

# Chest Tubes: From Indication to Removal

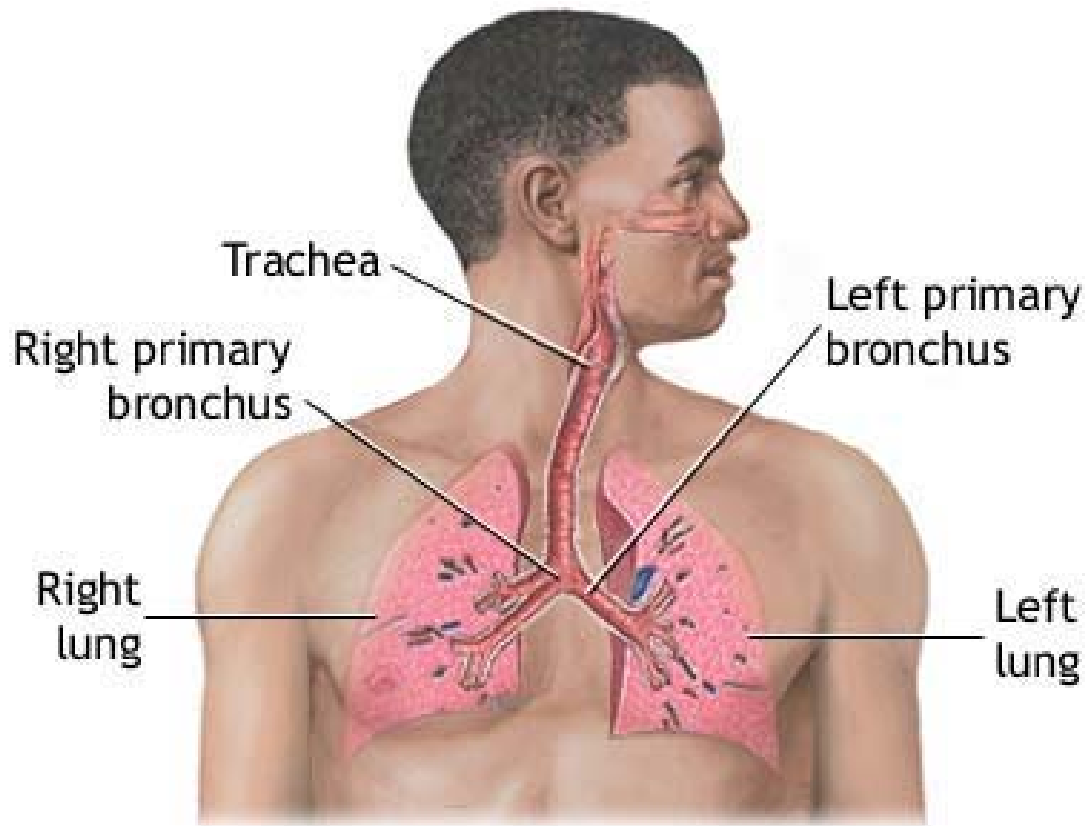


# Objectives

- ❖ 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

## Muscles of inspiration

### Accessory

Sternocleidomastoid  
(elevates sternum)

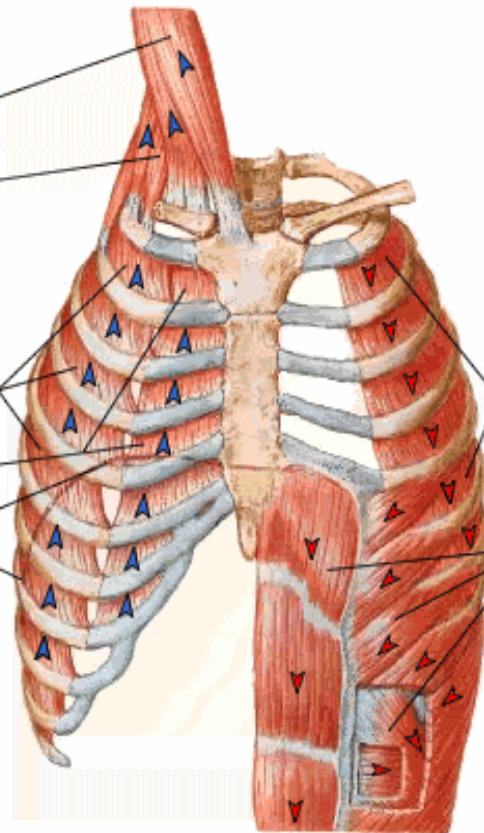
Scalenes Group  
(elevate upper ribs)

Not shown:  
Pectoralis minor

### Principal

External intercostals  
Interchondral part of  
internal intercostals  
(also elevates ribs)

Diaphragm  
(dome descends, thus  
increasing vertical  
dimension of thorac  
cavity; also elevates  
lower ribs)



## Muscles of expiration

### Quiet breathing

Expiration results from  
passive, elastic recoil  
of the lungs, rib cage  
and diaphragm

### Active breathing

Internal intercostals,  
except interchondral  
part (pull ribs down)

Abdominals  
(pull ribs down,  
compress abdominal  
contents thus pushing  
diaphragm up)

Note shown:  
Quadratus lumborum  
(pulls ribs down)

