

Chapter 30, Chest Injuries

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1. Introduction to Chest Injuries

- **chest trauma** results in over 1.2 million emergency department visits annually [6].
- These injuries can affect the **heart, lungs, and great vessels** [7].
- They can be caused by **blunt trauma, penetrating trauma, or both** [7].
- EMTs must immediately treat any injuries that interfere with **normal breathing** [8].
- Internal bleeding can accumulate, compressing the heart and lungs [9].
- Air can also collect, preventing the lungs from expanding [9].

Trauma Type	Description	Causes
Blunt Trauma	Skin is not broken [46]	Generally caused by blunt force [47]

Penetrating Trauma	Object penetrates the chest wall [55]	Object pierces the chest wall [55]
Both	Combination of blunt and penetrating forces [7]	Can involve both blunt impact and penetration [7]

2. Anatomy and Physiology of the Chest

- **ventilation** is the body's ability to move air in and out [12].
- **oxygenation** is delivering oxygen to the blood by diffusion [13].
- Injuries affecting ventilation and oxygenation are serious and life-threatening [13].
- The **thoracic cage** extends from the neck to the diaphragm [14].
- Penetrating chest injuries can also injure the liver, spleen, or stomach [15].
- Striated muscle like **intercostal muscles** allows for ventilation [17].
- intercostal muscles extend between the ribs and allow the chest to expand [18].
- The **neurovascular bundle** lies along the ribs and can cause significant bleeding [21].
- The **pleura** covers the lungs and thoracic cavity [23].
- **Parietal pleura** lines the chest wall, and **visceral pleura** covers the lung [24].
- pleural fluid allows lungs to move freely [25].
- The ribs connect to the vertebrae and sternum [26].
- The **trachea** divides into bronchi that supply air to the lungs [27].
- The thoracic cage contains the heart and **great vessels** [28].
- The **mediastinum** is the central chest area with the heart, vessels, esophagus, and trachea [29].
- The **diaphragm** separates the thoracic and abdominal cavities [30].

3. Mechanics of Ventilation and Respiration

- intercostal muscles and the diaphragm contract during inhalation [32].
- This decreases intrathoracic pressure, creating negative pressure [34].
- Negative pressure allows air into the lungs [34].

- Muscles relax during exhalation, allowing air out [35].
- Spinal cord injuries below C5 may affect intercostal muscles [36].
- The diaphragm should still contract with intact phrenic nerves [37].
- Spinal injuries at C3 or above can cause complete inability to breathe [37].
- **tidal volume** is the air moved in a single breath, about 500 ml [38].
- **minute volume** is tidal volume multiplied by breaths per minute [40].
- Changing tidal or minute volume affects air movement [41].
- Bag-mask devices can deliver 1000 to 1500 ml of air [42].
- Overventilation can cause gastric distension and impair lung function [43].
- Overventilation can also increase intrathoracic pressure, reducing cardiac output [44].

Measurement	Calculation	Average Value
Tidal Volume	Air moved in one breath	~500 ml [39]
Minute Volume	Tidal Volume x Breaths per Minute	Affects air movement [41]

4. Types of Chest Injuries: Closed vs. Open

- There are two main types: **open or closed** [45].
- In **closed chest injuries**, the skin is not broken [46].
- These are usually caused by **blunt trauma** [47].
- Blunt trauma can cause **cardiac contusion** and **pulmonary contusion** [48].
- Heart damage can lead to **cardiogenic shock** [50].
- Lung bruising can decrease gas exchange, causing **hypoxic and hypercarbic states** [52].
- **Rib fractures** can lacerate lung tissue and vessels, leading to **hypovolemic shock** [54].
- In an **open chest injury**, an object penetrates the chest wall [55].
- This causes immediate damage, but symptoms can develop over time [55].
- Do not remove an **impaled object** as it may be stopping bleeding [56].
- Removing it could cause heavy bleeding and further damage [57].
- Blunt trauma can fracture ribs, sternum, chest wall, and damage the aorta [58].

