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Chest Trauma

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Objectives

Upon completion of this module, you should be able to:

1. Diagnose, resuscitate, stabilize and manage chest trauma patients;
2. Identify common pathophysiologic conditions in chest trauma patients;
3. Describe the components of a primary survey in a chest trauma patient;
4. Generate a differential diagnosis of potential traumatic injuries based on history and physical exam;
5. List commonly utilized imaging modalities in chest trauma;
6. Discuss the eventual disposition of chest trauma patients based on their diagnosis;
7. Appreciate the necessity for emergent surgical intervention in certain chest trauma conditions.

Introduction

The thoracic cavity is the confluens of three major anatomical systems: the airway, lungs and the cardiovascular system. As such, any blunt or penetrating trauma can cause significant disruption to each of these systems that can quickly prove to be life threatening unless rapidly identified and treated. Chest trauma accounts for 25% of mortality in trauma patients.[1,2] This rate is much higher in patients with polytraumatic injuries. 85-90% of chest trauma patients can be rapidly stabilized and resuscitated by a handful of critical procedures. Trauma patients are commonly encountered in not only Level 1 Trauma centers but across all emergency departments. As such emergency medicine providers should be prepared to appropriately evaluate, resuscitate and stabilize any patient with chest trauma.

Unlike other disease entities, trauma patients often present with a known traumatic mechanism such as a car collision, fall, gunshot or stab wound. In rare cases where the patient presents altered and unable to provide any significant history, certain physical examination clues to the presence of trauma include findings such as contusions, lacerations and or deformity on inspection and palpation of crepitus.

In patients who are awake and lucid, chest trauma can present with chest pain to dyspnea to back or abdominal pain and occasionally syncope. Unstable chest trauma patients can present from respiratory distress to frank shock requiring emergent resuscitation. Unstable chest trauma patients can also deteriorate to a traumatic arrest and depending on the mechanism of chest trauma, may be candidates for an ED thoracotomy.

Mechanism of Injury

Thoracic trauma can be distinguished by the mechanism of injury. Blunt trauma refers to mechanisms causing increased intrathoracic pressure such as car collisions (most common cause of thoracic trauma), and falls. By comparison, penetrating trauma largely refers to gunshot and stab wounds, occasionally impalement. There is considerable overlap amongst the various traumatic disorders experienced in both penetrating and blunt chest trauma. However, compared to penetrating trauma, blunt chest trauma patients sometimes have a more subtle presentation. Furthermore, traumatic

arrest secondary to blunt trauma is not conducive to ED thoracotomies and is no longer routinely recommended. Instead ED thoracotomies are reserved for patients with penetrating thoraco-abdominal trauma who experience a traumatic arrest while in the ED or who arrest not more than 20 minutes prior to arrival.

Initial Actions and Primary Survey

Life-threatening injuries associated with thoracic injuries are often identified in the primary survey by carefully assessing the patient's ABCs. The injuries to be identified and treated during the primary surveyare:

1. Airway obstruction
2. Tension pneumothorax
3. Open pneumothorax
4. Flail chest and pulmonary contusion
5. Massive hemothorax
6. Cardiac tamponade

These injuries usually require simple interventions such as intubation, needle decompression, tube thoracotomy, or pericardiocentesis. These life-threatening injuries and related problems are resolved as they are discovered. Chest trauma patients can present to the ED via Emergency Medical Services, in which case they will be back-boarded and collared. They can also present as walk in in which case it is prudent to apply C-Spine collars and proceed with Advanced Trauma Life Support Assessment.

All trauma patients must be managed in accordance with ATLS algorithms[1]:

- A (Airway with c-spine protection): Is the patient speaking in full sentences?
- B (Breathing and Ventilation): Is the breathing labored? Bilateral symmetric breath sounds?
- C (Circulation with hemorrhage control): Pulses present and symmetric? Skin appearance (cold clammy, warm well perfused)
- D (Disability): GCS scale? Moving all extremities?
- E (Exposure/Environmental Control): Completely expose the patient. Rectal tone? Gross blood per rectum?
- IV – 2 large bore (minimum 18 Gauge) Antecubital IV
- O2 – Nasal cannula, Face Mask
- Monitor: Place patient on monitor.