## Thoracic Cage:

Manubrium

Ribs

Sternum

Vertebral Column

Xiphoid Process

## Muscles of Respiration:

Diaphragm

External Intercostals

## Accessory Muscles:

Abdominal Rectus

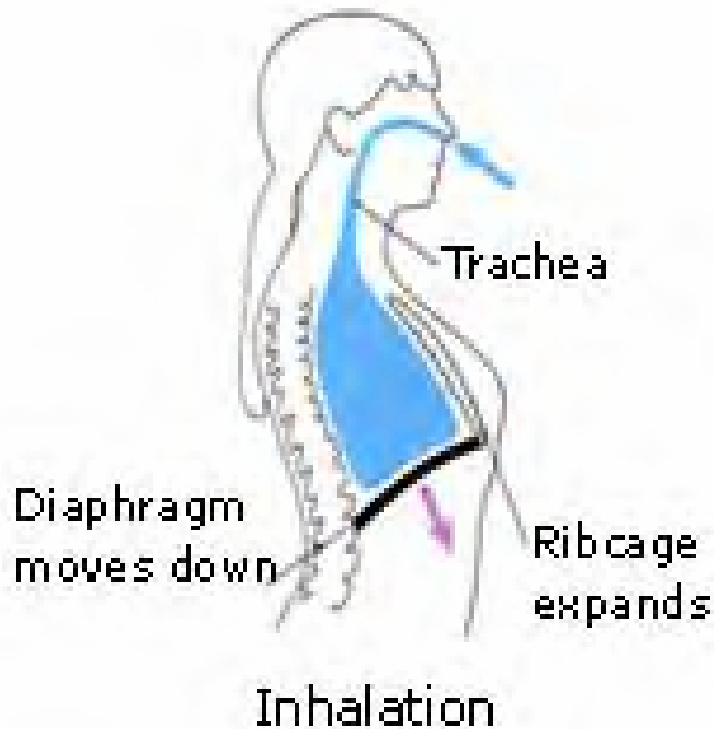
Internal Intercostals

Pectorals

Posterior Trapezius

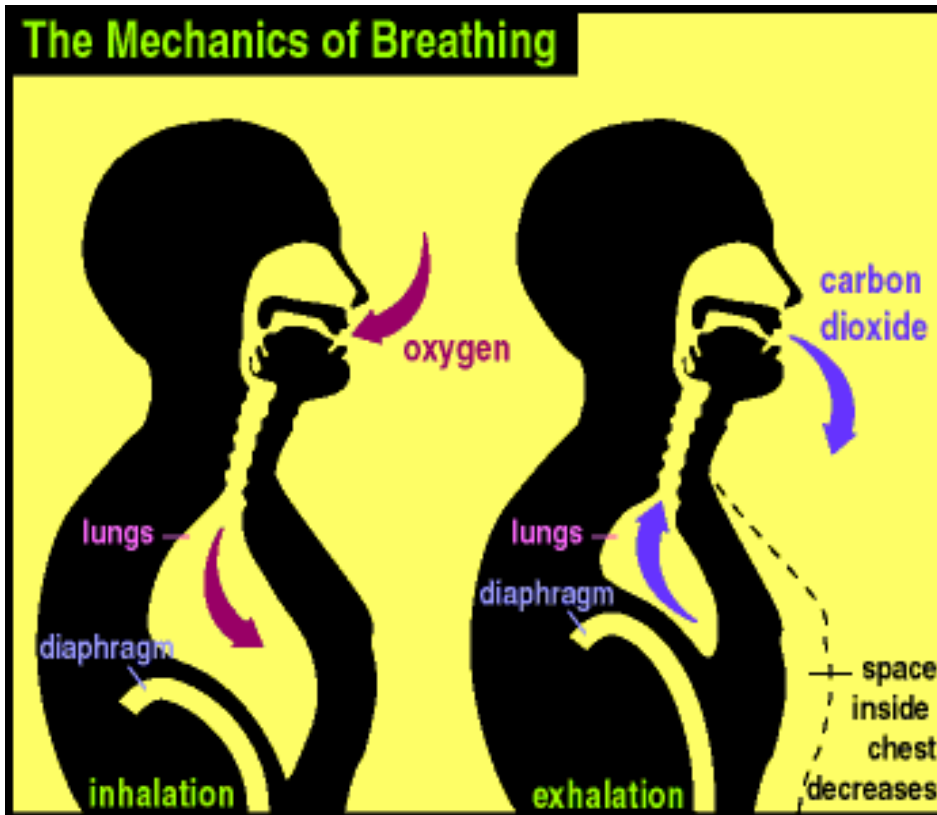
Sternocleidomastoid

# Inspiration



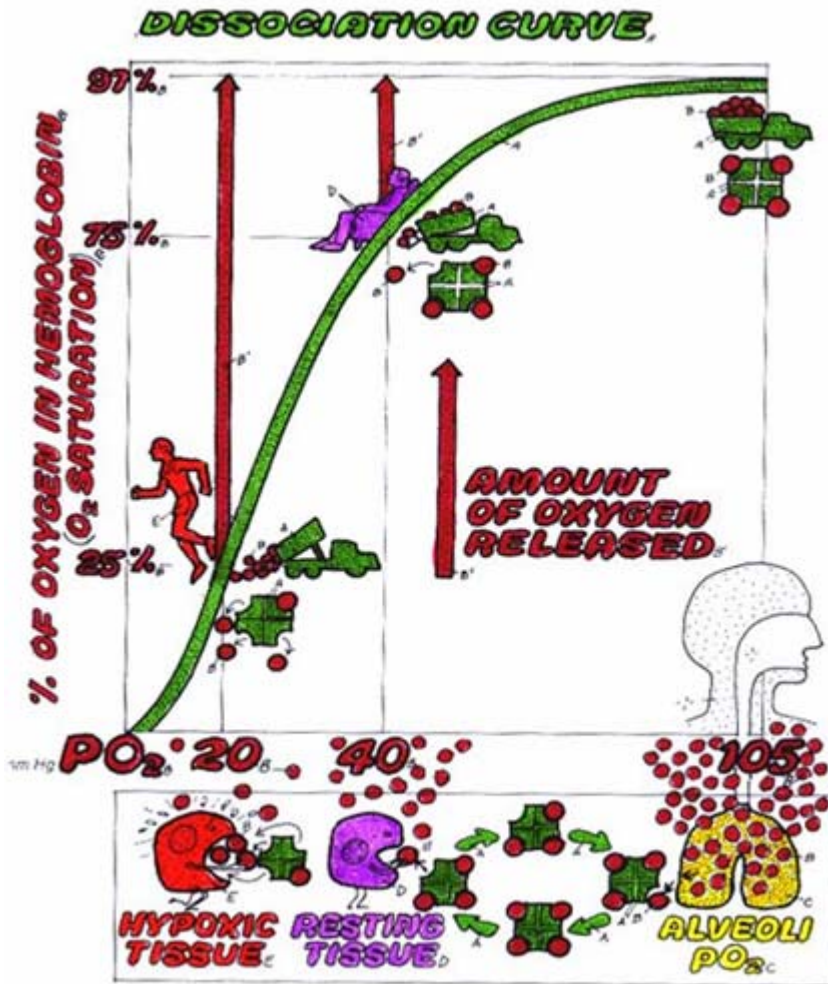
- ❖ Active process
- ❖ Thoracic cage **expands**
- ❖ Diaphragm contracts and lengthens thus lifting ribs upward and outward and displaces abdominal contents downward
- ❖ External intercostal muscles contract and pulls ribcage upward and increases width
- ❖ Net effect of is twofold:  
Intrathoracic volume 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

