will not soon be forgotten by us, nor by the patients they tended so devotedly. Knowing the risks they ran they were indefatigable in their efforts for their comrades—British, French, and Belgians alike. The toll they paid for their devotion is shown in the figures we give above.

ON THE RECRUDESCENCE OF LOCAL SEPSIS IN COMPLETELY HEALED WOUNDS

AS THE RESULT OF SOME SURGICAL INTERFERENCE OR PASSIVE MOVEMENT.

BY

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(A Report to the Medical Research Committee.)

In an article published in the British Medical Journal of September 25th under this heading by Colonel C. J. Bond, R.A.M.C., various questions are raised involving the power of organisms to remain dormant in the tissues, and to become suddenly active after some slight surgical interference. This problem has also impressed us, and in a long series of cases routine bacteriological examination has been undertaken of the tissues surrounding fragments of shell, shrapnel bullets, etc., which have remained imbedded in the body for varying times, but in which the wound of entrance has healed. In such cases it has become necessary to remove the fragment owing to pain or other cause. Two conditions are found:

1. The fragment is enclosed in a cavity lined by a smooth wall, and containing a glairy, mucoid fluid.
2. The fragment is tightly surrounded and adherent to the tissues, with no surrounding fluid.

Bacteriological examination was made from the fluid or from the fragment itself, including pieces of cloth carried in with the fragment. In a case under our care organisms have been obtained in pure cultivation from a piece of cloth carried into the wound, without any signs of surface suppuration.

The routine method of examination in all cases was as follows: Swabs were made from the incision before the foreign body was exposed, and from the cavity after exposure. Any fragment of cloth was removed intact to a sterile tube. Films were made from the material and stained by Gram's method and counterstained, and by Giemsa. Cultivations were made on (1) glucose formate broth; (2) egg broth recently boiled, with a layer of paraffin (anaërobic); (3) stab cultures on gelatin. The cultures obtained were plated out under aërobic and anaërobic conditions, and the organisms subsequently tested.

The aërobic and anaërobic organisms were thus determined, and in some instances anaërobes only were isolated.

The following cases illustrate the fact that organisms may remain for a considerable time in the vicinity of the foreign body without giving rise to constitutional symptoms.

Case I.

Private W. M. M. was wounded by shell fragments on November 2nd, 1914, one entering just below level of right knee-joint on the outer side of the tubercle of the tibia. The wound healed at once and had never discharged. Several months later the patient began to be conscious of pain on kneeling or upon pressure on the outer side of the knee-joint. Radiographic examination demonstrated a fragment of shell casing embedded in the outer condyle of the tibia, ⅜ in. from the articular surface. On August 9th, 1915, the fragment was removed by trephining the outer condyle of the tibia. There was no pus or fluid around the fragment, but attached to it was a small piece of cloth. This was removed and immediately dropped into a sterile tube. The wound was flushed with saline, and closed by suture; healing occurred by primary union.

Films failed to reveal the presence of any organisms. No growth appeared on any media for forty-eight hours, when gas formation took place in the glucose formate broth, and an organism identified as *B. proteus* was isolated in pure culture. This organism alone was present in the anaërobic and gelatin cultures. The organism, moreover, agglutinated with the patient's serum in a dilution of 1 in 600. Normal man's serum gave no agglutination in 1 in 50. Culture from the incision was negative.

In cases in which mucoid fluid surrounded the fragment, *B. perfringens* (*B. welchii*), streptococci, and a large Gram-positive diplococcus, etc., have been found.

Case II.

Lieutenant W. Shrapnel bullet wound of right shoulder, probably ricochet. External wound healed over. Six days after injury deformed bullet removed by incision. Bullet, not in contact with bony surface, was surrounded with mucoid fluid. Films showed numerous cells, mostly mononuclear, but no organisms. The aërobic cultures gave no growth. Anaërobic cultures, on the other hand, gave a growth of Gram-positive, non-motile bacilli, conforming to the type of *B. perfringens*. The wound healed without complication.

Case III.

Lieutenant R. Multiple small shrapnel case fragments in right shoulder. External wound healed. Fragments in closed cavity, surrounded by thick cartilaginous granulation tissue. No pus or fluid. Films showed a few cells of mononuclear type and a few Gram-positive cocci. Aërobic cultures gave no growth after seven days. Anaërobic cultures gave a growth of large Gram-positive cocci only.

These cases serve to show that organisms may remain dormant without causing clinical symptoms, and at the same time explain the lighting up of local inflammation long after the external wound is healed.

The recrudescence of local sepsis in healed wounds is by no means infrequent, and we have observed many instances, of which the following are examples:

Case IV.

