Chest Injury

- Thoracic injury accounts for 25% of all severe injuries.
- In a further 25%, it may be a significant contributor to the subsequent death of the patient.
- In most of these patients, the cause of death is haemorrhage.
- About 80% of patients with chest injury can be managed non-operatively.
- The key to a good outcome is early physiological resuscitation followed by a correct diagnosis.

Investigations

- Routine investigation in the emergency department of injury to the chest is based on clinical examination, supplemented by chest radiography.
- **Ultrasound** can be used to differentiate between contusion and the actual presence of blood.
- **Extended focused assessment with sonar for trauma (eFAST)** is becoming the most common investigation.
- The technique uses sonar assessment in the chest, looking for a cardiac tamponade or free blood and air in the hemithorax on each side, and assessment for blood in the abdominal cavity, in the paracolic gutters, subdiaphragmatic spaces and pelvis.

- In the physiologically grossly unstable patient, where physical examination is inconclusive and there is no time for radiological investigations, insertion of an **underwater chest drainage tube** can be a diagnostic procedure as well as a therapeutic one, and the benefits of insertion often outweigh the risks.
- **The computed tomography (CT) scan with contrast** allows for three-dimensional reconstruction of the chest and abdomen, as well as of the bony skeleton.
- It has become the principal and most reliable examination for major injury in thoracic trauma.
- CT scanning has replaced angiography as the diagnostic modality of choice for the assessment of the thoracic aorta and mediastinal vessels.

- The pitfalls of investigation are:
  - failure to assess tracheal shift immediately above the sternal notch clinically
  - failure to percuss and auscultate both front and back in a supine patient (an inflated lung will ‘float’ on a haemothorax, so auscultation from the front may sound normal);
  - failure to pass a nasogastric tube if rupture of the diaphragm is suspected
  - a supine chest radiograph can show a haemothorax as a homogenous increase in opacity of the hemithorax; this can cause confusion between the darker side and the lighter side, as to which may be a haemothorax (less radiolucent), or a pneumothorax (more radiolucent).
  - pursuing radiological investigation instead of resuscitation in the unstable patient.

Closed management of chest injuries

- About 80% of chest injuries can be managed with the insertion of an intercostal drain only.
- Do not close a sucking chest wound until a drain is in place.
- If bleeding persists, the chest will need to be opened and direct haemostatic control is obtained.

Immediate life-threatening injuries

- Life-threatening injuries can be remembered as the ‘deadly dozen’.
- Six are immediately life threatening and should be sought for and managed during the primary survey and six are potentially life threatening and should be detected during the secondary survey.
- A high index of suspicion must be maintained thereafter to diagnose the potential threats to life, as their symptoms and signs can be very subtle.

Airway obstruction

- Early intubation is very important, particularly in cases of neck haematoma or possible airway oedema.
- Airway distortion can be insidious and progressive and can make delayed intubation more difficult if not impossible.

Tension pneumothorax

- A tension pneumothorax develops when a ‘one-way valve’ air leak occurs either from the lung or through the chest wall.
- Air is sucked into the thoracic cavity without any means of escape, completely collapsing then compressing the affected lung.
- The mediastinum is displaced to the opposite side, decreasing venous return and compressing the opposite lung.
- The most common causes are penetrating chest trauma, blunt chest trauma with a parenchymal lung injury and air leak that did not spontaneously close, iatrogenic lung injury and mechanical positive pressure ventilation.

- The patient is increasingly restless with tachypnoea, dyspnoea and distended neck veins.
- Clinical examination may reveal tracheal deviation.
- There will also be hyper-resonance and decreased or absent breath sounds over the affected hemithorax.
- Tension pneumothorax is a **clinical** diagnosis and treatment should never be delayed by waiting for radiological confirmation.
- Treatment consists of immediate decompression, initially by rapid insertion of a large-bore cannula into the second intercostal space in the mid-clavicular line of the affected side, then followed by insertion of a chest tube through the fifth intercostal space in the anterior axillary line.

Pericardial tamponade

- Needs to be differentiated from a tension pneumothorax in the shocked patient with distended neck veins.
- It is most commonly the result of penetrating trauma.
- Accumulation of a relatively small amount of blood into the non-distensible pericardial sac can produce compression of the heart and obstruction of the venous return, leading to decreased filling of the cardiac chambers during diastole.
- All patients with penetrating injury anywhere near the heart plus shock must be considered to have a cardiac injury until proven otherwise.

