A Lecture

ON

SOME FEATURES OF GUNSHOT WOUNDS OF THE CHEST.

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THE recognition of penetrating wounds of the chest is not always easy, and the most careful examination of the chest should be made in wounds of the upper arm, neck, shoulder, and lumbar regions. The following case is very instructive in this respect:

CASE I.—Wound in Deltoid Region (Arm raised): Penetrating Wound of Chest: Haemothorax: Aspiration: Recovery.

On July 31st, 1917, Pte. G. M. was sitting in a railway carriage when a shell fell close to the train, and he felt he had been hit in the arm. He was helped out of the train, walked with assistance about 100 yards, and then sat on a form for some time. He had a little pain in the chest, and could not take a deep breath. There was no haemoptysis. The wound in the arm appeared to be trivial, and a dressing was applied.

He was sent on to hospital about fifteen miles by road. On admission there a wound was found over the insertion of the right deltoid. The bone was not injured and there was no exit wound. He rapidly became very ill with dyspnoea, haemoptysis, cyanosis, etc. With stimulation, warmth, and oxygen he improved. Dullness was present at the right base, extending up to the angle of the scapula. It was evident that while the arm was abducted the missile had passed through the biceps muscle, missing the vessels and nerves, across the axilla, and into the chest. X-ray examination showed the foreign body in the lung about the level of the angle of the scapula, midway between the front and back of the chest. The diaphragm was elevated on the right side and there was a large haemothorax. This was aspirated and found to be sterile. He rapidly improved and was evacuated to England on August 31st, 1917.

The puzzling character of the single wound low down in the upper arm is emphasized by the subsequent history of this patient. Some time after his return to England the old wound in the arm was reopened in the expectation of finding a foreign body, and this despite the fact that the missile had already been localized in the lung.

A great change has recently taken place in the method of treating wounds of the chest. Briefly the principles of treatment now adopted are identical with those governing the treatment of gunshot wounds in other parts of the body. Wounds are excised, haemorrhage is controlled, fragments of fractured bone and large and accessible foreign bodies are removed from the lung and pleura, and large open wounds are closed. If reference is made to the most instructive article by Gask and Wilkinson¹ it will be seen that the indications for early operative treatment given there cover a considerable proportion of the cases. The only cases in which operation is not advised are those in which the wounds of the chest wall are small and clean, when there is no evidence of fractured ribs, and when the foreign body retained in the chest is small. In those cases treatment on general medical principles is adopted.

The results of this early operative treatment may be studied in the articles by Gask and Wilkinson, Anderson, Roberts and Craig, Lockwood and Nixon, and others which have recently appeared. They are a striking triumph for British surgery. But there are failures, and it is to those cases in which early operative treatment has not been adopted, or in which it has not been completely successful, that I wish to draw attention.

The chief cause of failure is sepsis. This is a most formidable occurrence after early operative treatment. Such cases are detained on the lines of communication as unfit for further transport, and the mortality amongst these is high. The following case is an example:

CASE II.—Lacerated Wound of Lung: Immediate Closure: Sepsis: Gangrene of Lung: Death.

Pte. T. O'G. was wounded by a rifle bullet on October 4th, 1917, in the right side of the chest below the angle of the scapula. At a casualty clearing station the wound was excised, and fragments of fractured ribs and the rifle bullet removed. The lung was lacerated and there was a quantity of blood in the pleural cavity. The wound was completely closed without drainage.

On October 11th he was admitted to a general hospital off an ambulance train as "unfit for further transport." He was

extremely ill. Pulse 130; dyspnoea and cyanosis. The wound was very septic with much discharge. He was considered to be beyond further surgical aid, but improved a little under treatment, and on October 13th the wound was reopened. The parietal wound was sloughing and stinking. The lung was completely collapsed and the pleural cavity filled with foul discharge and sloughs of the parietal pleura. The lacerated portion of lung was gangrenous. A silver irrigation cannula was inserted through a separate puncture and the wound drained with a large tube. He survived until October 18th.