If patient's primary survey is intact, the adjuncts to the primary survey and resuscitation begins. The adjuncts to the primary survey include any of the following as necessary: EKG, ABG, chest X-ray, pelvis x-ray, urinary catheter, eFAST exam and/or DPL.

Do we have permission from Dr. Zwanck to use his wonderful video?

Next, a secondary survey must be performed. The secondary survey is the complete history and physical examination. This is completed after the primary survey and vital functions are returning to normal. Start by taking an "AMPLE" history. Chest exam should detail exit and entry wounds, number of wounds, ecchymosis and deformities, paradoxical movement. Bedside sonography should be used to perform an eFAST exam.

Details of the trauma mechanism are crucial. For motor vehicle accidents (MVAs) speed of collision, position of colliding car to each other, position of patient in the car, seatbelt use, extent of car damage (intrusion, wind shield damage, difficulty of extrication, air bag deployment) are important elements to elicit. With respect to falls, height of fall is very important. With respect to gun shot wounds, kind of gun, distance from the shooter, number of shots heard are all relevant. For stab wounds, it is prudent to obtain information on kind of weapon used.

Presentation

Chest trauma can lead to several serious injuries. Chest trauma patients usually present with chest pain and shortness of breath, but can also present in shock (altered mental status) or in traumatic arrest. Presenting vital signs tend to range from slightly abnormal to floridly unstable. Thoracic injuries are identified by primary survey signs: tachypnea, respiratory distress, hypoxia, tracheal deviation, breath sounds, percussion abnormalities, and chest wall deformity 1Chest trauma injuries can range from simple pneumothorax (PTX) to flail chest to cardiac tamponade. Any injury within the “box” described as the region in between the nipple lines, inferior neck line and diaphragm result in injury to underlying organs.

Tension Pneumothorax (PTX)

Tension PTX typically presents with shortness of breath chest pain in the setting of trauma and in certain cases traumatic arrest. Presenting clinical findings include absent breath sounds ipsilateral to the PTX, tracheal deviation opposite to the PTX, crepitus and jugular venous distension. Bedside sonogram can be used to confirm the absence of lung sliding on the site of suspicion. Once the diagnosis is made patients should undergo prompt needle decompression followed by tube thoracostomy. Tension pneumothorax is a clinical diagnosis and there should be no delays in obtaining portable chest x rays to make this diagnosis.

Pneumothorax

The presentation for this entity is typically less dramatic than tension pneumothorax. Patients present with chest pain and shortness of breath, tachycardia, tachypnea, hypoxia. On physical exam they often have bilateral breath sounds, although typically asymmetric with decreased noted on the site of the PTX. Chest X-ray (figure 1a) and bedside ultrasonography (figure 1b) is useful in making the diagnosis.

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Figure 1a. Simple traumatic left sided pneumothorax.4

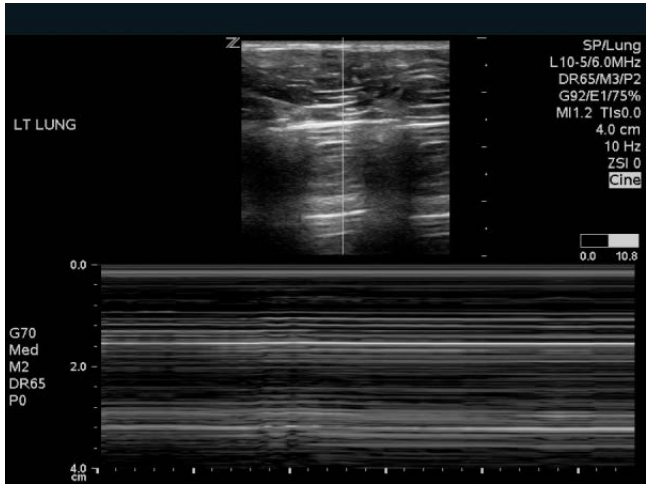

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Figure 1b: Ultrasound image including M Mode demonstrating a pneumothorax. Image courtesy of Creagh Boulger MD, The Ohio State University

Wexner Medical Center.

