UNITED STATES MARINE CORPS
FIELD MEDICAL TRAINING BATTALION
Camp Lejeune, NC 28542-0042

FMST 405

Manage Respiratory Trauma

TERMIAL LEARNING OBJECTIVES
1. Given a casualty in an operational environment, manage respiratory trauma to reduce the risk of further injury or death. (8404-MED-2003)

2. Given a casualty with a tension pneumothorax in an operational environment, equipment and supplies, perform a needle thoracentesis reducing the risk of further injury or death. (8404-MED-2009)

ENABLING LEARNING OBJECTIVES
1. Without the aid of reference, given a description or list, identify standard medical terminology related to the respiratory system, within 80% accuracy, per Prehospital Trauma Life Support, current Military Edition. (8404-MED-2003e)

2. Without the aid of reference, given a description or list, identify the anatomy of the respiratory system, within 80% accuracy, per Prehospital Trauma Life Support, current Military Edition. (8404-MED-2003f)

3. Without the aid of reference, given a description or list, identify the signs and symptoms of respiratory trauma, within 80% accuracy, per Prehospital Trauma Life Support, current Military Edition. (8404-MED-2003g)

4. Without the aid of reference, given a description or list, identify treatments for chest injuries, within 80% accuracy, per Prehospital Trauma Life Support, current Military Edition. (8404-MED-2003h)

5. Without the aid of reference, given a simulated casualty with a chest injury and Corpsman Assault Pack, manage the simulated casualty, to prevent further injury or death, per Prehospital Trauma Life Support, current Military Edition. (8404-MED-2003i)

6. Without the aid of reference, given a description or list, identify important anatomical landmarks for needle thoracentesis, within 80% accuracy, per the Prehospital Trauma Life Support, current Military Edition. (8404-MED-2009a)

7. Without the aid of reference, given a description or list, identify the indications for needle thoracentesis, within 80% accuracy, per the Pre-Hospital Trauma Life Support Manual, current Military Edition. (8404-MED-2009b)
8. Without the aid of references, given a description or list, **identify the proper equipment for performing needle thoracentesis**, within 80% accuracy, per the Pre-Hospital Trauma Life Support Manual, current Military Edition. (8404-MED-2009c)

9. Without the aid of references, given a description or list, **identify the procedural sequence for performing needle thoracentesis**, within 80% accuracy, per the Pre-Hospital Trauma Life Support Manual, current Military Edition. (8404-MED-2009d)

10. Without the aid of reference, given a description or list, **identify the potential complications when performing needle thoracentesis**, within 80% accuracy, per the Pre-Hospital Trauma Life Support Manual, current Military Edition. (8404-MED-2009e)

11. Without the aid of references, given a simulated casualty and a Corpsman Assault Pack, **perform a needle thoracentesis**, to prevent further injury or death, per the FMST Performance Examination Checklist. (8404-MED-2009f)
1. **RESPIRATORY SYSTEM TERMINOLOGY**

   **Dyspnea** - Difficult or labored breathing.

   **Wheeze** - A form of rhonchus, characterized by a whistling respiratory sound. It is caused by the movement of air through a narrowed airway.

   **Stridor** - A harsh shrill respiratory sound.

   **Hyperventilation** - An increase in the rate and depth of normal respirations. Responsible for increasing oxygen levels and decreasing carbon dioxide levels.

   **Hypoventilation** - Loss of ventilatory drive, usually from decreased neurological function most often after a TBI. This can also be caused by an upper or lower airway obstruction, and decreased expansion of the lungs.

   **Tachypnea** – An abnormally rapid rate of respiration.

   **Bradypnea** - An abnormally slow rate of respiration, usually less than 8 breaths per minute.

   **Hypoxia** - An insufficient concentration of oxygen in the tissue in spite of an adequate blood supply.

   **Apnea** - Total cessation of breathing, also known as respiratory arrest.

   **Subcutaneous emphysema** - The presence of free air or gas in the subcutaneous tissues. The face, neck, or chest may appear swollen with painful skin and produce a crackling sound (“Rice Krispies”).

2. **ANATOMY OF THE RESPIRATORY SYSTEM**

   **Thorax (Chest Cavity) (see Figure 1)**

   The skeletal portion of the thorax is a bony cage formed by the sternum, costal cartilages, ribs and the bodies of the thoracic vertebrae.

   **Ribs**
   - Joined in the posterior with the thoracic spine and anterior with the sternum via the costal cartilage.
   - A nerve, artery and vein are located along the underside of each rib.
   - Intercostal muscles connect each rib with the one above.
**Diaphragm** - The primary muscle of respiration.

