says:[2] 'I cannot doubt that operations of this kind' (referring to incisions of joints with closure of the wound), 'which, in the earlier years of my work, were done with great risk, or, with a wise fear of the risk, were left undone, may now, with antiseptic help, be done with an almost complete safety.'

[1] See leading article in *British Medical Journal*, April 1880.
[2] MacCormac's *Antiseptic Surgery*.

CHAPTER XIX.

RESULTS OF ANTISEPTIC SURGERY (*continued*).

Compound fractures. Differences between those produced accidentally and those caused by the surgeon: treatment and after-progress of each class. Tables of accidental compound fractures treated by Mr. Lister: *thigh; leg; humerus; forearm; skull; summary of results.* Tables of compound fractures produced intentionally by Mr. Lister; *femur; leg; clavicle; humerus; forearm; lower jaw.* General summary of Mr. Lister's results. Mr. Spence's results. Other operations on bones by Mr. Lister. MacEwen's osteotomies: Volkmann: Max Schede: Bardenheuer: MacCormac. Combined aseptic results. Results by other methods: Volkmann and Fraenckel: Holmes: St. Thomas's Hospital. Reyher's results in war. Open method: Krönlein. Septic methods.

I NOW pass on to a second class of cases which are often followed by most serious consequences: I refer to compound fractures occurring accidentally or made by the surgeon.

Compound fractures produced accidentally and those made by the surgeon differ from each other in various important particulars. In the first class dust is as a rule introduced into the wound before the surgeon sees the case, and, therefore, the problem is to destroy the energy of this dust. Whether such an attempt is successful or not, must of course always be a matter of doubt; and hence the results are uncertain. Then, also, the violence is often very severe and complicated with other injuries or with shock, and in this way life may be lost from causes which could not be avoided by any method of wound treatment. On the other hand, in the second class of cases the surgeon has only the ordinary aseptic problem before him, and if he is justified in other cases in looking with certainty for good results, he ought to be equally justified here. He is also independent of the other injuries and shock which so often complicate accidental compound fractures, and, therefore, the mortality ought also to be less. If we remember

these differences, we shall be able to form a just estimate of the value of the results.

The aseptic course in these cases corresponds to that described in Chapter XVIII.; and I need only indicate one or two points in the treatment and after-progress of the injury.

The treatment of compound fractures the result of accident has been already described at pp. 113 and 114. It consists in washing out the wounds thoroughly with a strong antiseptic lotion, generally the 1–20 watery solution of carbolic acid or the 1–5 mixture of carbolic acid and methylated spirit. This is done by injecting the lotion through a catheter attached to a syringe filled with the solution, the orifice of the wound being left freely open. In this way, by moving the point of the syringe in various directions, the lotion is introduced with certainty into all the recesses of the wound, while by leaving the orifice of the wound freely open there is no risk of forcing the fluid into the cellular tissue. It is well to clear out all the clots of blood. The skin in the neighbourhood is also thoroughly washed with 1–20 carbolic lotion, the whole being done in a spray of carbolic acid. The wound is left freely open, and in most cases a drainage-tube is passed into the deeper parts and kept in for a few days. In some instances, if there is much tendency to displacement, the ends of the fragments may be tied together with strong silver wire. A large gauze dressing, enveloping the limb, is then applied, and outside it a suitable splint. This dressing is changed on the following day, and afterwards according as it is necessary. After a few days, in compound fractures of the lower extremity, when the discharge has become small in amount, some arrangement like that described at p. 107 may be employed.

The after-progress of these cases depends on whether the causes of putrefaction were destroyed or not by washing out the wound. If they were not, then the case becomes one treated with antiseptics, but not aseptically. If the causes of putrefaction were eradicated, the wound follows an 'aseptic course' (p. 421). In cases of compound fracture, more especially from direct violence, the soft parts are often much contused and lacerated, and the bones are sometimes comminuted and much injured. The ordinary result in such cases, when

aseptic treatment is not employed, is, that sloughing of the contused and lacerated tissues occurs to a greater or less extent, and very generally portions of the broken fragments of the bone become necrosed. This process is accompanied with a considerable amount of suppuration. If, however, the wound is rendered aseptic, and if the irritation of the antiseptic is excluded, this sloughing and suppuration does not occur. The wound becomes filled with blood-clot; the interstices between the fragments of lacerated tissue also become filled up; the whole remains unaltered for many days, merely assuming a greyish appearance on the surface, but after some days, on scratching this clot, it bleeds, showing that it has become vascularised, and on detaching the superficial layer the greater part, or

