INFECTED WOUNDS OF THE KNEE-JOINT.

BY

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THE total number of cases which are reviewed here is 38. All were either Serbs, Russians, or Bulgars, admitted to hospital during the period August, 1916, to August, 1917. In all cases the condition was an infected wound involving the joint. Several were in the charge of my colleague, Captain L. D. Woods, R.A.M.C., surgical specialist in the hospital, to whom I wish to make my acknowledgements.

Of the total, 13 were admitted either four days or later after being wounded, 25 within the first four days.

The Influence on Results of Early Surgical Treatment.

Of the 25 cases treated within four days of the receipt of the wound—

18 recovered without amputation.
4 recovered after amputation.
3 died.

This shows a recovery of 72 per cent. without amputation. Of the 13 admitted on the fifth day or later—

4 recovered without amputation.
3 recovered after amputation.
6 died.

This shows a recovery of 30 per cent. without amputation.

The following table gives these figures, but distinguishes further between the cases with bone lesion or retained foreign body, and those of infected joint wound without these complications.

A. With Bone Lesion or Retained Foreign Body.

Early admissions (within four days):

Recovered	...	...	...	...	14
Amputation	...	...	...	...	2
Death	...	...	...	...	1

Late admissions:

Recovered	...	...	...	...	4
Amputation	...	...	...	...	2
Death	...	...	...	...	5

B. Without Bone Lesion or Retained Foreign Body.

Early admissions:

Recovered	...	...	...	...	4*
Amputation	...	...	...	...	2
Death	...	...	...	...	2*

Late admissions:

Amputation	...	...	...	...	1
Death	...	...	...	...	1†

* One case multiple wounds, death following amputation at shoulder.

† Gas gangrene of whole limb, the wound being of knee-joint.

Another point of importance showing the influence of early treatment is the recovery of function in the joint.

Of the 22 cases surviving without amputation 13 left hospital with recovery of function in the joint—that is to say, with a greater or less range of voluntary movement. I am unable to say how many of these eventually recovered with a "useful" joint, but the majority were at any rate promising. The point is of chief value in showing that the joint changes did not in these cases go on to complete destruction.

Of these 13 cases—

3 were admitted the day following the wound.
4 were admitted on the second day following the wound.
5 were admitted on the third day following the wound.
1 was admitted on the seventh day following the wound.

That it was by no means always the least complicated case which made a good functional recovery is shown by the following two histories:

Case 25.

No. 4483. Admitted December 1st, 1916. Wounded November 27th. The projectile passed through the knee-joint and fractured the femur. The joint was infected.

Operation.—Wounds excised, fragments of femur removed. Transverse incision above patella into joint. Joint washed out with saline. No drainage, no sutures.

December 7th, 1916. Wounds clean.

January 25th, 1917. Wounds healed; good movement in joint.

March 5th. Discharged to duty. Pain less and almost normal range of movement.

Case 35.

No. 7152. Wounded May 15th, 1917. Admitted May 18th, 1917. Entrance wound above outer upper quadrant of patella; wound traverses femur, comminuting the junction of shaft and

condyles; exit wound below adductor tubercle. Temperature on admission 100.4°.

Operation.—Wounds excised, loose fragments of femur removed. Joint full of pus and blood. Transverse incision above patella into joint. No drainage material used into joint; tube passed through special incision down to trigone of femur at site of fracture. No sutures.

May 24th. Apyrexia. General condition good. Wounds healthy.

May 28th. Inflammatory swelling of joint structures subsided.

July 12th. Good movement in knee-joint. Lower end of upper fragment of femur is displaced somewhat backwards.

These groups of figures indicate the urgency of operative treatment in infected knee-joint wounds, and the fair results which may be expected in cases so treated.

I am unable to give the bacteriology of the majority of the infections. I am aware that some surgeons attach much importance to this as a guide to treatment; for my own part I do not, for two reasons: firstly, that I have seen knee-joints left unopened because they were reported as staphylococcal infections, but went completely to the bad and ended in amputation; secondly, because there is no danger in opening a knee-joint if certain things be done and others left undone. Bacteriology and the cytology of the effusion are of importance in prognosis, but that they provide a reliable guide to treatment is contrary to my experience.

Operative Treatment of Early Infections.

Punctured penetrating wounds of the joint with effusion are not included in this communication. All that is required in such cases is fixation. This should be both absolute and prolonged. In early infections—that is to say, in cases in which the infection is not so established as to have disorganized the joint—the details of operative treatment are as follows:

(a) Excision of the wound, or wounds, including the capsular and synovial membrane wounds.