**Pleura** (see Figure 2)

The pleura are thin membranes separated by a small amount of fluid, which creates surface tension and causes them to cling together, counteracting the lung’s natural tendency to collapse.

- **Parietal pleura** - a thin membrane that lines the inner side of the thoracic cavity.
- **Visceral pleura** - a thin membrane that covers the outer surface of each lung.

![Figure 2. Pleura](image)

**Lungs** (see Figure 3)

- The lungs occupy the right and left halves of the thoracic cavity.
- The left lung is divided into two lobes.
- The right lung is larger than the left lung and is divided into three lobes.

**Alveoli** - the smallest components of the lungs. They are small saclike structures through which the exchange of carbon dioxide and oxygen take place.

![The Lungs](image)

**Figure 3. Lungs**
Mediastinum

The area in the middle of the thoracic cavity in which all the other organs and structures of the chest cavity lie. It encases the:
- Heart
- Great vessels (aorta, superior/inferior vena cava)
- Trachea (windpipe)
- Mainstem bronchi (there are two bronchi - a right and left)
- Esophagus (lies directly behind the trachea)

3. SIGNS & SYMPTOMS OF RESPIRATORY TRAUMA

Chest injuries are the second leading cause of trauma deaths each year, although the vast majority of all thoracic injuries (90% of blunt trauma and 70 to 85% of penetrating trauma) can be managed without surgery. Traumatic chest injuries can be caused by a variety of mechanisms; however, these injuries are usually classified as either blunt or penetrating.

Penetrating Injuries - caused by forces distributed over a small area (i.e., gunshot wounds or stabbings). Most often, the organs injured are those that lie along the path of the penetrating object.

Blunt Trauma - caused by forces distributed over a larger area, and many injuries occur from deceleration, bursting, or shearing forces. Conditions such as pneumothorax, pericardial tamponade, flail chest, pulmonary contusion and aortic rupture should be suspected when the mechanism of injury involves rapid deceleration, including motor vehicle collisions, falls, sport injuries and crush injuries.

Assessment of Respiratory Trauma - besides the overall mechanism of injury, casualties are asked of any symptoms they may be experiencing if they are conscious and able to communicate. Victims of chest trauma will likely be experiencing chest pain, which may be sharp, stabbing, or constricting. Frequently, the pain is worse with respiratory efforts or movement. The casualty may experience shortness of breath and may feel apprehensive or lightheaded if shock is developing.

The next step in assessment is a physical examination. The components to the physical examination include: observation, auscultation, and palpation.

Observation - casualty is observed for pallor of the skin and sweating, which may indicate shock. The presence of cyanosis (bluish discoloration of skin, especially around the mouth and lips) may be evident in advanced hypoxia.

- Observe frequency of respirations (rate, rhythm, and depth), and the appearance of having trouble breathing (gasping, contractions of the accessory muscles in the neck, or nasal flaring.)

- Look for signs of trachea deviation and distended jugular veins.
- The chest is examined for contusions, abrasions, lacerations, and whether the chest wall expands symmetrically with breathing. Identify whether any portion of the chest wall moves paradoxically with respiration (instead of moving out during inspiration, does it collapse inward and vice versa during exhalation)?

**Auscultation** - the entire chest is evaluated to identify decreased breath sounds on one side compared to the other which may indicate pneumothorax or hemothorax on the examined side. Pulmonary contusions may result in abnormal breath sounds (crackles).

**Palpation** - by gently pressing the chest wall with hands and fingers, assessment for the presence of tenderness, crepitus (either bony or subcutaneous emphysems), and bony instability of the chest wall is performed.

**Management of Specific Injuries**

**Rib fracture** - occurs when pressure is applied with enough force to exceed the strength of the rib. Remember that any fractured rib can cause associated injuries to nearby structures.

**Causes** - blunt trauma, crushing injuries to the chest.

**Signs and Symptoms**
- Pain at the site with inhalation/exhalation
- Shortness of breath
- Deformity
- Crepitus
- Bruising to area

**Treatment**
- Anticipate potential complications such as tension pneumothorax, pericarditis, or cardiac tamponade.
- Simple rib fractures usually require no treatment other than analgesics.
- Multiple rib fractures may require immobilization of the arm on affected side to protect the ribs.
- Encourage coughing and deep breathing despite associated pain. This is to prevent the collapse of the lung tissue and preventing the exchange of CO2 and O2 (atelectasis).
- Avoid any taping or bandaging that encircles the chest.
- Monitor and TACEVAC as necessary.

