

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

FMST 203

Manage Respiratory Trauma

TERMINAL LEARNING OBJECTIVES

1. Given T/O weapon, supplies, and a casualty in a tactical environment, perform Tactical Combat Casualty Care to reduce the risk of further injury or death using correct interventions. (HSS-MED-2002)

ENABLING LEARNING OBJECTIVES

1. Without references, given a list, **identify the anatomy of the respiratory system**, within 80% accuracy, IAW Hospital Corpsman NAVEDTRA 14295. (HSS-MED-2002t)
2. Without references, given a list, **identify the signs and symptoms of respiratory trauma**, within 80% accuracy, IAW the Pre-Hospital Trauma Life Support manual, Military Edition, Current Edition. (HSS-MED-2002u)
3. Without references, given a list, **identify the signs and symptoms of a sucking chest wound**, within 80% accuracy, IAW CoTCCC Guidelines, and the Pre-Hospital Trauma Life Support manual, Military Edition, Current Edition. (HSS-MED-2002v)
4. Without references, given a list, **identify the steps used to perform a needle decompression for a casualty suffering from a pneumothorax**, within 80% accuracy, IAW CoTCCC Guidelines, and the Pre-Hospital Trauma Life Support Manual, Military Edition, Current Edition. (HSS-MED-2002w)
5. Given a simulated casualty with a sucking chest wound and a pneumothorax, **perform the required treatment**, IAW CoTCCC Guidelines, and the Pre-Hospital Trauma Life Support manual, Military Edition, Current Edition. (HSSMED-2002x)

1. ANATOMY OF THE RESPIRATORY SYSTEM

Thorax (Chest Cavity) (see Figure 1)

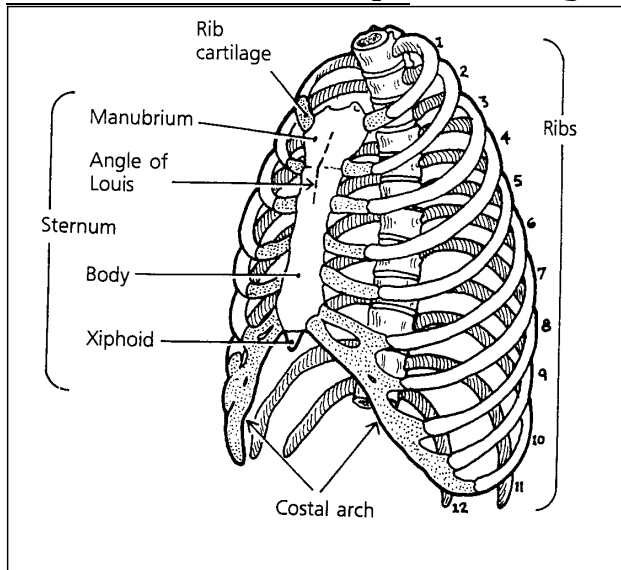


Figure 1. Thorax

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

Diaphragm - The primary muscle of respiration.

Intercostal Muscles -

- External intercostal muscles aid in quiet and forced inhalation
- Internal intercostal muscles aid in forced expiration (quiet expiration is a passive process)

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.

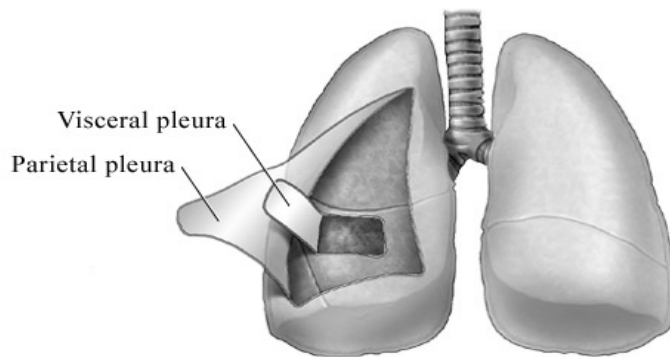


Figure 2. Pleura

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.

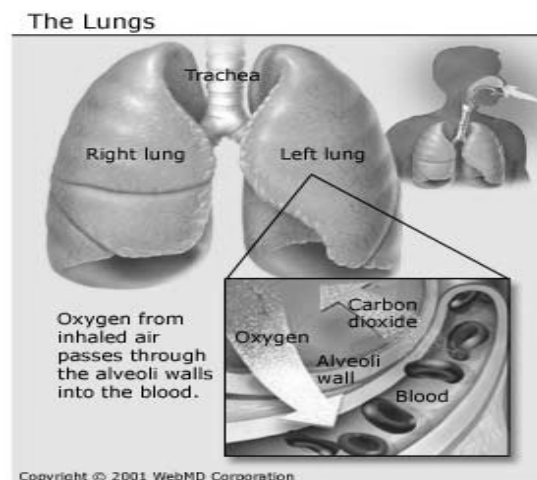


Figure 3. Lungs

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)

RESPIRATORY SYSTEM TERMINOLOGY

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.

