Evaluation & Examination of Respiratory System

Interpretation of Chest X-ray & CT Thorax

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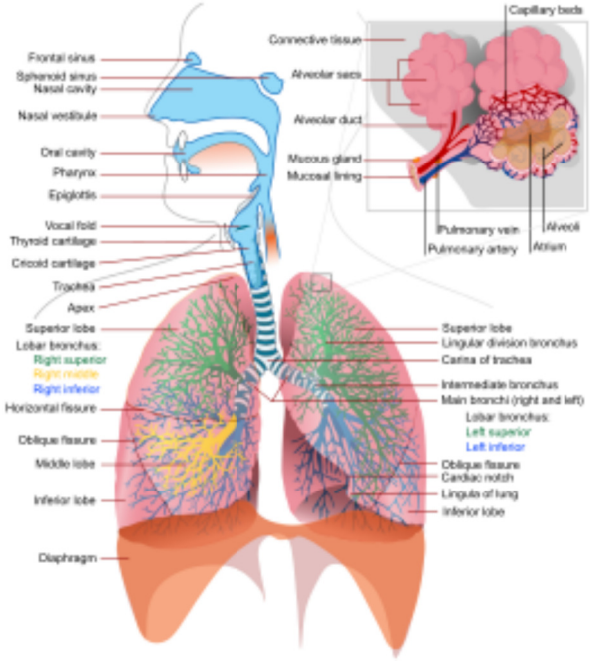
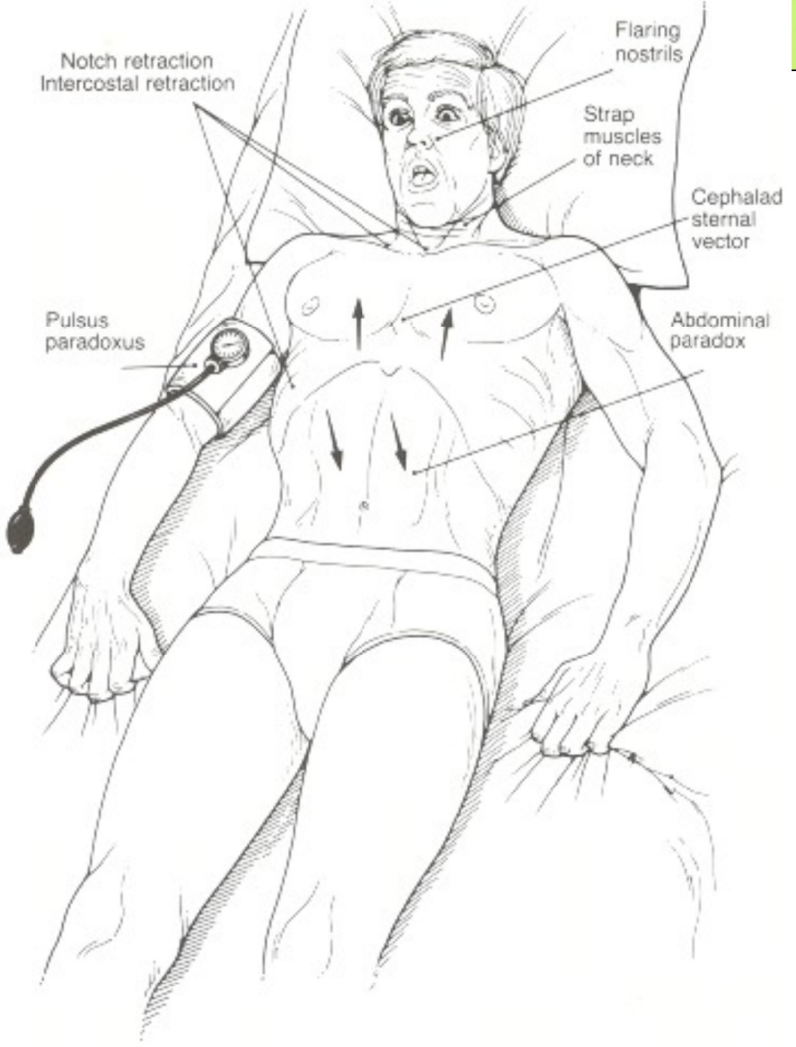
Respiratory Function



- Respiratory Mechanics
- Gas exchange (Lung parenchymal function)
- Cardiorespiratory interaction

- *Tachypnea*
- *Anxiety*
- *Air hunger*
- *Flaring alae nasi*
- *Use of strap muscles of neck*
- *Suprasternal & supraclavicular notch retraction*
- *Sternum tends to move upwards*
- *Abdominal wall pulled in*



Acute Respiratory Distress

Age

- Co-morbidities
- Increased risk for respiratory disease
- Loss of elasticity
- Decreased ventilation of the lower lobe
- Decreased ability to cough
- Increased AP diameter (barrel chest)
- Diminished chest expansion
- Kyphotic changes
- Brain less sensitive to hypoxia / hypercapnea

History

- Respiratory disease
- Smoking
- Environmental exposures
- Dyspnea
- Cough/sputum
- Fever, chills
- Chest pain with breathing
- Treatment, medications, etc.