**Flail chest** - a condition of the chest wall due to two or more adjacent ribs being fractured in at least two or more places. The flail segment moves paradoxically in with inspiration and out during expiration (see Figure 4)

**Causes** - blunt trauma to the chest wall, especially an impact into the sternum or the lateral side of the thoracic wall.
Signs and Symptoms
- Localized chest pain, aggravated by breathing or coughing
- Rapid shallow respirations
- Tenderness and/or bony crepitus with palpation
- Subcutaneous emphysema

Treatment
- Immobilize flail segments upon inhalation using strips of tape.
- If you suspect respiratory failure, give positive pressure ventilation using a bag valve mask.
- Administer analgesics
- Administer oxygen if available.
- TACEVAC to the next capability of care.

As a result of paradoxical chest wall movement during inspiration, the flail segment of the rib cage moves inward (instead of outward), which results in reduced air intake.

Pneumothorax - a simple pneumothorax is caused by the presence of air in the pleural space. The air separates the two pleural surfaces, causing the lung on the involved side to collapse as the separation expands. As air continues to build up and pressure in the space increases, the size of the lung on the affected side continues to decrease. Eventually, the lung may partially or totally collapse.

Causes
- Penetrating trauma from either chest wall injury or abdominal injuries that cross the diaphragm.
- Blunt trauma
- Spontaneous (with no apparent cause)

Signs and Symptoms
- Pleuritic chest pain
- Tachypnea/dyspnea
- Decreased or absent breath sounds on the injured side
- Decreased chest wall motion
**Treatment**
- Place patient in sitting up or Semi-Fowlers position
- Use BVM if hypoxia is present
- Administer oxygen if available
- If caused by a wound, apply an occlusive dressing to the site
- Monitor for signs and symptoms of a tension pneumothorax
- TACEVAC ASAP

**Tension Pneumothorax** (see Figure 5) - A type of pneumothorax in which air can enter the pleural space but cannot escape via the route of entry. This is the second leading cause of preventable death on the battlefield. This leads to an increase of pressure in the pleural space and eventual collapse of the lung. This pressure forces the mediastinum to the opposite side, which results in two serious consequences: (1) breathing becomes increasingly difficult and (2) cardiac blood flow is severely decreased.

**Cause** - chest injuries.

**Signs and Symptoms**

**Early signs**
- Unilateral (one sided) decreased or absent breath sounds
- Dyspnea
- Tachypnea

In some cases, the only signs of a developing tension pneumothorax are compromised oxygenation, tachycardia, tachypnea, and unilateral decreased or absent breath sounds.
Progressive signs
- Increased dyspnea
- Increased tachypnea
- Increased difficulty ventilating

Late signs
- Jugular vein distention (JVD)
- Tracheal deviation
- Signs of acute hypoxia
- Narrowing pulse pressures
- Signs of uncompensated shock

Treatment
- Treat all chest injuries
- Perform needle thoracentesis
- Administer oxygen therapy if available
- Pain management
- Monitor and TACEVAC

Open Pneumothorax (Sucking Chest Wound) - a collection of air or gas in the pleural space causing the lung to collapse. An open wound allows air to enter when the intrathoracic pressure is negative and blocks the air’s release when the intrathoracic pressure is positive; creating a “sucking chest wound,” that has the potential to cause a tension pneumothorax.

Causes - most often the result of gunshot wounds, but they can also occur from impaled objects, stabbings, and occasional blunt trauma.

Signs and Symptoms
- Pain at the injury site
- Chest wall trauma
- Shortness of breath
- Tachypnea
- Subcutaneous emphysema
- Decreased chest wall motion
- May hear a moist sucking or bubbling sound as air moves in and out of the chest wall defect.

Treatment
- The immediate treatment is to seal the wound with an occlusive dressing. This intervention helps to restore air flow into the lung during inspiration, but could lead to the development of a tension pneumothorax. If an exit wound is present tape it on all four sides.
- Assess both anterior and posterior torso for penetrating trauma.
- Monitor for signs and symptoms of tension pneumothorax. If signs of increasing respiratory distress develop, the dressing over the wound should be removed to allow for decompression of any accumulating tension. If this is ineffective, needle decompression and positive pressure ventilation (if available) should be considered if not already employed.
- Administer oxygen if available
- Place patient on affected side
- Pain management
- Monitor and TACEVAC

Hemothorax - the accumulation of blood in the pleural space caused by a laceration of the great vessels within the chest that can significantly compromise respiratory efforts by compressing the lung and preventing adequate ventilation.