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

Dyspnea - difficult or labored breathing.

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

Tachypnea - An abnormally rapid rate of respiration.

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

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").

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 decrease 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.

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 Trauma - 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: inspection, auscultation, and palpation.

Inspect- 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.

Pulse Oximetry - Pulse oximetry tells:

- Heart rate
- Percent of oxygenated blood ("O2 sat")
- 98% or higher is normal at sea level
- 86% is normal at 12,000 feet due to the lower atmospheric pressure at that altitude
- Consider using pulse oximetry on:
 - A casualty with severe penetrating, blunt, or blast chest trauma at risk for developing a tension pneumothorax.
 - TBI- good O2 saturation is very important for a good outcome
 - Unconscious casualty
- Oxygen saturation values as shown on pulse ox may be inaccurate in the presence of:
 - Hypothermia

- Carbon monoxide poisoning
- Very high ambient light levels

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.

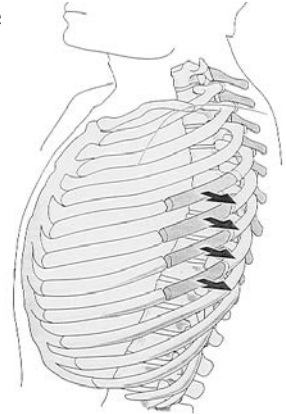


Figure 4. Flail Chest

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 supine 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.

Suspect a tension pneumothorax and treat when a casualty has significant torso trauma or primary blast injury and one or more of the following:

- Severe or progressive respiratory distress
- Severe or progressive tachypnea
- Absent or markedly decreased breath sounds on one side of the chest
- Hemoglobin oxygen saturation <90% on pulse oximetry
- Shock
- Traumatic cardiac arrest without obvious fatal wounds

NOTE: If not treated promptly, tension pneumothorax may progress from respiratory distress to shock and traumatic cardiac arrest.

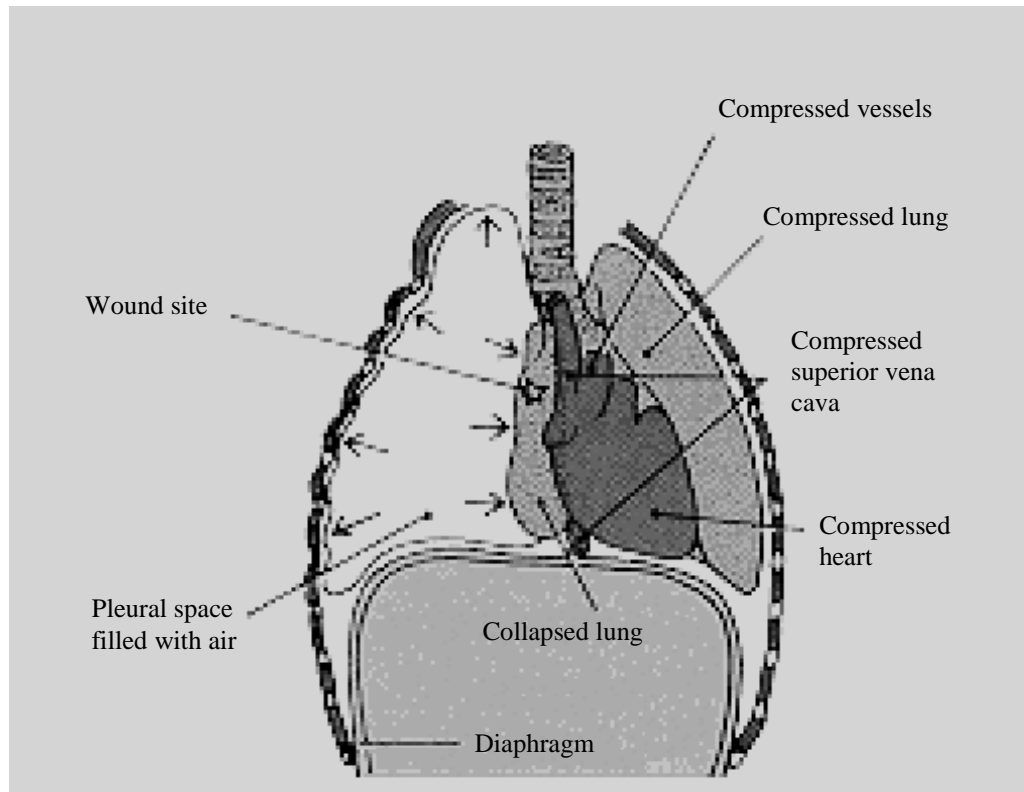


Figure 5. Tension Pneumothorax

Cause - chest injuries.