In this instance as soon as the wound was reopened it was converted into an open "flapping" wound. It could not be resutured around a tube owing to the sloughing muscles and pleura. All that could be done was to make provision for drainage and irrigation and to pack the wound firmly with gauze.

CASE III.—Closure of Wound: Septic Haemothorax and Purulent Bronchitis: Recovery.

Pte. J. W. G. was wounded on August 1st, 1917, by a rifle bullet in the left side of the chest. The wound was explored and fragments of broken rib removed with the foreign body. There was a considerable haemothorax. It was not noted whether the lung was injured. The wound was stitched up. He was admitted to a general hospital on August 8th, from an ambulance train as "unfit for further transport." He was collapsed and cyanosed and there was extensive dullness in the left chest. The wound was reopened in part and a drainage tube inserted, giving exit to a large quantity of stinking pus. He was very ill for some weeks, purulent bronchitis of the opposite lung being a serious complication. He eventually did well, and was evacuated to England on November 17th.

These cases emphasize the danger of evacuating a case in which the chest has been primarily closed until such time as the possibility of infection has passed.

SEPSIS AFTER IMMEDIATE CLOSURE.

In what proportion of cases treated by thoracotomy and immediate closure of the chest is secondary sepsis to be feared?

Gask and Wilkinson¹ give the following figures: Sixty-seven thoracotomies for various injuries with immediate closure of the chest, followed by empyema in 22 cases (32 per cent.) and death in 19 cases (28 per cent.). In 15 of these cases the operation was performed for infected haemothorax, and in 12 (80 per cent.) an empyema subsequently developed, with 5 deaths (33 per cent.).

Anderson² tabulates the results of 58 thoracotomies with immediate closure. Secondary drainage was necessary in 12 (20 per cent.), and there were 14 deaths (24 per cent.). What proportion of the cases of empyema died is not apparent.

Roberts and Craig³ give 25 thoracotomies and complete closure, with 10 deaths = 40 per cent.. The number of cases in which a secondary drainage was necessary is not given.

Lockwood and Nixon⁴ divide their cases into two groups, before and after August, 1917. The figures refer to the latter group only. Of 82 thoracic and abdomino-thoracic cases in which thoracotomy was performed with immediate closure there were 24 deaths (29 per cent.). It is difficult to decide from a study of the statistical tables published with the paper in what proportion of cases infection of the pleura contributed to the mortality. Apparently in 5 cases only did an empyema develop. Empyema occurred in 5 cases in which no primary operation was performed, with 1 death.

Duval,⁵ whose early work in the field of thoracic surgery has done so much to stimulate other surgeons, gives details of 29 thoracotomies with 8 deaths (27 per cent.), followed by empyema in 9 cases with 2 deaths.

In all these series of cases the late mortality and empyema rates do not appear to be included. This is impossible at the present time, and probably all the facts about these cases will not be available until long after the war. But it can safely be said that the mortality and morbidity among chest cases evacuated from the casualty clearing stations is still considerable, and almost entirely due to sepsis.

The best preventive of sepsis is early and thorough operative treatment with complete closure of the chest, but there will always be a number of cases received some time after the receipt of the wound, cases in which some degree of sepsis is inevitable. In some the infection is derived from the lung, and may not be prevented by primary operative treatment, however early and thorough.

Drainage.

Can these cases be saved by drainage? Colonel H. M. W. Gray,⁶ in contrasting the results of immediate closure and drainage, gives the following figures: 198 cases in which the pleural cavity was drained, with a 50 per cent. mortality; and 57 cases of complete closure, with 29.8 per cent. mortality. He states that the operation with complete closure is therefore 20 per cent. better than the operation with drainage. I do not think this conclusion can be accepted literally, as the late, the most seriously wounded, and the most heavily infected cases would be drained.

Still the results of drainage are undoubtedly bad. Many cases succumb to sepsis, despite a free and dependent opening. This is to be prevented by treating the infected pleura and lung as other infected wounds are treated—namely, by washing the whole of the infected area with an antiseptic fluid at regular intervals—the progressive sterilization of the wound—combined with efficient drainage. I shall describe later how this may be done.