- The presentation consists of central venous pressure elevation, decline in arterial pressure with tachycardia and muffled heart sounds.
- However, in cases in which major bleeding from other sites has taken place, the neck veins may be flat.
- A central line should be inserted, checking for a rising central venous pressure.
- A high index of suspicion and further diagnostic investigations will be needed to make the diagnosis is those cases that are not clinically obvious.
- These include an eFAST showing fluid in the pericardial sac.
- This is the most expeditious and reliable diagnostic tool, or chest radiography looking for an enlarged heart shadow.

- Needle pericardiocentesis has been suggested.
- However, in penetrating injury to the heart there is usually a substantial clot in the pericardium, which may prevent aspiration.
- A dry pericardiocentesis proves only that there is a ‘clot’ on both ends of the needle!
- Pericardiocentesis has a high potential for iatrogenic injury to the heart and it should, at the most, be regarded as a desperate temporising measure in a transport situation.
- The correct immediate treatment of tamponade is operative, either via a subxiphoid window, or by open surgery.

Open pneumothorax ('sucking chest wound')

- This is due to a large open defect in the chest (>3 cm), leading to immediate equilibration between intrathoracic and atmospheric pressure.
- If the opening in the chest wall exceeds about two-thirds of the diameter of the trachea, then with each inspiratory cycle, air will be preferentially drawn through the defect, rather than through the trachea.
- Air accumulates in the hemithorax (rather than in the lung) with each inspiration, leading to profound hypoventilation on the affected side and hypoxia.
- If there is a valvular effect, increasing amounts of air in the pleura will result in a tension pneumothorax.

- Initial management consists of promptly closing the defect with a sterile occlusive plastic dressing (e.g. Opsite®), taped on three sides to act as a flutter-type valve.
- A chest tube is inserted as soon as possible in a site remote from the injury site.

Massive haemothorax

- The most common cause of massive haemothorax in blunt injury is continuing bleeding from torn intercostal vessels or occasionally from the internal mammary artery secondary to fractures of the ribs.
- In penetrating injury, a variety of viscera, both thoracic and abdominal (with blood leaking through a hole in the diaphragm from the positive pressure abdomen into the negative pressure thorax) may be involved.
- Accumulation of blood in a haemothorax can significantly compromise respiratory efforts, compressing the lung and preventing adequate ventilation.

- Presentation is with haemorrhagic shock, flat neck veins, unilateral absence of breath sounds and dullness to percussion.
- The initial treatment consists of correcting the hypovolaemic shock, insertion of an intercostal drain and, in some cases, intubation.
- Initial drainage of more than 1500 mL of blood or ongoing haemorrhage of more than 200 mL/h over 3–4 hours is generally considered an indication for urgent thoracotomy.

Flail chest

- This condition usually results from blunt trauma associated with multiple rib fractures, and is defined as three or more ribs fractured in two or more places.
- The blunt force typically also produces an underlying pulmonary contusion.
- The diagnosis is made clinically in patients who are not ventilated, not by radiography.
- To confirm the diagnosis the chest wall can be observed for paradoxical motion of a chest wall segment.
- Voluntary splinting of the chest wall occurs as a result of pain, so mechanically impaired chest wall movement and the associated lung contusion all contribute to the hypoxia.
- There is a high risk of developing a pneumothorax or haemothorax.

- The CT scan, with contrast to display the vascular structures and a 3-D reconstruction of the chest wall, is the gold standard for diagnosis.
- Treatment consists of oxygen administration, adequate analgesia (including opiates) and physiotherapy.
- If a chest tube is *in situ*, topical intrapleural local analgesia introduced via the tube, can also be used.
- Ventilation is reserved for cases developing respiratory failure despite adequate analgesia and oxygen.
- Surgery to stabilise the flail segment using internal fixation of the ribs may be useful in a selected group of patients with isolated or severe chest injury and pulmonary contusion.