Signs and Symptoms

Early signs

- Unilateral (one sided) decreased or Absent breath sounds
- Dyspnea
- Tachypnea

Progressive signs

- Increased dyspnea
- Increased tachypnea
- Increased difficulty ventilating

Late signs

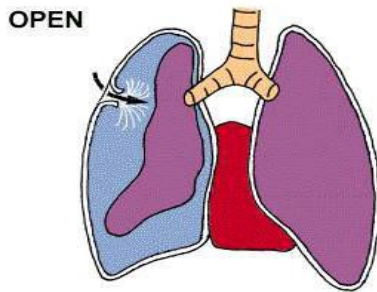
- Jugular vein distention (JVD)
- Tracheal deviation
- Signs of acute hypoxia
- Narrowing pulse pressures
- Signs of uncompensated shock

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

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.

It takes a hole in the chest the size of a nickle or larger for this to occur.

Treatment

- Occlusive Dressing
 - Apply a vented chest seal or

- Improvised chest seal
 - Tape on all sides
- Assess anterior and posterior torso for entrance/exit wounds
- Roll patient on AFFECTED Side
- Monitor for signs/symptoms of tension pneumothorax
- Administer O2, if available
- Pain management
- Monitor and TACEVAC ASAP

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 supine or in the recovery position
- Treat any chest injuries
- Treat for shock
- Administer O2, if available
- Pain management
- Monitor and TACEVAC

The BCS is a sterile, occlusive chest wound dressing for treating open pneumothorax and preventing tension pneumothorax that result from gunshots, stab wounds, or other penetrating chest trauma. The failure-proof triple-valve design of the BCS allows air and blood to escape while preventing the re-entry of

either, thereby eliminating any unwanted gas or liquid exchange at the trauma site.

- The H & H Wound Seal Kit provides a fast application for sealing wounds quickly to stop external bleeding. The Wound Seal Kit is a sterile, TCCC-compliant, occlusive dressing that comes vacuum sealed with a 6" x 8" or 8"x11" (extreme) plastic sealing square and hydrogel adhesive to stick to the wound and the surrounding skin through blood and debris

- Along with the wound seal, the kits come with a sterile 6" x 8" cotton sponge. This sponge is used for clearing fluids and debris from the wound area prior to application of the wound seal. The sealing square has the same polyurethane carrier and adhesive characteristics as the Bolin Chest Seal.

- 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.

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.

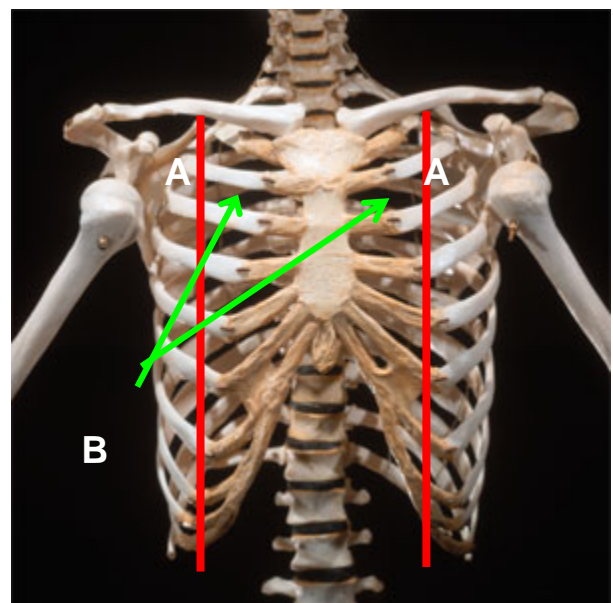
ANATOMICAL LANDMARKS (See Figure 6)

Mid-Clavicular Line (MCL)

- Imaginary line that dissects the middle of the clavicle on the right or left side

2nd Intercostal Space

- Space between the 2nd and 3rd rib.
- From the MCL, palpate down. The first space



A – Mid-Clavicular Lines B– 2nd Intercostal Space
Figure 6. Needle Thoracentesis Anatomical Landmarks

immediately after the clavicle is the 1st intercostal space.

