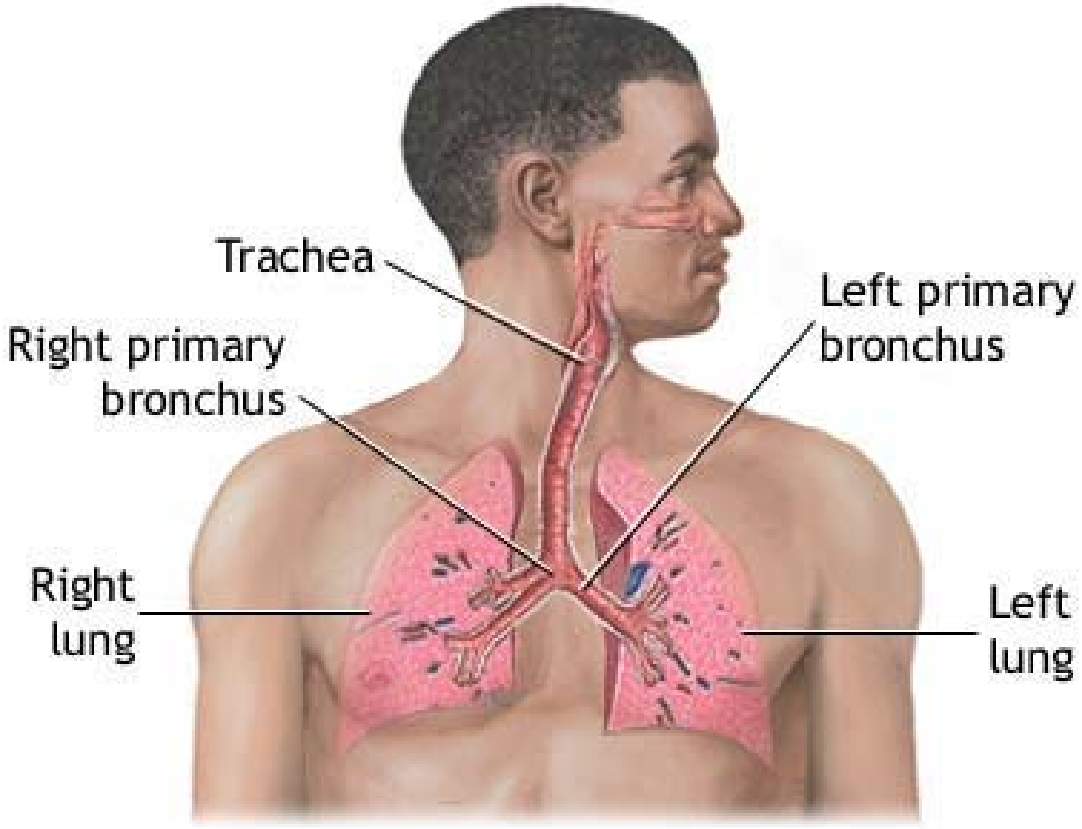
Chest Tubes: From Indication to Removal

Objectives

- Review respiratory anatomy and physiology.
- Discuss assessment of the pulmonary system.
- Recognize indications for chest tube placement.
- Explain nursing responsibilities with chest tube insertion, daily care, trouble shooting, and removal.

Anatomy of the Respiratory Tract



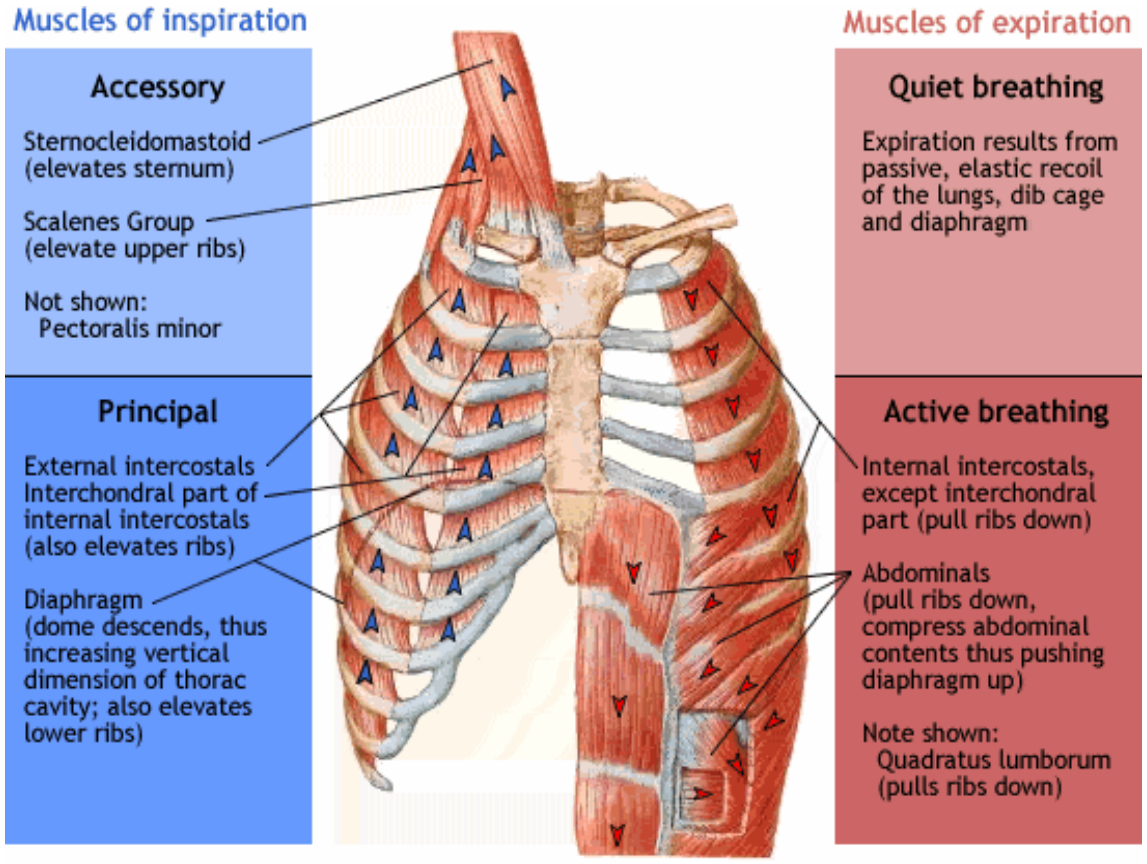
Upper Respiratory Tract:

- Nose
- Mouth
- Nasopharynx
- Oropharynx
  - Laryngopharynx
  - Larynx

Lower Respiratory Tract:

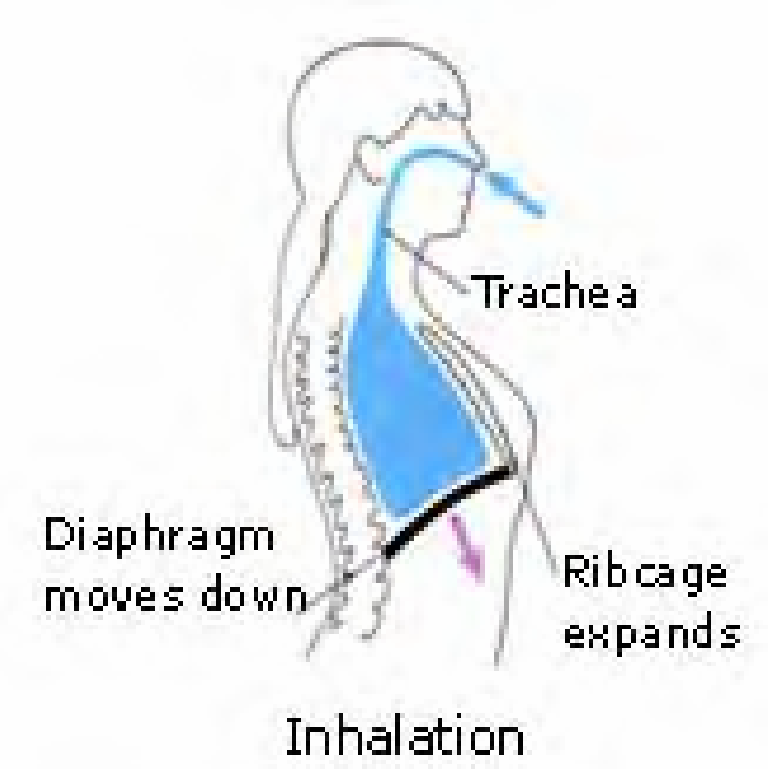
- Trachea
  - Primary Bronchi
  - Lobar Bronchi
  - Segmental Bronchi