Lieutenant D. Motor accident on June 28th, 1915, when he sustained comminuted fracture of the lower end of the left femur. One sharp spicule pierced the upper pouch of the knee-joint and the skin immediately above the patella. There was also an oblique fracture of the left tibia and a simple fracture of the left radius. The area in front of the knee-joint was well scrubbed with iodine under an anaesthetic. On July 8th all the effusion into the knee-joint had disappeared. On August 12th the fractures were well united, but the patella was fixed to the articular surface of the femur and lateral movement of the patella was begun. On August 14th there was tense effusion of the knee-joint. On August 15th fluid was drawn off into a sterile tube. The fluid separated into three layers—an upper clear yellow fatty, a middle red clear, and a lower purple. Smears from the lowest layer showed numerous streptococci and diplococci, very few of them within the pus cells. The organisms stained well, and showed no signs of plasmolysis. A pure culture of a long-chained streptococcus, growing best under anaërobic conditions, was obtained.

These streptococci had evidently gained entrance to the knee-joint at the time of the fracture, but had remained dormant until lit up to an acute process by the simple expedient of breaking down the adhesions between the patella and the femur.

Case V.

Private G. A. Severe gunshot wound of lower right arm on May 5th, 1915, with compound fracture of the humerus 1½ in. above the lower articular surface. On May 9th the wound was opened under an anaesthetic. It was very septic and foul-smelling; several pieces of bone and cloth were removed. The fracture was comminuted, extension was applied, and the wounds thoroughly drained. Bacteriological examination made at the operation showed the presence of a large number of organisms in the pus: Gram-positive bacilli, a few with spores of clostridial form; Gram-negative bacilli, fine and slender, with oval terminal spores; Gram-negative diplobacilli; and Gram-positive cocci. The aërobic cultures gave *B. proteus*, streptococci, and staphylococci. The anaërobe cultures gave a large number of motile bacilli, Gram-positive, with oval central spores, staining irregularly by Gram's method. Many free spores were also present. Gram-positive bacilli, non-motile and capsulated, were also found. In addition, many long-chained streptococci were observed. The bacillus of malignant oedema—*B. perfringens*, and an organism similar to *B. rodella 3*—were isolated anaërobically. The wounds were merely covered with layers of sterile gauze soaked in peroxide, and oxygen passed in twice daily. On May 31st, as the fragments could not be retained in alignment, a vertical incision was made through the triceps, the ends freshened and wired together. On August 13th, the wounds being entirely healed, there being little movement of the elbow-joint, the elbow was moved under an anaesthetic, which was followed next day by diffuse inflammation about the joint, requiring superficial incisions. Again, on August 30th, passive movement in the joint produced intense inflammatory reaction.

CASE VI.

Private K. Wounded November 6th, 1914, in the anterior aspect of the right thigh. Femur fractured. December 5th, on admission, there was a small depressed sinus in middle of thigh discharging foul pus. On December 9th the sinus was opened through wound in front of thigh, and a counter opening made. In thirty-six hours the thigh was much swollen and there was a discharge of thick serous fluid, which contained a large number of sporing bacilli and bubbles of gas. The wound was freely opened, and the muscles in the centre of the sinus were found blackened and semi-digested. A portion of this tissue was examined microscopically. The individual muscle bundles were burst, semi-digested, and large numbers of spore-forming organisms were seen tightly packed between the muscle bundles, and actually passing into and invading the muscle fibres themselves. Surrounding the larger collections of bacteria, the tissue was transparent and hardly took up the stain at all. Practically no pus cells were seen. The sporing organisms were isolated in pure culture and identified as the bacillus of malignant oedema. An organism of the *proteus* type was the only other organism isolated, although a few capsulated Gram-positive organisms were observed in the original films. Within three days of the operation the patient's haemoglobin had fallen to 40 per cent., and he was acutely ill, but finally made an excellent recovery. The wounds were treated throughout with hydrogen peroxide, covered by a thin layer of gauze soaked with peroxide, and oxygen constantly passed into the wounds. The limb was ultimately useful, though somewhat shortened.

In this case the bacillus of malignant oedema had apparently lain dormant for nearly five weeks, but was activated by the incision to provide adequate drainage. Bacteriologically this case suggests symbiotic activity between the bacillus of malignant oedema and the *B. proteus* or *B. perfringens*.

Another type of case, such, for instance, as Case IV and possibly Case V, owes its peculiar features to a process analogous to anaphylaxis; the tissues, having originally been subjected to constant doses of bacterial poison, are, after an interval, subjected to an anaphylactic dose of the original poison.

OBSERVATIONS ON THE TREATMENT OF WOUNDS IN WAR.

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[*Translated for the "British Medical Journal" by* DR. A. S. GUBB, *Aix-les-Bains.*]

FROM the first I instituted the following treatment: The only dressing employed was the aseptic. The material for dressings—gauze and absorbent cotton—is autoclaved in special tin boxes of limited capacity, which are only opened when required. The ordinary cotton and carded peat for padding splints and the cloths for covering the field of operation are sterilized in the same way. The gauze compresses and cotton bandages are taken out of the boxes with sterilized forceps.