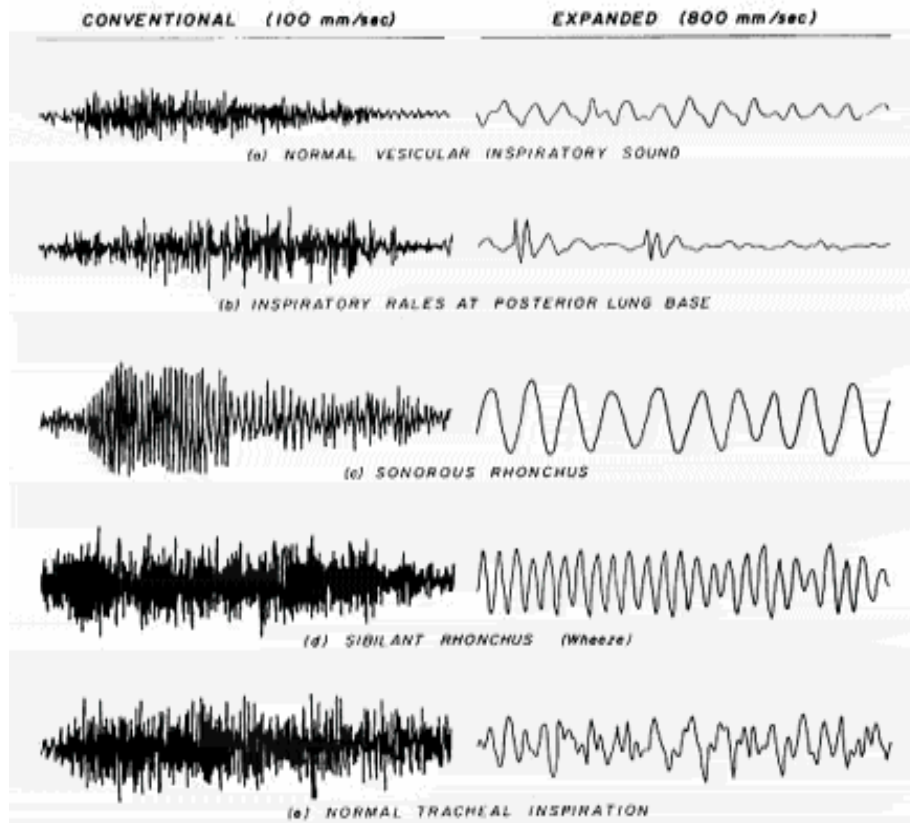
## Bronchovesicular:

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

## Vesicular:

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

# Adventitious Lung Sounds



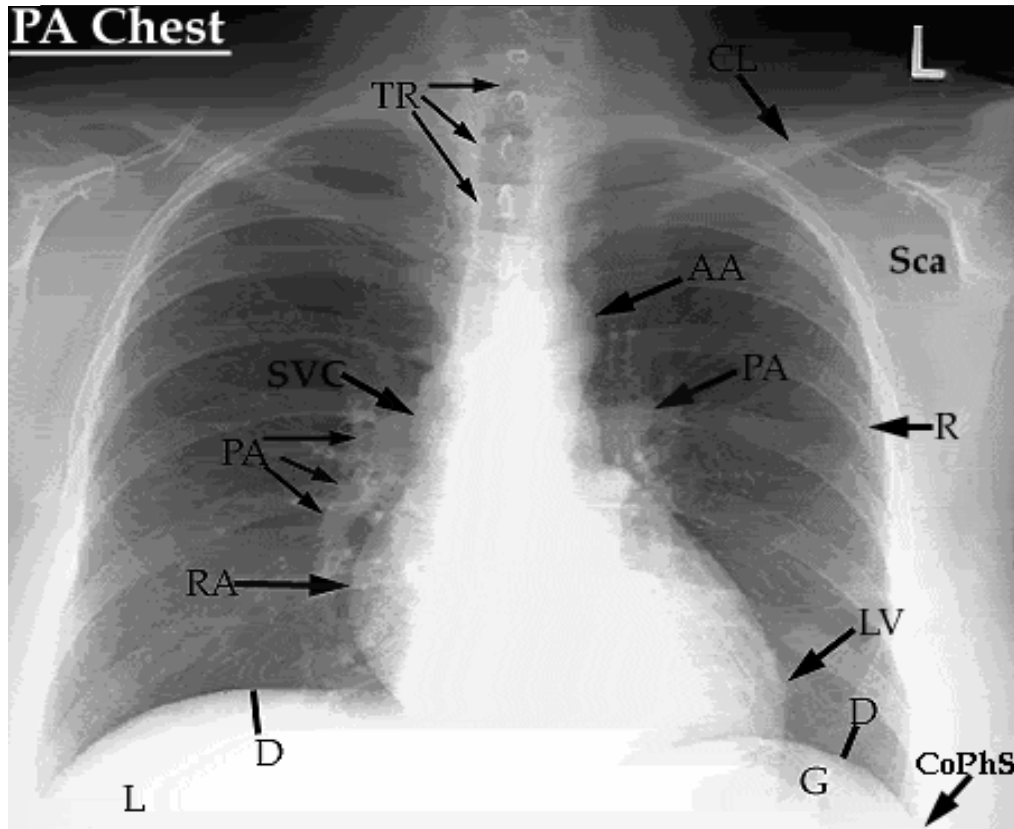
- ❖ Crackles: Fine, high-pitched/coarse low-pitched, short, discontinuous, commonly heard during inspiration, indicative of air passing through fluid in small airways
- ❖ Rhonchi: Low-pitched, continuous snoring sound, commonly heard during expiration, potentially large airway obstructed by fluid
- ❖ 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)



PA=Pulmonary Artery  
TR=Trachea  
CL=Clavicle  
AA=Aortic Arch  
SVC=Superior Vena Cava  
RA=Right Atrium  
CoPhS=Costophrenic Sulcus

LV=Left Ventricle  
D=Diaphragm  
G=Gastric Air Bubble  
L=Liver  
Sca=Scapula  
R=Rib