INFECTED HAEMOTHORAX.

Let us now turn our attention to those cases in which a primary operation is not performed, where a haemothorax is present, and signs of infection develop. According to Bradford and Elliott,⁷ infection of a haemothorax occurs in about 25 per cent. of cases. Henry, who carried out the bacteriological investigations in this series, found that organisms such as the pneumococcus, *B. influenzae*, and *M. tetragenus* were present in about 20 per cent. of infected cases, and that in the remaining 80 per cent. streptococci, staphylococci, and anaerobes were found. Sir J. Rose Bradford⁸ says: "It would seem that infection of a haemothorax is much more frequently derived from the skin or clothing than directly from the lung." He divides the cases into early and late infections. In the one case the infection occurs in the first few days and is undoubtedly due to organisms carried in by the missile. In the late cases symptoms may be delayed to the second or third week. The usual symptoms are increasing dyspnoea, rise in pulse-rate, elevation of temperature, etc., and in the later stages, jaundice. For the physical signs reference may be made to Sir J. Rose Bradford's paper. The cases in which urgent symptoms most rapidly arise are those in which gas develops in the pleural cavity. Marked displacement of the heart sometimes occurs with great rapidity.

These late cases of infection of a haemothorax are extremely dangerous. The patient may be in transit to the base or even to England, and if that be so he is at a great disadvantage, as very early operative treatment is necessary.

For this reason these cases require most careful watching. When treatment is required it is required most urgently. The co-operation of the physician and the surgeon is very necessary. For one thing, the condition of the opposite lung is of the greatest importance. Purulent bronchitis, a contralateral haemothorax, or pneumonia may be present, or pericarditis. Gask and Wilkinson mention a case in which a plug of blood and mucus had been aspirated into the bronchus of the opposite lung, death occurring from respiratory failure when the affected side of the chest was opened.

Diagnosis of Infected Haemothorax.

When symptoms suggesting infection arise the chest must be explored to determine the sterility or otherwise of the haemothorax. Valuable information is frequently obtained, but a negative report is not always reliable, and if too much importance is attached to these findings necessary treatment may be delayed. If the patient's symptoms suggest that infection has occurred the chest should be opened. Radiography, to determine the amount of fluid, position of missile, etc., is of the highest importance, but it must not be allowed to delay treatment.

Treatment of Infected Haemothorax.

Preliminary aspiration may be resorted to in very desperate cases, but the serious condition of the patient is only in part the result of the mechanical pressure of fluid or fluid and gas. It is largely due to septic absorption. If the patient is relieved an operation should be performed as soon as possible.

Drainage of the Chest.

This may be performed in one of two ways:

1. Resection of a short length of rib, and insertion of a drainage tube under local anaesthesia. This is the method usually adopted.

2. Thoracotomy under local or general anaesthesia. Resection of a considerable length (4½ to 5 in.) of rib, preferably the eighth, insertion of a spreader (Tuffier's *Ecarteur* is very satisfactory), inspection of the chest cavity, removal of clots, fluid, foreign bodies, fragments of bone, etc., repair of damage to lung and diaphragm.

The operation is, in fact, the same as that done in the early stages for chest wounds, only it is done in the presence of established sepsis. The operation may in certain cases be followed by immediate closure of the chest, but this is only possible in the early stages of an infection, and is certainly not practicable in all. In many cases a drain must be inserted.

The disadvantage of the first procedure is that no exploration of the chest is possible, and clots, foreign bodies, fragments of bone, cannot be easily removed. Nevertheless, in certain cases, this is all that can be done at the time. In some cases a more extensive thoracotomy may be required at a later date.

However established, either after a limited or an extensive operation, drainage alone is insufficient. When the infection is serious and well established it is not controlled by drainage, and the patient may succumb to sepsis. In any case free suppuration continues for a period more or less prolonged, much lymph is thrown out on to the lung, and the parietal pleura and the lung fail to expand. The cavity will perhaps close after considerable falling in of the chest wall, or the patient will be left with a chronic empyema.

Antiseptic Instillation.