Musculoskeletal Anatomy of Respiration



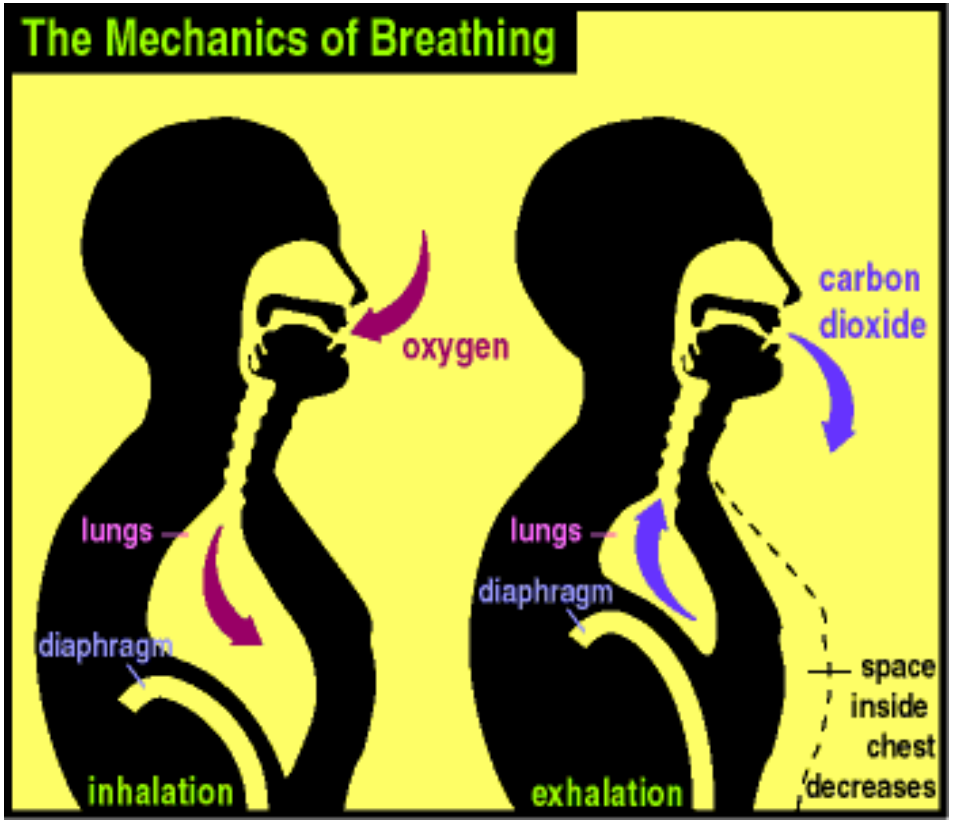
<u>Thoracic Cage:</u>
Manubrium
Ribs
Sternum
Vertebral Column
Xiphoid Process
<u>Muscles of Respiration:</u>
Diaphragm
External Intercostals
<u>Accessory Muscles:</u>
Abdominal Rectus
Internal Intercostals
Pectorals
Posterior Trapezius
Sternocleidomastoid

Inspiration



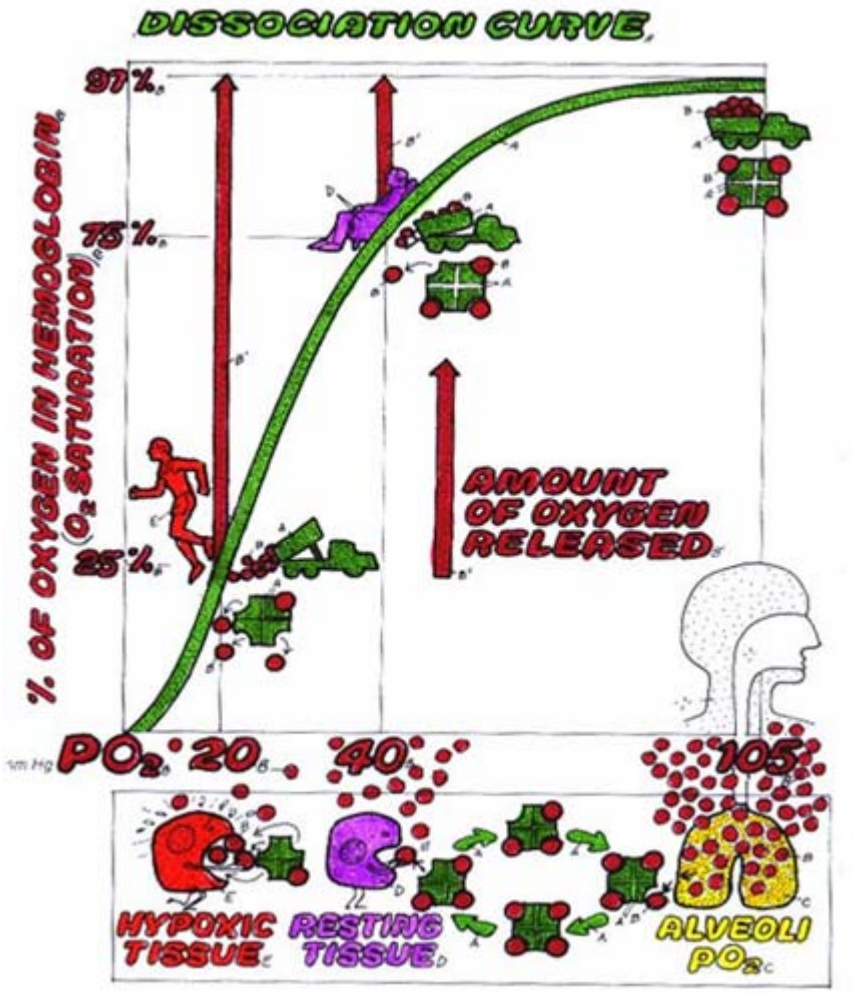
- Active process
- Thoracic cage expands
- Diaphragm contracts and lengthens thus lifting ribs upward and outward and displaces abdominal contents downward
- External intercostal muscles contract and pulls ribcage upward and increases width
- Net effect of is twofold: Intrathoracic volume increases and pressures are lowered
- Pressure gradient causes air to move into lungs

Expiration



- Relatively passive process
- Diaphragm moves upward and external intercostals relax, size of thoracic cage decreases
- Accessory muscles contract, ribcage moves upward, abdominal contents rise
- Pressures become slightly positive and air flows out of the lungs

A Little Physiology



- Human breathes 12-15/minute
- About 500 milliliters per breath
- 6-8 liters/ minute
- Air mixes in alveoli
- Oxygen enters blood in pulmonary capillaries
- Carbon dioxide enters the alveoli
- 250 milliliters of oxygen enters while 200 milliliters of carbon dioxide departs
- 250 volatile substances identified in human breath

Assessment of Respiratory System

- Presenting illness
- Past medical history
- Physical assessment:
  - Inspection
  - Palpation
  - Percussion
  - Auscultation of breath sounds and quality of voice

Inspection

Relaxed, effortless, occasional sighing, eupnea, pink, moist mucous membranes, trachea midline and straight, symmetrical chest, scapulae on same horizontal plane, alert and oriented, inspiration to expiration ratio 1:2, angulation at base of nail and finger, diaphragmatic (male) vs thoracic (female) breathing, spine straight, sitting or reclined without difficulty

Palpation

- Presence and quality of pulses
- Skin smooth, warm, and dry
- Capillary refill less than 2 seconds
- Mild vibration on chest wall during vocalization
- Spine and ribs non-tender symmetrical lateral chest expansion (3-8 cm)

Percussion

- Resonance is easily heard.
- Equal quality bilaterally.
- Low-pitched and hollow sounding .
- Diaphragmatic excursion 3-5 cm and hemi-diaphragm moves 3-6 cm.

