distress for more than three months. In the organization of such a unit it should be borne in mind that for the adequate use of the x-ray spot machines and the interpretation of the pictures obtained training for at least two years is required. One should perform at least 1,000 examinations to become sufficiently experienced in interpreting the quickly changing gastroscopic pictures. About two years' training is required to attain this efficiency. A well-trained medical staff is as important as the instruments used. Two x-ray spot machines should be available so that the service may go on when one of them needs repair. For the same reason at least four gastroscopes should be on hand, two having a visual angle of 80 degrees and two with a visual angle of 50 degrees. Technical details on these points are given in my textbook on gastroscopy (Schindler, 1937).

Summary

I have reported thirteen case histories of patients of the post-war period who suffered from epigastric distress and who were referred by the local military hospital for gastroscopic examination. In ten of these organic disease (chronic gastritis, ulcer, gastritis caused by a silk suture, benign tumour) was found; in three cases no changes in the gastric mucosa were seen.

It has been emphasized that chronic gastritis is the most frequent gastric disease. In soldiers complaining of epigastric distress, especially in time of war, the differential diagnosis usually lies between chronic gastritis, psychoneurosis, and malingering. Only gastroscopy with the safe flexible gastro-scope permits an accurate diagnosis. Patients suffering from chronic gastritis are usually unable to perform military service and are often more or less disabled in any kind of work.

Suggestions are offered for the organization of military medical service for patients complaining of epigastric distress. Centralization seems to be imperative. The need for a sufficiently trained medical staff is emphasized.

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In the Hong Kong Annual Medical Report for 1938 it is stated that the year was marked by prevalence and persistence of infectious disease, chiefly small-pox and cholera. Hong Kong had an influx of poverty-stricken and starving refugees from the mainland—victims of the war. There was thus much overcrowding, and the low resistance of these people made them a ready prey to infection from the local carriers of cerebrospinal meningitis, so that this disease rapidly rose to epidemic proportions. Malaria, thanks to the maintained energies of the Malaria Bureau, yearly becomes less of a scourge, and no case of blackwater fever is recorded. Pulmonary tuberculosis killed 4,920 people in the year, causing one out of eight of all deaths. Dysentery was also rife. Scarlet fever remains a rarity in the colony. The death rate is estimated at 37 per 1,000; in 1937 it was 34.4. Every effort is being made to bring the sanitary inspectors under direct control of the health officers. Hitherto they have taken their orders from the chairman of the urban council—an unsatisfactory system which is described as being imperfect and inadequate. The health department under the D.M.S., Dr. Selwyn-Clark, is actively administered, but has to contend with various difficulties, such as overcrowding of hospitals, that retard its progress.

X RAYS IN DIAGNOSIS AND TREATMENT OF GAS GANGRENE

BY

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When gas gangrene can be diagnosed from the clinical findings the likelihood of cure is remote: cure is dependent upon early diagnosis. Bacteriological examination of the suspected tissues involves biopsy, which, apart from the possibility that it will spread the infection, results in a considerable loss of valuable time. By radiography it is possible within a few minutes and without any injury to the patient to detect the formation of gas in the tissues before it has produced any clinical signs. Indeed, Kelly, Dowell, Russum, and Colien (1938) urge that x-radiation is the application which offers the best therapeutic results; while in those cases which have progressed so far that gas crepitation is detected clinically we can obtain by radiography a good idea of the extent of the invasion and also a guide to the possibility of eradication by amputation.

Radiographic Appearances

The radiographic appearances are dependent upon the nature of the anaerobic bacterial invasion and the stage of the disease. In the penetrating wound the formation of gas bubbles around the foreign body will be the first indication of anaerobic infection; but it must be remembered that the foreign body, such as wood splinters, clothing, and other materials of this density, in or by which the organisms were introduced will not be revealed by the radiograph, so that the gas bubble may be the only evidence of the presence of foreign material. Such localized collections of gas were more frequently discovered during the radiographic examination of a wound a week or two after its production, and were usually associated with the *B. sporogenes* or *B. perfringens* (now classed by some authorities with *B. welchii*). Examples of such radiographs have been published previously (Brailsford, 1939). Radiographic localization of such small collections of gas, and surgical cleansing (including the employment of bipp) of the wounds which include them, resulted in the eradication of the infection (Brailsford, 1939).