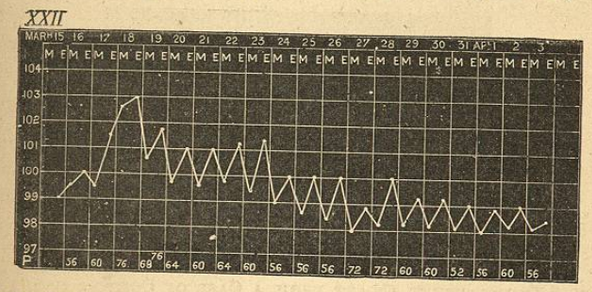

FIG. 78.—TEMPERATURE CHART FROM A CASE OF COMPOUND FRACTURE, IN WHICH THE ATTEMPT TO ERADICATE THE CAUSES OF FERMENTATION WAS UNSUCCESSFUL, AND WHICH THEREFORE BECAME A SEPTIC CASE (CASE 26, p. 472).

indeed the whole of the wound, will be found to have become covered with epithelium. (This process will be more minutely discussed hereafter.) There is no suppuration at all from the wound, and no separation either of dead skin or tissue, or of dead bone. If, however, no protective be used, or the wound be deluged with strong carbolic acid, the superficial layer of the clot becomes irritated, and when vascularised, granulates, and suppuration occurs from its surface; at the same time, the portions of dead tissue being impregnated with carbolic acid, become irritating, cause granulation and suppuration where they are in contact with the living parts, and are thus separated as sloughs. The sloughing in this instance, however, is not as a rule nearly so extensive as in the case of a septic wound.

The constitutional condition also depends in the main on the success or failure of the attempt to render the wound aseptic. If the attempt fails, the temperature is generally high, as in other septic cases (see fig. 78); if, on the other hand, it is successful, the temperature generally remains normal or nearly so, though it may be high for a few hours after the injury (see fig. 79). (I shall not go into this matter further at present, as I intend to discuss it more fully in a future chapter.) The general well-being of the patient also closely corresponds to the septic or aseptic state of the wounds; if the wound is septic and the temperature high, the patient generally feels ill, and has other symptoms of fever; if, however, the wound is

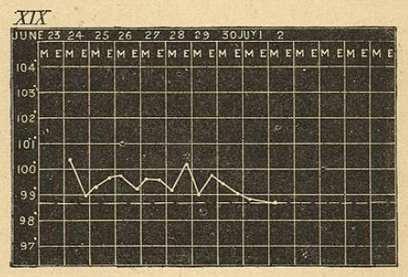

FIG. 79.—TEMPERATURE CHART FROM A CASE OF COMPOUND FRACTURE WHICH FOLLOWED AN ASEPTIC COURSE (CASE 23, p. 472).

rendered aseptic the patient feels practically in a normal state of health.

In the case of compound fractures made by the surgeon, the progress of the wound and the constitutional state of the patient are similar to those described as typical of operations on joints (p. 421); and I need not repeat what I said there. In performing these operations a free incision is made down to the bone with the various aseptic precautions; the bone is chiselled or sawn across, or a portion of bone is removed according to circumstances; the bleeding vessels are secured; a drainage-tube is introduced down to the bone; as a rule, no stitches are inserted; and the dressing is applied according to the ordinary rules previously described. In a few hours the wound is filled with blood-clot, which becomes vascularised and organ-

ised, and cicatrisation occurs beneath its superficial layer without previous granulation or suppuration. As a proof of this I may refer to the fact mentioned by Dr. MacEwen, that he had made 835 compound fractures, and that in only 8 of the wounds was there any pus formation, although none of these injuries was subcutaneous. After operations conducted in this way the general state of the patient remains normal.