Auscultation

Bronchial:

- Heard around trachea and larynx
- Harsh, hollow, tubular quality
- Loud, high-pitched

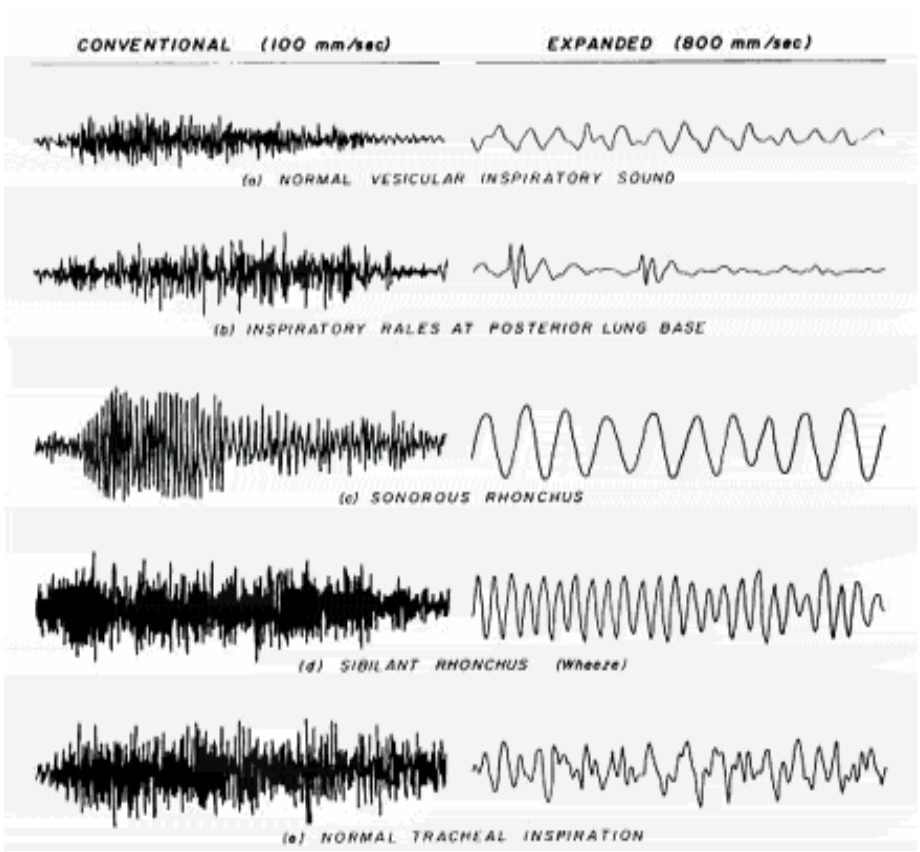
Bronchovesicular:

- Heard around scapulae, upper sternum in first and second intercostal spaces

Vesicular:

- Heard over peripheral lung fields
- Low, soft rustling sounds

Adventitious Lung Sounds

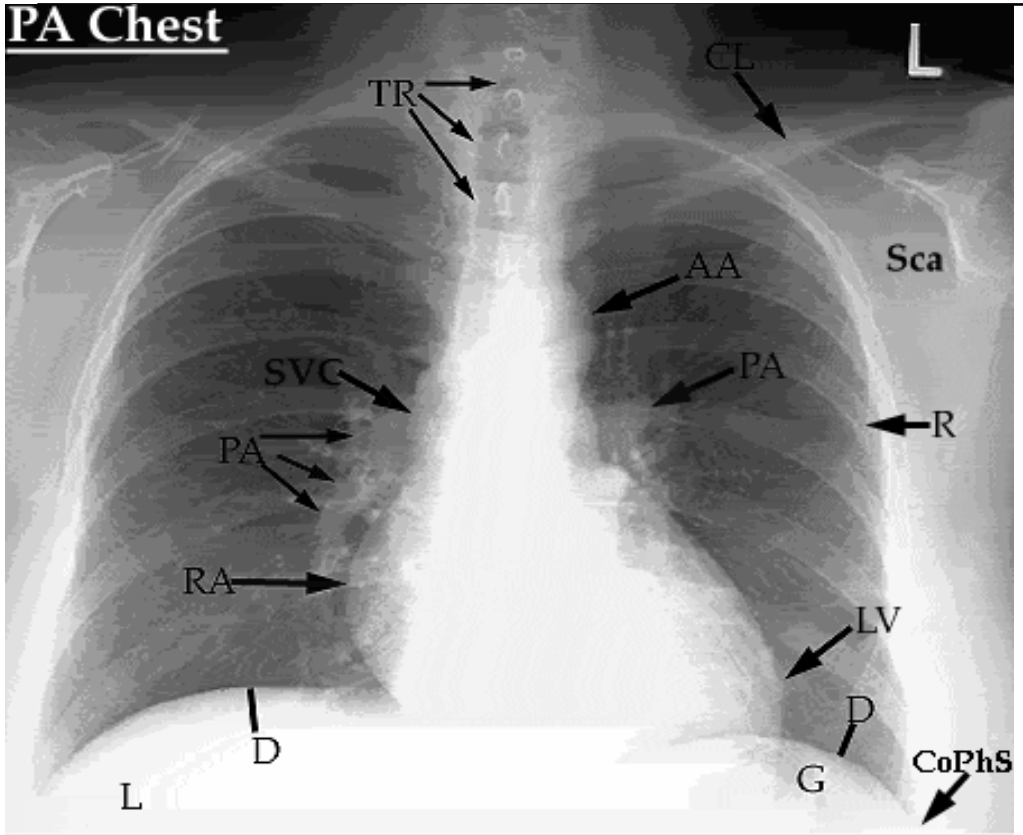


- Crackles: Fine, high-pitched/coarse low-pitched, short, discontinuous, commonly heard during inspiration, indicative of air passing though fluid in small airways
- Rhonchi: Low-pitched, continuous snoring sound, commonly heard during expiration, potentially large airway obstructed by fluid
- Wheezes: High-pitched whistling sounds, heard in expiration and inspiration, indicates air passing through narrow airways
- Pleural Friction Rub: Scratching, grating, rubbing, creaking best heard at base of lung during end-expiration, and indicates inflamed pleura.\

The Patient in Respiratory Distress

- Abdominal/Accessory muscles use.
- Abnormal breath sounds
- Asymmetrical chest wall motion
- Decreased oxygen saturation
- Decreased urine output
- ECG changes
- Hyper/hypoventilation
- Jugular venous distention
- Nasal flaring
- Restlessness/confusion/agitation
- Shortness of breath
- Skin color changes
- Tachycardia and hypertension
- Tracheal shift

Normal Chest Roentgenogram (X-ray)



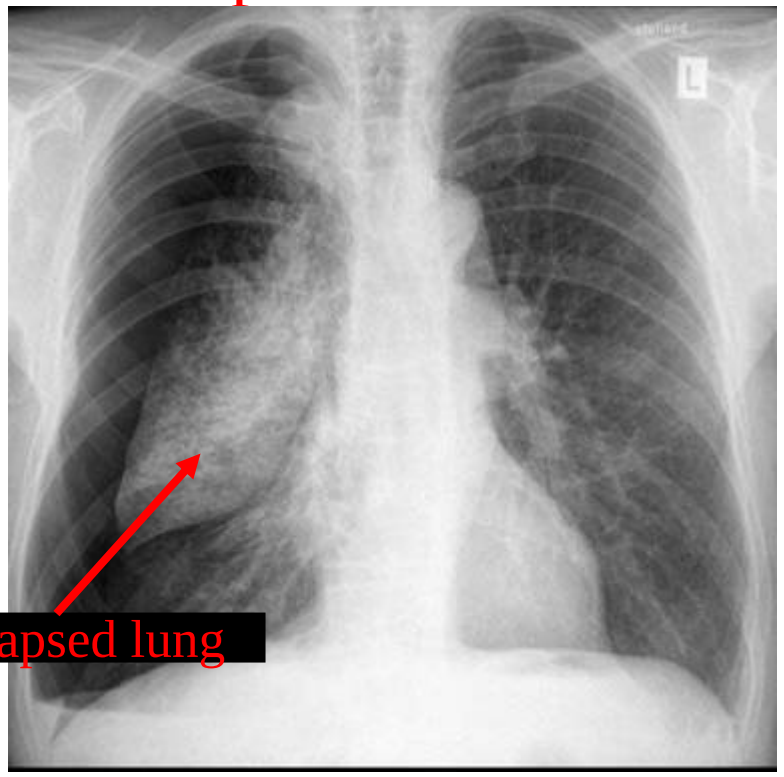
Based on systematic evaluation:

- Soft tissues of neck, shoulders, breasts, axillae, diaphragms, and upper abdomen
- Skeletal structures such as clavicles, ribs, vertebrae, scapulae, and sternum
- Trachea, bronchi, pleural spaces, and lung parenchyma
- Tubes, lines, and monitoring devices

Comparison of Chest Radiographs (Pneumothorax)

Normal Chest X-ray

Simple Pneumothorax



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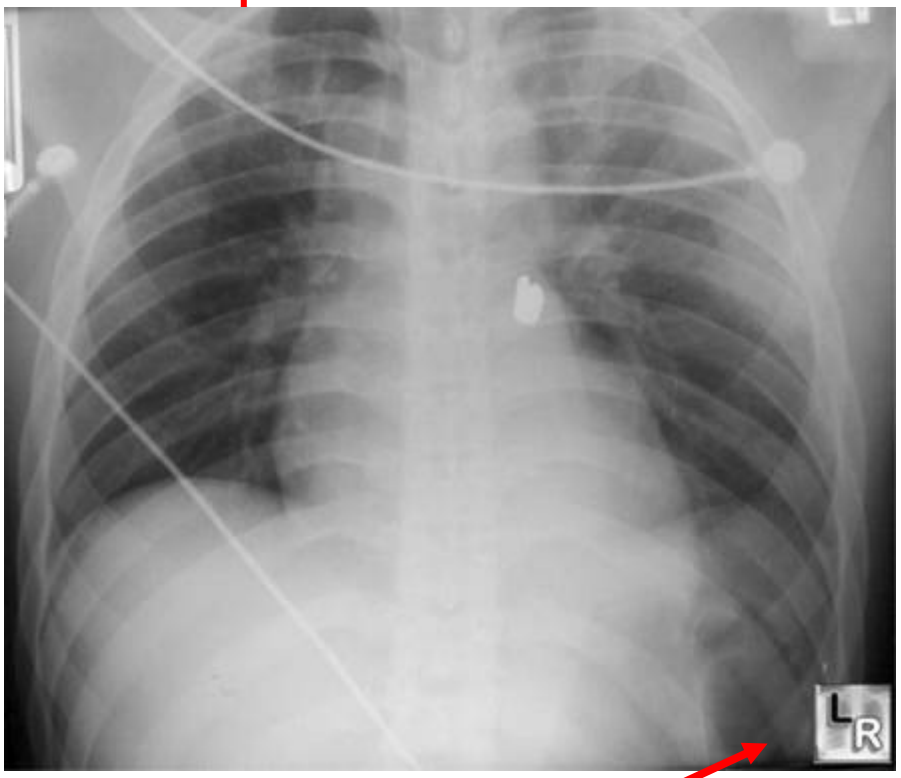


Deep Sulcus Sign

Comparison of Chest Radiographs (Pneumothorax)

Normal Chest X-ray

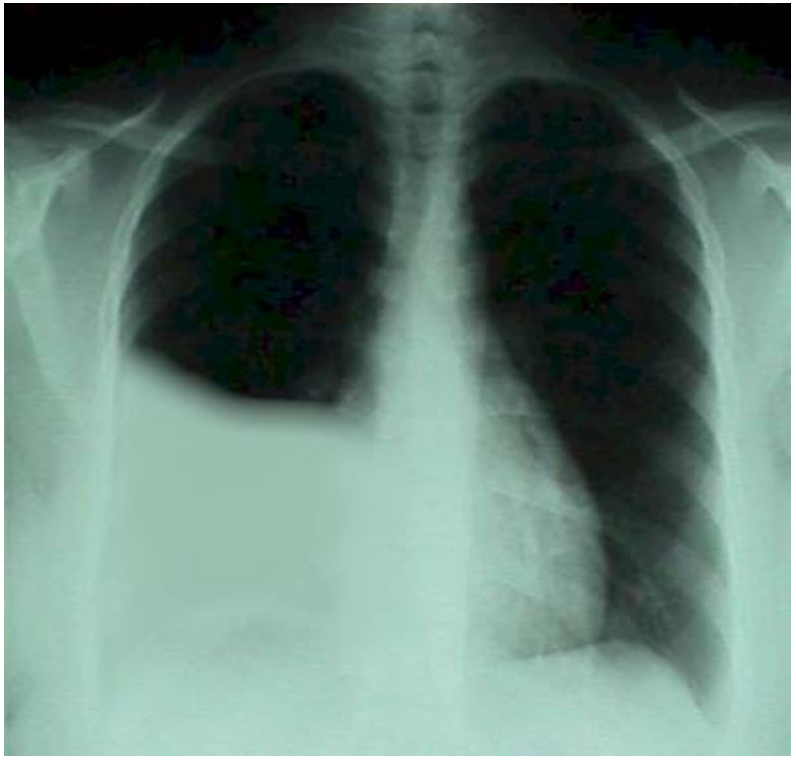
Tension Pneumothorax

Note the mediastinal shift !!

Comparison of Chest Radiographs (Hemothorax)

Normal Chest X-ray

Right Hemothorax

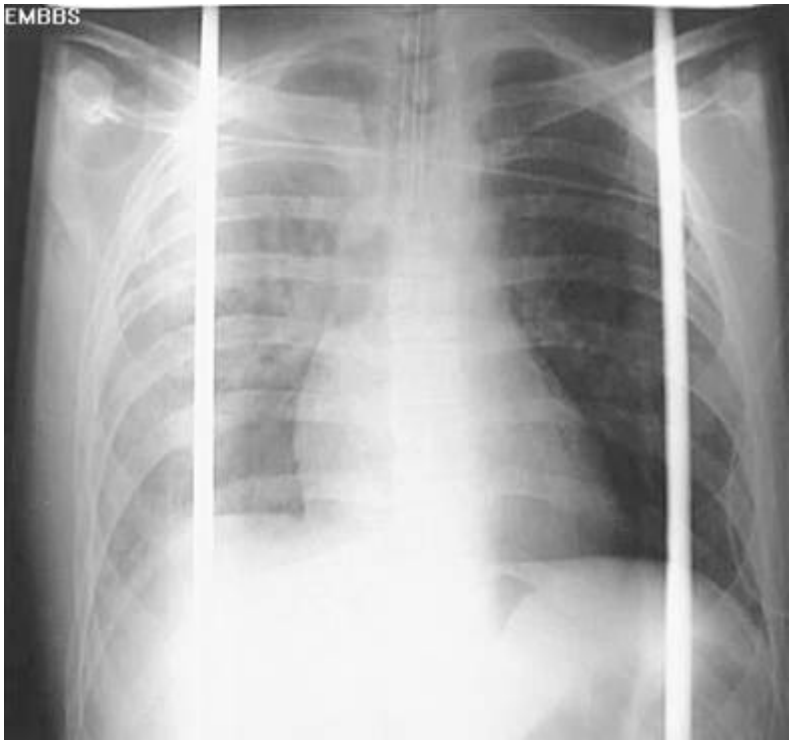


Patient Supine – blood layers inferiorly

Comparison of Chest Radiographs (Hemothorax)