Invasion of damaged tissues by *B. welchii* (*Vibrio septique*) occurring after abrasions of contused tissues, penetrating wounds, and sometimes subcutaneous and intramuscular injections results in an acute fulminating gas gangrene which presents a very different radiographic appearance, for most cases are not submitted for x-ray examination until there is clinical evidence of gas gangrene and the prognosis is extremely grave. When the organisms are introduced by abrasions gas bubbles first appear in the subcutaneous tissues. These may develop to a large size and later, by virtue of the gas pressure within, spread along these tissues to the extremity of the affected limb or on to the trunk. Often by the time the nature of the infection is suspected the invasion has passed beyond the bounds of the subcutaneous tissues, and the radiographs will reveal separation of the muscle fibres by the interspersation of linear accumulations of gas as in Figs. 1 and 2. An estimation of the extent of the invasion can be determined by a careful inspection of a radiograph large enough to well cover the affected area. The rapidity of the invasion of the tissues could be shown by the comparative examination of further radiographs after a short

interval, for once the intermuscular tissue is invaded the progress is so rapid that one can actually watch it spread. There is no other condition affecting man capable of giving rise to radiographic appearances similar to those of this acute fulminating gas gangrene, but it should be noted that the earlier stage—that is, the isolated gas bubbles—may be simulated by the gas bubbles produced

palpation. An x-ray examination was made. The radiographs showed a large collection of gas in the subcutaneous tissues extending from the region of the great trochanter to the external femoral condyle. A smaller collection extended in the subcutaneous tissues to the middle third of the leg. More striking than this was the infiltration of the whole of the musculature of the thigh by myriads of gas bubbles in linear form, taking the direction of the muscle fibres, which

FIG. 1.—Radiograph of the upper half of the thigh, showing infiltration of the musculature by gas bubbles in linear form.

FIG. 2.—Radiograph of the lower half of the thigh in the same case as Fig. 1.

by the irrigation of a wound with hydrogen peroxide. The following is the history of a recent case of this nature.

Case Report

At 1.10 p.m. on December 30, 1939, a man aged 39 was driving a horse lorry when the horse shied and he slipped off the lorry, sustaining surface abrasions of the antero-lateral aspect of the skin of the right thigh and knee. He was admitted to hospital at 1.30 p.m. On inspection the abraded surfaces were dirty. They were excised, cleansed, and stitched up, and an injection of 2,000 units of anti-tetanus serum was given. On the 31st he was apparently quite well, but in the evening complained of pain in the right leg. The possibility of gas gangrene was not suspected. When examined the following morning the limb was found to be considerably swollen and reddened, and a deep dark-bluish discoloration as of extensive bruising was present over an antero-lateral area some 18 by 14 inches. Gas crepitation was detected on

appeared to be dissected by it (Figs. 1 and 2). These changes seemed to be spreading into the buttock and the anterior abdominal wall, an advance which appeared to extend while the limb was under observation. An injection of 10,000 units of *B. welchii* serum was given, but the gravity of the man's condition developed rapidly and at 2.15 p.m. of that day he died of the toxæmia.

After death the lesions appeared to spread and the whole swollen limb presented a very reddened appearance, except in those large areas which showed a dark bluish discoloration as of an extensive subcutaneous haemorrhage. An unusually stale smell was present during the examination.

The striking feature of this case of gas gangrene was the rapid fatal termination within a few hours in a man whose wounds were of the nature of abrasions, though no doubt associated with deeper contusions, which were radically treated in hospital by excision, cleansing with methylated ether, and stitching within an hour of the accident. This

unusual fatality gives rise to the question whether the simpler and less heroic measures for the treatment of an abrasion are not freer from risk of this infection. Excision and closure of the wound would appear to produce a suitable nidus for the development of anaerobic organisms. If such an event can occur in a patient having the advantage of hospital treatment and observation, the relative rarity of such untoward results in street accidents is surprising. That it can occur should be borne in mind by all who treat casualties, so that a careful watch may be kept on the progress of such lesions, penetrating wounds, and even the site of subcutaneous injections, for these have been recorded as the origin of these cases. As infection by gas-forming anaerobic organisms is detected earliest by radiography it is advisable to have radiographs taken of the area of the wound if pain or fever develops or if there is any swelling or unusual discoloration. The radiographs should be scrutinized for the presence of gas bubbles. Absence of these should not be taken as conclusive evidence that such infection has not occurred, but the radiographic examination should be repeated after an hour or so if the signs and symptoms persist or show any evidence of progress. If gas bubbles are detected suitable measures should be instituted immediately.

