WAR INJURIES OF THE CHEST.

GENERAL CONSIDERATIONS.

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In war, wounds of the chest may be produced not only by bullets, shrapnel balls and fragments of high explosive shell, but also by foreign bodies such as gravel and pieces of wood thrown up by the explosion. Portions of the leather and metal equipment, pieces of clothing and coins and other contents of the patient's pockets are not infrequently indriven. Fragments of the patient's ribs or other bones may add to the severity of the wound. Especially in air raids crushing injuries may be produced by falling masonry, girders, etc.

Principal types of wound.

(1) *Tangential wounds* of the chest wall without penetration of the pleura, apart from hæmorrhage, are not usually dangerous, though they may be large and ragged.

(2) *Traversing wounds* with entry and exit wounds which may be large or small. The missile may traverse one or both sides of the chest, and though the original missile makes its exit, it may carry pieces of clothing, fragments of rib, etc., into the chest, and these may be retained.

(3) *Penetrating wounds* with one or more retained foreign bodies. These again may be in the side of the chest opposite to that of the entry wound.

(4) *Sucking or blowing wounds* in which air enters the open pleural cavity through a small or large opening which may sometimes be valvular.

(5) *Abdomino-thoracic wounds* where the missile traverses both body cavities.

(6) Wounds of the chest may be *single or multiple*, and are often complicated by wounds of other parts of the body.

Causes of risks to life.

Death may occur rapidly from wounds of the heart or great vessels or from the shock and hæmorrhage of very extensive wounds. Apart from this, early or late infection is the major risk to life. This infection may develop in the wound of the chest wall, and spread inwards to the pleura or its contents, or it may originate within the pleura or lung from bacteria carried in by foreign bodies, or by infection of a wounded lung via the respiratory passages.

Recurrent or delayed hæmorrhage accounts for some deaths, but here again sepsis is often the cause.

Tetanus may of course occur after any wound, however trivial, but gas gangrene is almost always limited to the chest wall, and rarely occurs in the lung itself, possibly due to its aerobic conditions.

Yet another set of dangers arises from interference with the movements of respiration and the difficulty of expelling secretions from the lungs. Aspiration pneumonia in the opposite lung and massive collapse of one or more lobes due to bronchial obstruction by plugs of mucus, or occasionally actual blood clot are causes of late deaths.

Principles of Treatment.

Apart from cases with small, clean wounds made either by bullets, or as in Spain, by the tiny fragments of metal into which some of the aerial bombs splintered, the indication is to remove the infection by a careful and radical excision of the

superficial wound or wounds, to clean out the pleura, and excise any ragged tissue in the wounded lung, at the same time removing foreign bodies. Because this procedure requires a skilful surgeon and anaesthetist and to get the best results a somewhat extensive equipment both for operation and after-treatment, the patient should be removed as soon as possible after the minimum of first aid treatment, to a properly equipped operating centre. As regards time, the aim is to operate before the bacteria which at first are lying superficially on the walls of the wound track have multiplied and grown into the underlying tissues. This often occurs within a very few hours. On the Somme in 1918 well developed gas gangrene was often seen in compound fractures of the leg within four to six hours. After twelve hours it is rarely possible to sterilise a wound by excision. The aim then should be to operate, if operation is deemed necessary, as soon as the condition of the patient permits.

First aid treatment.

First aid treatment should therefore be confined to immediate life saving measures of the simplest type, and every endeavour be made to expedite the transfer to the operating unit in the shortest possible time. These measures are:—

- (1) The arrest of hæmorrhage in the superficial wound.
- (2) The closure of a sucking wound by a wet dressing or a pad of gauze smeared with vaseline, and kept tightly applied by adhesive strapping if small, or by suture of the chest wall if larger.
- (3) Fixation of the mobile chest wall in crushing injuries with multiple rib fractures by adhesive strapping applied from the mid-line in front to the mid-line behind.
- (4) General treatment for shock.
- (5) Administration of anti-tetanic serum.

Preliminary treatment at the operation centre.