Drainage should be supplemented by the progressive sterilization of the pleural cavity by the instillation of an antiseptic. This may be effected in various ways:

1. By irrigation of the cavity once or twice a day through a drainage tube. This is only satisfactory in the presence of a very small cavity. The greater part of the pleura cannot be reached.

2. By the method employed by Tuffier—namely, irrigation every two hours through a number of Carrel tubes supported on wires and inserted into the pleural cavity in all directions through the drainage aperture.

I have no personal experience of this method except in the case of small cavities. So far as I know there are no published records of the results, but they are said to be exceedingly good. The disadvantage of the method would seem to be that the dressings are difficult and tedious.

3. By filling the pleural cavity with Dakin's solution every four hours through the drainage tube, the patient lying on the sound side, the fluid being siphoned off at the end of two hours. (Campbell's method.⁹)

However efficacious, this method would seem to be exceedingly tedious and very difficult to carry out in times of stress.

4. Irrigation through a special silver cannula which I have employed and which is described and illustrated in the BRITISH MEDICAL JOURNAL, February 2nd, 1918.

The cannula is used in the following way: After opening the chest a point on the chest wall towards the upper limit of the cavity is selected where the cannula may most conveniently be introduced. This is usually in the third or fourth space, about or just external to the mammary line; a small incision is made through the skin, and the cannula pushed through the intercostal muscles into the chest. The tip of the cannula should point outwards and downwards, and the instrument is fixed in position by two sutures to the skin. The original incision is then closely sutured around a drainage tube, which may be long enough to reach into a bottle of antiseptic fluid. The tube of a Carrel ampoule is then attached to the cannula, and the cavity irrigated every two hours. Hitherto I have generally used eusol, but no doubt other solutions will be as efficacious.

This is a simple and very effective device for instilling antiseptic fluids into the pleural cavity. If the cannula is judiciously placed (and in large cavities more than one can be inserted) the whole of the pleural cavity is easily exposed to the action of the antiseptic. When the thoracotomy wound is closely sutured around the drainage tube no dressings are required for several days. The tube passes out through the dressings into a bottle, and the cavity is washed out every two hours without any disturbance of the patient. The best method of fixing the drainage tube and occluding the wound around it is to pass two catgut

sutures, one on either side, through the muscles and through the wall of the tube supported by two silkworm gut stitches through the skin, also picking up the drainage tube. There is then no leakage around the tube, the dressings remain dry, and can be left undisturbed. The silver cannula is very easily inserted; washing through is quite a simple process, and is not attended with discomfort. The saving in dressings and in the nursing required is enormous.

The results of drainage and irrigation by this method are striking. The general condition of the patient improves rapidly. The amount of discharge is much lessened, and in many cases there is practically none. The lung expands quickly and undoubtedly much more rapidly than in cases treated by drainage alone.

The following two cases are examples of infected haemothorax treated in this way.

CASE IV.—Late Thoracotomy: Irrigation: Rapid Recovery.

Pte. C. N. McC. was wounded on October 9th, 1917, by a fragment of high explosive shell in the right side of the chest and head. He received no surgical treatment at the casualty clearing station. When admitted to a general hospital on October 14th there was no history of haemoptysis, but considerable dyspnoea. Haemothorax on the right side was explored, and a coliform bacillus cultivated from it. X-ray examination showed a foreign body in the upper part of the right lung, three inches above the nipple.

On October 18th thoracotomy was performed, the eighth rib being resected, a large quantity of bloody fluid evacuated, and clots cleared out. The lung was much collapsed. The foreign body was not sought for. An irrigation tube was inserted in front through a separate small incision in the nipple line in the fourth space, with a large drain behind. The cavity was irrigated every two hours with eusol. Rapid improvement in the general condition ensued. The discharge was never abundant.

On November 3rd it was noted that the lung was expanding very well. As soon as the condition of the patient permitted the scalp wound was explored and a fracture of the occipital bone found, without injury to the dura. This was dealt with in the ordinary way, and healed satisfactorily. He was evacuated to England on December 1st, there being a very small amount of discharge and the lung well expanded.