- Nearly one-third of car crash fatalities are due to **aortic rupture** [59].

Injury Type	Skin Condition	Cause	Potential Consequences
Closed Chest Injury	Not broken [46]	Blunt trauma [47]	Cardiac/Pulmonary contusion, Cardiogenic/Hypovolemic shock [48]
Open Chest Injury	Broken [55]	Penetrating object [55]	Immediate damage, potential bleeding from impaled object [55]

5. Signs and Symptoms of Chest Injuries

- Signs include **pain at the injury site** [60].
- Pain often worsens with breathing [60].
- Look for **bruising on the chest wall** [60].
- **Crepitus** may be felt when touching the chest [60].
- Any **penetrating injury** is a sign [60].
- **Dyspnea** (difficulty breathing) is common [60].
- One or both sides of the chest may not expand normally [60].
- A **rapid weak pulse** and **low blood pressure** can indicate injury [60].
- Look for **cyanosis** around the lips or fingernails [60].
- **Diminished breath sounds** on one side may be present [60].
- Low oxygen saturation is a key sign [60].
- Patients often have **tachypnea** (rapid breathing) [61].
- Respirations may be shallow due to pain [61].

6. Patient Assessment for Chest Trauma

- Begin with **scene size-up**, ensuring safety and precautions [62].
- Do not disturb evidence if it's a crime scene [63].
- Request law enforcement for violent scenes [64].
- Call for utility, fire, and ALS early if needed [65].
- Determine the **mechanism of injury**, common in crashes, falls, industrial accidents, and assaults [66].

- Determine the number of patients and consider **spinal stabilization** [68].
- Perform a **primary assessment**, starting with a general impression [69].
- Address **life-threatening hemorrhage** immediately, even before airway [70].
- Note the patient's level of consciousness [72].
- Perform a **rapid physical exam** [72].
- Assess **airway and breathing** (A and B) [73].
- Ensure a clear and patent airway [75].
- Consider early **cervical spinal immobilization** for blunt trauma [76].
- Note **jugular vein distension**, a sign of pressure on the heart [77].
- Determine if breathing is present and adequate [78].
- Inspect for **DCAP-BTLS** (deformities, contusions, abrasions, punctures, burns, tenderness, lacerations, swelling) [78].
- Check for **equal chest wall expansion** [79].
- Look for **paradoxical motion**, indicating multiple fractured ribs [79].
- Apply an **occlusive dressing** to all penetrating chest injuries [80].
- Apply **oxygen** with a non-rebreather mask at 15 liters [81].
- Provide **positive pressure ventilation** at 100% if breathing is inadequate [81].
- Be alert for decreasing oxygen saturation [82].
- Watch for signs of impending **tension pneumothorax** [82].
- Assess **circulation** (C) [73].
- Assess pulse presence and adequacy [83].
- Consider the patient in shock if the pulse is abnormal or skin is pale, cool, or clammy [83].
- Address life-threatening external bleeding immediately [83].
- Make **transport decisions**, prioritizing those with airway, breathing, or circulation issues [84].
- Pay attention to subtle clues like skin appearance, consciousness, and a sense of impending doom [84].
- When in doubt, transport the patient rapidly [84].
- Take **history**, investigating the chief complaint and mechanism of injury [86].
- Identify associated signs, symptoms, and pertinent negatives [86].
- Ask about the mechanism, speed, safety equipment, weapon, and number of wounds [87].

- Get a **SAMPLE history** (Signs, Allergies, Medications, Past medical history, Last oral intake, Events leading up to injury) [87].
- Complete a basic evaluation if time allows [87].
- Perform a **secondary assessment** [88].
- For isolated injury, focus on the affected area [89].
- Ensure wounds are identified and bleeding is controlled [90].
- Locate the extent of the injury and assess underlying systems [90].
- Assess the anterior and posterior chest wall [90].
- Note changes in the ability to maintain adequate respirations [90].
- For significant trauma, perform a **rapid physical exam** using DCAP-BTLS [91].