Causes - Penetrating or blunt trauma

Signs and Symptoms
- Shortness of breath
- Chest pain
- Tachypnea
- Signs of shock (pallor, confusion, tachycardia, hypotension)
- Decreased breath sounds on affected side
- Hemoptysis (coughing up blood)
- Decreased chest wall motion

Treatment
- Place patient in the Fowler’s position
- Treat any chest injuries
- Treat for shock
- Administer O2, if available
- Pain management
- Monitor and TACEVAC

Hemopneumothorax - often with penetrating trauma, a pneumothorax is associated with a hemothorax, and an accumulation of air, blood, and fluid within the pleural cavity.

Causes - penetrating trauma to the chest wall, the great vessels, or the lung.

Signs and Symptoms
- Tachypnea
- Decreased breath sounds
- Signs of shock

Treatment
- Place patient in Fowler’s position
- Perform needle thoracentesis to relieve pressure. If blood is withdrawn, immediately remove needle and catheter.
- Administer oxygen, if available
- Treat for shock
- Monitor and TACEVAC
NEEDLE THORACENTESIS

Needle thoracentesis is a procedure where a needle and catheter are inserted through the chest wall into the pleural space. The catheter provides a pathway for the release of accumulated pressure within the pleural space. This procedure helps reduce pressure on the heart, lungs and major vessels within the chest cavity that have compromised the patient’s breathing and circulation.

4. **ANATOMICAL LANDMARKS** (See Figure 6)

**Mid-Clavicular Line (MCL)**
- Imaginary line that dissects the middle of the clavicle on the right or left side.

**2\(^{nd}\) Intercostal Space**
- Space between the 2\(^{nd}\) and 3\(^{rd}\) rib.
- From the MCL, palpate down. The first space immediately after the clavicle is the 1\(^{st}\) intercostal space. Continuing down, the first space below the next rib is the 2\(^{nd}\) intercostal space.

An acceptable alternative location is the 4\(^{th}\) or 5\(^{th}\) intercostal space at the anterior auxiliary line. This method will not be taught during FMST; however you will learn this technique at follow-on training.

5. **INDICATIONS**

**Tension Pneumothorax**
- Any casualty with thoracic injury is at risk for developing a tension pneumothorax.
- Casualties at particular risk are those who have a penetrating wound to the chest and those with signs of rib fracture.
- There are no significant contraindications for needle thoracentesis with penetrating chest trauma.
6. **PROPER EQUIPMENT**
   - 14-gauge, 3.25-inch needle/catheter
   - Antiseptic solution (if available)
   - Gloves

7. **PROCEDURAL STEPS**

   **Assess Casualty and Make Decision** - based on mechanism of injury (MOI) and a noted increase in difficulty breathing.
   - **Inspect** - look for bilateral rise and fall of the chest during respirations.
   - **Auscultate** - listen to the lung fields at the mid-clavicular and mid-axillary lines bilaterally if tactical situation allows (it may be hard to hear in a combat setting).
   - **Palpate** - feel for flail segments or crepitus.

   **Assemble and Check Equipment** - Gather 14-gauge, 3.25-inch needle/catheter, alcohol swab and gloves.

   **Prepare Patient**
   - **Position** the patient in upright position (if possible)
   - **Explain** the procedure to the patient, if conscious
   - **Expose** the anterior chest

   **Identify Landmarks  **ON THE AFFECTED SIDE**
   - **Midclavicular line**
   - **2nd Intercostal space**

   **Perform the Procedure**
   - **Cleanse the area**
   - **Insert catheter** - Firmly insert the needle into the skin over the top of the third rib into the second intercostal space at a 90 degree angle.
   - **Puncture the parietal pleura** - Ensure the chest cavity has been penetrated, as evidenced by feeling a "pop" as the needle enters the chest cavity. The pressure may be so great that a rush of air may be encountered.
   - **Remove needle** - secure catheter to chest wall.
Reassess the Patient

- Inspect, Auscultate, and Palpate (IAP) Chest
- Visually inspect the neck
- Monitor the patient’s response to the needle thoracentesis (respiratory rate, lung sounds, and skin color)
- Be ready to insert a 2nd catheter if the patient does not improve.

8. COMPLICATIONS

**Hemothorax** - blood within the pleural space. May be caused when the needle punctures any vessels within the chest wall.

**Cardiac Tamponade** - pressure on the heart that occurs when blood or fluid builds up in the space between the heart muscle and the pericardium. Ensuring that the insertion site for the needle is at or lateral to the nipple line will help avoid this complication.

**Subcutaneous emphysema** - released air becomes trapped within the subcutaneous tissue. Feels like “Rice Krispies” underneath the skin.

**Misdiagnosis** - performing a needle thoracentesis on a casualty with non-penetrating torso trauma could result in a pneumothorax if not already present.

FYI!!!