CASE V.—Late Thoracotomy: Irrigation: Rapid Recovery.

Pte. G. B. was wounded on October 10th, 1917—a through-and-through bullet wound of the left chest. He received no surgical treatment at the casualty clearing station, and was admitted on October 14th to a general hospital. He was then very ill with an evident gas-infected haemothorax, the heart being much displaced; $4\frac{1}{2}$ in. of the eighth rib were resected; the left pleural cavity was filled with foul-smelling bloody fluid with gas; the lung was almost completely collapsed. A drainage tube and silver cannula were inserted, and the cavity irrigated every two hours with eusol. The patient improved rapidly; the discharge was never profuse. The temperature oscillated for some time, and convalescence was delayed by an attack of tonsillitis. The lung expanded well.

He was evacuated to England on December 1st, 1917. He was discharged from hospital early in January, 1918, and left for Australia, the wound being healed and his general condition excellent.

In most cases it becomes necessary to remove the silver cannula before the cavity is completely closed. The rapidly expanding lung presses the point of the cannula against the chest wall and causes some pain. It is as well to continue the progressive sterilization of the cavity after the cannula has been removed, by inserting an ordinary Carrel tube through the drainage wound for the instillation of the chosen antiseptic. This is continued until the lung is completely expanded. In a normal case the lung may be expected to expand rapidly and the cavity to close in a short time. Can anything be done to expedite this?

Tufter and Depage¹⁰ are of the opinion that the best way of hastening the expansion of the lung is, after sterilization of the chest cavity, to close the parietal

wound by secondary suture, leaving a pneumothorax. The results are said to be good, but I know of no published records of cases. I have not ventured to do this in any of my cases. One is hampered by the fact that it is frequently necessary to evacuate them before the cavity is sufficiently sterilized, but the expansion of the lung is so rapid that it would seem to be unnecessary in the majority of cases.

CHRONIC EMPYEMA.

Chronic empyema is a not infrequent result of infected haemothorax. It is due to failure of expansion of the lung, and may be due to imperfect drainage or the retention of a foreign body. In comparatively early cases of chronic empyema, when the adhesions tethering the lung are not very dense, they may stretch after a time and allow sufficient expansion of the lung, which, with some amount of falling in of the chest wall, will permit the parietal and visceral pleura to come into contact and so effect closure of the cavity. If this does not take place suppuration continues for an indefinite period and the patient is likely to develop amyloid disease.

Operations for Closure of Chronic Empyema.

The following are the principal operations available for closing a chronic empyema cavity:

1. Estlander's, Schede's, or Wilms's operations* aim at effecting closure of the cavity by removing the whole or portion of the overlying ribs and allowing the chest wall to fall in, on to the collapsed lung. Schede, in addition to excising ribs, also removed the thickened parietal pleura. These methods are not free from danger; it is frequently necessary to perform the operation at several sittings, and complete success is not easily attained. At the best the lung is left unexpanded.

2. By combining an osteoplastic resection of ribs with filling of the cavity by the insertion of flaps of muscle cut from the latissimus dorsi, the scapular, or pectoral muscles.

These methods are apt to be only partially successful and the lung remains unexpanded.

3. By decortication of the lung after an osteoplastic resection. The thickened visceral

pleura is stripped from the surface of the lung exposed in the cavity. By releasing the lung from the compression of its dense pleural covering it is thought that its re-expansion will be favoured. In some cases this undoubtedly occurs, but on the whole the results seem to be very disappointing. Haemorrhage is sometimes severe and the lung tissue is easily torn. It is a dangerous operation and not to be recommended.

4. By separating the adhesions which bind the lung down to the chest wall.

Types of Chronic Empyema.

My experience of chronic empyemata leads me to believe that there are three main types:

1. *Localized empyema*, such as is diagrammatically illustrated in Fig. 1. In this form the lung is partially collapsed, though in contact with the costal pleura both in front of and behind the empyema. The collection of pus may be laterally, posteriorly or anteriorly situated, though rarely the latter.