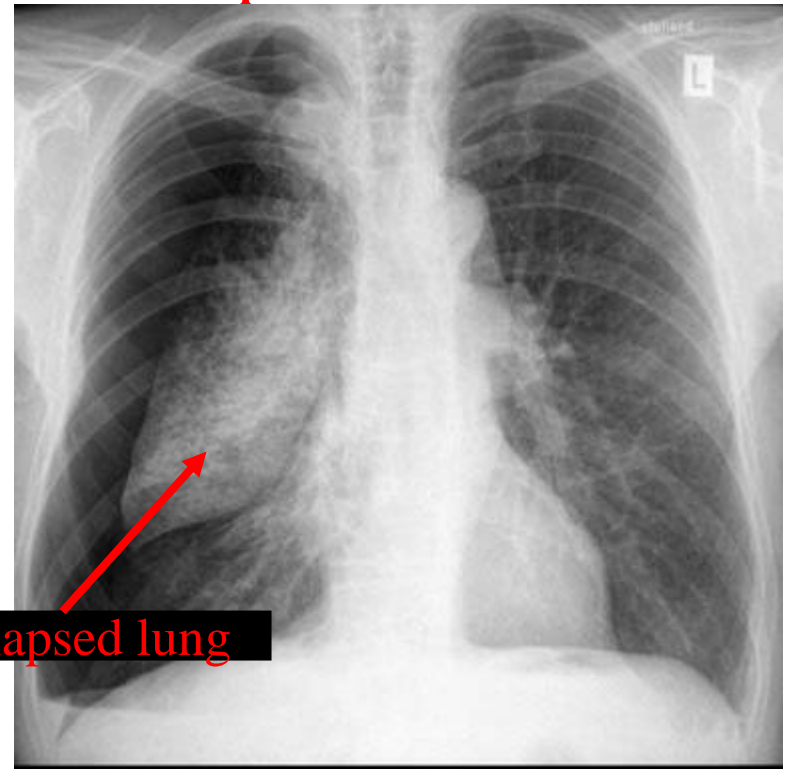
- Based on systematic evaluation:
- ❖ Soft tissues of neck, shoulders, breasts, axillae, diaphragms, and upper abdomen
  - ❖ Skeletal structures such as clavicles, ribs, vertebrae, scapulae, and sternum
  - ❖ Trachea, bronchi, pleural spaces, and lung parenchyma
  - ❖ Tubes, lines, and monitoring devices

# Comparison of Chest Radiographs (Pneumothorax)

Normal Chest X-ray



Simple Pneumothorax



Collapsed lung

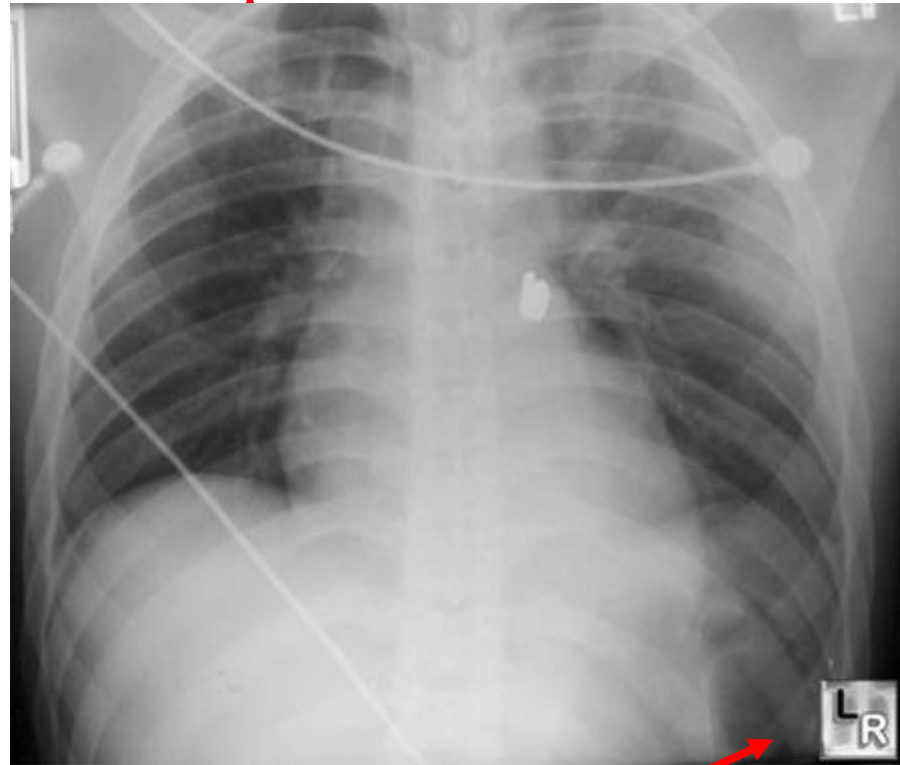


# Comparison of Chest Radiographs (Pneumothorax)

Normal Chest X-ray



Simple Pneumothorax



Deep Sulcus Sign

# Comparison of Chest Radiographs (Pneumothorax)

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Normal Chest X-ray



**Tension** Pneumothorax



**Note the mediastinal shift !!**

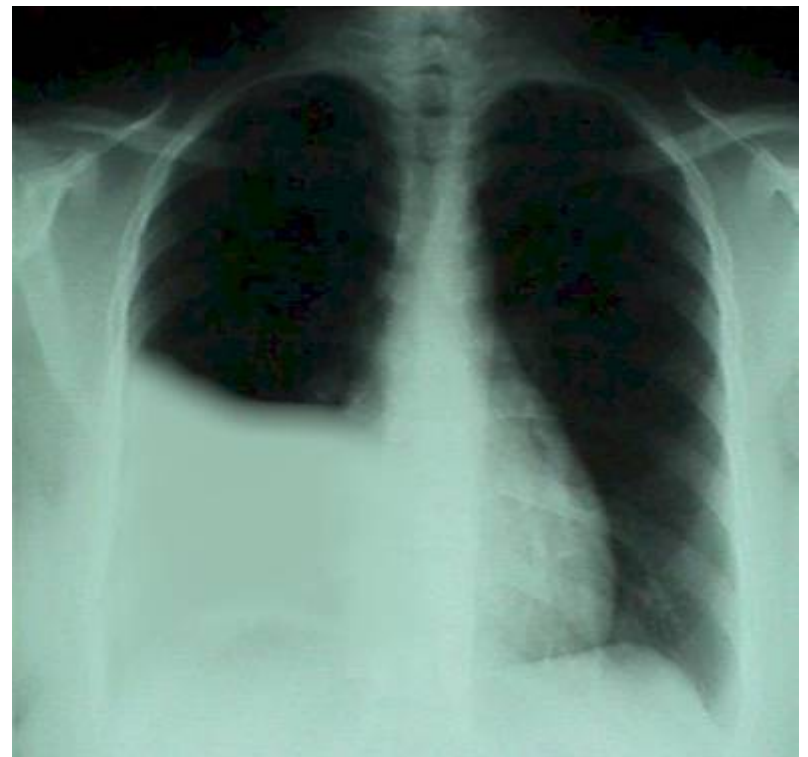
# Comparison of Chest Radiographs (Hemothorax)