- Continuing down, the first space below the next rib is the 2nd intercostal space, or:

5th Intercostal Space Anterior Axillary line (AAL)

- The 5th intercostal space is located at the level of the nipple in young, fit males.
- The AAL is located at approximately the lateral aspect of the pectoralis major muscle.
- Easily located in males.

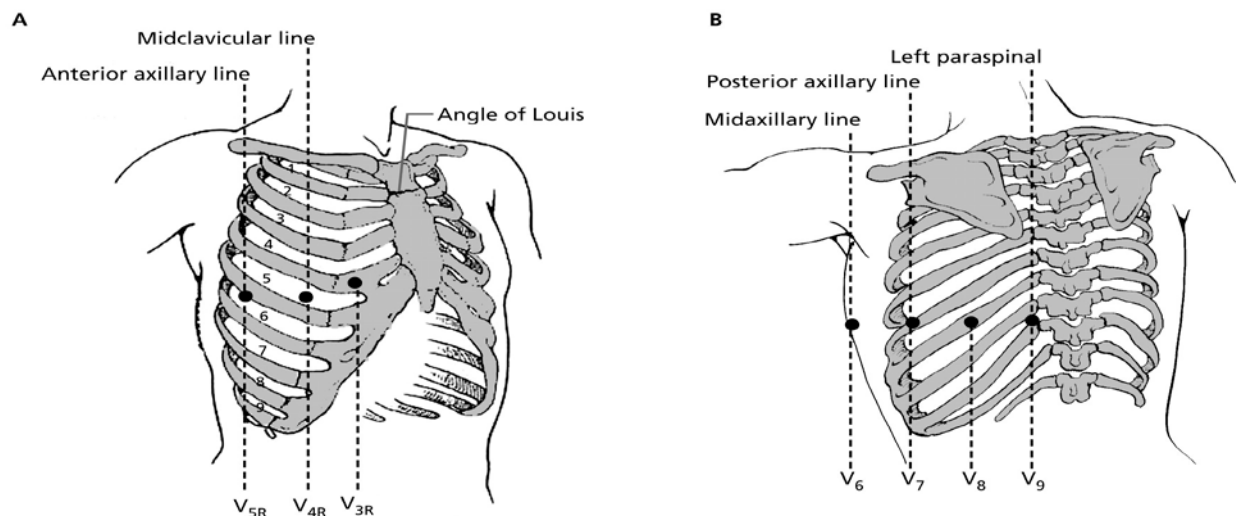
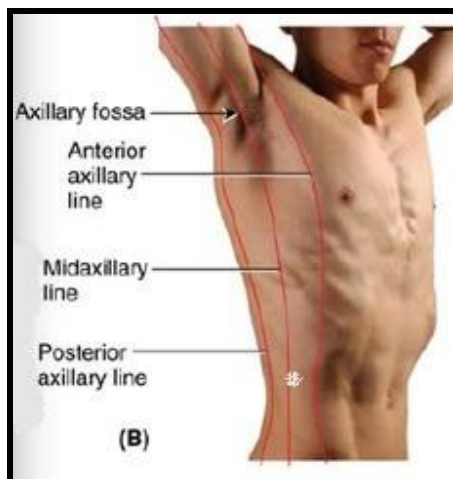


Figure 9. Anterior Axillary Line



Nipple level is variable in females - but you can lift the breast and use the level of the infra-mammary fold.

Measure four fingers down from the axilla (measure the width of your hand placed under the patient's axilla with their arm down) at the lateral aspect of the breast/pectoral muscle.

Another option - two finger breadths below the bottom of the axillary hairline. Can see even if just shaved.

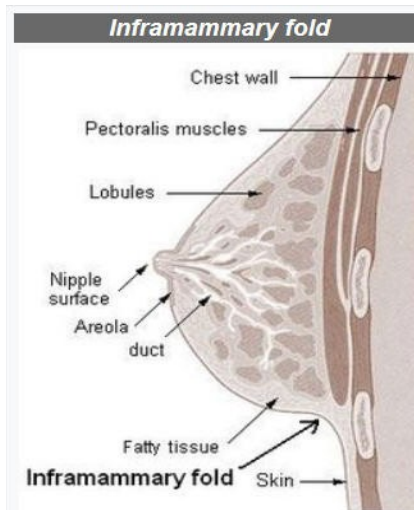


Figure 10. Inframammary Fold

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 or a 10-gauge, 3.25-inch needle/catheter unit
- 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 or a 10-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

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 perpendicular to the chest wall and just over the top of the lower rib at the insertion site. **Not medial to the nipple line and not towards the heart.**
- Puncture the parietal pleura - Insert the needle/catheter unit all the way to the hub and hold it in place for 5-10 seconds to allow decompression to occur. 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.