2. *A more complete form*, in which the lung is much more collapsed (Fig. 2), the anterior border having receded and the organ collapsed into the paravertebral fossa. This condition may involve the whole lung, though, as a rule,

* A very full account of these operations is to be found in a paper by S. Robinson, *Collected Papers of the Mayo Clinic*, vol. vii, p. 618.

FIG. 1.

the apical portion of the upper lobe is not collapsed and remains in contact with the chest wall. This is the variety commonly met with in large chronic empyemata.

3. *Complete Collapse of the Lung*.—In this form (Fig. 3) the organ is greatly shrunken and collapsed on to the hilum; practically all that remains is a stump of tissue attached to the vessels and bronchi.

There are other, much rarer, forms—multilocular, apical, diaphragmatic, and interlobar—and their occurrence must be borne in mind.

As an empyema develops a layer of fibrin is deposited on the pleural membrane, on that portion covering the lung and that lining the chest wall. In time organization of the fibrinous layer occurs, and a more or less dense fibrous membrane is the result. The parietal and visceral pleura become thickened, sometimes to an astonishing degree. If the empyema is drained in its early stages before fibrous changes have occurred rapid expansion of the lung is the rule. But fibrous changes prevent expansion of the lung. Fibrosis may be due to delay in recognizing and draining the empyema or to failure to control the infection after drainage, with consequent persistent suppuration. As has been said, the resulting chronic empyema may be cured by operations producing collapse of the chest wall or by removing the thickened visceral

diaphragm may be separated in a similar way. Separation of the adherent lung is not usually attended by much haemorrhage; in any case this is easily controlled by irrigation.

This method of freeing the lung is only possible in the types of empyema depicted in Figs. 1 and 2. When collapse of the lung is absolutely complete, as illustrated in Fig. 3, the cavity can only be closed by an extensive osteoplastic operation.

The following cases are examples of chronic empyemata treated in this way:

CASE VI.—*Chronic Empyema treated by Stripping Thickened Pleura: Recovery.*

Pte. T. W. was wounded on September 15th, 1917, by shell fragment. An infected haemothorax was treated in the casualty clearing station by resection of a portion of rib (ninth) and drainage. There was continuous discharge for a month.

On October 14th, when admitted to a general hospital, he was very anaemic, with rise of temperature, poor pulse, and much stinking discharge. The whole of the left chest was dull except at the apex. X-ray examination showed a foreign body in the lower lobe of the lung.

On October 18th thoracotomy was performed, 5 in. of the eighth rib being resected, and a large quantity of foul pus evacuated. The cavity occupied two-thirds of the pleural space and the lung collapsed into the paravertebral fossa. There was a sinus in the lower lobe of the lung leading to the foreign body, which was removed (a piece of high explosive

FIG. 2.

FIG. 3.

pleura covering the surface of the lung exposed in the cavity. No doubt the thickening of this portion of the pleura is a factor in preventing expansion of the lung, but it is not the only or indeed the chief factor. This expansion is prevented by the firm adhesions at the points marked A and B in Figs. 1 and 2. It is the fixation of the lung at these points which prevents expansion. At A and B the adhesions are generally very dense and firm, but beyond these points—in the areas figured A to C, B to D—adhesions are much less dense. If these barrier adhesions at A and C are separated the lung will expand. It seems probable that the limited success which has attended the operation of decortication is not due to the fact that the removal of the thickened visceral pleura has permitted expansion of the lung, but is the result of the undesigned separation of these barrier adhesions. The object of the operation for chronic empyema should be to close the cavity by effecting expansion of the lung, and this can be done by dividing these barrier adhesions at the points marked A and B on the diagrams. In fairly early cases these barrier adhesions can be separated by the fingers; when they are very firm the scissors will be necessary. The lung should not be wounded nor should any attempt be made to strip off the thickened visceral pleura from its surface. Some immediate expansion occurs always, and in some cases the results are astonishing. Once the barrier adhesions are passed separation along the lines A to C, B to D is very easy. Adhesions to the

shell). The adherent lung was stripped from the paravertebral fossa without difficulty and with little haemorrhage, and marked immediate expansion of the lung occurred. The original wound was explored and found to drain a small loculus below the main cavity. There was considerable necrosis of the ninth rib at the site of the previous resection. The silver cannula was not inserted, as one was not available. The cavity was irrigated by the side of the drainage tube. On November 3rd it was noted that the lung was expanding very satisfactorily and that there was very little discharge.