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Normal Chest X-ray



Right Hemothorax



Patient Supine – blood layers inferiorly

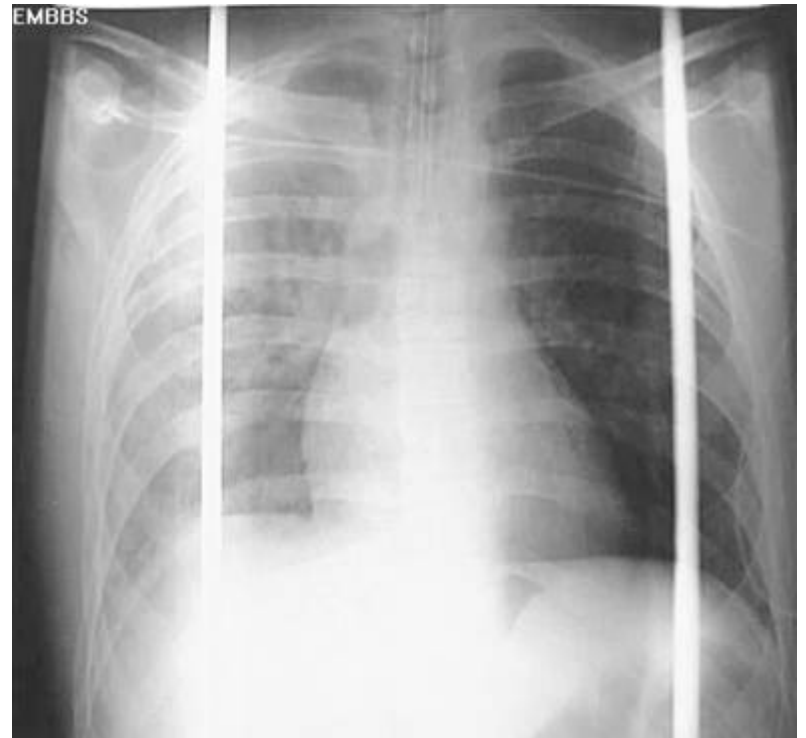
# Comparison of Chest Radiographs (Hemothorax)

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Normal Chest X-ray



Right Hemothorax



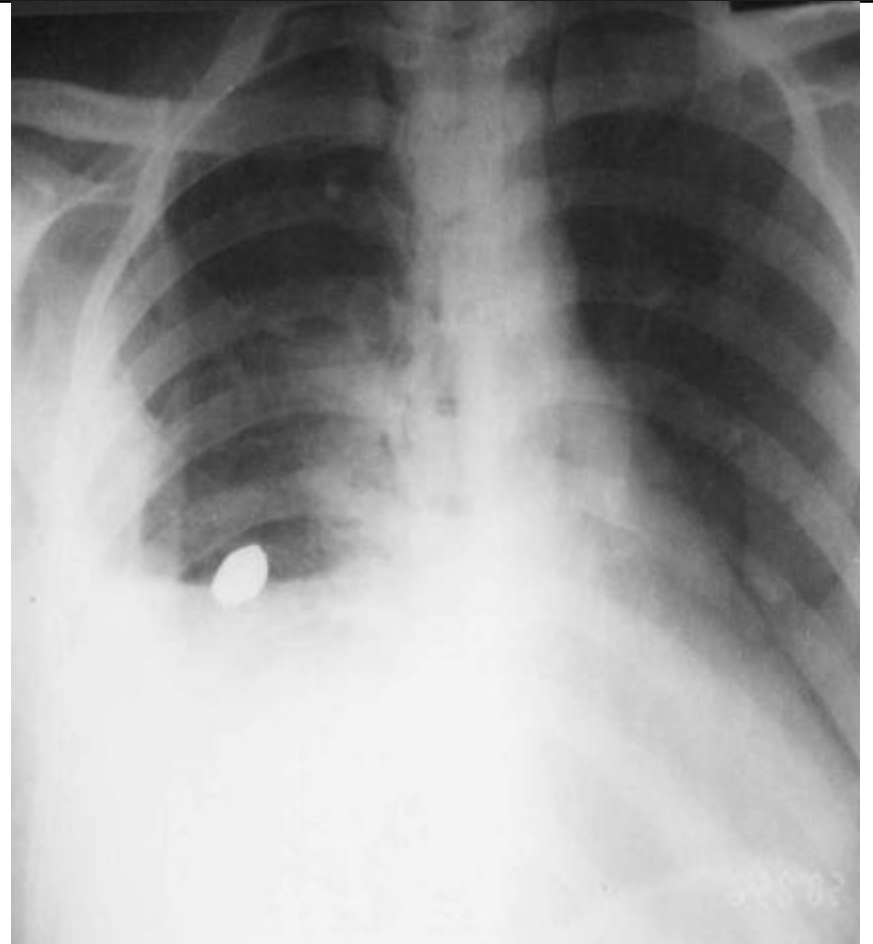
Patient Prone – blood layers posteriorly.

# 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

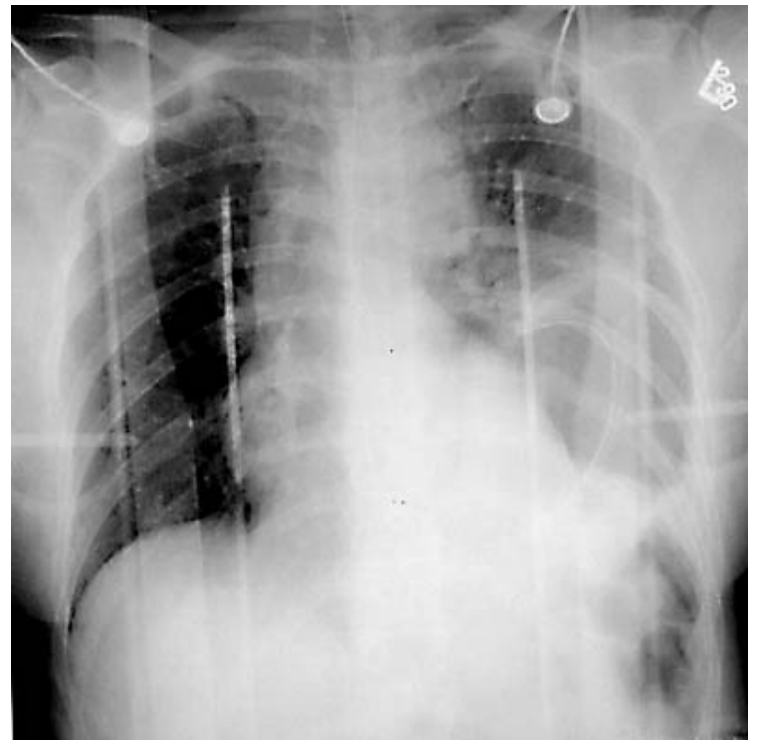
## What do you see?

