CASE III.

Pte. A. S. There was an irregular incised wound on the inner side of the left calf. X-ray report: Two pieces of metal and gas present (Fig. 3).

Treatment.—Metal removed and free drainage established. Temperature 104°, pulse 140. Peroxide bath given. A few days later he was discharged to England.

CASE IV.

Pte. F. N. was wounded in the upper part of the left calf. There was considerable swelling. The presence of gas was not suspected. Temperature 102°, pulse 120. X-ray report: Several pieces of metal, and gas, present.

Treatment.—The metal was removed, and the wound freely opened. The temperature was then 103°. On the following day the temperature was 104°, pulse 144. As the patient's condition continued to get worse, amputation was performed. On the following day temperature 102°, pulse 110. A week later the patient was discharged to England; temperature 100°.

CASE V.

Here, too, the presence of gas was diagnosed by the x rays (Fig. 5) before any clinical evidence was visible, except some swelling of the leg, which might have been due to an ordinary septic wound.

CASE VI.

Pte. A. M. was wounded in the knee, near the head of the fibula. X-ray report: No metal present. The skiagram suggested the presence of gas in the anterior portion of the knee-joint, above the level of the patella. Temperature 102°, pulse 116. Next day temperature 101°, pulse 112. He was discharged to England.

CASE VII.

Pte. A. G. was wounded about the middle of the patella. X-ray report: Some damage to the lower pole of the patella. A piece of metal lies just below and internal to this bone. No gas was noticed at the subsequent operation. The recovery was uninterrupted, the temperature being normal after the fifth day.

Again, compare with these last two the following:

CASE VIII.

In this case no wound was present. The shadow of the air space (Fig. 8) was probably caused by a bursa under the tendon of the quadriceps extensor.

Fig. 6 shows surgical emphysema of the chest wall in a case of haemothorax.

Fig. 7 is a skiagram of a normal knee, showing the shadow caused by the popliteal space.

CASE IX.

In this case there were no clinical signs which suggested the presence of gas. This was, however, diagnosed by the x rays (Fig. 1). The infection did not spread after free drainage had been established.

REFERENCES.

- ¹ *Archives of Radiology and Electrotherapy*, December, 1915.
- ² *Journal de Radiologie et d'Electrologie*, July-August, 1916.

THE DETECTION OF GAS IN THE TISSUES BY X RAYS.

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(With Special Plate.)

To Colonel Gilbert Barling, Consultant Surgeon to the Southern Command, I am indebted for the suggestion to record the experiences we have had in the Birmingham Base Hospital at Hollymoor of the x rays detection of gas in the tissues.

It has been shown that gas gangrene may assume various forms and be due to different organisms.

At Hollymoor few cases of the acute or rapidly spreading form have occurred, and in these the diagnosis has been only too obvious without the help of the x-ray department. The less malignant form has been seen more commonly, and the object of this note is to emphasize the value of x rays in diagnosis.

In the last six months there have been nine cases radiographed by my assistant, Sergeant Brailsford, in which he has demonstrated the presence of gas. When these cases were sent for x-ray examination there was in most instances no suspicion that any gas was present, and in no case was it clinically certain. The demonstration of the presence of gas was a great help to the surgeon in the treatment of the cases, and it is obvious that, by dealing with the condition in its early stages, much relief was given to the wounded patients, and a large amount of destruction of the tissues must have been obviated.

The appearances of gas in the tissues are similar to those we are accustomed to see on pictures of normal body cavities that contain air—namely, a black area on the negative or a white area on the positive, which contrasts with the surrounding greyness.

The size of the area of blackness or whiteness varies naturally with the amount of gas present. In some of the cases it was a single spot less in size than a threepenny piece (1.6 cm. in diameter); in others it was as large as a florin (2.8 cm. in diameter). In most of the cases there were several spots present, and these were apparently isolated from one another. When the areas were small their outline was more or less oval and the margins sharp.

These gas bubbles are very clearly shown on the negatives, but, being small, they are very difficult to reproduce. I have chosen two of the cases, in which the gas collections were large, for illustration.

An interesting point in the cases is that in every case in which gas was shown on the negative the culture made from the pus or foreign body showed the *Bacillus perfringens*. In some of the cases no gas could be detected at the operation when the tissues were opened up, but the constant finding of this bacillus on culture confirmed the x-ray diagnosis.