Assessment Step	Key Actions	Source
Scene Size-up	Ensure safety, identify MOI, consider spinal stabilization	[62]
Primary Assessment	General impression, address hemorrhage, assess LOC, rapid physical exam	[69]
Airway & Breathing	Ensure patent airway, spinal immobilization (blunt trauma), assess breathing	[74]
Interventions (A&B)	Apply occlusive dressing, oxygen, positive pressure ventilation	[80]
Circulation	Assess pulse, look for shock, control external bleeding	[83]
Transport Decision	Prioritize rapid transport for ABC problems	[84]
History Taking	Investigate chief complaint, MOI, get SAMPLE history	[86]
Secondary Assessment	Physical exam focusing on isolated or significant trauma, DCAP-BTLS	[88]

7. Vital Signs and Reassessment

- Assess **pulse, respiration, blood pressure, skin condition, oxygen saturation, and pupils** [92].
- Re-evaluate the patient every five minutes or less [93].
- A rapid pulse or respiratory rate can indicate **hypoxia or blood loss** [93].
- Increased work of breathing is shown by the use of **accessory muscles** [94].
- Pulse and respiratory rates may decrease in later stages [94].
- **Reassess** by repeating the primary assessment [95].
- Reassess the chief complaint [95].
- Re-evaluate airway, breathing, pulse, perfusion, and bleeding [95].

8. Management and Interventions for Chest Injuries

- Reassess vital signs and observe trends [96].
- Provide appropriate **spinal immobilization** for blunt trauma with suspected spinal injuries [96].
- Maintain an **open airway** [96].
- Control significant visible bleeding [96].
- Place a **vented chest seal or semi-vented dressing** over penetrating trauma [96].
- Provide **aggressive treatment for shock** [96].
- **Transport rapidly** [96].
- Do not delay transport for non-life-saving treatments [97].
- These treatments can be performed en route [97].
- Communicate all relevant information to the receiving facility staff [97].

Key Intervention	Purpose	Source
Spinal Mobilization	Protect potential spinal injuries in blunt trauma	[96]
Maintain Open Airway	Ensure clear passage for air	[96]
Control Visible Bleeding	Stop external blood loss	[96]

Vented Chest Seal/Dressing	Seal penetrating wounds, allow air to escape	[96]
Aggressive Shock Treatment	Address inadequate perfusion	[96]
Rapid Transport	Get patient to higher level of care quickly	[96]

9. Specific Chest Injuries: Pneumothorax

- **Pneumothorax** is the accumulation of air in the pleural space [98].
- Air enters through a hole in the chest wall or lung surface [99].
- Breathing attempts cause the lung on that side to collapse [100].
- Blood passing through the collapsed lung is not oxygenated [101].
- **Diminished breath sounds** may occur if the lung collapses significantly [102].
- **Absent breath sounds** may indicate a **tension pneumothorax** [103].
- A **sucking sound** on inhalation and rushing air on exhalation indicate a penetrated chest [103].
- An **open chest wound** is called an open pneumothorax or sucking chest wound [105].
- These wounds must be sealed with an **occlusive dressing** after airway management and oxygen [106].
- A **flutter valve** is a one-way valve letting air out but not in [107].
- Follow local protocols for flutter valves [108].
- An occlusive dressing can be taped on three sides to allow air to leak from one side [109].
- Monitor for signs of **tension pneumothorax** after applying the dressing [110].
- If tension pneumothorax develops, open one side of the occlusive dressing [111].
- A **simple pneumothorax** does not significantly change cardiac physiology [114].
- It's often caused by **blunt chest trauma** resulting in fractured ribs [114].
- Signs include **pleuritic pain, dyspnea, tachypnea, accessory muscle use, decreased oxygen saturation, and subcutaneous emphysema** [115].

