Chest trauma

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Abstract

This article summarises major life-threatening injuries in thoracic trauma. Timing, clinical features, necessary investigations and interventions are described within the clinical approach of primary and secondary surveys. Emphasis is on immediate resuscitation with some discussion on further management. Injuries included are tension pneumothorax, open pneumothorax, massive haemothorax, pericardial tamponade, aortic injuries, cardiac injuries, lung contusion, flail chest, diaphragmatic injury, airway injury and oesophageal rupture.

Keywords Aorta; blunt; flail; haemothorax; penetrating; pneumothorax; tamponade; thorax; trauma

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Learning objectives

After reading this article you should be able to:

- list the mechanism of common deadly injuries in chest trauma
- describe why specific injuries require urgent interventions
- describe a systematic approach to assessing and managing thoracic injuries

Chest injuries

Chest injuries are commonly responsible for 20–25% of deaths due to trauma. These injuries arise from penetrating (usually gunshot or knife) and non-penetrating trauma (deceleration injuries and blunt trauma mechanisms such as motor vehicle accidents (MVA), falls, crushes, blasts, and burns).

This article addresses common life-threatening injuries (Table 1) appearing:

- immediately
- early (in the primary survey)
- late (hours to days after hospital presentation).

Injuries may be single organ or more complex depending on the mechanism and pattern of injury (stabbing vs. motor vehicle crash). Penetrating wounds usually require earlier (sometimes during resuscitation) surgical intervention, with faster recovery. Blunt injuries more likely require complex imaging after initial stabilisation and longer recovery times.

Thoracic spine and spinal cord injuries, whilst significant and common, are not dealt with in this review, but are addressed elsewhere.

The approach to the management of chest trauma contributes within a more comprehensive approach to resuscitation in the context of major trauma. The primary survey and correction of immediate life-threatening injuries includes a systematic, preferably team approach to assessment and correction of respiratory, cardiovascular and neurological injuries. This involves:

- securing or maintaining a patent airway
- protecting the patient from further spinal cord injury
- optimizing ventilation and oxygenation
- controlling major external haemorrhage
- establishing large-bore intravenous access for necessary drug and fluid delivery
- blood sampling for cross-match, blood counts, biochemistry, blood gas analysis
- assessing neurological deficits
- full exposure of the patient
- immediate access to chest and pelvic X-ray, and focussed assessment with sonography for trauma (FAST).

Invasive procedures

Further invasive procedures are sometimes immediately necessary in the resuscitation of patients with chest trauma, as follows.

- Tube thoracostomy (or finger thoracostomy): an intercostal catheter (ICC) is placed in the mid-axillary line at the fourth or fifth intercostal space.
- Emergency department thoracotomy is indicated in blunt and penetrating thoracic trauma, where arrest is witnessed or within 10 minutes of arrest if suitably skilled staff are present.[1] This allows for internal cardiac compressions. Closed chest compression is rarely successful in the trauma setting.
- Needle chest decompression: a large-bore cannula inserted through the second intercostal space in the mid-clavicular line.

Primary survey resuscitation

Chest injuries include five immediate life-threatening conditions which dominate the primary survey (Table 2).

Tension pneumothorax, in which air accumulates under positive pressure in the pleural space, collapsing and shifting

Deadly injury; typical timing

Immediate (at scene)	Early (minutes to hours)	Late (hours to days)
• Aortic rupture	• Tension pneumothorax	• Flail chest
• Cardiac chamber rupture	• Open pneumothorax	• Lung contusion
• Cardiac arrhythmia	• Massive haemothorax	• Sepsis
	• Pericardial tamponade	
	• Aortic tears then rupture	

Table 1

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Classic signs differentiating deadly injuries