Another point of interest is the length of time or latent period between the date of the injury and the detection of the gas. In one case this was almost five weeks.

The patients presented no unusual clinical features. All had a moderate pyrexia, all complained of pain. Tenderness was present on pressure over the affected areas, but no crepitation could be felt.

After operation a speedy recovery was the rule.

I append a summary of the cases made for me by Sergeant Brailsford, to whom I am much indebted. I also wish to express my thanks to the surgeons in charge of the cases for their permission to publish them.

CASE I.

Pte. L. Wounded in left thigh on April 4th; admitted April 17th. Radiographed on April 18th. Bullet shown at depth of 3½ in. with gas. The next day another radiograph showed that the gas had increased, the shadow being about the size of a florin, whereas the previous day it was about the size of a sixpence.

On April 20th Colonel Gilbert Barling removed the bullet, but no gas was detected at operation. Culture from the bullet showed *Bacillus perfringens*.

CASE II.

Pte. C. Wounded July 1st; admitted July 6th. A radiograph on July 6th showed (Fig. 1) a large piece of metal in the axilla at a depth of 2½ in., with a large area of gas overlapping the shadow of the neck of the humerus.

The metal was removed by Mr. Hewetson on July 7th; gas obvious at operation. Culture from the metal revealed *Bacillus perfringens*.

CASE III.

Sergeant D. Wounded in shoulder July 25th; admitted August 7th. Radiograph on same day showed fracture of fifth and sixth ribs, with bullet at depth of 1½ in.

Another radiograph made on August 19th showed small gas bubbles. Bullet removed by Colonel Barling; no gas detected at operation. Culture showed *Bacillus perfringens*.

CASE IV.

Pte. N. Wounded in thigh on July 31st; admitted August 6th. Radiograph on August 7th showed bullet and gas. The bullet was removed by Mr. Savage on August 8th; gas was noticed at the operation. Culture grew *Bacillus perfringens*.

CASE V.

Pte. L. Wounded in thigh August 26th. Radiograph on September 29th showed (Fig. 2) fracture of femur, many metallic fragments, and a gas bubble around the shadow of a bullet (upper left corner of print).

Operated on by Major Tweedy September 30th. Culture showed *Bacillus perfringens*.

CASE VI.

Cpl. S. Wounded August 31st; wound opened up in France. Admitted September 6th. Continued slight secondary haemorrhage. Pain in wound severe. Radiograph on September 13th showed shrapnel bullet 2½ in. deep, with gas in the muscles.

Opened by Mr. Lewis Graham the same day. Bullet removed, but no gas observed. Culture from bullet revealed *Bacillus perfringens*.

CASE VII.

Rifleman J. Wounded September 3rd; admitted September 21st. Radiograph on September 25th showed comminution of scapula and of the head of the humerus, many metallic fragments, and several gas bubbles.

On September 26th Major Tweedy opened up the area; no gas was detected. Culture showed *Bacillus perfringens*.

CASE VIII.

Pte. G. Wounded September 10th; admitted September 20th. Three wounds present over lower part of sternum and one large laceration from which pus poured. Radiograph on September 24th showed three foreign bodies and gas.

Metal removed by Mr. Hewetson. Culture from pus showed *Bacillus perfringens*.

CASE IX.

Ionbardier R. Wounded in left loin on September 26th; admitted October 2nd. Radiograph on October 4th showed large piece of metal at a depth from the back of 3 in., with a halo of gas.

Removal by Mr. Furneaux Jordan on October 5th. Gas obvious at operation. Culture from bullet grew *Bacillus perfringens*.

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NOTE ON THE KEEPING QUALITIES OF
THERAPEUTIC SERUMS.

BY

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At the present time, when it is necessary to keep large stocks of therapeutic serums on hand to meet any sudden call, it becomes of importance to know the rate at which serums deteriorate.

The serum which has been the most carefully studied in this respect is antidiphtherial serum.

Diphtheria Antitoxin.

Anderson (1910) examined the question under experimental conditions and found that the average yearly loss in unitage was about 20 per cent. when the serum was kept at room temperature (70° F.-95° F.); at 15° C. the loss was about 10 per cent., and at 5° C. about 6 per cent. per annum. Dry diphtheria antitoxin kept in the dark at 5° C. remains stable for at least five and a half years. Old serums are just as good as fresh serums when the relative unitage is taken into account.