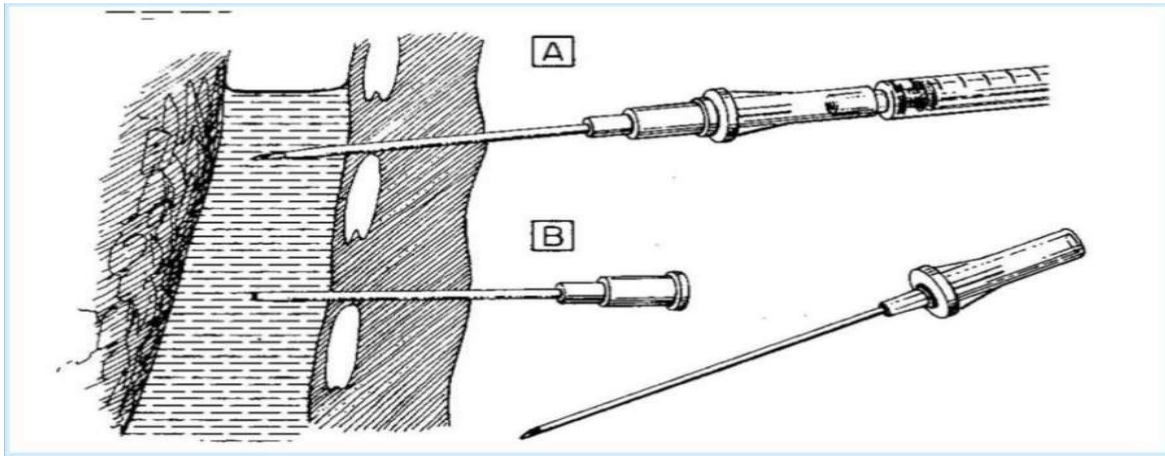


Figure 11. Enter Just Over the Top of the Rib Below

The NDC (needle decompression) should be considered successful if:

- Respiratory distress improves, or
- There is an obvious hissing sound as air escapes from the chest when NDC is performed (this may be difficult to appreciate in high-noise environments), or
- Hemoglobin oxygen saturation increases to 90% or greater (note that this may take several minutes and may not happen at altitude), or
- A casualty with no vital signs has return of consciousness and/or radial pulse.

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.

If the initial NDC fails to improve the casualty's signs/symptoms from the suspected tension pneumothorax:

-Perform a second NDC on the same side of the chest at whichever of the two recommended sites was not previously used. Use a new needle/catheter unit for the second attempt.

-Consider, based on the mechanism of injury and physical findings, whether decompression of the opposite side of the chest may be needed.

If the initial NDC was successful, but symptoms later recur:

-Perform another NDC at the same site that was used previously. Use a new needle/catheter unit for the repeat NDC.

Tension pneumothorax is another common cause of preventable death encountered on the battlefield.

-It's easy to treat.

-Tension pneumothorax may occur with entry wounds in the chest, abdomen, back, shoulder, or neck.

-Blunt (motor vehicle crash) or penetrating trauma (GSW) or primary blast injury may cause tension pneumothorax.

-Continue to re-assess!

- Tension pneumothorax is a common but easily treatable cause of preventable death on the battlefield.
 - Diagnose and treat aggressively!

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. Although, if the casualty has penetrating trauma to that side of the chest, the needle won't make it worse if there is no pneumothorax. If the casualty does have a pneumothorax, you will save his life!

If a casualty has significant torso trauma or primary blast injury and is in traumatic cardiac arrest (no pulse, no respirations, no response to painful stimuli, no other signs of life), decompress both sides of the chest before discontinuing treatment.

REFERENCE(S) :

Prehospital Trauma Life Support, current Military Edition
CoTCCC Guidelines
Deployedmedicine.com



CASUALTY ASSESSMENT AND RESPIRATORY TRAUMA

Tactical Field Care Phase: M.A.R.C.H. Assess Respiratory effort. Expose and assess the chest. If the casualty has had a known or suspected torso trauma and difficulty breathing, assume the casualty has a tension pneumothorax and perform a Needle Thoracentesis (Needle Decompression). Treat any sucking chest wounds (entrance and exit). Remember, a tension pneumothorax can develop at any time after an injury, not just immediately after, so continuous assessment of the casualty is necessary. Note and treat all respiratory injuries.