(b) Evacuation of effusion.

(c) Removal of foreign bodies and of detached bone fragments.

(d) Transverse incision into the joint a fingerbreadth above the patella 4 in. in length.

(e) Either (and usually) no sutures or catgut suture of the excised wounds passing through synovial membrane only. No drainage material passed into the joint.

(f) Fixation on splint, with fixed extension and elevation of the limb to an angle of 45 degrees at the hip-joint.

It is usually necessary to maintain the patency of the transverse incision into the joint by passing a pair of dressing forceps at the daily dressing for three or four days. The results shown in the cases of which details are given here appear to me to demonstrate the value of this method of operative treatment in cases in which infection is not advanced.

When the joint wound is complicated by fracture the question of a *primary* resection of the joint may be entertained if the stability of the joint is otherwise doubtful. This operation has probably a very limited utility; it is only likely to be successful in early cases in which the infection is not acute. It was not carried out in any of the cases reported here except Case 16, in which a resection was done elsewhere before admission.

Indications for Amputation.

When cases submitted to arthrotomy continue to exhibit signs of active infection on the days following operation a secondary amputation should be done; no lesser procedure is likely to be successful. Delay in amputating in such cases beyond the third day after arthrotomy is likely to be dangerous.

Case 34.

No. 7090. Admitted May 16th, 1917. Wounded May 14th. Grenade wound. Entrance to inner side of ligamentum patellae; joint distended. No exit.

Operation.—Foreign body removed from head of tibia; wounds excised; transverse incision above the patella. No drainage.

May 19th. Joint condition unsatisfactory. Three Carrel's tubes inserted, two down into lateral joint pockets, one down to wound in head of tibia.

May 24th. General and local condition worse; temperature last night 101°, pulse 120; this morning temperature 101.6°, pulse 116.

May 25th. Death.

Amputation was delayed too long in this case; during the last two days it was judged inadvisable owing to the general condition.

A secondary formal resection has been advocated in some of these cases of established infection as an alternative to amputation. It is certainly advisable to confine it to cases in which there is definite reason to believe that the infection is of a subacute type. The objections are:

- (a) The danger of uncontrollable septic osteitis.
- (b) The probable instability of the resulting "joint."

No evidence has yet been produced to show that if resection is done in these cases of established infection and the bone surfaces are separated a stable limb is likely to result.

Amputation is advisable if infection of the joint is complicated by a serious bone injury, if, for example, the condyles are shattered or a fracture extends from joint into shaft and infection is well established. Amputation is further indicated if the joint wound is complicated by injury to the femoral or popliteal artery or by section of internal or external popliteal nerves.

In the treatment of patients transferred from other units and admitted in the subacute stage, in which the joint is more or less infiltrated with septic granulation tissue and there are various operation wounds more or less providing drainage, in my opinion the choice of procedure lies between:

(a) Leaving them alone carefully splinted and only operating if some secondary collection in the thigh or leg presents itself.

(b) Amputation. This should be chosen when signs of general infection and septic intoxication persist; when secondary collections or tracks are present in the popliteal space; when it is obvious from the extent of the bone destruction that a weight-carrying limb cannot be anticipated. A large proportion of the cases with posterior collections and tracks end in secondary haemorrhage. Bone loss, which will leave crippling deformity and joint disorganization, which has resulted in falling back of the tibia from the femoral condyles, will always lead to a decision to amputate.

The cases fall into two groups—that belonging to the autumn and winter of 1916 and that belonging to the months of May, June, and July, 1917. In the earlier group the method of arthrotomy advocated above was not employed as routine; in most of them drainage tubes were placed in the joint, and in other respects the operative procedure differed from that adopted in the later group. The results obtained in the nine cases belonging to the later group were much superior to those obtained in the earlier, and this fact in my opinion is due to—

1. Operation at the earliest possible time.
2. Early removal of foreign bodies and loose bone fragments.
3. Careful wound excision.
4. Omission of drainage tubes and sutures.
5. Provision of drainage by transverse incision above the patella combined with elevation of the limb.
6. Complete fixation, with fixed extension.

Case 1.—C. 5. Admitted August 22nd, 1916. Shell wound of right knee. Removal of shell fragment; wound excision; arthrotomy. Recovery.

Case 2.—F. 8. Admitted August 23rd, 1916. Shell wound of right knee. Removal of foreign body; wound excision; arthrotomy. Recovery.

Case 3.—B. 7. Admitted August 24th, 1916. Bullet wound of left knee. Removal of bullet; wound excision; arthrotomy. Recovery.