The writer (1913) also carried out some experiments in this direction. His results confirm those of Anderson inasmuch as he found that the loss during one year amounted to 7 per cent. when the serum was kept in an ice chest, and to 14 per cent. when the store temperature varied between 6° C. in winter and 16° C. in summer. At 36° C. the loss was 37 per cent. in six months and 51 per cent. in twelve months. One serum kept in bulk (100 c.cm.), instead of in the ordinary ampoules, at 36° C. lost 62 per cent. of its antitoxin in six months.

We see from these observations what we can count upon when the serum is kept under proper conditions, namely, in the dark and in the cold.

But serums on the market are not always stored so carefully, judging from tests carried out on samples of serum which have been in commerce.

In the *Journal of the Royal Army Medical Corps*, vol. iii, 1904, p. 601, are given results of an examination of some samples of diphtheria antitoxin. The interval between the tests was about fourteen months, and during that time some of the samples had made two voyages to India and back. The maximum loss in unitage was 20 per cent., and the average loss some 7 to 8 per cent.

Miller (1935), who examined eighty-two samples of returned serum, mentions that "A half-dozen packages of serum had evidently been exposed to considerable heat, as the serum in them was firmly coagulated." He concluded that—

1. The high potency serums change more rapidly than the weaker, but in neither case is the loss of potency as rapid as is usually supposed.

2. The ordinary packages of serum retain their full therapeutic value for the time limit, which is often stamped on the labels.

3. The demand frequently made for fresh antitoxin is not justified.

Kinyoun and Hitchens (1907) tested 100 serums, samples of "returned antitoxin" which had been subject to the usual commercial conditions. The time between the first and final tests varied from thirteen to twenty-seven months. The loss in unitage varied from 0 to 48 per cent.; the latter occurred in eighteen months. Many of the serums were out for more than eighteen months without losing so much.

In the following table are given the results of an examination of a number of samples of serum which had been in commerce, and which were all returned at the same time. It must be noted that the tests were not carried closer than 50 units. Thus a 450 unit serum might be 475 units or more, a 300 unit serum might be 340, and so on. Serum No. 4, for instance, may originally have been, say, 640, and the loss really 6 to 7 per cent., but as the serum was, for market purposes, originally reckoned as 600 units its loss in commerce was *nil*. These batches of serum were made up of bleedings which had been kept for varying periods before being mixed up to form a batch. Serum No. 7 was composed of serums which had been in store for from two to sixteen months before being mixed, and therefore the "age of serum" is put as two to sixteen months:

TABLE I.—Showing the Loss of Antitoxin which occurred in Samples of Diphtheria Antitoxin which had been in Commerce for Various Periods.

No. of Batch.	Age of Serum.*	Period between First and Final Tests.	Unitage when Sent Out.	Unitage when Returned.	Loss in Unitage.
	Months.	Months.			Per Cent.
1	19-24	72	500	400	20
2	6-23	55	450	300	33
3	11	46	900	800	11
4	4-14	51	600	600	<i>Nil</i> .
5	9-13	47	550	300	45
6	3-54	49	450	300	33
7	2-16	44	550	450	18
8	3-16	41	450	350	22
9	5-13	40	450	350	22
10	7	39	1,100	600	45
11	5-9	39	450	350	22
12	6-9	36	600	400	33
13	5-6	36	450	300	33
14	4-7	33	450	350	22
15	2-9	32	450	350	22
16	10-16	25	450	400	11
17	13-16	24	450	400	11
18	6-12	29	600	450	25
19	4-7	29	550	350	36
20	7-13	28	400	300	25
21	10-14	27	450	400	11
22	13-20	18	450	350	22
23	11-16	23	500	450	10
24	7-16	22	500	450	10
25	11-22	22	600	450	25
26	12-16	19	450	300	33
27	7-16	19	400	350	12
28	10	21	500	350	30
29	13-24	17	550	400	27
30	11-14	17	500	400	20
31	14-22	9	450	400	11

* That is, period between the date of collection and the date of first testing and sending out into commerce.

The average period during which these serums were on the market is about two and a half years, and the average loss in unitage during that period is about 23 per cent., or about 10 per cent. per annum. Nothing is known about the conditions under which these serums were stored while in commerce, but it is obvious that the rates of deterioration varied greatly. If we compare the losses in Nos. 19, 20, and 21, and also those in 26 and 27, we must conclude that unless we know how serum has been stored the putting on the label of a time expiry limit tells us nothing, and may lead to a false sense of security.