Open Pneumothorax

Open pneumothorax is a sucking chest wall wound from penetrating injury, usually with a big defect in the chest wall. Patients present with chest pain shortness of breath with sonorous breath sounds on physical exam, sucking air from wound and shallow respirations. It is treated by placement of a square dressing tape on three sides to create an escape valve. If this is not performed, this injury can turn into a tension PTX. Ultimately a chest tube is placed ipsilateral to the side of the wound but at a different anatomic location than the wound.

Hemothorax

Patients present with shortness of breath, chest pain or occasionally asymptomatic. Typically presents with decreased breath sounds, dullness to percussion on exam. Although vital signs typically indicate tachycardia, tachypnea or hypoxia, occasionally they can present as completely normal. The diagnosis can be confirmed with a bedside ultrasound which can reliably reveal the presence of a hemothorax. Although chest Xray can be utilized, the sensitivity of an upright chest Xray exceeds that of a portable. The typical treatment is placement of a chest tube. If the hemothorax is retained despite the chest tube then a video assisted thorascopic surgery is recommended. Indications for emergent surgery are greater than 1500 ml of blood on initial chest tube placement and if there is greater than 200 ml/hour of blood for 2-4 hours. Diagnosis can also be made using bedside ultrasonography (figure 2).

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Figure 2: Shows a collection of blood above (to the left on the figure) the diaphragm on this Hepatorenal

view ultrasound (courtesy of Creagh Boulger MD, The Ohio State University Wexner Medical Center).

Flail Chest

Occurs when patients suffer multiple rib fractures (3 or more ribs in 2 places). Pulmonary contusion is a frequent complication. Patients present with chest pain, dyspnea, painful respirations and are tachycardic, tachypneic and hypoxic. Clinical findings are pertinent for a visible or palpable deformity, bruising or crepitus, paradoxical movement and splinting with secondary hypoventilation. Chest X-Ray can be used to make the diagnosis (figure 3). Early intubation is advocated in elderly patients, those with multiple rib fractures or if patients are in respiratory failure. The treatment goal is to re-expand the lung with CPAP (positive pressure) or physiotherapy, and to avoid atelectasis. For patients with less severe injuries pain control and incentive spirometry can be attempted. All patients need admission for observation.

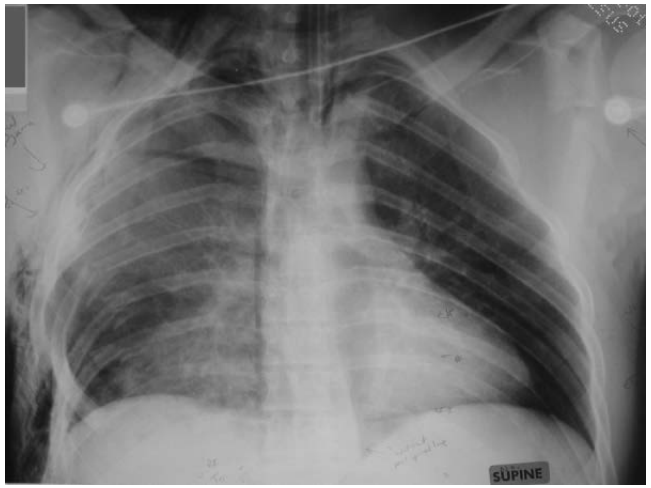

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Figure 3. A patient with flail chest and pulmonary contusions on the chest X ray.5