Case 4.—B. 5, Bulgar. Admitted August 16th, 1916. Shell wound of right knee; fracture of femoral condyles; septic osteitis established. Arthrotomy; incisions. Death August 27th.

Case 5.—534. Admitted August 21st, 1916. Gunshot wound of left knee. Subacute infection. No operation on admission. Arthrotomy August 29th. Transferred convalescent October 30th.

Case 6.—1218. Admitted August 27th, 1916. Gunshot wound of left knee; fractured femur. Amputation through thigh September 1st. Death from septicaemia October 23rd.

Case 7.—2002. Admitted September 14th, 1916; wounded September 12th. Gunshot wound of right knee. Shell fragment in femur, with fracture of external condyle into joint; infected. Foreign body removed; arthrotomy; no drainage; no sutures. February 19th, 1917: Function of joint good; only slight restriction of extension. Transferred February 26th.

Case 8.—2007. Admitted September 14th, 1916. Wounded September 12th. Gunshot wound of left knee; infected. Removal of foreign body; arthrotomy. November 29th: Transferred; healed; fair movement in joint.

Case 9.—2048. Admitted September 14th, 1916. Removal of foreign body; arthrotomy. Further incisions for secondary collections September 24th and 29th. Transferred November 22nd. Convalescent; ankylosis.

Case 10.—1434. Admitted August 27th, 1916. Gunshot wound of right knee. Compound fracture of femur; infected. Wound excision, arthrotomy the same day. Incisions for secondary collections September 29th and November 6th. Amputation through the mid-thigh November 24th. Transferred February 12th, 1917.

Case 11.—1180. Admitted August 27th, 1916. Gunshot wound of left knee. Arthrotomy August 29th. Progress unsatisfactory. Death from septicaemia September 25th.

Case 12.—2250. Admitted September 20th, 1916; wounded September 17th. Infected wound of right knee; fractured patella. Wounds excised on day of admission. No drainage. Gradual subsidence. Transferred January 24th, 1917. Healed; ankylosis.

Case 13.—2253. Admitted September 20th, 1916. Gunshot wound of right knee; fractured femur. Wound excision; arthrotomy. Further incision October 23rd. Amputation November 13th. Transferred February 12th, 1917.

Case 14.—2566. Admitted September 30th, 1916; wounded September 29th. Gunshot wound of left knee; infected. Internal condyle comminuted; fractured patella. Bomb fragment passed through joint. Arthrotomy; wounds excised. January 27th, 1917. About twenty degrees of movement in joint; marked genu varum. Wounds healed. February 15th, supracondylar osteotomy to correct deformity.

Case 15.—2654. Admitted October 2nd, 1916. Gunshot wound of right knee; infected. Operated on October 6th. Removal of foreign body; arthrotomy. Subsequent operations, October 13th, 18th, and 20th. Death October 23rd from septicaemia.

Case 16.—3077. Admitted October 14th, 1916; wounded October 4th. Gunshot wound of left knee, infected, with fracture of lower end of femur. Before admission had "atypical resection" of joint; condyles removed. Admitted four days after this operation. Profound infection. Secondary haemorrhage from popliteal artery December 20th; amputation through upper third of thigh same day. Transferred March 2nd, 1917.

Case 17.—3532. Admitted October 26th, 1916. Gunshot wound of right knee; infected; subacute infection. Arthrotomy. Gradual subsidence. Recovery.

Case 18.—3566. Admitted October 30th, 1916. Gunshot wound of left knee. Removal of foreign body November 1st, and wound excision; arthrotomy. Recovery. Transferred November 20th.

Case 19.—3946. Admitted November 13th, 1916. Gunshot wound of right knee; infected. Knee-joint opened and drained. Continued infection. Amputation through mid-thigh December 19th. Transferred February 12th, 1917.

Case 20.—3950. Admitted November 13th, 1916. Gunshot wound of right knee, arm, and hand. Removal of foreign body and drainage November 18th. Incisions for drainage of secondary collections December 26th. Death from septicaemia pneumonia January 9th, 1917.

Case 21.—4341, Bulgar. Admitted November 25th, 1916. Gunshot wound of right knee; fractured patella; frostbite both feet. Operation November 26th. Removal of patella, lateral and posterior incisions into knee-joint. Amputation through mid-thigh December 4th. Death December 15th.

Case 22.—4324. Admitted November 23rd, 1916. Gunshot wound of right knee by shell fragment. Entrance outer side of popliteal space; exit over inner tuberosity of tibia; tibial tuberosity smashed. No foreign body present; subacute infection. No operation on admission. January 13th, 1917, slipped and injured knee; effusion, pain, pyrexia. January 17th, continued pyrexia, 102.4°. Knee opened above patella, washed out, and closed; sero-purulent fluid. January 25th, same operation repeated. Transferred convalescent March 5th.