Treatment

The radiographs will have revealed the presence of any metallic foreign body, and if the primary hygiene of the wound has not extended to its neighbourhood the foreign body should be accurately localized as a guide to the surgeon during the subsequent radical cleansing of the track. If the radiographs indicate that the infection is of the acute fulminating type of gas gangrene, which as yet does not appear to have extended beyond operable limits, the question of amputation of the part may arise, and this would seem to be the proper procedure. Kelly, Dowell, Russum, and Colien (1938), who have paid particular attention to the x-radiation treatment of the condition, and for this purpose have collected the evidence from 140 cases, are strongly opposed to amputation. They state: "We cannot over-emphasize our opposition to amputation because of gas gangrene, and feel that anyone amputating or advocating the amputation of an extremity solely because it is infected with gas-forming organisms is definitely out of touch with the proper and conservative treatment of the condition." Their technique is given as follows:

"The thicker the part the higher the voltage and the more filtration is indicated, but since it is only necessary to treat over a period of three days, or at the longest five days, making the number of treatments vary from six to ten, no complications should arise from the use of 100 r per port per treatment, regardless of how many ports it may take, if the correct voltage and filtration are used—at least 1 mm. of aluminium in all cases. The ordinary precautions against radiation burns should be taken."

They advise that treatment should be applied twice a day, and consider that the irradiation may have some antitoxic effect. They further state that "the use of serum is not absolutely essential to recovery and its use should be conservative, avoiding serum sickness, which only adds to the patient's difficulty"; for "up to this time no patient has died of gas gangrene who has received a treatment [irradiation] in the morning and a treatment in the evening for three days over all the involved tissue."

With such testimony one might feel justified in vigorously prosecuting all cases in this way, but more than an element of doubt is aroused in their statement: "One

should not become over-enthusiastic regarding the use of the x rays and neglect other measures. Surgery is commonly necessary in these cases and must be employed as indicated." How many of the cases treated by these measures were of the nature of those commonly seen in the great war and treated successfully by removal of the foreign bodies and adequate cleansing of the track one cannot estimate, but a more extensive investigation of the value of x-radiation in the cases which are of the acute fulminating type must be undertaken before it can be universally recommended. Until this evidence is forthcoming one would feel justified in recommending x-radiation treatment in all such cases in which the radiograph indicates that the infection has extended beyond reasonable bounds for amputation or in any other case in which surgery is contraindicated.

It is interesting to note that cattle suffer from a condition closely resembling the acute fulminating type of gas gangrene in man. The condition is known as blackleg, blackquarter, and quarter-evil, and by various other names. It appears to originate from an abrasion of the skin, its progress is very rapid, and the animal dies of toxæmia before the lesion has gone much beyond the bounds of the affected limb. Through the kindness of the late Sir John Robertson and Mr. E. Hothersall, chief meat inspector to the Birmingham Public Abattoir, I was privileged to see a number of these cases, and radiographs which I took in 1915 bear a striking resemblance to those cases of acute fulminating gas gangrene in man.

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EXPERIMENTS IN THE ACCELERATION OF WOUND HEALING

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Those who, like myself, had the privilege during the last war of meeting Alexis Carrel at Compiègne have followed his subsequent work with the interest that arises from confidence in its integrity. It will be remembered that his studies in tissue culture and repair arose from and were associated with the technique of secondary closure of wounds when, after Carrel-Dakin treatment, the number of organisms in the wound discharge had been reduced to two or three per microscopical field. In 1916 Carrel and Hartmann published a paper on the cicatrization of wounds based on observations on animals; this confirmed findings, made in men in 1908, that the rate of repair was greater at the beginning than at the end of cicatrization and depended not at all on the age of the wound but on its size, being directly proportional to it.

Technique of Measurement of Wound Repair

The procedure of taking measurements is as follows. The surface of the wound is dried by filter-paper and a sheet of sterile cellophane is applied; the bare area is outlined by wax pencil on the cellophane, and this drawing is reproduced in ink on paper. From this the area is