Pulmonary Contusion

Severe blunt chest trauma causes leakage of blood and proteins into alveoli causing atelectasis and that can lead to ARDS (figure 3). Patients with pulmonary contusions can be occasionally asymptomatic but often present with shortness of breath, chest pain, hemoptysis and cough. On exam tachypnea, tachycardia, hypoxia is common. In severe cases ecchymosis can be evident over chest wall and decreased breath sounds on auscultation. Although CXR is typically performed the initial CXR can be relatively normal especially within the first 6-12 hours. CT has a greater sensitivity and specificity for diagnosis of pulmonary contusions. For large pulmonary contusions patients need to be intubated. Smaller contusions can be managed with conservative management that includes incentive spirometry, pulmonary toilet, pain control and careful fluid administration.

Cardiac Contusion

The right atrium/ventricle are most commonly injured in blunt chest trauma. This injury is closely associated with sternal fractures. Patients may present with lack of any specific signs or symptoms however most report some chest pain. Physical exam may be completely normal. Some patients can have chest wall contusions. Those with sternal fractures will have obvious sternal pain. 40% of patients with cardiac contusions can develop signs of decreased cardiac output. Diagnosis requires a high clinical suspicion. EKG usually shows non-specific findings. First-degree AV block, PVCs, RBBB can sometimes be seen. Cardiac enzymes can be sent but these have no role in making the diagnosis. Patients with suspected cardiac contusions need to have formal echocardiograms (2D-ECHOs) for evaluation of EF. They should be observed for at least 23 hours on telemetry as they are at risk of developing dysrhythmias and cardiogenic shock. If the 2D-ECHO shows a reduced EF (new from prior) patients should undergo a dobutamine stress test. Elderly individuals are high risk for this entity and it is important to note that frequently they may present to the ER 12-72 hours after injury with signs of cardiac compromise.

Cardiac Tamponade

Penetrating injury to the heart (penetrating cardiac injury) with subsequent tamponade. Patients present with chest pain shortness of breath, with air hunger, frequently altered mental status. On exam Beck’s triad (hypotension JVD and distant heart sounds) is sometimes present. More frequently patients present hypotensive in shock, with pulsus parodoxus and narrowing of pulse pressure. Diagnosis is clinical however can be made with bedside sonogram while performing the eFAST exam (figure 4). Although EKG can show electrical alternans, it is not frequently seen in traumatic tamponade. CXR can show an enlarged cardiac silhouette. In hemodynamically stable patients pericardiocentesis is indicated. Unstable patients need emergency surgical intervention in the OR. If patients lose their vitals while in the ED, ED thoracotomy is indicated.

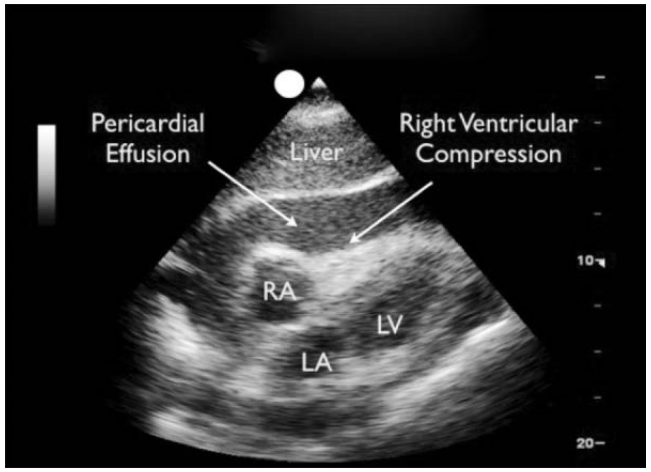

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Figure 4. Pericardial Tamponade on bedside eFAST exam.6