Case 23.—4345. Admitted November 25th, 1916. Gunshot wound of right knee and left upper arm. Amputation at shoulder-joint. November 26th, arthrotomy, right knee. Death two days later from shock.

Case 24.—4347, Bulgar. Admitted November 25th, 1916. Admitted moribund; gas gangrene spreading from gunshot wound of left knee. Death the following day.

Case 25.—See text above.

Case 26.—4590. Admitted December 5th, 1916; wounded December 3rd. Gunshot wound of right knee; infected. December 6th, wounds excised; foreign body removed; joint washed out with saline; no drainage. March 5th, 1917, fair movement in knee-joint; wounds healed. Transferred.

Case 27.—4691. Admitted December 9th, 1916. Gunshot wound of right knee; infected. Entrance wound above patella; exit on outer lateral aspect. December 11th, joint opened by transverse incision above patella. December 16th, two lateral incisions added. December 29th, collection under

quadriceps opened. January 20th, 1917, amputation through mid-thigh. Transferred April 4th.

Case 26.—4778. Admitted December 13th, 1916. Gunshot wound of left knee; infected. Fractured patella. Wounds excised on admission. December 20th, lateral incision into joint; washed out with saline; no drainage. January 26th, 1917, wounds healthy, granulating. February 7th, collection in calf tracked down from popliteal space under outer head of gastrocnemius; opened by three transverse incisions. April 7th, healed; slight voluntary movement. Transferred.

Case 29.—168 (O). Admitted November 20th, 1916. Gunshot wound of right knee; infected. Amputation through mid-thigh the following day. Recovery.

Case 30.—6919. Admitted May 10th, 1917; wounded the same day. Gunshot wound of left knee. Joint distended; wounds lacerated, through-and-through; entrance outer side ligamentum patellae; exit behind semimembranosus tendon. May 11th, wounds excised; arthrotomy; turbid fluid. Transverse incision above patella. May 24th, apyrexia; local condition satisfactory. June 8th, healed; still on splint. July 1st, discharged; fair and increasing movement in joint.

Case 31.—7072. Admitted May 14th, 1917; wounded May 11th. Through-and-through wound from outside; infected. Operation on day of admission. Wounds excised; loose fragments of head of tibia removed; transverse incision above patella; no drainage tubes, no sutures. May 18th, local and general condition satisfactory. May 24th, apyrexia; wounds clean. June 9th, wounds healing; joint quite healthy. August 6th, good range of voluntary movement in joint.

Case 32.—7080. Admitted May 14th, 1917; wounded the previous day. Single wound to outer side of patella; joint distended. Operation May 15th. Wound excised; foreign body removed; arthrotomy. Joint full of turbid blood; bacteriological report, staphylococcal infection. May 24th, general and local condition good; wounds healing. June 8th, normal progress. July 22nd, fair voluntary movement in joint.

Case 33.—6953. Admitted May 12th, 1917; wounded May 10th. Bullet wound from distance of 10 metres. Fractured tibia and fibula; septic. Arthrotomy; removal of bone fragments; three Carrel's tubes. May 16th, septic condition persists. May 24th, some improvement, local and general. June 4th, Amputation through mid-thigh. Recovery.

Case 34.—See text above.

Case 35.—See text above.

Case 36.—7403. Admitted May 26th, 1917; wounded May 23rd. Grenade wounds both thighs. Three wounds on outer side of right thigh, one involving knee-joint. Operation May 27th. Wounds excised; knee wound excised to joint; fragments of fractured patella removed; no foreign body found. Transverse incision above patella; no drainage, no sutures. June 8th, knee-joint satisfactory; some discharge from wound on outer side of ligamentum patellae. No oedema of joint structures. August 10th, wounds healed; slight voluntary movement in knee-joint.

Case 37.—7617. Admitted June 7th, 1917; wounded June 5th. Gunshot wound of left knee. Entrance on inner side, fracturing anterior aspect of femoral articular surface. There is also simple fracture of middle of shaft of femur, without direct relation to gunshot wound. Transfer notes say: "Arthritis purulenta, phlegmon incipiens; arthrotomia facta." Tube and gauze in the joint on admission. June 8th, tube and gauze removed; transverse incision above patella; joint "very septic." No drains of any sort inserted. The limb fixed on a Wallace-Maybury splint and elevated. June 25th, irregular pyrexia until 20th, since then apyrexia; wounds healthy. August 10th, patient goes about on crutches. Wounds healed; slight movement in knee-joint. About a quarter of an inch shortening of limb.