Instruments to be used at operations are sterilized in a Poupinel sterilizer, as are those for use in dressing wounds; the drainage tubes are boiled in a solution of borax. All antiseptic solutions are made with boiled water.

Before being dressed every wound is cleansed by washing with an antiseptic solution: dilute hydrogen peroxide, 1 in 1,000 solution of potassium permanganate, 50 per 1,000 solution of carbolic acid, or a 7 per 1,000 solution of salt. The neighbouring skin is freely painted with tincture of iodine (1 in 20).

It is now many years since I gave up using antiseptic dressings—carbolized or boricated cotton, or iodoform, salolized or mercury perchloride gauze—on account of the drawbacks attending their use: painful erythema round the wounds, excoriations consequent upon outbreaks of medicinal eczema, iodoform poisoning, etc. Injurious to the animal cell, hindering the natural processes of healing and organic defence, antiseptics should only be employed within very narrow limits.

Rapid complete disinfection of the wounds, after free opening up, with antiseptic solutions and a dry aseptic dressing, has been my rule of conduct throughout.

Early and free laying open of all war wounds, more particularly those inflicted by fragments of shell, drainage with simple or perforated tubes, according to their length. In the neighbourhood of vessels as few dressings as possible—these also are rules that have been rigidly adhered to.

As soon as suppuration begins to diminish the drains are removed, and directly the sloughing tissues have been eliminated and the wound takes on a healthy aspect, washing with saline solution is substituted for antiseptic solutions.

Tetanus.

During the first few months of the war we had several cases of tetanus, but such cases have become excessively rare since injections of antitetanic serum have been systematically given at the front. I give a second injection eight days after the first.

Gaseous Gangrene.

I have pretty frequently met with cases of gaseous phlegmons which all had a favourable termination after free opening up, and the extraction of projectiles and débris of clothing.

The three following cases, which came from the front in the same train, are of interest in that they exemplify what may be termed the fulminating form of this infection, in contradistinction to the cases in which the decomposition of pus in partially closed cavities or pockets determines a variable amount of subcutaneous emphysema. To put it plainly, all cases of infection, or even gangrene associated with gas formation, are not cases of gaseous gangrene. The latter term should be reserved for instances of deep, rapidly spreading, rapidly fatal infection. Unfortunately the stress of work is such that it is hardly practicable to devote much attention to the bacteriological aspect of the question, but clinically there is every difference between the real cases of gaseous gangrene and the comparatively mild infections in which there may be some gas formation. My experience is that in the grave form no treatment is of any avail, since death follows in from six to twelve hours after the supervention of the earliest characteristic symptoms of the affection.

These three cases all came from the same corner in Champagne (Souain), and, as might be expected, the infection is particularly apt to occur in subjects who from force of circumstances have been left for many hours, or possibly days, on the ground without medical aid. It is not, however, confined to such cases, for there are instances of its occurrence in men whose wounds were attended to promptly.

CASE I.

A. G., a volunteer, received his wound in the grand offensive of September 29th, and was dressed two hours later at the *poste de secours*. He presented an enormous contused wound involving the left calf and popliteal space, in addition to a seton wound of the left shoulder by a fragment of shell. He received an injection of antitetanic serum on September 29th. He came under my care on October 2nd. On the evening of October 3rd the wound showed signs of gangrene. The tissues were swollen, of a dark colour, and on pressure the crackling of subcutaneous emphysema was felt. The limb was at once amputated through healthy tissue, but the disease rapidly spread, and he died on the following afternoon.

CASE II.

This man was a German soldier, wounded in the same fray on September 27th. He was admitted under my care on October 1st. He had a very extensive lacerated wound on the outer aspect of the right arm, with fracture of the humerus; also a contused wound of the left hand, entailing the loss of the index and middle fingers. A gutter had been ploughed in the region of the right olecranon. Resection of the elbow-joint was forthwith performed; within a few hours symptoms of gaseous gangrene set in, and, in spite of extensive incisions and the application of antiseptics, he died thirteen hours later.

CASE III.

C. C., wounded on September 28th, was admitted on October 2nd. As he had fallen in a spot which was constantly swept by the enemy's fire, it was not found possible to bring him in for forty-eight hours. He presented a seton wound by bullet of the left thigh, fracturing the femur, also a deep excoriation of the left heel. There was already some gaseous formation round about the wound, and amputation was performed high up the thigh, through apparently healthy tissue. The gangrene, however, spread upwards, distending the scrotum and penis, and proved fatal within a few hours.

It was noted that these patients, far from feeling depressed or ill, experience a curious impression of comfort and well-being which persists to the moment of death.

In two other cases amputation of the thigh in the first, extensive incisions and injections of hydrogen peroxide, etc., in the second, proved ineffectual. Both patients died in six or eight hours with abdominal distension, intestinal haemorrhage, and the euphoria peculiar to this affection.