When a patient on arrival at the centre is found to have an open sucking wound, this should be closed before further steps are taken. Where there is free entry and exit of air into the pleural cavity not only is there respiratory distress from mediastinal movement, but the filling of the right side of the heart is seriously interfered with, especially when the wound is right sided.

In cases where there is a valvular wound which allows air to enter the pleural cavity on inspiration, but not to escape again, a tension pneumothorax is set up. The heart is displaced to the opposite side, there is a tympanic note on percussion and absence of breath sounds. An exploring needle passed through an intercostal space will allow the air to escape, and suture of the wound will prevent more entering.

With these exceptions the primary indication in a great many cases is to put the patient to bed and treat him for shock and hæmorrhage. Rest in a semi-sitting position, supported by a bed rest, warmth supplied by hot water bottles, electric lamps in a cradle, or an electrical blanket, morphia, a blood transfusion if necessary, are the usual procedures. To these may be added oxygen in a concentration sufficient to raise the alveolar oxygen to 80—90 per cent. This can be obtained by the B.L.B. mask with 6—7 litres of oxygen a minute. As far as this country is concerned, this treatment is still experimental, but good accounts of it come from America.

If the patient is in good condition it is an advantage for an X-ray examination to be made to obtain information as to the numbers and sites of metallic foreign bodies. If a portable apparatus is available, this can be done with little disturbance

of the patient in his bed. A single antero-posterior film is usually all that is necessary at this stage. While very exact X-ray localisation of foreign bodies is imperative before late operations, it is usually easy to follow the track of the wound in a primary operation. To attempt it on a recently resuscitated patient may undo all the good which has been obtained, as the necessary movement of the patient is very exhausting.

Indications for expectant treatment.

Where the wounds are clean punctures, such as may be made by a rifle bullet or tiny shell fragments, whether the missile is retained or not, there is no urgent need to operate. If the wounds are of this character and a moderate hæmothorax is present, it is better to leave it alone at first. With these exceptions the majority of thoracic wounds are better submitted to early operation.

Operative treatment.

Anæsthesia by nitrous oxide and oxygen given by an apparatus which allows a small positive pressure when necessary is well borne and is very suitable. Local anæsthesia in the chest wall is better not used owing to the danger of spreading infection in the tissues, but for some cases spinal anæsthesia supplemented by oxygen given by a mask may be used.

Operations will be dealt with in detail in other papers in this series, but the general principles are:—

(1) All wounds of the chest wall are radically excised, both soft tissues and fractured bones.

(2) If the pleura is found to be open, even by a small hole, the wound is extended in an intercostal space, or if this would not give good access, a new incision is made in the sixth intercostal space postero-laterally.

(3) All blood is removed from the pleural cavity, preferably by suction rather than by rough swabbing.

(4) Foreign bodies are removed from the lung, taking care that fragments of clothing as well as pieces of metal are looked for. Any lacerated lung tissue is excised, and the wounds in the lung are sutured with catgut.

(5) The chest wall is carefully sutured.

(6) Except when there is reason to believe that all infection has been got rid of with certainty, and where the patient can remain under constant expert care, it is better to drain the pleura by a tube either through the wound if this is in a convenient place, or through a new small wound in a dependent position. The chest wall should be sutured tightly around it, and it should be connected with a water sealed empyema bottle. In this way the expansion of the lung is aided. As air is expelled through the tube, a slight negative pressure is obtained, and in the event of a broncho-pleural fistula occurring, no tension pneumothorax with its alarming symptoms supervenes. If infection of the pleura occurs, drainage is already established. Under war conditions, when large numbers may have to be nursed by a limited personnel, drainage after thoracotomy is almost always safer.

(7) If the pleural cavity is not drained, sufficient air should be removed by an artificial pneumothorax apparatus to cause a negative intrapleural pressure of, say, 0—4 cms. of water.

Treatment of abdomino-thoracic injuries.

Wounds which traverse both the chest and abdomen may be divided into two categories.