Case 38.—9030. Admitted July 22nd, 1917; wounded July 20th. Single contused and septic gunshot wound on outer side of right knee; skiagram shows foreign body (portion of shell) above patella and in front of femur. Patella fractured. Temperature 101°. July 23rd, operation. Wound excised, including wound of capsule and synovial membrane. Loose fragments of patella removed. Transverse incision above the patella; foreign body removed; joint full of turbid blood. Suture of excised wound in synovial membrane with catgut. No other sutures. August 4th, temperature fell to normal two days after operation and has remained so. Wounds now healing; no oedema of joint structures.

THE (American) National Association for the Prevention of Tuberculosis, in co-operation with the surgeon-general of the army, the Y.M.C.A., and other agencies, has drawn up a plan for a military anti-tuberculosis campaign. The name of every man discharged from the army on account of tuberculosis will be sent to the various State organizations and health boards so that the case may be followed up. The association is also co-operating with the surgeon-general to help the Government in providing the necessary sanatoriums. The educational part of the programme includes the supply of a number of stock lectures with lantern slides, and a number of special tuberculosis exhibits with moving picture films will be sent to the camps.

THE PREVENTION OF THE SPREAD OF EPIDEMIC DISEASE AT SCHOOLS.

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EPIDEMIC diseases at schools, especially measles, are a constant source of anxiety to all masters and doctors. In the early part of last year epidemic disease assumed grave proportions, and was of unusually severe type at many of the schools, even causing serious loss of life.

Much care and thought has been spent on combating these outbreaks, but, in my opinion, too little attention has been paid in recent years to the study of their prevention. In any epidemic it is those who have been exposed to the infection who should be dealt with, and any measure which can limit an outbreak in a school by checking the development of the disease in such "contacts" and probable "contacts" deserves the closest consideration.

In 1915 Lieut.-Colonel M. Gordon was appointed to organize a special department to deal with the investigation and treatment of cerebro-spinal meningitis. One of the most serious problems presented was the treatment of carriers, investigations having shown that a considerable number of soldiers, though not suffering from the disease at the time, had the meningococcus, often in large numbers, in the naso-pharynx. Many instances occurred in which such apparently healthy individuals conveyed the disease to others presumably possessed of less powers of resistance. To disinfect or to render harmless these carriers Colonel Gordon and his staff, after much experimental work, introduced a steam spraying apparatus designed by Major Hine, the disinfecting agent used being chloramine-T. The method was fully described in his paper in the BRITISH MEDICAL JOURNAL, November 18th, 1916; since then the apparatus has been greatly improved and enlarged. Chloramine-T was superseded by a zinc sulphate solution, as this was found to be at least as efficacious and better tolerated by most individuals. In addition to the inhalation of the medicated steam spray, Colonel Gordon introduced a system of nasal douching and of gargling with potassium permanganate solution in normal saline, which was both simple and effective. The solution is poured into the palm of the hand and snuffed up one nostril, the other being closed with the finger, and the process repeated with the other nostril. The fluid which has passed down the naso-pharynx is spat out. The patient is then instructed to gargle thoroughly with a fresh quantity of the fluid.

Although originally devised for the treatment of carriers of the meningococcus, it was obvious that the spraying method might be useful in the prevention of other infectious fevers, and, so far as I know, its first application was on a transport ship in which measles had broken out and a severe epidemic appeared to be inevitable. The results of the treatment were most striking—no further cases occurred.

It occurred to me that it would be important to apply the same methods to the prevention of epidemics of various infectious fevers in schools and elsewhere. The first opportunity which I had of trying the efficacy of the nasal douching was at the 1st London General Hospital. In a large and overcrowded ward of forty-six beds a soldier was admitted on December 5th, 1917, with fever and bronchitis. Three days later he developed typical measles. All the patients on that floor (about 100) were put in quarantine, and orders were given that all patients and nurses on that floor were to nasal douche and gargle twice daily (a 1 in 4,000 solution of potassium permanganate in normal saline was used). On the fourteenth day one fresh case occurred in a V.A.D. nurse, who, as it turned out, had been the only person on the floor who had not carried out the orders. No subsequent cases arose. Dr. Mouncey Atkinson, the resident medical officer, who very ably superintended the carrying out of these measures, has reported to me that in every case which has occurred in the hospital since then these precautions have proved efficacious. No contacts have developed the disease with the exception mentioned above.

Apparatus for steam spraying is being installed at various naval and military centres and at Osborne and