In considering the results of compound fractures, it is quite clear that all cases, in whatever way they are treated, whether by primary or secondary amputation or conservatively, must be mentioned and grouped together in the first instance. For the frequency of primary amputation after compound fracture will depend not only on the great severity of the injury and destruction of tissue, but also on the dangers to which, in accordance with the experience of the surgeon in charge, the patient will be afterwards subjected. If the surgeon feels that the method of treatment which he has been accustomed to adopt in these cases is not such as to secure the patient from the after consequences, he will naturally take into frequent consideration the question of primary amputation. If, on the other hand, he has been led to expect that the dangers incident to these injuries are not likely to occur under the method of treatment which he adopts, he will perform primary amputation less frequently. Therefore, in order to judge of the results of any method of treatment in compound fractures, the number of primary amputations and the sort of injuries in which they are performed must be mentioned. With regard to secondary amputation it must be remembered that these, as well as the fatal cases, are those in which the attempt to treat conservatively has failed, and therefore it is not sufficient merely to state the results of cases treated conservatively to the end. In the following tables I have attempted to indicate, as fairly as possible, the nature of the injuries and the after-progress of the cases which have occurred in Mr. Lister's practice since 1872. In some instances the notes have been deficient, but I have tried to render them complete by tracing out these cases as far as I could.

I. Compound Fractures, the Result of Accident.

In considering these I have included *all* Mr. Lister's cases since 1871: those requiring primary amputation as well as those treated conservatively or amputated secondarily. I omit the lesser compound fractures of the hand and foot.

Compound Fractures of the Femur (accidental).

No.	Name and Age	Date of Admission and Discharge; with Result.	Injury	Treatment	Remarks
1	A case of extensive compound fracture of the femur where primary amputation was performed at the hip-joint. The patient died almost immediately. There is no record of the case in the books, but I know that it occurred.				
2	J. S., 45 . . .	*Ad.*, June 26, 1874. *Died.*, June 26, „ Cause of death was shock.	Extensive compound comminuted fracture of the femur, and severe laceration of leg	Primary amputation just below the trochanters.	Patient was unconscious when admitted, and never rallied. He died in about two hours. Cause of death was shock.
3	George P., 12 .	*Ad.*, Sept. 29, 1871. *Dis.*, Feb. 14, 1872. In process of cure.	Compound fracture of the femur from a fall. Direct violence.	Wound injected with 1-20 carbolic lotion. Opening enlarged. Drainage-tube inserted, and splints applied.	The bones had firmly united on November 14, and the patient seems to have done well. On January 19 the sinus had not yet closed, and Mr. Lister introduced a pair of sinus forceps to see if there was any loose bone. No precautions were used to disinfect the air which entered (no spray or carbolic lotion), and putrefaction seems to have followed. When the patient was discharged there was still a piece of bare bone to be felt, but he was in perfect health.
4	R. P., 17 . . . (Septic case)	*Ad.*, Nov. 15, 1872. *Died*, Dec. 14, „ Cause of death was bronchitis and cardiac disease.	Two railway trucks passed over his leg, causing a simple comminuted fracture of both bones of the leg, and a simple comminuted fracture of the thigh. The skin over the fracture of the femur sloughed, and the bone protruded on November 22. Patient was suffering from cardiac disease.	An attempt was made to keep the slough sweet, but putrefaction had already occurred, and therefore the attempt was unsuccessful.	Abscesses formed about the knee and higher up in the thigh. The notes are incomplete, but the patient is entered in the hospital books as having died of bronchitis and cardiac disease, from which he was suffering previous to admission. (This was a septic, not an aseptic, case, so that whatever was the cause of death, it does not influence the result in aseptic cases.)
5	Mrs. D., 50 .	*Ad.*, Oct. 15, 1878. *Dis.*, June 20, 1879. *Result*, healed.	Compound fracture of the femur.	See No. 9, p. 424, and No. 70.	Aseptic course. The wound healed, but the bones did not unite. (See T. Chart II, p. 438.)

There were thus five compound fractures of the femur, of which two were amputated primarily, both dying of shock; and three were treated conservatively, one of these dying of bronchitis and cardiac disease. This last was, however, a septic case, and therefore all the cases (two in number) of compound fracture of the femur treated conservatively and aseptically recovered.

Compound Fractures of the Leg (accidental).