Normal Chest X-ray

Right Hemothorax

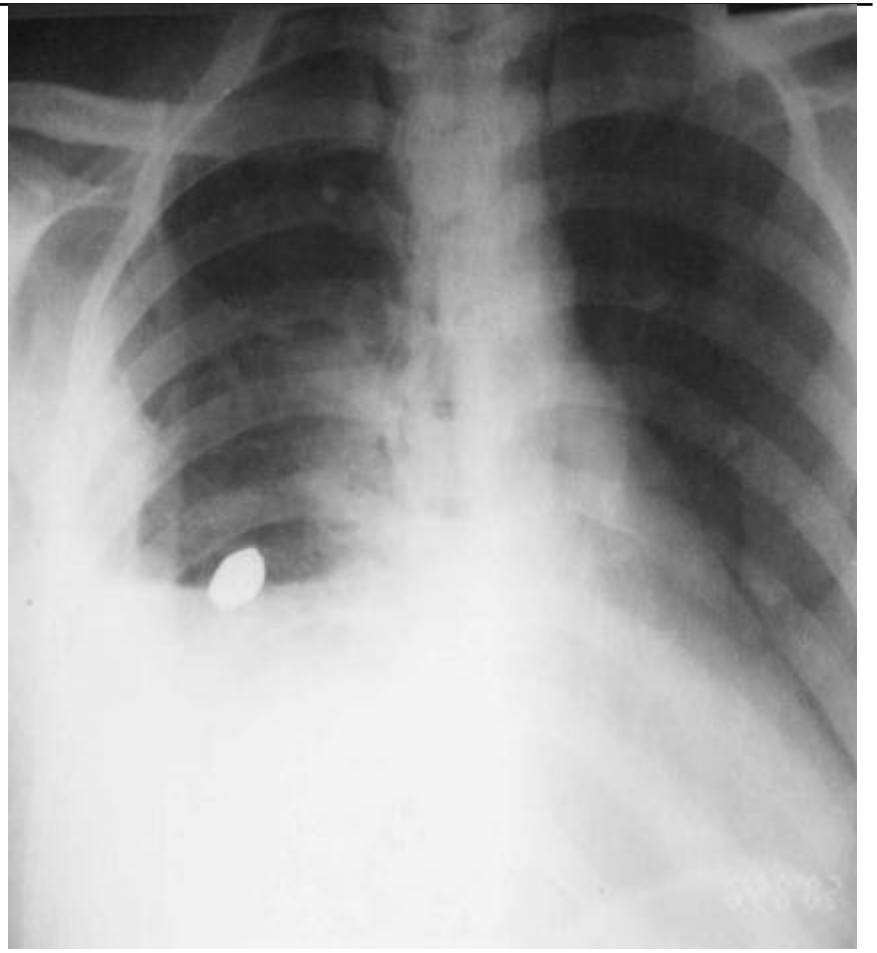


Patient Prone – blood layers posteriorly.

Comparison of Chest Radiographs (Pleural Effusion)

A pleural effusion and a hemothorax look the same, depending on the position of the patient.

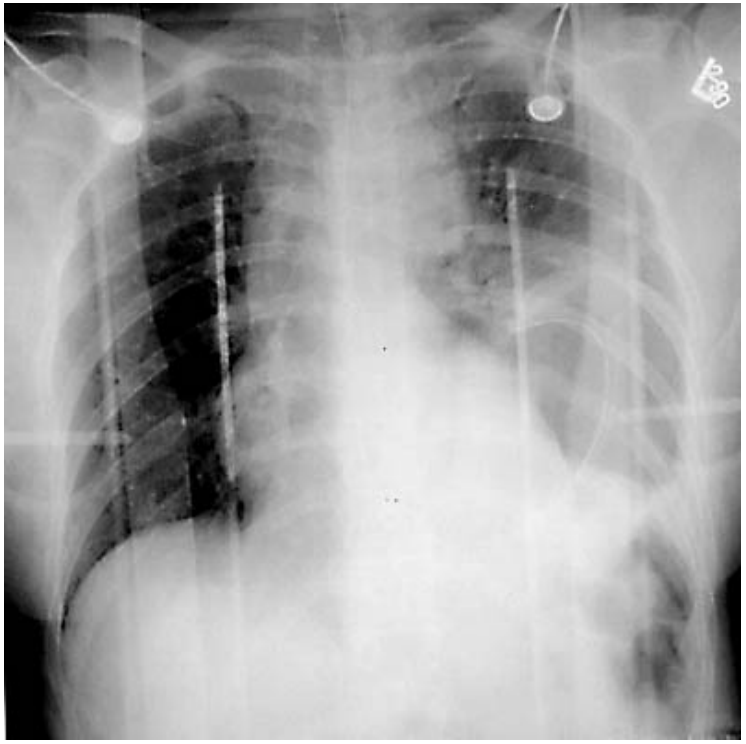
Comparison of Chest Radiographs (Hemopneumothorax)



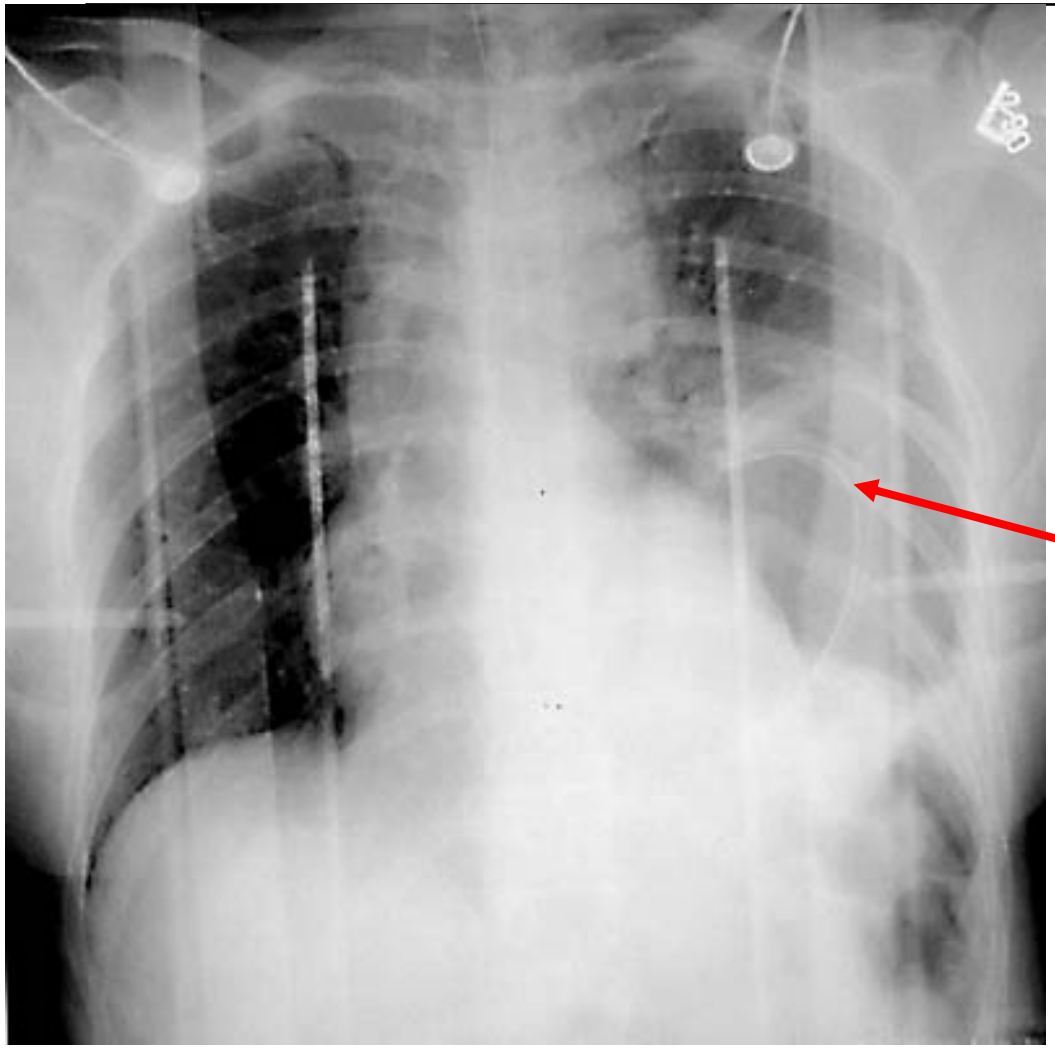
Comparison of Chest Radiographs
What do you see?

Normal Chest X-ray

Well?



Comparison of Chest Radiographs (?????)

