adherent to underlying structures. There was marked wrist-drop and apparently considerable loss of muscular tissue. The proximal and distal ends of the radial fracture could be readily felt at about a distance of two inches from each other. This was well seen also in the skiagram.

Employing strict aseptic precautions, I operated on November 26th. I took the graft from the tibia, and followed Albee's technique throughout, except that I used a Hey's saw instead of a motor-driven circular saw. A long curved incision was made on the front of the forearm, well away from the scar. This was completely undermined, and found to be adherent to the fractured ends of the radius, most of the muscular tissue in the proximity of the fracture having been destroyed either at the time of the wound or by subsequent sloughing. On completion of the operation the forearm was put up on a splint midway between pronation and supination.

At the end of a week I dressed the wound for the first time and found that, although the skin incision had healed by first intention, part of the original scar tissue about the size of a five shilling piece had sloughed, exposing about an inch of the graft. My first impression was that the operation was doomed to failure. Employing very strict technique, according to Rutherford Morison's method, however, I applied "Bipp"¹ to the sloughing surface, and renewed the "Bipp" every ten days, with the result that the skin wound had healed nine weeks after operation, and the union of the graft to radius was strong. The skiagram showed the graft in excellent position.

The use of "Bipp" after this bone-grafting operation was suggested to me by the excellent results I had by it in compound comminuted fractures, hernia cerebri, etc.

In this connexion I wish to take the opportunity of thanking Lieutenant-Colonel Sir Berkeley Moynihan for advising and encouraging me—on one of his official visits of inspection at this hospital—to persevere with "Bipp" in the treatment of troublesome comminuted fractures. Also Lieutenant-Colonel Robert Jones for the opportunity he gave me of seeing a bone-grafting operation at the Military Orthopaedic Hospital, London.

A CASE OF GAS GANGRENE ASSOCIATED WITH B. OEDEMATIENS.

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The following paper gives an account of a case of gas gangrene associated with *B. oedematiens* (Weinberg), some notes on anaerobic infections observed in routine examination of wounds.

J., a French soldier, aged 23, was wounded on September 14th, at 4.30 p.m., at Maurecourt, by shell fragment in the left thigh. The first dressing was applied soon afterwards, and the wound was dressed daily until admission to the Scottish Women's Hospital at 1 p.m. on September 17th, when the temperature was 100.4° and the pulse 90. The face showed a yellowish pallor but the general condition was good. High up on the inner side of the left thigh was a perforating subcutaneous wound, and the skin between the wounds of entrance and exit was gangrenous; a purulent discharge present was slightly offensive, and there was slight crepitation in the neighbourhood of the wound, and localized swelling of the thigh above the wound. The x-ray report was to the effect that there was no fracture of the femur and no foreign body in the limb. The bacteriological report was that films of the purulent discharge showed streptococcus, *B. perfringens*, and other sporing anaerobes.

First Operation.

On September 17th, at 7 p.m., under chloroform, the gangrenous skin between the wounds was excised, the muscles below were found to be gangrenous and crepitant, and portions of the sartorius and adductor longus muscles were cut away; a piece of *capote* was removed. The wound was dressed with chlorinated soda, and continuous irrigation with Carrel's solution arranged.

September 19th: Wound looking clean; temperature 101°, pulse good; patient still very yellow.

September 20th (evening): Patient sleepless and complaining of pain in leg; some swelling of muscles present in the wound; tissues above wound swollen, but no general swelling of thigh or of abdomen; pulse weak and rapid.

Second Operation.

On September 21st, at 9 a.m., the patient was very much collapsed, the wound offensive, the temperature 98°, and the pulse 120. Muscles gangrenous and gaseous; swelling extending up to Poupart's ligament due to firm gelatinous exudate in and between muscles. Slight amount of swelling present on abdominal wall. Leg amputated above wound. Artery normal,

¹The formula given for "Bipp" by Mr. Rutherford Morison (*Lancet*, 1916, vol. ii, p. 268) is bismuth subnitrate, 1 oz. by weight; iodoform, 2 oz. by weight; liquid paraffin sufficient to make a thick paste.

but gangrene noted in muscles superficial and internal to artery. The patient did not rally after operation and died at 1 p.m. The temperature throughout the illness was not higher than 101° F.

Bacteriological Examination.

A portion of gangrenous muscle, removed on September 21st, was firm, oedematous, and foul smelling. Fragments of muscle fibre and some serous exudate from the mass of muscle were inoculated into three broth tubes containing pieces of coagulated egg-white. The tubes, which were at a temperature of 100° C. when inoculated, were kept at 100° C. for one minute, three minutes, and five minutes respectively, and then rapidly cooled. From each heated broth tube a series of five deep agar tubes was inoculated by introducing five drops of heated emulsion into the first tube, mixing well and conveying five drops of the mixture to the second tube, then inoculating the third tube from the second, and so on.