6	William R., 12	*Ad.*, June 17, 1872. *Died*, same day. Cause of death was shock.	Compound fracture of left leg and right thigh. Skin torn off for a considerable distance. Patient in a state of collapse when admitted.	Primary amputation through the upper ⅓ of left leg and upper ½ of right thigh.	Patient never rallied, but died in two or three hours from shock.
7	A. R., 18. . .	*Ad.*, April 7, 1874. *Dis.*, Sept. 3, 1874. *Result*, cured.	Leg crushed by a beam. Severe compound comminuted fracture of the leg.	Primary amputation. (Modified Carden.)	For some time the patient suffered from carbolic poisoning, but after the carbolic dressings were left off and boracic dressings were substituted for them, he soon recovered, and the stump healed slowly.

I. Compound Fractures, the Result of Accident (*continued*).

No.	Name and Age	Date of Admission and Discharge; with Result	Injury	Treatment	Remarks
8	F. D., 22 . . .	*Ad.*, Dec. 12, 1873. *Dis.*, March 13, 1874. *Result*, cured.	Railway engine passed over leg, almost severing the foot, and producing a severe compound comminuted fracture of the leg.	Primary amputation through the calf.	Hæmorrhage occurred on several occasions in connection with a portion of the anterior flap which sloughed, but the rest of the wound did well, and the whole was quite superficial on February 1, and quite healed when the patient was discharged.
9	James B., 18 .	*Ad.*, Aug. 3, 1874. *Dis.*, Sept. 13, ,, *Result*, cured.	Railway engine passed over his ankle, crushing the bones very severely. A considerable amount of shock.	Primary amputation through the upper third of the leg. (Modified circular.)	Aseptic course (*i.e.* no local or constitutional disturbance). The wound healed by first intention except where the drainage-tubes were and at the centre of the flaps, where a little gaping occurred. The wound was absolutely healed on September 18.
10	R. H., 25. . .	*Ad.*, March 17, 1874. *Dis.*, April 27, ,, *Result*, cured.	Very severe compound fracture of both bones of the leg. Foot drawn through a port-hole of a vessel by an anchor chain.	Primary amputation just below the knee. (Modified circular.)	The line of incision healed for the most part by first intention. A slight tendency to gaping at the centre of the incision was easily overcome by the use of strapping applied aseptically. Wound was quite healed when the patient was discharged.
11	George A., 41 .	*Ad.*, July 1, 1872. *Died*, July 3, ,, Cause of death was exhaustion.	Compound comminuted fracture of both bones of the leg.	Wound enlarged and injected with 1-20 carbolic lotion. Wound left open.	Patient got gradually weaker, and, without any special symptoms, died in forty hours.
12	George S., 24 . (Septic case)	*Ad.*, March 15, 1872. *Died*, May 20, ,, Cause of death was diphtheria.	Compound comminuted fracture of both bones of the left leg. Fracture of right thigh with very severe bruising. Patient almost moribund.	Wounds washed out with 1-20 carbolic lotion. (Secondary amputation.)	Putrefaction was not avoided, and on March 17, when this was evident, amputation was performed through the middle of the thigh. This wound had almost completely healed when, on May 17, he complained of sore throat. His temperature went up; diphtheritic patches appeared on the fauces; and he died on May 20 from diphtheria. (See T. Chart XVIII.)
13	James D., 24 .	*Ad.*, Aug. 2, 1872. *Dis.*, Sept. 17, ,, *Result*, healed.	The wheel of a cab passed over the leg, causing a compound fracture. Small wound.	Wound enlarged and injected with 1-20 carbolic lotion. Wound left open.	Aseptic course. The temperature only once rose above 100° F., and then it reached 101° F., thirty-six hours after the accident. The wound had quite healed, without any suppuration, by September 7. The bones were not quite firm when the patient was discharged. He was sent out with the leg in a case of plaster of Paris.
14	Peter M., 22 (Septic case)	*Ad.*, Sept. 9, 1872. *Dis.*, Oct. 31, ,, *Result*, cured.	Severe compound comminuted fracture of both bones of the leg. Leg crushed by a heavy stone.	Washed out with 1-20 carbolic lotion. (Secondary amputation.)	Putrefaction was not avoided, and as the temperature was going up (it had reached 103°), Mr. Lister thought it better to amputate. This he did through the lower third of the femur on September 13. The stump followed a perfectly aseptic course, and healed by first intention, except where the drainage tubes were. It had completely healed on October 18.
15	Anne L., 60 .	*Ad.*, Oct. 28, 1872. *Died*, on same day. Cause of death was shock.	Compound comminuted fracture of the leg. Also fracture of the pelvis. Patient moribund when admitted.	Wound injected with 1-20 carbolic lotion.	Patient died three hours after admission. On p. m. examination extensive fractures of the sacrum and pelvis were found.