On December 1st he was evacuated to England, with the lung expanding very well and his general condition excellent. There was still some discharge from the site of the first operation, and sequestra were coming away.

A note on the further history of this patient was received on January 23rd, 1918. The wounds were healed, and the left side of the chest was expanding very well, but there was still some flattening of the chest.

In this case the immediate results of stripping the adherent lung were very striking. The barrier adhesions were so dense and firm that it is certain the cavity would never have closed unless they had been divided, and a secondary rib resection would have been required.

CASE VII.—*Chronic Empyema treated by Stripping Thickened Pleura: Recovery.*

Pte. J. F. was wounded on November 17th, 1917, in the right chest below the nipple. The wound was excised and the fractured rib removed. The diaphragm was perforated, and a fragment of shell was removed from the liver; the wounds in the liver and diaphragm were sutured, the haemothorax

evacuated. The lung was not damaged. The chest was closed without drainage.

Aspiration was performed on November 20th, 24th, and 30th. On the last occasion pus with faecal odour was evacuated. Aspiration was performed again on December 1st, and on December 12th he was admitted to a general hospital. He was very upset by his journey from the casualty clearing station, and was received in a state of collapse. There was an obvious empyema. The thorax was reopened, Tuffier's spreader inserted, pus evacuated, and adherent and collapsed lung stripped from the paravertebral fossa. Considerable immediate expansion of lung occurred. A silver irrigation cannula was placed in position anteriorly. The thoracotomy wound was tightly sutured around a long drainage tube. The patient was propped up in bed on a bed-rest, the drainage tube passing out through the dressings between the bands of the bed-rest into a bottle. The pleural cavity was irrigated every two hours with dichloramine-T, 3 per cent., through the silver cannula.

From the beginning there was very little discharge. The dressings were not disturbed for five days; the wound was then healed except at the point of exit of the tube. The dressings remained dry until the large tube was removed on the eleventh day and replaced by a smaller one. The silver cannula was removed and reinserted from time to time. The patient's general condition rapidly improved; the temperature, after some oscillations, fell to normal.

On December 29th, 1917, it was noted that the right lung was markedly expanded, and that breath sounds were heard down to the level of the tube. After the silver cannula was removed the small remaining cavity was irrigated through a Carrel tube inserted through the drainage aperture.

The further progress of this case was uneventful. A note received early in February, 1918, was to the effect that his general condition was excellent, and the lung completely expanded; a small sinus remained at the site of drainage.

CASE VIII.—Chronic Empyema: Repeated Thoracotomy: Stripping of Lung.

Pte. J. M. L. was wounded by a piece of shell on October 25th, 1917. The missile passed into the left chest and penetrated the diaphragm. Thoracotomy was performed at the casualty clearing station, the diaphragm sutured, and the chest closed. Laparotomy was performed, but no intra-abdominal lesion detected. On November 5th 1½ in. of rib was excised and a fragment of shell removed from the pleura. The cavity was washed out with flavine and closed without drainage. On November 9th 2 in. of rib were resected and one pint of stinking pus evacuated; drainage. On November 13th 2 in. of the third rib were removed. A cavity containing serous fluid was opened, washed out, and closed. A note on November 28th stated that the left lung was completely collapsed, and that the tube drained a large cavity.

When admitted to a general hospital on December 1st there was a large quantity of discharge and the lung was collapsed. X-ray examination showed a small fragment of shell lying beneath the inner end of the clavicle. Culture yielded streptococci, staphylococci, and coliform bacilli. Thoracotomy was performed by Major J. H. Cobb through the old wound over the seventh rib, the cavity wiped out, and adherent lung stripped; some immediate expansion occurred. A silver irrigation cannula was inserted.