Blunt Aortic Injury

Usually seen in sudden deceleration type injuries secondary to abrupt deceleration from > 30 mph or > 40 ft fall. Majority of injuries are proximal aortic injuries. Patients fall into three categories: A) dead on scene – presumed complete aortic transection on impact. B) hemodynamically unstable – full thickness transection with active hemorrhage from aorta (look for non sustained improvement in BP on fluid bolus). C. Hemodynamically stable patients – partial thickness transection with possibility of pseudoaneurysm aorta with vague complaints including chest/back pain and lower extremity complaints. In unstable patients apart from hemodynamic instability, patients can present with a left sided hemothorax. In stable patients physical findings are nonspecific, however look for chest wall contusion, pulse and blood pressure discrepancy in extremities. Diagnosis is suggested is the mediastinum is widened on a CXR (figure 5). A CTA (spiral CT) is diagnostic. Angiography is considered the gold standard and only performed if the spiral CT is unequivocal. TEE can be used for unstable patients however they need to be intubated prior to this test. The treatment for hemodynamically unstable patients is emergent surgery to cross clamp the aorta. For stable patients aggressive BP control to a SBP< 120 mmHg followed by eventual surgical correction is advocated.

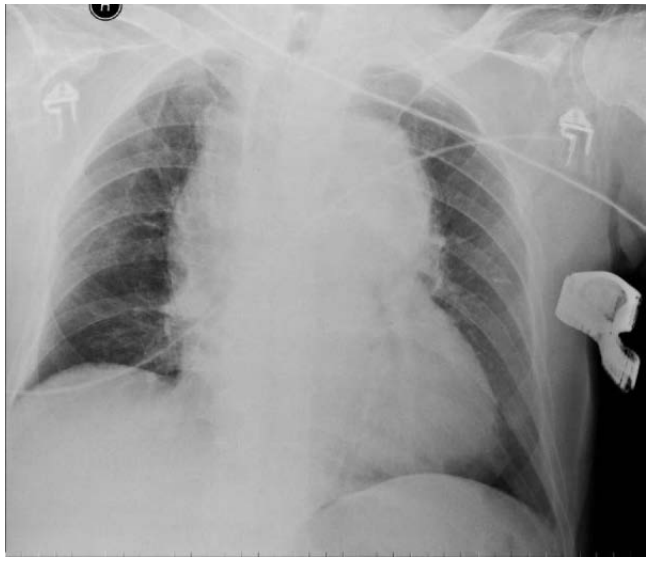

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Figure 5. Widened mediastinum in a patient with blunt chest injury.7

Great Vessel Injury

Great vessels include the aorta, vena cava and pulmonary trunk. Patients present with unstable and hypotensive with minimal improvement in blood pressure on fluid challenge. Most patients present in frank hypovolemic shock. Physical findings suspicions for great vessel injuries include an expanding hematoma, acute superior vena cava syndrome, hematoma compressing trachea. Diagnosis is primarily clinical. If patient is stable enough for advanced imaging, a CTA or Angiography are helpful, however most patients are unstable and need emergent surgical intervention (OR thoracotomy). Treatment consists of initial fluid resuscitation followed by transfusion of packed RBC.

Traumatic Arrest Secondary to Penetrating Chest Trauma

A traumatic arrest from penetrating chest injury can occur due to penetrating cardiac injury and great vessel injury leading to massive hemorrhage. In these situations, closed CPR is futile. Management requires stabilization of airway via endotracheal intubation, bilateral chest tubes and ED thoracotomy which allows open heart CPR, pericardiotomy and cross clamping of the aorta. If a pulse is obtained after said interventions, patients

need STAT surgical intervention in the OR. Patients with a penetrating injury and PEA within 5 minutes of arrival are appropriate candidates for resuscitative thoracotomy. Important caveats include the fact that a qualified surgeon must be present at the time of the patient's arrival to determine the need for and potential success of an emergency department resuscitative thoracotomy (ATLS 9th Edition).