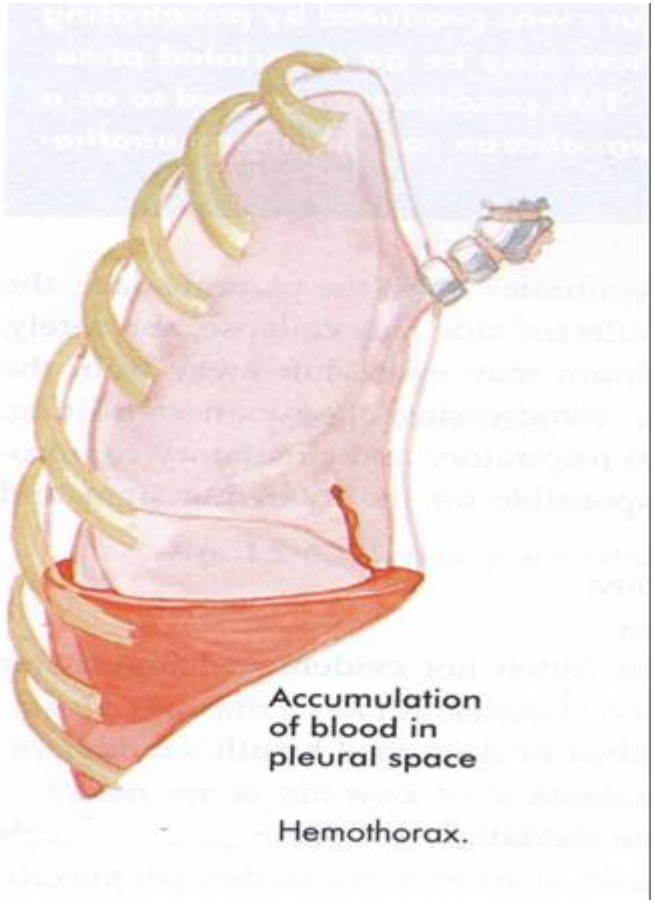


NGT floating freely in the left hemithorax…..diagnostic for a ruptured left hemidiaphragm !!

A Little History

- Hippocrates (470-500 BC) described techniques to cannulate the pleural space
- Hillier (1867) opened empyema under water
- Playfair (1872) introduced water seal
- Hewett (1876) incorporated use of continuous chest drainage system with water seal
- WWI U.S. Army formed Empyema Commission
- WWII saw use in thoracotomies
- Korean War saw use in trauma

Indication for Chest Tube Placement

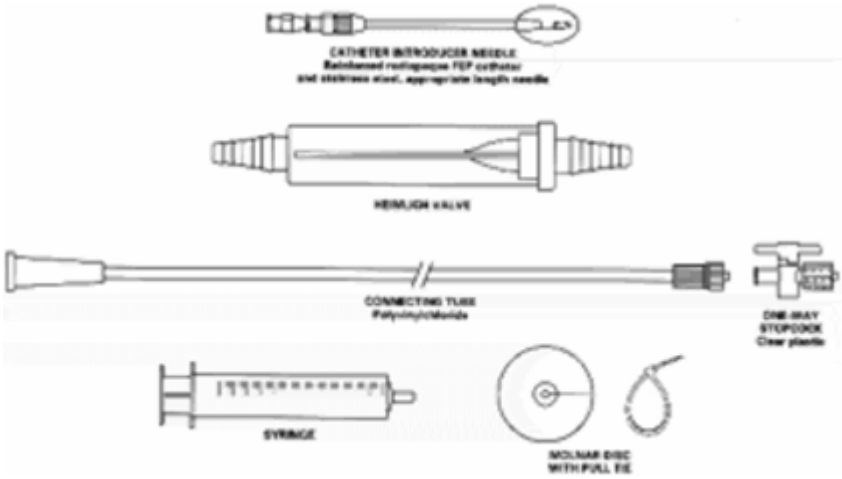


Hemothorax.

- Pneumothorax
- Hemothorax
- Symptomatic pleural effusion
- Empyema
- Complicated parapneumonic effusion
- Chylothorax
- Sclerosis of recurrent malignant effusions

Chest Tubes

- French sizing refers to the diameter of the tube in millimeters from 8-40 Fr
- Tube is sterile, flexible, nonthrombogenic composed of vinyl or silicone
- Typically packaged with aluminum trocar
- Measures 20 inches in length (50 cm)
- Proximal end is fenestrated
- Indications and patient size dictates size
- Pneumothorax: 20-24 Fr
- Fluid: 28 Fr
- Average adult/teen male: 28-32 Fr
- Average adult/teen female: 28 Fr



Chest Tube Insertion

Insertion site is at the 6th intercostal space, anterior axillary line

Consent is obtained and the procedure is explained

Pretreatment with analgesia, oxygen, and/or anxiolytics

Patient placed supine and arm raised over head

.

Chest Tube Insertion

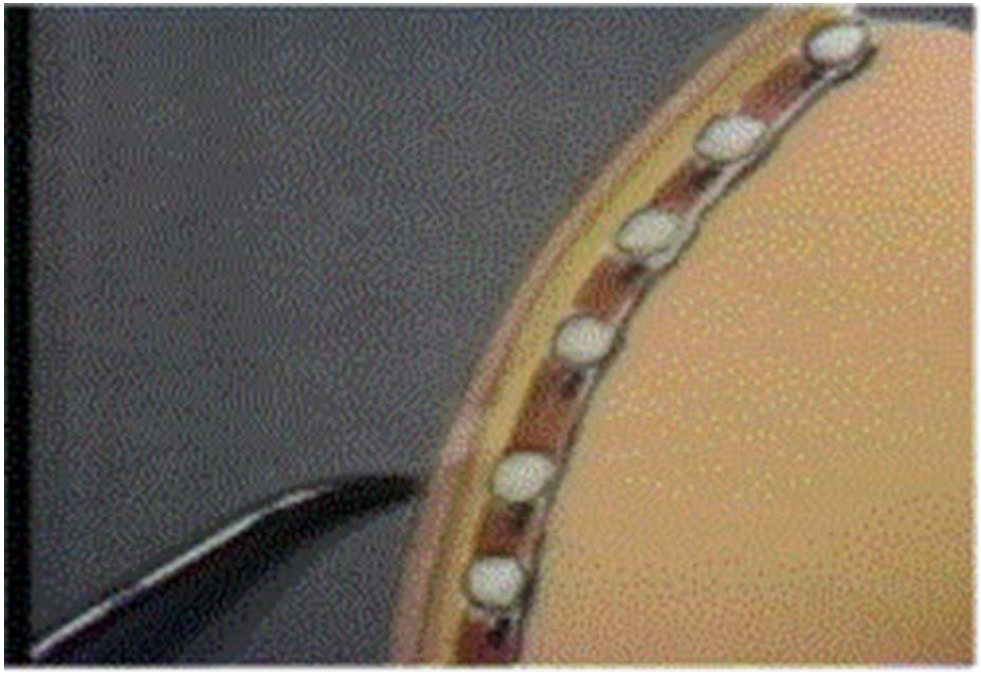
Chest is surgically prepared in normal sterile fashion

Local anesthetic is infiltrated into skin, subcutaneous tissue, chest wall, intercostal muscle, periosteum, and parietal pleura