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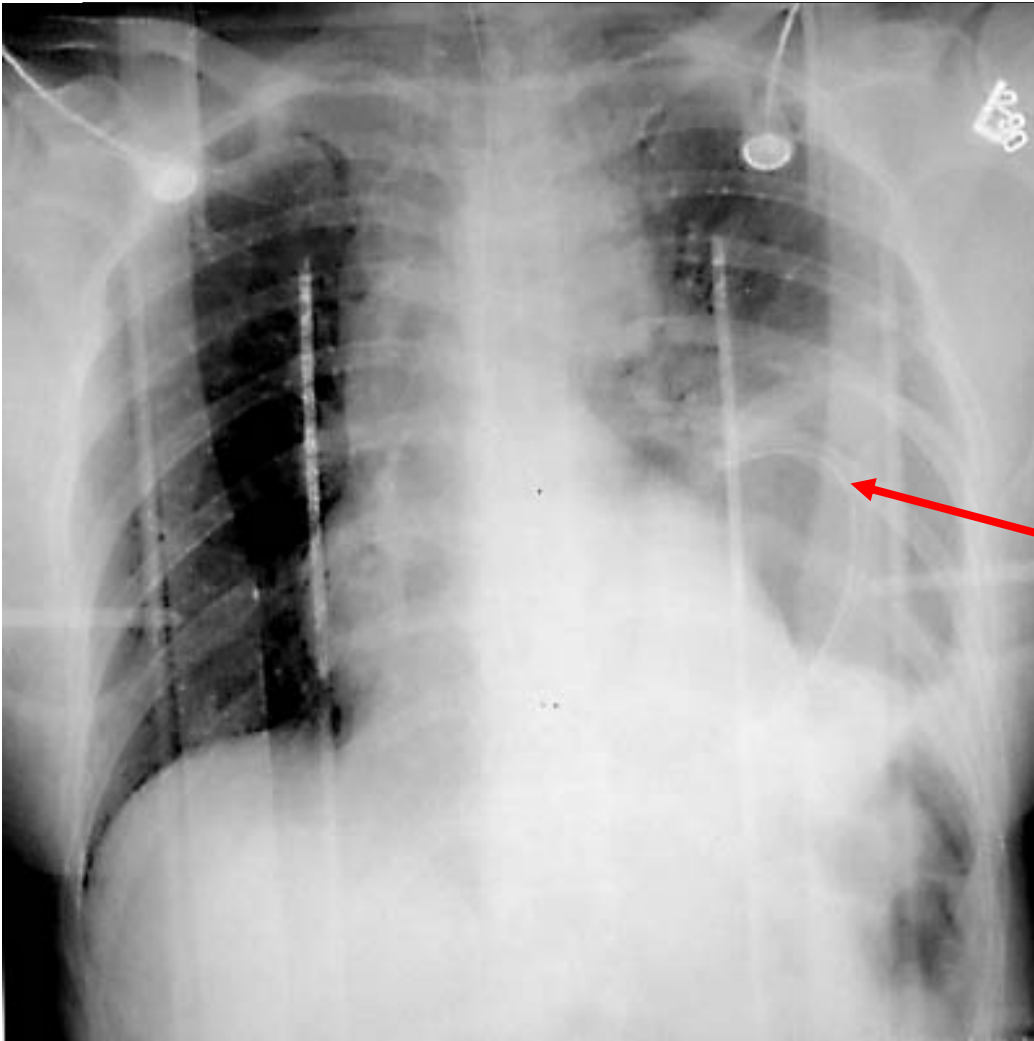
Normal Chest X-ray



Well?



# Comparison of Chest Radiographs (?????)



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

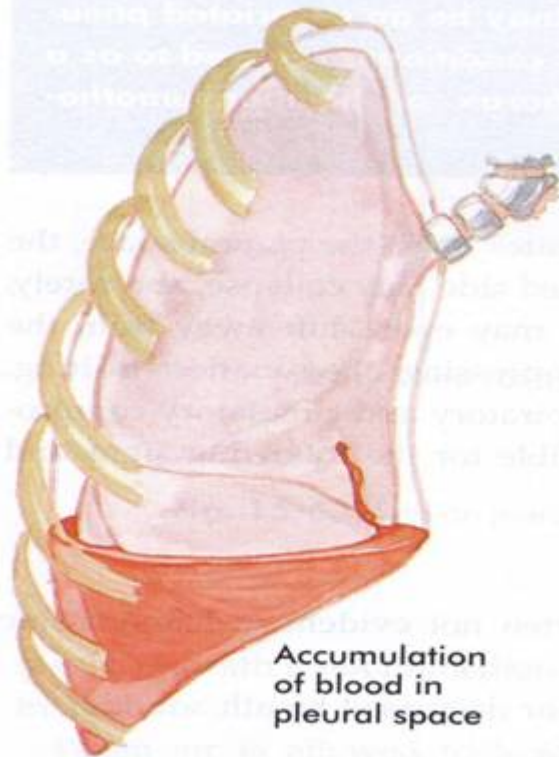


# A Little History



- ❖ 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



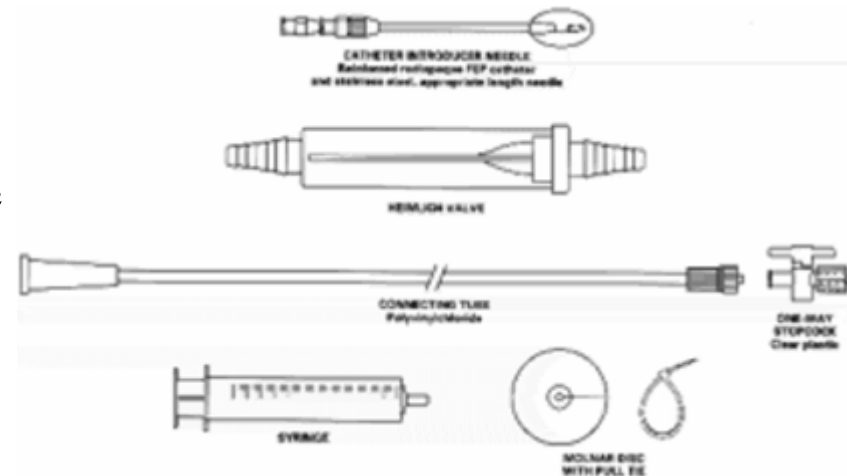
Accumulation  
of blood in  
pleural space

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 6<sup>th</sup> 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