- Late findings can be **decreased breath sounds, lethargy, and cyanosis** [116].
- Pre-hospital treatment involves high flow O2 and monitoring [117].
- **tension pneumothorax** is ongoing air accumulation in the pleural space [118].
- Increased pressure causes complete collapse of the uninflated lung [119].
- The **mediastinum** is pushed into the opposite cavity [120].
- It's more commonly caused by blunt trauma where a fractured rib lacerates the lung [120].
- Common signs include chest pain, tachycardia, marked respiratory distress, low oxygen saturation, and absent or decreased lung sounds on the affected side [121].
- Signs of shock, JVD, cyanosis, or tracheal deviation may also be present but not always [121].
- Pre-hospital treatment includes ventilatory support with high flow oxygen [122].
- Request advanced life support and transport immediately [122].
- Needle decompression may be performed by ALS or ED staff [123].

Type of Pneumothorax	Cause	Signs/Symptoms	Management
Simple Pneumothorax	Blunt trauma, fractured ribs [114]	Pleuritic pain, dyspnea, tachypnea, accessory muscle use, decreased O2 sat, subcutaneous emphysema [115]	High flow O2, monitor readings and breath sounds [117]
Open Pneumothorax	Penetrating chest wound [105]	Sucking sound on inhalation, rushing air on exhalation [103]	Seal with occlusive dressing (vented or taped on 3 sides), monitor [106]
Tension Pneumothorax	Ongoing air accumulation, lung laceration [118]	Chest pain, tachycardia, respiratory distress, low O2 sat, absent/decreased lung	Ventilatory support with high flow O2, request ALS, immediate transport [122]

		sounds, JVD, cyanosis (late) [121]	
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10. Specific Chest Injuries: Hemothorax and Hemopneumothorax

- **hemothorax** is the collection of blood in the pleural space [\[124\]](#).
- This blood comes from bleeding around the rib cage, lung, or great vessel [\[125\]](#).
- When both **blood and air** are present, it's called a **hemopneumothorax** [\[127\]](#).
- Suspect a hemothorax if the patient shows signs of **shock** without obvious external bleeding [\[128\]](#).
- **Decreased breath sounds** on the affected side are also a sign [\[128\]](#).
- Bleeding cannot be controlled in the pre-hospital setting [\[129\]](#).
- Provide **rapid transport** to a facility capable of performing surgery [\[129\]](#).

11. Specific Chest Injuries: Cardiac Tamponade

- **cardiac tamponade** occurs when the pericardial sac fills with blood or fluid [\[131\]](#).
- This prevents the heart from pumping enough blood [\[132\]](#).
- Fluid buildup compresses the heart's chambers [\[132\]](#).
- This dramatically impairs the heart's ability to pump blood [\[132\]](#).
- Signs and symptoms are known as **beck's triad** [\[133\]](#).

Component	Description	Source
Distended Jugular Veins	Engorged veins on both sides of the trachea [133]	[133]
Narrowing Pulse Pressure	Decreasing difference between systolic and diastolic BP [133]	[133]
Muffled Heart Tones	Heart sounds are difficult to hear [133]	[133]

- Pre-hospital care includes **supporting ventilations** [\[134\]](#).

- Rapidly transporting the patient to a facility capable of intervention is crucial [134].

12. Specific Chest Injuries: Rib Fractures and Flail Chest

- **Rib fractures** are common, especially in older patients [135].
- Fractures of the upper four ribs suggest a substantial mechanism of injury [136].
- A fractured rib can lacerate the lung surface [137].
- This can cause pneumothorax, tension pneumothorax, hemothorax, or hemopneumothorax [137].
- Patients report localized tenderness and pain when breathing [138].
- Pre-hospital treatment includes **supplemental oxygen** [139].
- A **flail chest** is caused by two or more adjacent fractures in two or more places [140].
- This detaches a segment of the chest wall [140].
- The detached segment moves opposite to normal breathing, called **paradoxical motion** [141].
- paradoxical motion is a late sign [142].
- Pre-hospital treatment includes maintaining the airway [143].
- Provide respiratory support if needed [144].
- Give supplemental oxygen [144].
- Perform ongoing assessments for pneumothorax or respiratory complications [144].
- Treatment may include positive pressure ventilation with a bag valve mask [145].
- Restricting chest wall movement with a bulky dressing is no longer recommended [146].
- flail chest may indicate serious internal damage and possible spinal injury [147].