In twenty-four hours the series of tubes inoculated from emulsions heated for one minute and three minutes showed aerobic organisms present and numerous colonies of anaerobes. These were not further investigated. The third series, inoculated with material heated for five minutes, showed in the first and second tubes a scanty growth of colonies of one type only, and the remaining tubes were sterile. The unfamiliar appearance of these colonies suggested further investigation, and in process of identifying them the following observations were made.

I. Cultural Characters.

Attempted subcultures from agar shake culture into glucose broth and egg-white broth failed altogether in the ordinary Bulloch jar anaerobic apparatus, but succeeded under conditions of more strict anaerobiosis (as described later) and showed peculiar appearances. In thirty-six hours growth was visible as clear fine flocculent masses throughout the liquid; in forty-eight hours the fluid had cleared and the culture had settled in a fine cloud at the bottom of the tube. The cloud diminished in size and became more opaque, and in four days was reduced to a fine granular deposit at the bottom of a tube of clear liquid. A faint fetid smell was present in broth cultures after thirty-six hours.

The corresponding microscopic examination showed that the growth in thirty-six hours consisted of auto-agglutinated masses of rather long, non-motile, Gram-positive rods, the majority of which were curved or bent, with few straight forms; later cultures showed loss of Gram-fast property in many of the organisms and the appearance of numerous spores, large, oval, and sub-terminal; still later the granular deposit at the bottom of the tubes consisted of spores detached from the rods which were present only as faintly staining fragments.

On serum agar a scanty surface growth was present of flat, clear colonies with finely lobulated borders. In deep glucose agar there appeared after thirty-six hours small white colonies with opaque centre and irregular clear border; under the low power of the microscope could be noted the varying opacity of the colony from centre to edge, and the finely filamentous margin. Gas formation was scanty or absent altogether.

Stained specimens from deep agar colonies showed Gram-positive bacilli, often with irregular Gram-negative patches in their length. Straight forms were rare, and individual bacilli were curved, bent, twisted, or coiled, irregular in outline and variable in length.

In alkaline meat medium (prepared according to M. Robertson's¹ formula) after five days' anaerobic incubation, there was abundant acid and gas production, without putrefactive change or digestion of the medium. Spores were readily produced in this medium and stained with great difficulty, after prolonged heating by the Ziehl-Neelson method.

These observations, and the character of the case from which it was obtained, suggested that the organism was identical with the *B. oedematiens* described by Weinberg and Séguin,² and isolated by them from similar cases in 1915.

II. Inoculation Experiments.

A serum test was therefore made with guinea-pigs, using for the purpose anti-*oedematiens* horse serum, prepared by Dr. Weinberg, and kindly supplied by him from the Pasteur Institute.

A thirty-six-hour unheated culture of the organism in bouillon was used, and the injections were made deeply into the thigh muscles of guinea-pigs A, B, C, and D. A received an injection of 2 c.cm. of culture; B an injection of 1 c.cm. of culture; C received an injection of 1 c.cm. of culture + $\frac{1}{2}$ c.cm. of anti-*oedematiens* horse serum; D received 1 c.cm. of culture + $\frac{1}{2}$ c.cm. "anti-Tibrion septique" horse serum (Weinberg).

The doses for C and D were mixed with the respective serums and allowed to stand at room temperature for thirty minutes before injection.

A showed severe illness and considerable swelling of the thigh in four hours, and died within twelve hours.

B, Thigh very much swollen in six hours; the animal died during the night.

C showed no effects whatever of inoculation.

D, Thigh very much swollen in six hours; the animal died during the night.

The conclusion drawn was that $\frac{1}{4}$ c.cm. of anti-*oedematis* serum mixed with 1 c.cm. of culture thirty minutes before injection had prevented the infection of the animal.

The post-mortem appearances in A, B, and D were identical. At the site of inoculation the thigh muscles were dark, haemorrhagic, slightly fetid, and gangrenous, and were separated from the skin by a dense gelatinous blood-stained oedema. A similar oedema, but clear and not blood stained, spread from the thigh over the abdomen and thorax. When incised, the oedema was sufficiently firm to remain solid, without any outflowing of fluid or alteration in consistency. A minute quantity of gas bubbles was present at the spreading edge of the oedema and in the depths of the gangrenous muscle, but very small in amount compared with the oedema produced. Close to the site of inoculation and in the gangrenous muscle the curved Gram-positive sporing bacilli were present, but in preparations made from the oedema at a distance from the wound they were rarely detected.

In all the features of morphology, cultural character, auto-agglutination, and serum tests, the organism conformed to the description given by Weinberg and Séguin of *B. oedematis*.³ Cultures were sent to Dr. Weinberg at the Pasteur Institute for examination, and were pronounced by him to be identical with the *B. oedematis* of Weinberg and Séguin.

During September a similar organism was observed in five other cases, but was not isolated in pure culture. The difficulty in isolating the bacillus is associated with the necessity for a very strict anaërobiosis, which can be effectively provided by the following method employed at the Pasteur Institute for anaërobic cultivation in fluid media. The test tube containing fluid medium is inoculated and is then heated above the level of the fluid and drawn out into a thin neck. The mouth of the tube is unaltered, and the cotton-wool plug is pushed down towards the constriction and the tube attached to a pump and exhausted. During the process of exhaustion gentle heating of the fluid drives out all air dissolved in the liquid, and the tube is then sealed by Bunsen flame at the constricted neck, and is ready for incubation.