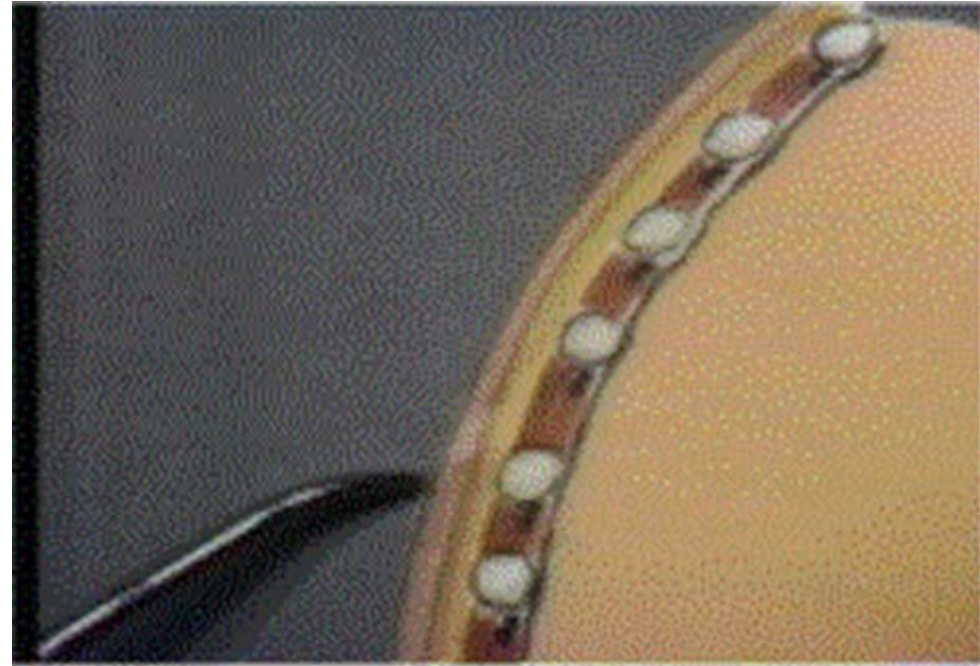
# Chest Tube Insertion



1-inch incision is  
made directly over  
the rib

# Chest Tube Insertion

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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