Transverse wounds of the lower part of the chest may traverse the diaphragm, particularly if inflicted during expiration. It is better in this case to open the chest rather than the abdomen, as the wounded abdominal viscera can easily be dealt with, by enlarging the wound in the diaphragm if necessary, while if a laparotomy is done first, the intrathoracic lesions would require a thoracotomy in addition. An incision through the abdominal wall causes much more interference with the mechanism of respiration than a thoracotomy does, so that post-operative sequelæ tend to be more severe. During the last war I had the experience of twice performing splenectomy and three times suturing the colon through the diaphragm. All the patients survived.

Where the missile enters the chest and makes its exit through the abdomen, judgment must be used as to which cavity to open. Where the chest signs are slight and the abdominal serious, obviously the abdomen should be opened first. In some cases both must be operated on.

Hæmothorax.

A hæmothorax may be unilateral or bilateral, and if the latter, may be due to the same or distinct projectiles. It may be simple or combined with air as a pneumo-hæmothorax. If there are previous pleural adhesions it may be loculated. The blood may come from the great vessels with rapid death, or from vessels of the chest wall such as the internal mammary or intercostal arteries, almost always accompanied by fracture of ribs. In this case operation is urgently called for.

If, however, the bleeding takes place from the lung, usually from the pulmonary and not bronchial vessels, conditions are different. The blood pressure in the pulmonary circulation is low, and the bleeding usually ceases as the affected lobe is collapsed by the pressure of effused blood. Unless therefore the pulse is steadily rising and the condition of the patient deteriorating, it is better to leave such a hæmothorax alone at first. The blood will excite the formation of a pleural effusion, so that the signs of increasing fluid do not in themselves mean that bleeding is continuing.

If the bleeding is caused by a bullet or small fragment, the blood may remain unclotted for some time, but with larger wounds it clots readily. The clot as it contracts squeezes out serum usually coloured red by hæmolysis, so that it is often mistaken for unclotted blood.

While it is an advantage to leave a moderate hæmothorax alone for a time, the blood is a good culture medium and often becomes infected. If left to absorb it may produce functional disabilities due to pleural adhesions and immobility of the ribs. It is better then, even in the absence of infection, to remove it. This may be done by simple aspiration or by inducing a pneumothorax and introducing two cannulæ, one for a thoracoscope and the other for an aspirating tube, by means of which blood clot can be broken up and removed as well as the fluid. This aspiration is best done between the sixth and eighth day.

Infection of the blood can only be determined with certainty by bacteriological examination, unless a sample is found to be foul-smelling. Constitutional signs may be due to a sterile pleural effusion excited by the blood, and not to infection, and are no safe guide. In all cases where infection occurs an open operation is called for, all clot and blood being removed. If done early, it is not always necessary to drain. The chest may be closed, M. and B. 693 administered, and the pleura kept dry by repeated aspiration. Even without the drug this treatment succeeded in many cases in the last war.

Where bilateral hæmothorax occurs, one side may be infected and one sterile, or both may become infected. If one side has to be drained the other should be treated as long as possible by aspiration.

Treatment of crushing wounds.

Where a section of the chest wall is rendered mobile by the fracture of several ribs in two places, it is important that concomitant injuries such as scalp wounds, fractures of long bones, etc., should not be treated radically at first. The mortality is high. After immobilisation of the chest wall by strapping, or if this is inefficient, by passing sutures round two or three ribs and tying them over a metal bar supported on two rubber sponges on the chest wall, it is unwise to excise scalp wounds and deal with fractures on a permanent basis. The added shock may kill the patient. It is better just to apply dressings to wounds, and fix a fractured femur in a Thomas splint over the clothes for a time.

Post-operative treatment.

The treatment of post-operative complications and late operations is an extensive subject requiring a special article, but attention may here be drawn to the necessity of restoring function by properly administered breathing and physical exercises. The old blowing of bottles is quite ineffective, and should be obsolete. Many cases of persisting dyspnœa are due to inco-ordination between the movements of the diaphragm and ribs, and can be cured by re-education.