On December 31st, 1917, there was practically no discharge from the cavity, but it was still of some size, and extended upwards towards the clavicle. Some expansion of the lung had occurred. The general condition was very markedly improved.

A further note of this patient's condition was received in February, 1918. He was very well, and the lung was completely expanded; a small sinus remained at the site of the first operation.

It is extremely important in every case of chronic empyema to have a radiograph of the chest taken, not only to discover the presence of a missile, but to exclude the possibility of a lost drainage tube. On three occasions in the last six months I have removed a lost drainage tube from the chest; one case was one of my own. An infected haemothorax was drained after resection of a rib under a local anaesthetic. The tube was secured to the skin by two silkworm-gut sutures. The following day it was missing. A radiograph showed it to lie inside the chest, whence it was easily removed. In another case (a man evacuated from a casualty clearing station, and put off the ambulance train as unfit for further transport) the patient complained of great pain in the chest. Five inches of half-inch drainage tube with a safety-pin attached was extracted from the pleura. Both these cases did well.

In another case a drainage tube was removed from the track of a missile through the substance of the upper lobe of the right lung. It had probably been lost for several days. This patient ultimately died from gangrene of the upper lobe of the lung.

The question arises whether it would not be better to provide adequate drainage and to sterilize the cavity by irrigation before separating the adherent lung, which could be done at a later stage. In very septic cases, in

exhausted and debilitated individuals, and in patients with signs of incipient amyloid disease, this would no doubt be the better course.

The Late Removal of Foreign Bodies from the Lung and Pleura.

If an operation is performed for infected haemothorax or empyema the foreign body, whenever accessible, should be removed if the patient's condition will permit it.

CASE IX.—Removal of a Foreign Body in the Absence of Sepsis.

Pte. C. W. was wounded on October 8th, 1917, by a piece of high explosive shell which entered the left chest close to the nipple.

On October 14th he was admitted to a general hospital. The note stated that he had had a pneumothorax on the left side, but no active treatment had been necessary. His general condition was good. X-ray examination showed a foreign body—a long, ragged piece of shell—in the lower lobe of the left lung.

On October 25th thoracotomy was performed, 4½ in. of the eighth rib being resected. Tuffier's spreader was inserted. The foreign body was felt in the lower lobe of the lung; the lung was incised, and the foreign body extracted. The wound in the lung was sutured. Complete collapse of the lung was prevented by adhesions. The patient was not at all disturbed during the operation, the pulse remaining quiet throughout. The wound was completely closed by suture in layers—pleura, muscles, and skin.

On November 16th he was evacuated to England. The wound had healed by primary intention, the lung had expanded well, and his general condition was excellent.

The question of the necessity of removing the foreign body in such a case as this has still to be determined. I have heard it seriously advanced by an administrative officer that any foreign body, however small and wherever situated, should be removed from the chest, for the reason that no man who knows he has a foreign body in the chest ever goes back into the front line. The same can probably be said of men upon whom thoracotomy has been performed. There are definite indications—haemoptysis, abscess of lung, etc.; pain and dyspnoea are also indications, but it is not always easy to be sure when these complaints are genuine.

My thanks are due to Colonel T. Gowans for permission to publish the details of the cases mentioned. I am also greatly indebted to Captain T. S. Parkinson and Captain M. J. Stewart for their invaluable assistance.

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WAR SCARS AND THEIR PAINS:

WITH SPECIAL REFERENCE TO PAINFUL AMPUTATION STUMPS.*

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CIVILIAN and pre-war scar tissue was made up of fibrous tissue in which there were few foci of round cells and fewer organisms. These round cells represented areas of repair and did not exist for long. In consequence they were of little importance. In war scars all these conditions were increased and exaggerated, the round cells of the inflammation being more numerous and polynuclear, the neighbouring connective tissue cells proliferating and some also becoming oedematous and distended with fluid, whilst organisms, as long as three years after the wound had healed, have been grown from the ends of the nerves in a painful amputation stump. The nerves were removed at operation and dropped straightway into a culture medium. In such ways cultures of staphylococci, colon bacilli and diplococci have

* An address delivered at the Welsh War Hospital, Cardiff.