Clinically *B. oedematis* appears to be associated with a specially severe form of gas gangrene, characterized by acute general intoxication and extensive spreading solid oedema, with little gas formation other than that due to associated organisms in the neighbourhood of the wound. It is probable that a close search under conditions of satisfactory anaërobiosis would demonstrate its presence in many cases of gas gangrene.

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NOTES ON SOME RECENT CASES OF DYSENTERY.

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DURING the months of December, 1916, and January, 1917, a good many convalescent cases of dysentery were admitted from France to the 2nd Southern General Hospital, and of these eighty have been under my care. All these cases were transferred with a diagnosis of "dysentery," and with many of them short accounts of the phenomena which occurred overseas were also sent. From these and the histories given by the men themselves the phenomena appear to have been fairly uniform in character. There was a sudden onset of the frequent passage of blood and mucus per rectum, with tenesmus, frequently preceded for a few hours and generally accompanied by abdominal pain and tenderness. This gradually

lessened under treatment, and in most cases subsided in about a fortnight. The disease, with very few exceptions, appears to have occurred in the Somme district, and the eighty cases came from sixty-five separate units.

Examination of the blood by Professor Walker Hall for agglutinins of typhoid, paratyphoid A, and paratyphoid B gave the following results:

- Class I. Agglutinins for all three diseases were present in 46 cases = 57.5 per cent.
- " II. Agglutinins for typhoid only were present in 23 cases = 28.7 per cent.
- " III. Agglutinins for typhoid and paratyphoid A were present in 6 cases = 7.5 per cent.
- " IV. Agglutinins for typhoid and paratyphoid B were present in 4 cases = 5 per cent.
- " V. No agglutinins for these diseases in one case = 1.2 per cent.

Of the 23 men in Class II, 9 were inoculated in 1914 or 1915; the remaining 14 were inoculated in 1916, and of these 8 quite definitely with T.A.B.; of the 6 men in Class III, all had quite definitely been inoculated with T.A.B. in 1916.

Of the 4 men in Class IV, 3 had been inoculated with T., and only one with T.A.B.

The man with no agglutinins in his blood stated that he had not been inoculated.

These facts show that agglutinins for paratyphoid A and B disappear from the blood much more quickly than do those for typhoid, and in some cases within a year.

Three of the four men in Class IV, who were inoculated with T. only, must have become infected with paratyphoid B during their service. This conclusion would throw doubt on a supposition that in the case of the six men in Class III agglutinins for paratyphoid B had disappeared from the blood, whilst those for paratyphoid A persisted. It is equally probable that in the case of these men agglutinins for both A and B disappeared from the blood and that they had subsequently suffered from an infection with paratyphoid A.

It follows from the above that of eighty men who were invalided with dysentery, three had previously been infected with paratyphoid B, and possibly six with paratyphoid A. Questions were asked of these men, but all declared that they had had good health previous to suffering from dysentery.

Many men are transferred to England with a diagnosis of P.U.O. (pyrexia of unknown origin), and bring with them temperature charts showing a simple fever of from seven to ten days. Some of these show agglutinins for typhoid and paratyphoid A or paratyphoid B in the blood, and have been inoculated previous to 1916. It is therefore probable that, as in the case of typhoid, paratyphoid A and B may be of all degrees of severity, varying from a malady which escapes attention, through cases of short fevers with no distinctive signs, to the easily recognized typical diseases.

Although no carriers of paratyphoid A or B have been detected among these cases of dysentery, or among those of P.U.O., this was always a possibility, and was guarded against by examination of faeces and blood.

Direct or indirect evidence of the cause of the dysentery was found in fourteen cases = 17 per cent. In three cases *Amoeba histolytica* was found—none of these had served abroad, except in France. In eleven cases the cause was bacillary—in three *B. dysenteriae* (Flexner) was found at the 2nd Southern General Hospital, although the blood showed no agglutinins for this organism; in four cases *B. dysenteriae* (Flexner) was stated to have been present in France, and in one of these the blood showed agglutinins for this organism at the 2nd Southern General Hospital; in one case *B. dysenteriae* (Flexner and Shiga), in another *B. dysenteriae* (Y), and in another agglutinins for *B. dysenteriae* (Y) were found in France.

These results show that agglutinins are not necessarily present in the blood in cases of infection by these dysentery-causing organisms, so that their absence does not negative a bacillary cause. Further, they suggest that antidysenteric serum might be used with good effects in the majority of these cases in the early stages.

The occurrence of these cases—both amoebic and bacillary—in France is probably to be explained in the transference there from the East of men who were undetected carriers. Thus six out of the eighty men had served at the Dardanelles, and of these four had been invalided thence with dysentery.

These convalescent cases after arrival in England showed but little trace of their previous illness. Most had