Chest Tube Insertion

1-inch incision is made directly over the rib

Chest Tube Insertion

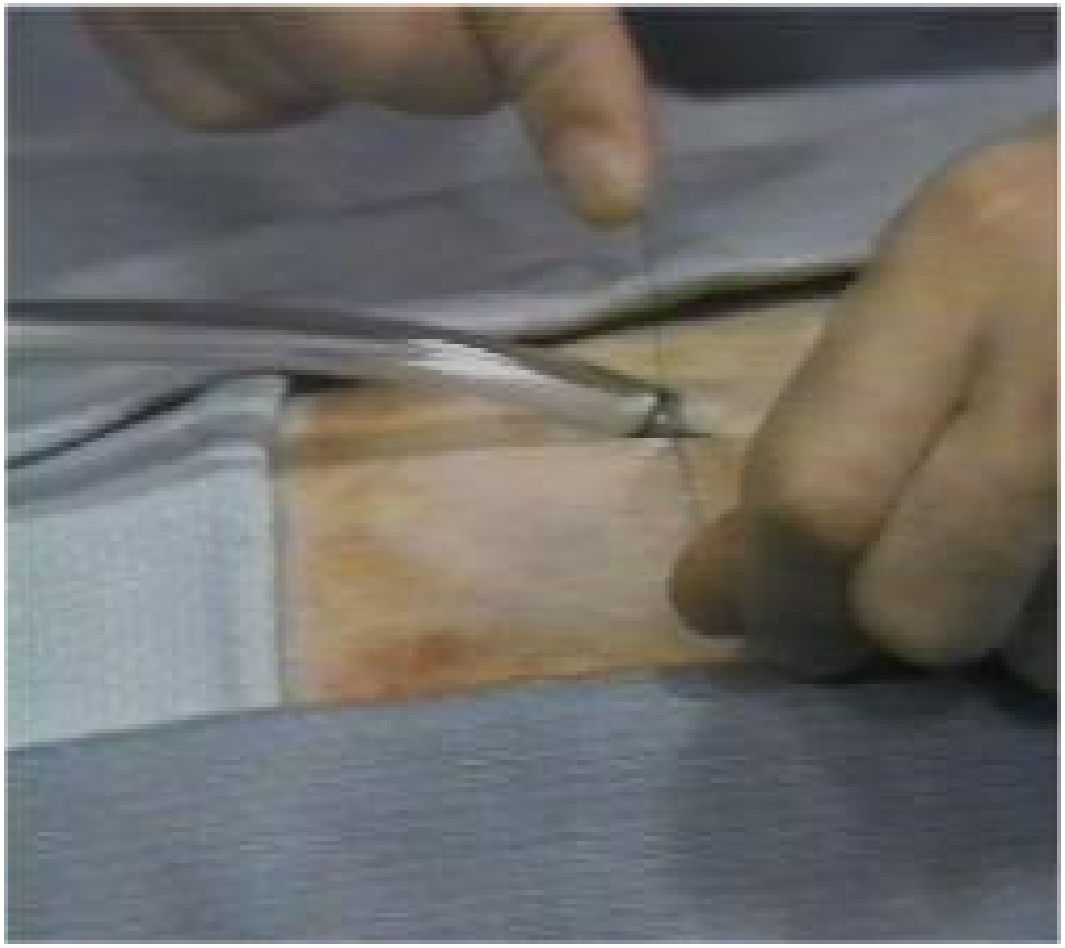


A hemostat is used to spread the subcutaneous tissues down to the rib. It is then used to pop into the pleural space just above the rib

Chest Tube Insertion

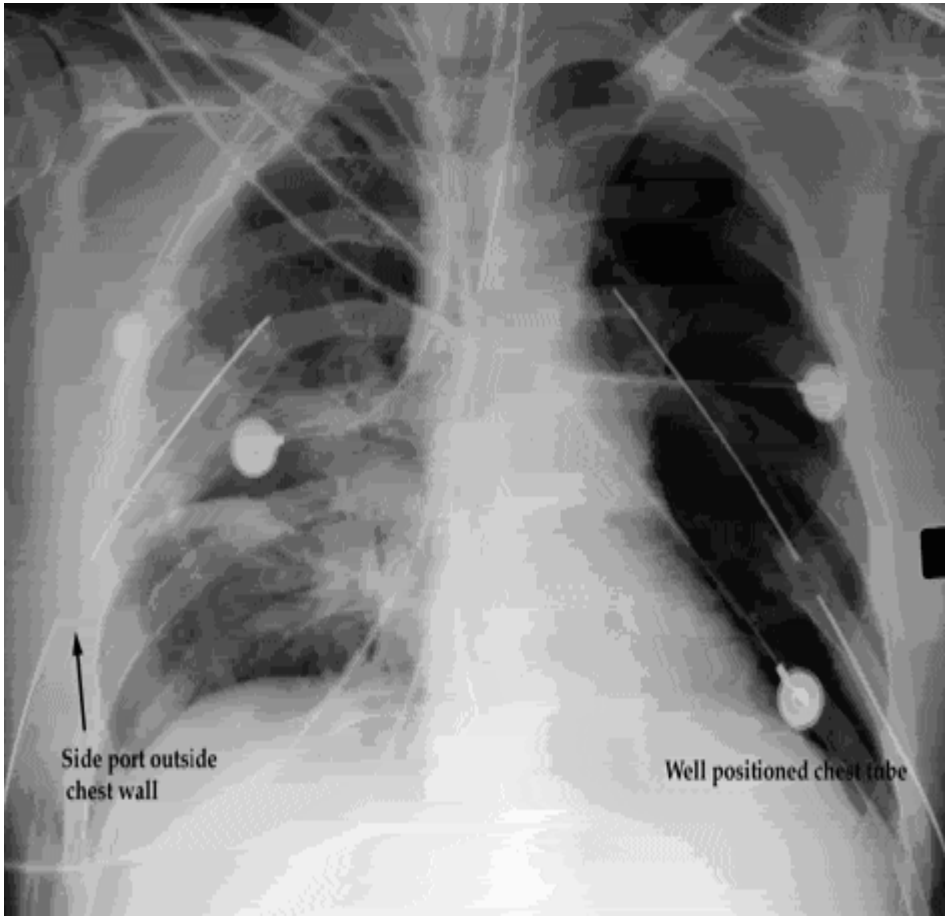
After the pleural space has been penetrated, a hemostat is used to grasp the tip of the chest tube and guide it through the subcutaneous tunnel and into the chest cavity

Chest Tube Insertion



The incision is closed and the chest tube is tied in place

Common Complications of Chest Tube Insertion



- Allergic reaction
- Bronchopleural fistula
- Cardiac injury
- Hemorrhage
- Hepatic injury
- Infection
- Intercostal nerve, artery, or vein injury
- Lung laceration
- Re-expansion pulmonary edema
- Splenic injury
- Subcutaneous emphysema

Nursing Responsibilities

- Conduct routine patient assessment
- Frequently assess the insertion site, tube, tubing, and drainage unit
- Monitor amount, color, and consistency of the drainage
- Encourage positioning with head of bed up to 30 degrees
- Educate about the benefits of coughing, deep breathing, use of the incentive spirometer, and/or flutter valve every two hours
- Advocate ambulation and position changes

Amount, Color, and Consistency

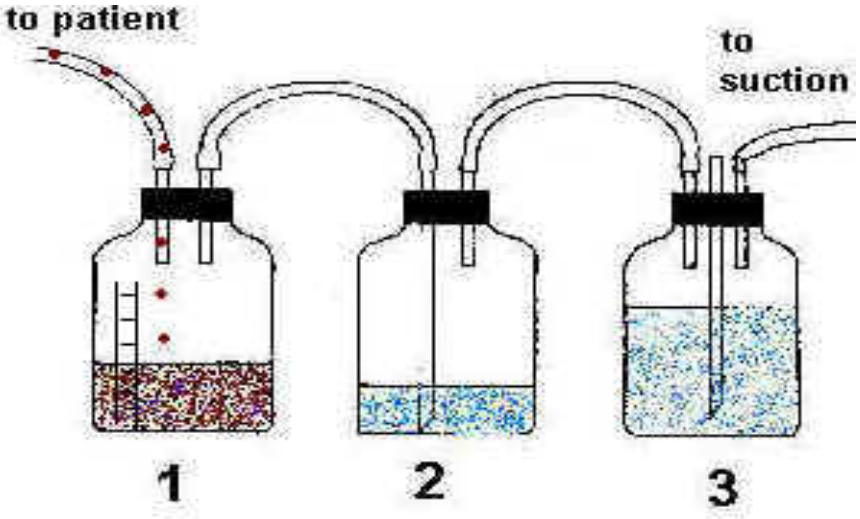
❖Sudden drainage increases could be indicative of hemorrhage

❖Changes in drainage from serosanguinous to red could indicate hemorrhage

❖Consistency changes from thin, clear fluid to milky could be evidence of evolving infection

❖Decreased drainage may be a sign of tube displacement, kinked tubing, or a clot may be obstructing the lumen of the tube

How Does a Chest Tube Function?