Potentially life-threatening injuries

Thoracic aortic disruption

- Traumatic aortic rupture is a common cause of sudden death after an automobile collision or fall from a great height.
- If the adventitia is intact, the patient may remain haemodynamically stable.
- For this subgroup of immediate survivors, salvage is frequently possible if aortic rupture is identified and treated early.

- Aortic disruption should be clinically suspected in patients with gross asymmetry in systolic blood pressure (between the two upper limbs, or between upper and lower limbs), widened pulse pressure and chest wall contusion.
- Erect chest radiography can also suggest thoracic aortic disruption, the most common radiological finding being a widened mediastinum.
- The diagnosis is confirmed by a CT scan of the mediastinum, or possibly by transoesophageal echocardiography, in unstable patients who cannot be moved to the scanner.
- Initially, management consists of control of the systolic arterial blood pressure (to less than 120 mmHg).
- Thereafter, an endovascular intra-aortic stent can be placed, or the tear can be operatively repaired by direct repair or excision and grafting using a Dacron graft.

Tracheobronchial injuries

- Severe subcutaneous emphysema with respiratory compromise can suggest tracheobronchial disruption.
- A chest drain placed on the affected side will reveal a large air leak and the collapsed lung may fail to re-expand.
- Bronchoscopy is diagnostic.
- Treatment involves intubation of the unaffected bronchus followed by operative repair.
- Referral to a trauma centre is advised.

Blunt myocardial injury

- Significant blunt cardiac injury that causes haemodynamic instability is rare.
- Blunt myocardial injury should be suspected in any patient sustaining blunt trauma who develops early ECG abnormalities.
- Two-dimensional echocardiography may show wall motion abnormalities.
- A transoesophageal echocardiogram may also be helpful.
- All patients with myocardial contusion diagnosed with conduction abnormalities are at risk of developing sudden dysrhythmias and should be closely monitored.

Diaphragmatic injuries

- Any penetrating injury below the fifth intercostal space should raise suspicion of diaphragmatic penetration and, therefore, injury to abdominal contents.
- Most diaphragmatic injuries are silent and the presenting features are those of injury to the surrounding organs.
- There is no single standard investigation.
- The most accurate evaluation is by video-assisted thoracoscopy (VATS) or laparoscopy, the latter offering the advantage of allowing the surgeon to proceed to a repair and additional evaluation of the abdominal organs.
- Operative repair is recommended in all cases.
- All penetrating diaphragmatic injury must be repaired via the abdomen and not the chest, to rule out penetrating hollow viscus injury.

Oesophageal injury

- Most result from penetrating trauma; blunt injury is rare.
- The patient can present with odynophagia, subcutaneous or mediastinal emphysema, pleural effusion, air in the perioesophageal space and unexplained fever.
- Mediastinal and deep cervical emphysema are evidence of an aerodigestive injury until proven otherwise.
- The mortality rate rises exponentially if treatment is delayed.
- A combination of oesophagogram in the decubitus position and oesophagoscopy confirm the diagnosis in the great majority of cases.
- The treatment is operative repair of any defect and drainage.

Pulmonary contusion

- Occurs more frequently following blunt trauma, usually associated with a flail segment or fractured ribs.
- This is a very common, potentially lethal injury and the major cause of hypoxaemia after blunt trauma.
- The natural progression of pulmonary contusion is worsening hypoxaemia for the first 24–48 hours.
- Contrast CT scanning can be confirmatory.
- Haemoptysis or blood in the endotracheal tube is a sign of pulmonary contusion.
- In mild contusion, the treatment is oxygen administration, pulmonary toilet and adequate analgesia.
- In more severe cases mechanical ventilation is necessary.
- Normovolaemia is critical for adequate tissue perfusion and fluid restriction is not advised.

Emergency Thoracic Surgery

- Emergency thoracic surgery is an essential part of the armamentarium of any surgeon dealing with major trauma.
- A timely surgical intervention for the correct indications can be the key step in saving an injured patient's life.
- The clinical decision as to whether a patient requires ED surgery or can be transferred to the operating room can be complex.
- Emergency department thoracotomy should be reserved for those patients suffering **penetrating** injury **in whom signs of life are still present**.

- Planned emergency thoracotomy implies an emergency thoracotomy performed as a planned procedure in the operating room, directed at the management of a specific injury.
- As such, the approach chosen is dependent on the indication for surgery and the organ injured.