Diagnostic Testing

1. Chest X-ray: All chest trauma patients should receive a portable chest radiograph. However, the sensitivity of a chest radiograph is only 65% for detection of acute traumatic injuries such as pneumothoraxes/hemothoraxes. Chest CTs have a much higher sensitivity for detection of acute traumatic chest injuries, however in unstable patients Chest CTs may not be an immediate option.
2. eFAST Ultrasound: Recent studies[8] have also established the utility of bedside ultrasound – specifically the eFAST exam in the diagnosis and management of several acute chest injuries such as hemo and pneumothorax as well as tamponade.
3. EKG: May be helpful in patients with blunt chest trauma or single car MVA's to help elucidate a cause of the accident.
4. Pulse Oximetry: To assess adequacy of oxygenation and need for supplemental O2.
5. Blood work including ABG does not have utility in making the diagnosis of any of the conditions listed above. As a general rule for all trauma patients a type and screen must always be requested. In cases where massive transfusion is expected, a massive transfusion protocol should be activated.

Treatment

The goal of treating patients with chest injuries is to establish normal gas exchange and normal hemodynamics. That said, the specific treatment depends on the actual traumatic condition:

- Hemodynamically unstable patients: Packed RBC (O-Neg) transfusion), consideration of STAT OR for surgical intervention.
- Pneumothorax: Tube thoracostomy. Please see video: http://www.nejm.org/doi/full/10.1056/NEJMvcm071974 (http://www.nejm.org/doi/full/10.1056/NEJMvcm071974).[9]
- Open Pneumothorax: Tape wound and tube placement at site separate from injury
- Hemothorax: As above, except if greater than 1500 cc of blood obtained on initial chest tube placement or more than 150-200cc/hr x 4 hours, patient needs to go to the OR under Cardiothoracic surgery.
- Flail Chest: Symptomatic Support, intubate and ventilate as needed. Incentive spirometry. In extreme cases patient may need cardiothoracic surgical intervention.
- Pulmonary Contusion: Symptomatic support, high flow oxygen, early intubation if needed, incentive spirometry.

- Cardiac Contusion: Monitoring if any significant changes in ejection fraction
- Cardiac Tamponade: Pericardiocentesis followed by OR thoracotomy. Please see video: http://www.nejm.org/doi/full/10.1056/NEJMvcm0907841 (http://www.nejm.org/doi/full/10.1056/NEJMvcm0907841).[10]
- Blunt Aortic Injury: If stable blood pressure control followed by close observation and delayed aortic repair. If unstable, massive transfusion protocol, transfuse pRBC and stat emergency aortic repair by Cardiothoracic and Vascular surgery.
- Great Vessel Injury: Typically unstable shock like presentation: Massive transfusion with concurrent OR thoracotomy.

Resuscitative Thoracotomy Indications [1,11]

- Patients with a penetrating injury and PEA, especially if the loss of signs of life is recent, are appropriate candidates for resuscitative thoracotomy.
- A qualified surgeon must be present at the time of the patient's arrival to determine the need and potential for success of an emergency department resuscitative thoracotomy.
- Once the chest is opened, bleeding must be controlled.

Disposition

Apart from patients with very superficial lacerations, superficial contusions and solitary rib fractures, most patients warrant admission for observation under Trauma services. Treatment depends on the nature of injury.

Pearls and Pitfalls

- Chest trauma patients can present with several conditions each of which can be acutely life threatening; Majority of these conditions can be clinically diagnosed and treated during the primary survey.
- Tension pneumothorax is a clinical diagnosis, chest x rays are not indicated for making this diagnosis.
- Bedside sonography can be extremely useful for diagnosing acute traumatic chest conditions.
- Only hemodynamically stable patients should be sent for advanced imaging such as CT scan
- ED Thoracotomies are reserved for Traumatic arrest secondary to penetrating chest trauma only

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