Goal is to remove fluid or air from the pleural space, prevent re-accumulation, and allow for lung re-expansion.

1) Collection Bottle: collects fluid and debris delivered by chest tube. Connected to water seal chamber

2) Water Seal Bottle: One way valve for air to escape from the pleural space, measures negative pressure in chest, and determines degree of air leak

3) Suction Control Bottle: Volume of water determines amount of negative pressure in pleural space

Pleur-Evac

- Atmospheric vent
- Collection chamber
- Filtered high negativity relief valve
- High negativity float valve
- Patent air leak meter
- Positive pressure relief valve
- Self-sealing diaphragm
- Suction control pressure scale
- Suction tubing
- Water seal pressure scale

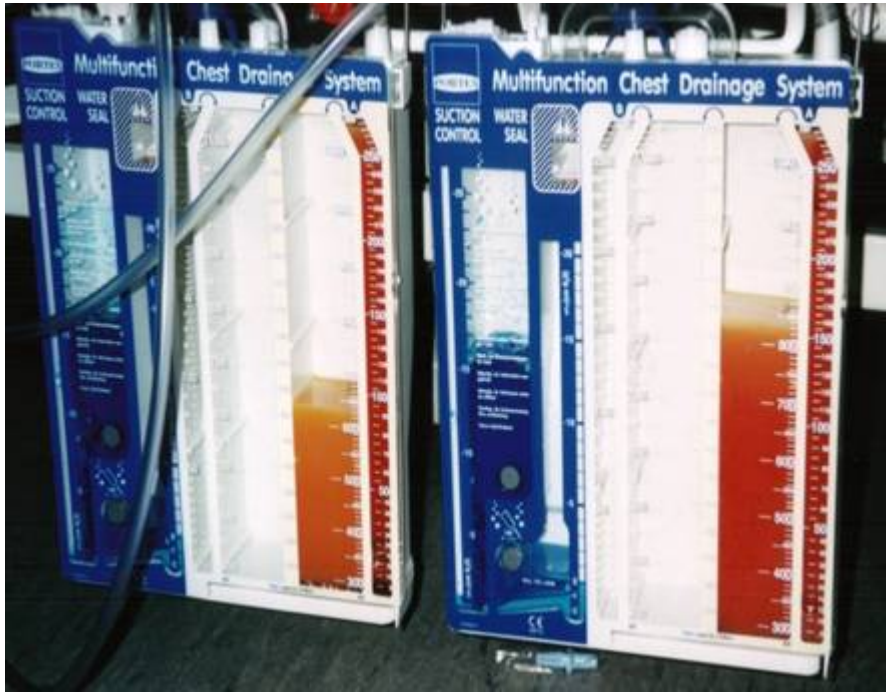
Setting Up the Pleur-Evac

- Fill water seal chamber
- Connect to chest tube
- Connect to suction
- Fill suction chamber
- Turn on suction

Assessing the Water Seal Pressure Scale

- Tidaling is the rhythmic fluctuations in the water seal chamber that correspond to respirations
- If bubbling is seen, this indicates an air leak. Assess from insertion site down to the chest drainage system
- Negative pressure in the water seal pressure scale indicates negative pressure in the pleural space
- Under filled chamber could result in pneumothorax as there is no water seal
- Over filled chamber could increase the need for more pressure to actually drain the chest

Assessing Air Leaks



What is it? Bubbling seen in the water seal pressure scale. Usually will have some rise and fall with each breath, but constant bubbling is a clue that there could be a problem in:

- Chest tube drainage system
- Poorly positioned chest tube
- Injury to bronchus/esophagus
- Continued air leak in the lung

Assessing Air Leaks

To help determine the location of an air leak, the chest tube may be clamped near the chest wall:

If the air leak disappears, then the “leak” is coming from the patient (i.e. persistent lung injury)

If the air leak continues, the leak is coming from a location distal to the clamp….i.e. hole in chest tube, loose connection, leak in the tubing, faulty pleuravac system, etc…

Don’t forget to release the clamp!!!

Bad Things Happen to Good People

❖Chest tube gets dislodged: If you hear air leaking, cover site with three sided dressing. If no air is heard, cover with sterile dressing and notify the physician.

❖Chest drainage unit breaks: change the unit, assess, and notify physician

❖In emergent situations, tubing could be placed in sterile water/saline at a depth of 2-4 cm to re-establish the water seal

When is it Time to Come Out?

- When indication for insertion is no longer present (i.e. resolution of pneumothorax, hemothorax, etc…)
- No air leak evident the day before considering chest tube removal
- Drainage less than 50cc/8 hours or 150cc/day
- Patient able to tolerate chest drainage system being brought to water seal from suction
- Chest x-ray shows complete re-expansion of the lung

Discontinuing the Chest Tube

- Procedure is explained and appropriate pre-medication is performed
- Assumes supine position with arm above head on side of tube
- Chest drainage unit brought to water seal and the dressing is removed
- Either upon deep inspiration (if patient is intubated)or exhalation (if patient is on CPAP or not intubated), the tube is removed with one steady movement
- Site is dressed and x-ray obtained 24 hours later

Questions

Very Special Thanks

- Marlo Anderson RN. Surgical Trauma Neurological Intensive Care Unit
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- Laura Gallagher RN, MSN. Emergency Department
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American College of Surgeons Committee on Trauma. (2004). *Advanced trauma life support for doctors (Student Course Manual),* (7th ed, p. 125-30),Chicago IL:Author.

Carroll, P.(1995). Chest tubes made easy. *RN,* 58(12), 46-8.

Chest Tubes Ocala Regional Medical Center Ocala, FL:Accessed online 07/19/2005.

Dennison, RD.,& Mathews, PJ.(2002). *Illustrated manual of nursing practice* (3rd ed p. 324-51), Springhouse, PA:Lippincott Williams & Wilkins.

Emergency Nurses Association.(2000). *Trauma nursing core course (Instructor Supplement).* (5th ed p.63-72, 278-82).Des Plaines, IL:Author.

Emergency Nurses Association.(2003).*Course in advanced trauma nursing-II: A conceptual approach to injury and illness (Student Manual),* (2nd ed, p. 39-59), Des Plaines, IL:Author.

Ganong, WF.(2001). *Review of medical physiology* (20th ed., p 644-73). New York, NY: McGraw Hill Medical Publishing Division.

Genzyme Biosurgery,(2003). *Pleur-evac chest drainage unit package insert*, Fall River, MA: Genzyme Corporation.

Hanson, CW., Manaker, S.,&Lanken, PN.(2001). *The Intensive Care Unit Manual* (p 381-86), Philadelphia, PA:Saunders.

Jarvis, C.(1996) *Physical examination and health assessment*, (2nd ed, p.460-88).Philadelphia, PA: W.B. Saunders Company.

Kapit, W., & Elson, LM.(2003). *Anatomy coloring book,* (2nd ed, p. 91-97). New York, NY:HarperCollins Publishers.

Kapit, W., Macey, RI., Meisami, E.(2000). *Physiology coloring book,* (2nd ed, p. 49-57).New York, NY:HarperCollins Publishers.

Lazzara, D.(2002).Eliminate the air of mystery from chest tubes. *Nursing 2002,* 30(6), 36-43.

Marino, PL.(1998). *The ICU book*. (2nd ed p. 459-62) Baltimore, PA: Williams & Wilikins.

Parsons, PE., & Heffner, JE.(2002). *Pulmonary/Respiratory therapy secrets* (2nd ed, p. 68-73).Philadelphia, PA: Hanley&Belfus, Inc.

Parsons, PE., & Wiener-Kronish, JP.(2003). *Critical care secrets*. (p.61-66). Philadelphia, PA: Hanley&Belfus, Inc.
Phipps WJ., Sands JK., Marek JF.(2004). *Medical-surgical nursing: concepts and clinical practice*, (6th ed, p.837-52).St. Louis, MO: Mosby, Inc.

Schell, HM., & Puntillo, KA.(2001). *Critical care nursing secrets*. (p.162-66). Philadelphia, PA: Hanley&Belfus, Inc.
Lazzara, D.(2002).Eliminate the air of mystery from chest tubes. *Nursing 2002,* 30(6), 36-43.

All the best..