I. COMPOUND FRACTURES, THE RESULT OF ACCIDENT (*continued*).

No.	Name and Age	Date of Admission and Discharge; with Result	Injury	Treatment	Remarks
16	William K., 16	*Ad.*, March 26, 1873. *Dis.*, July 12, ,, *Result*, cured.	Compound fracture of both bones of the leg. A piece of stone fell on his leg. Admitted twenty-four hours after the accident.	Wound injected with 1-5 solution of carbolic acid in methylated spirit. Wounds enlarged. McIntyre splint applied.	Putrefaction avoided. A small abscess formed in the leg and was opened on March 31. Afterwards the wounds progressed well, and were superficial on May 16. Boracic dressing was then applied. Erysipelas attacked the wound on May 23, but it had passed off on May 30, and the wounds healed rapidly. The bones were quite firm and there were only two superficial spots to heal when the patient was discharged.
17	J. M., 32. . . (Septic case)	*Ad.*, June 16, 1873. *Dis.*, Sept. 15, ,, *Result*, cured.	The wheel of a tramway car passed over his leg, causing a compound comminuted fracture of both bones. Patient admitted immediately.	Wound injected with a solution of carbolic acid in methylated spirit, 1-5.	Putrefaction was not avoided. The wound suppurated freely, and a small piece of bone necrosed. The temperature was not regularly taken, but for twelve days it was above 100° F., ranging from 100° to 103·9°. The bones had united and the wounds had almost healed when the patient was discharged.
18	J. McA. . . .	*Ad.*, Aug. 22, 1873. *Dis.*, Dec. 18, ,, In process of cure.	A stone fell on his leg, causing a compound comminuted fracture of both bones. The patient was admitted two hours after the accident.	Some fragments of bone were removed. The wound was washed out with carbolic lotion, 1-20.	Putrefaction was avoided. There was a very little superficial 'antiseptic suppuration.' There was no inflammation or formation of abscesses. When discharged the leg was firm, but there was still a sinus leading down to bare bone. The temperature only once rose to 100°, thirty-six hours after the accident.
19	James B., 56 . (Septic case)	*Ad.*, Sept. 15, 1873. *Dis.*, March 12, 1874. In process of cure.	A van ran over his leg, causing compound fracture of both bones, two inches above the ankle-joint. Seen at once.	Wound injected with 1-20 carbolic lotion.	Putrefaction was at first avoided, but the patient, during an attack of delirium tremens, tore off the dressings, and the wound putrefied. It was henceforth treated with lint soaked in carbolic acid and glycerine. When discharged there was still a sinus leading down to bare bone, but the bones were quite firm.
20	A. R., 25 . . . (Septic case)	*Ad.*, Feb. 18, 1875. *Dis.*, Sept., ,, *Result*, cured.	Leg was run over. Severe compound comminuted fracture of both bones. Admitted two hours after the accident.	Wound injected with 1-20 carbolic lotion.	Putrefaction was not avoided. Two abscesses formed, and the wound and the abscess cavities suppurated. For six weeks the temperature varied from 100° to 103° F. Other abscesses formed, but ultimately the parts began to recover, and healing was complete at the end of September.
21	T. N., 30 . . .	*Ad.*, April 26, 1875. *Dis.*, Sept. 20, ,, *Result*, cured.	Compound fracture of tibia caused by a wooden beam falling on his leg. Upper end of lower fragment protruding. Accident happened four hours before admission.	Wound injected with 1-20 carbolic lotion.	Aseptic course. The highest temperature recorded was 99·7°. The wound had healed (exact date not given), and the bones had united when the patient was discharged.
22	Jane L., 36 . .	*Ad.*, Oct. 18, 1875. *Dis.*, March 11, 1876. In process of cure.	Compound fracture of tibia. Leg crushed by a wooden beam. Lower end of upper fragment protruding. Done four hours before admission.	Wound washed out with 1-?0 carbolic lotion.	No constitutional disturbance, but two small fragments lost their vitality, and were not removed till a few days before the patient was discharged. At that time the bones were firm, and there remained only a small superficial sore.