Defense Health Board (DHB) Needle Decompression of Tension Pneumothorax TCCC Guidelines 2012-05:

Cardiopulmonary resuscitation on the battlefield for victims of blast or penetrating trauma who have no pulse, no ventilations, and no other signs of life will not be successful and should not be attempted. **However, casualties with torso trauma or polytrauma who have no pulse or respirations during Tactical Field Care should have bilateral needle decompression performed to ensure they do not have a tension pneumothorax prior to discontinuation of care.**
9. **RESPIRATORY SUPPORT DURING TACEVAC**

Manage the casualty with respiratory trauma during TACEVAC with the same procedures as during Tactical Field Care with the following additions:

- Consider Chest Tube insertion if there is no improvement from the needle decompression or if a long transport is anticipated

Most combat casualties do not require supplemental oxygen, but it may benefit those who:

- have low O2 SATs
- have injuries associated with impaired oxygenation
- are unconscious
- have suffered a TBI (maintain SATs at >90%)
- are in shock

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**CASUALTY ASSESSMENT AND RESPIRATORY TRAUMA**

<table>
<thead>
<tr>
<th>Care Under Fire Phase:</th>
<th>In the absence of life-threatening hemorrhage from the respiratory system, the material in this section is unlikely to be addressed in the Care Under Fire phase.</th>
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<tbody>
<tr>
<td><strong>Tactical Field Care Phase:</strong></td>
<td>During this phase, you will be required to assess the quality of breathing, which will require you to expose the casualty’s chest. Consider needle thoracentesis, if warranted. Needle thoracentesis is a skill that is used during the Tactical Field Care phase and during the TACEVAC phase in the treatment of respiratory trauma. If a casualty has a known or suspected torso trauma and difficulty breathing, you should assume they have a tension pneumothorax and perform a needle thoracentesis. Remember, a tension pneumothorax can develop at any time after an injury, not just immediately after, so continuous assessment of the casualty is necessary. Don PPE. Note and treat all respiratory injuries. Complete a head to toe assessment using DCAP-BTLS noting and treating additional injuries. Determine if vascular access is required (see Tactical Fluid Resuscitation lesson) and give fluids if necessary. If the casualty is able to drink fluids, they should be encouraged to do so. Consider pain medications and give antibiotics if warranted. Reassess all care provided. Document care given, prevent hypothermia, and TACEVAC.</td>
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**REFERENCE**

Prehospital Trauma Life Support, current Military Edition
**Field Medical Training Battalion**  
**NEEDLE THORACENTESIS**  
**PERFORMANCE EXAMINATION CHECKLIST**

**STUDENT** (Rank Last Name, First Name)  

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<tr>
<th>PROCEDURAL STEPS FOR PERFORMING A NEEDLE THORACENTESIS</th>
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<td>* State the indication for a needle thoracentesis (tension pneumothorax)</td>
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<td>State the possible complications of a needle thoracentesis (hemothorax, cardiac tamponade, subcutaneous emphysema)</td>
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<td>* Assess casualty and make decision to decompress (ABC’s, LLF, S/SX of pneumothorax)</td>
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<td>Assemble and check equipment (14-gauge, 3.25-inch needle/catheter, alcohol)</td>
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<td>Prepare patient (position, explain, expose)</td>
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<td>* Identify landmarks (midclavicular line, 2nd intercostal space)</td>
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<td>Cleanse the area</td>
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<td>* Insert catheter at 90-degree angle and puncture the parietal pleura</td>
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<td>* Remove needle (allow lung to decompress)</td>
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<td>Secure catheter to chest</td>
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<td>Reassess &amp; monitor patient for improvement (decrease in respiratory difficulty)</td>
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**GRADING CRITERIA**  

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<td>Total Non-Critical Items (3 or greater constitutes a failure)</td>
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<td>Total Critical Items (Any critical items missed constitutes a failure)</td>
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<td>“Stop &amp; Think” (2 allowed for critical items, third constitutes a failure)</td>
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1st Evaluator:  
2nd Evaluator:  
3rd Evaluator:  

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4-59
Respiratory Trauma Review

1. Identify five structures found in the mediastinum.

2. Identify the appropriate treatment for a simple rib fracture.

3. Identify the two serious consequences of a tension pneumothorax.

4. Identify the treatment for a sucking chest wound.
5. Identify the major landmarks used in performing a needle thoracentesis.

6. What are the indications for a needle thoracentesis? Contraindications?

7. List the equipment needed to perform a needle thoracentesis.

8. Explain the acronym IAP and what you are specifically looking for before making the decision to perform a needle thoracentesis.

9. Explain how and where to insert the needle/catheter.

10. Identify the possible complications of performing a needle thoracentesis.