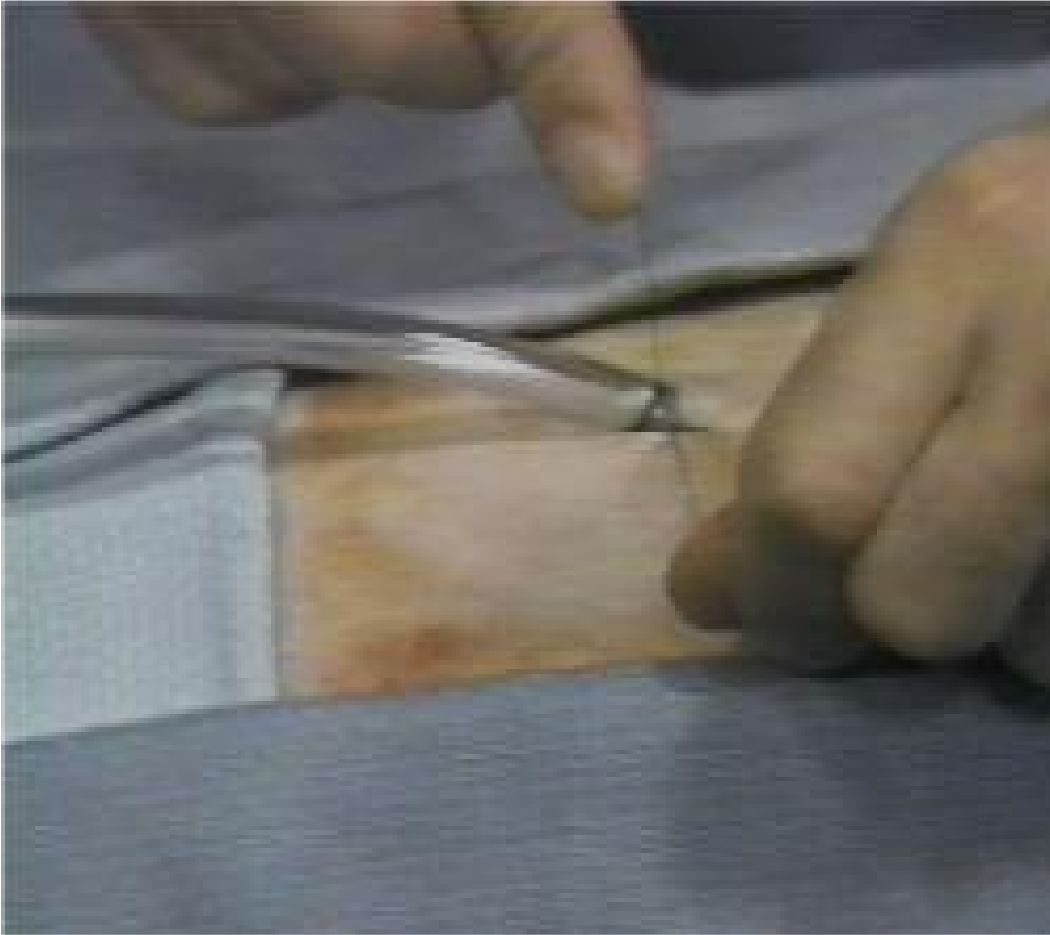
# Chest Tube Insertion



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

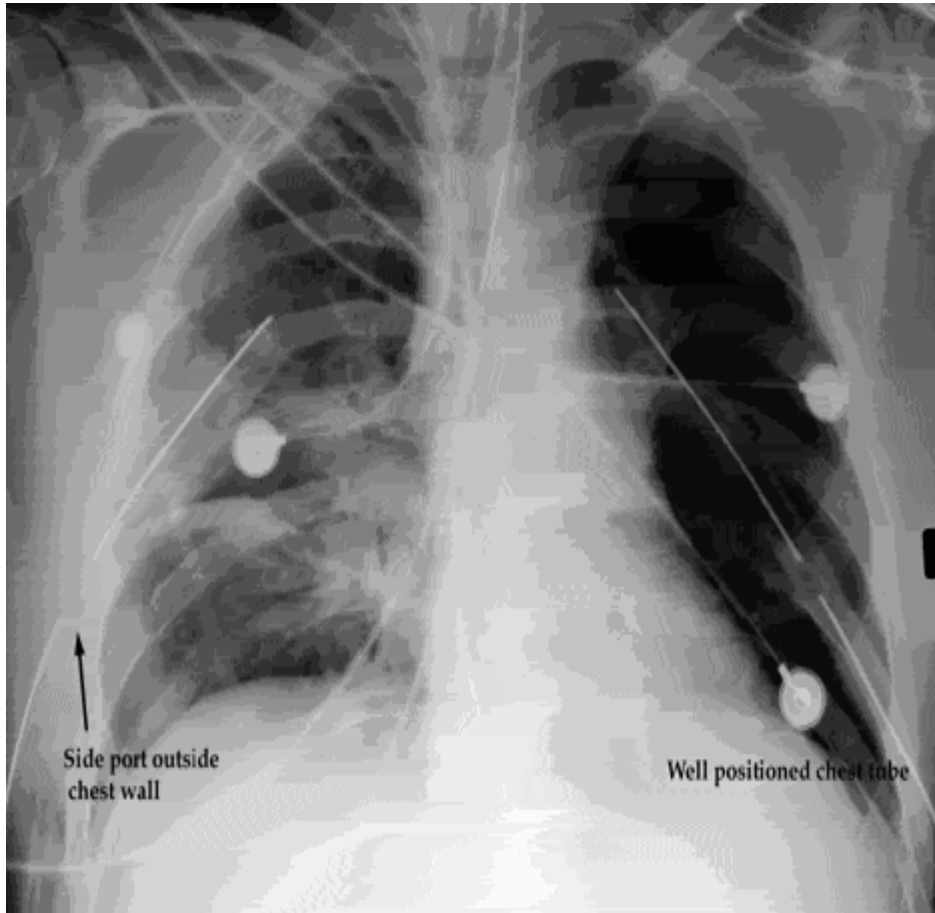


# Chest Tube Insertion



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



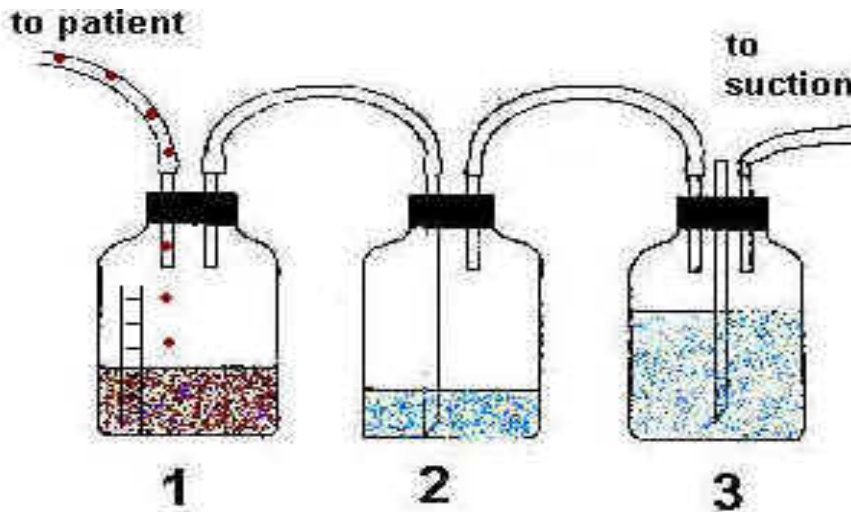
- ❖ Conduct routine patient assessment
- ❖ Frequently assess the insertion site, tube, tubing, and drainage unit
- ❖ Monitor amount, color, and consistency of the drainage
- ❖ Encourage positioning with head of bed up to 30 degrees
- ❖ Educate about the benefits of coughing, deep breathing, use of the 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



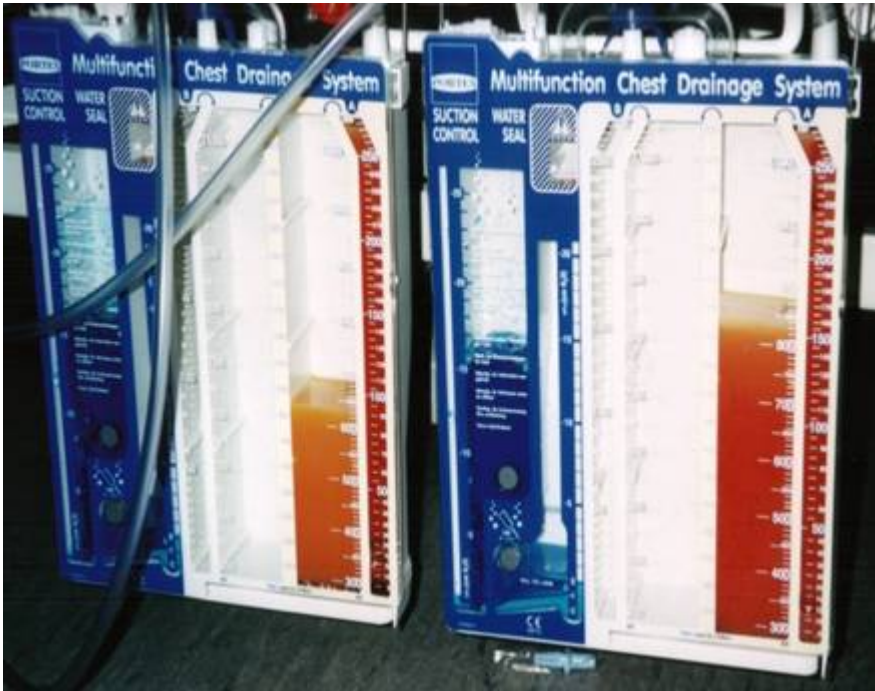
# Assessing the Water Seal Pressure Scale



- ❖ 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

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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

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# Very Special Thanks

- ❑ Marlo Anderson RN. Surgical Trauma Neurological Intensive Care Unit
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- ❑ Joseph Walters, MD. Department of Psychiatry





# References

- American College of Surgeons Committee on Trauma. (2004). *Advanced trauma life support for doctors (Student Course Manual)*, (7<sup>th</sup> 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* (3<sup>rd</sup> ed p. 324-51), Springhouse, PA:Lippincott Williams & Wilkins.
- Emergency Nurses Association.(2000). *Trauma nursing core course (Instructor Supplement)*. ( 5<sup>th</sup> 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* (20<sup>th</sup> 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*, (2<sup>nd</sup> ed, p.460-88).Philadelphia, PA: W.B. Saunders Company.
- Kapit, W., & Elson, LM.(2003). *Anatomy coloring book*, (2<sup>nd</sup> ed, p. 91-97). New York, NY:HarperCollins Publishers.
- Kapit, W., Macey, RI., Meisami, E.(2000). *Physiology coloring book*, (2<sup>nd</sup> 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*. (2<sup>nd</sup> ed p. 459-62) Baltimore, PA: Williams & Wilkins.
- 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*, (6<sup>th</sup> 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..

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