13. Other Chest Injuries

- **pulmonary contusion** should be suspected with a flail chest [148].
- Alveoli fill with blood, and fluid accumulates, causing hypoxia [148].
- Treatment includes supplemental oxygen and positive pressure ventilations [149].

- **Sternal fractures** require significant force and may involve lungs, vessels, and heart [150].
- **Clavicle fractures** can damage the neurovascular bundle [152].
- Suspect upper rib fractures with medial clavicle fractures [152].
- Be alert for signs of a developing hemothorax [152].
- **traumatic asphyxia** results from severe chest compression [153].
- It causes increased pressure in the chest [153].
- Characteristics include distended neck veins, cyanosis of face and neck, and hemorrhage into the sclera [154].
- This suggests underlying heart injury and possible pulmonary contusions [155].
- Treatment involves ventilatory support with supplemental oxygen and monitoring during transport [156].
- **commotio cordis** is a blunt injury from a sudden blow to the chest [157].
- It occurs during a critical part of the heartbeat [157].
- This results in **immediate cardiac arrest**, often **ventricular fibrillation** [157].
- It is often responsive to defibrillation and early CPR [158].
- More common in sports injuries, suspect it in unconscious patients after a chest blow [159].
- **Laceration of great vessels** can cause massive, rapidly fatal hemorrhage [159].
- .
- Treatment includes CPR, ventilatory support, immediate transport, and monitoring for shock [160].

Injury Type	Cause	Key Features/Signs	Management
Pulmonary Contusion	Flail chest, blunt trauma [148]	Alveoli filled with blood, fluid accumulation, hypoxia [148]	Supplemental O2, positive pressure ventilations [149]
Sternal Fractures	Significant force [150]	May involve lungs, great vessels, heart [151]	Assess for underlying injuries [151]

Clavicle Fractures	Significant force [152]	Possible damage to neurovascular bundle, suspect upper rib fractures, hemothorax [152]	Assess for associated injuries [152]
Traumatic Asphyxia	Severe chest compression [153]	Distended neck veins, face/neck cyanosis, scleral hemorrhage [154]	Ventilatory support, supplemental O2, immediate transport [156]
Comotio Cordis	Sudden blow to chest during critical heartbeat [157]	Immediate cardiac arrest (VF) [157]	Early CPR, defibrillation, suspect in unconscious after chest blow [158]
Great Vessel Laceration	Penetrating/blunt trauma [159]	Massive, rapidly fatal hemorrhage [159]	CPR, ventilatory support, immediate transport, monitor for shock [160]

14. Review and Conclusion

- Aortic shearing kills almost one-third of patients in rapid deceleration car crashes [163].
- The aorta is the body's largest artery [165].
- Shearing from its structures causes rapid bleeding out [166].
- Signs of chest injury do not typically include **hemoemesis** (vomiting blood) [167].
- For an open wound to the chest from a stabbing, the immediate action is to cover the wound with an **occlusive dressing** [167].
- When caring for a patient with signs of pneumothorax, the most immediate concern is **ventilatory inadequacy** [168].
- A one-way flutter valve allows air trapped in the pleural space to be released [169].

- Signs of cardiac tamponade include **distended jugular veins, narrowing pulse pressure, and muffled heart tones (beck's triad)** [133].
- Collapsed jugular veins are not a sign of cardiac tamponade [170].
- traumatic asphyxia, characterized by scleral hemorrhage, is also accompanied by **cyanosis to the face and neck** [171].
- Immediate cardiac arrest in a baseball player hit in the chest is likely **commotio cordis** [172].
- **Paradoxical chest movement** is typically seen in patients with a **flail chest** [174].
- A patient with a large bruise over the sternum and irregular pulse after hitting a steering wheel is likely to have injured their **myocardium** (bruised heart muscle) [175].