	RR	BP	HR	O_2sats	JVP	Tracheal deviation	Chest examination/auscultation	Other signs
Tension pneumothorax	↑	↓	↑	↓	↑	Contralateral	Quieter, hyper-expanded, hyper-resonant	
Open pneumothorax	↑	↓/–	↑	↓	↑/–	Contralateral or midline	Quieter, hyper-expanded, hyper-resonant	Sucking wound
Massive haemothorax	↑	↓	↑	↓/–	↓/–	Contralateral or midline	Quieter, dull percussion. Reduced expansion	
Pericardial tamponade	↑	↓	↑	↓/–	↑↑	Midline	Muffled heart sounds	Pericardial fluid on FAST scan. Pulses paradoxus (10%)
Flail chest	↑	–	↑	↓/–	–	Midline	Paradoxical chest wall movement during spontaneous ventilation	Signs may disappear after intubation
Lung collapse (e.g. after right main bronchus intubation	?	–	–	↓	–	Ipsilateral	Quieter and reduced expansion over collapse	

Table 2

mediastinal structures away from the affected side. Death occurs due to obstruction to venous return causing obstructive shock, coupled to hypoxia due to lung collapse.

Signs: hypoxia, tachycardia, tachypnoea, hypotension and contralateral tracheal deviation. Reduced air sounds, hyper-resonance, hyper-expansion and reduced thoracic wall movements on the affected side. Subcutaneous emphysema is common.

Treatment traditionally included needle decompression, followed by ICC insertion. Many now advocate tube thoracostomy rather than needle decompression due to higher failure rates of needle thoracostomy.[2] In the case of cardiac arrest, bilateral tube or finger thoracostomy is indicated rather than needle thoracostomy.

Where cardiorespiratory compromise is present and tension pneumothorax is suspected clinically, needle decompression may be performed without awaiting imaging, but must be followed by definitive intercostal catheter placement. The catheter usually need *not* be under suction. A one-way valve or single bottle drainage system will usually suffice.

Bilateral pneumothorax is a difficult diagnosis to make clinically. If suspected or confirmed on imaging (ultrasound or X-ray), bilateral tube thoracostomies are indicated. Simple pneumothorax may be managed conservatively with surveillance chest X-ray (CXR) at 4–6 hours if small, but tube thoracostomy should be placed if intubation is required, or the pneumothorax is expanding.

Open pneumothorax involves an open wound communicating with the pleural space, leading eventually to death by tension pneumothorax.

Signs are the same as simple or tension pneumothorax, but include a 'sucking' wound allowing air to enter the thorax during inspiration.

Treatment consists of application of an occlusive dressing, sealed on three out of four sides allowing air to escape from the pleural space, and preventing entry of air in through the wound. This is accompanied by ICC insertion at a sight separate from the wound. Positive pressure ventilation will reverse the 'sucking' negative intrapleural pressure during inspiration, but can convert a simple pneumothorax to a tension pneumothorax. Tube thoracostomy should precede airway intubation and positive pressure ventilation.

Massive haemothorax occurs when a large amount of blood (typically >1.5 litres) accumulates in the pleural cavity. This can cause lung compression with collapse, and contralateral mediastinal shift. Death occurs due to haemorrhagic shock and further cardiovascular compromise due to obstruction to venous return, coupled with respiratory compromise.

Signs that distinguish haemothorax from pneumothorax are dull percussion note rather than hyper-resonance. Investigations that confirm haemothorax include CXR, CT scan and ultrasound.

Treatment is immediate large-bore intercostal catheter insertion, requiring low pressure suction (<20 cmH_2O), fluid resuscitation and replacing necessary blood and coagulation products. Surgical thoracotomy should be considered and is indicated if large rates, typically more than 200 ml/hour, of bleeding continue.

Pericardial tamponade is caused by bleeding (as little as 50 ml) into the pericardial space. It is more common in penetrating wounds but should be considered in blunt trauma where there is distended neck veins and hypotension out of keeping with blood loss volume. Death occurs because of cardiovascular compromise, due to reduced venous return because of collapsing right-sided heart chambers and subsequent failure of delivery of blood to the left ventricle.

Signs include hypotension, pulsus paradoxus >10 mmHg, tachycardia, tachypnoea, raised JVP and dull heart sounds. ECG changes include diminished voltages and electrical alternans. None of these signs is 100% sensitive. Investigations to confirm the diagnosis include FAST scan or formal echocardiography.[3]