Dyspnoea

- Breathlessness inappropriate to physical exertion or even without activity
- Cardiorespiratory diseases, anemia, thyrotoxicosis and metabolic acidosis
- Diurnal / seasonal variations

Grade 1	Not troubled by breathlessness except on strenuous exercise
Grade 2	Short of breath when hurrying on the level or walking up a hill
Grade 3	Walks slower than most people on the level, stops after a mile or stops after 15 minutes walking at own pace
Grade 4	Stops for breath after walking about 100 yards or after a few minutes on level ground
Grade 5	Too breathless to leave the house, or breathless when undressing

Dyspnoea grading
(Medical Research Council)

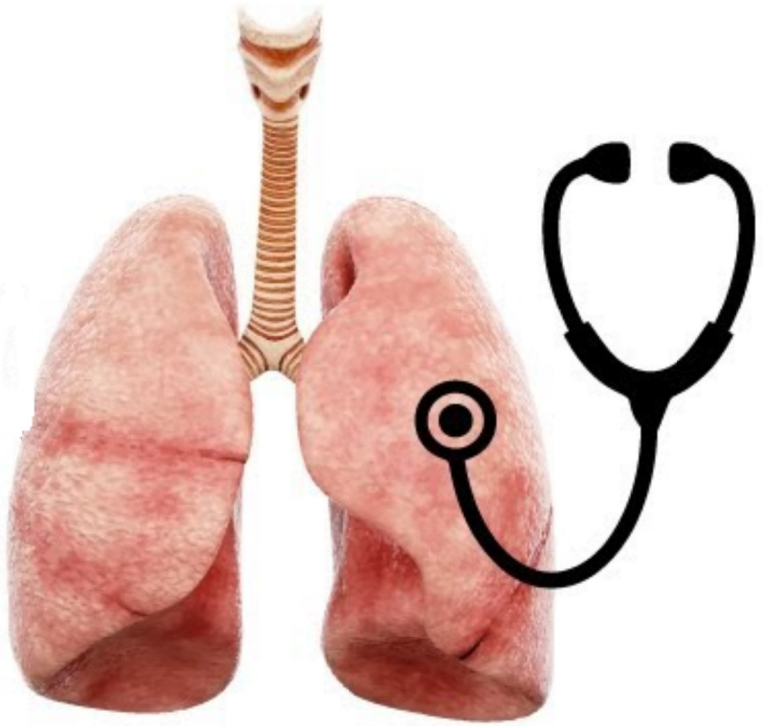
Cough

- Productive/non-productive
- Duration
- Diurnal / seasonal variations
- Aggravating / triggering factors (smoke, allergen, exercise, cold)

Sputum

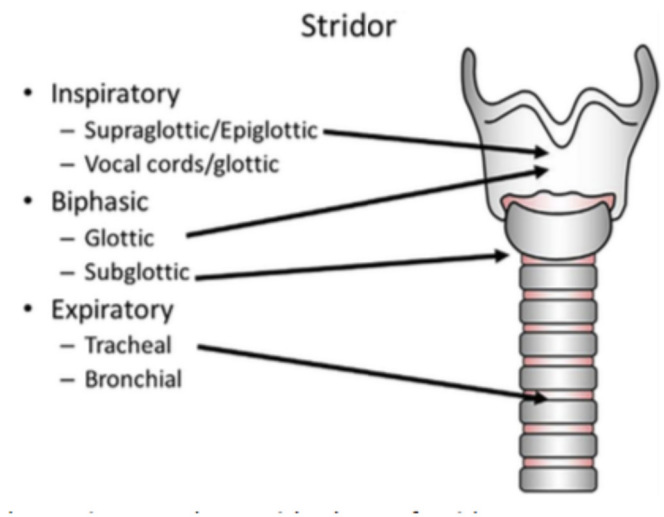
- Clear, purulent
- Bloody (hemoptysis)
- Rust colored
- Pink and frothy
- Quantity of sputum
- Positional & seasonal variations

Wheezing



- Age of onset
- Variations with age / season
- Noises while breathing

Stridor



- Indicates narrowing of larynx, trachea or main bronchi
- May be mistaken for wheeze

Chest pain

- Musculoskeletal in severe cough
- Cardiorespiratory disease
- Relation with inspiration, expiration
- Location of pain

Associated symptoms

- Fever
- Night sweats
- Fatigue
- Weight change

Smoking

- Active / passive smoking
- Environmental exposure
- Type & amount of smoking
- Pack years
- Ex-smoker

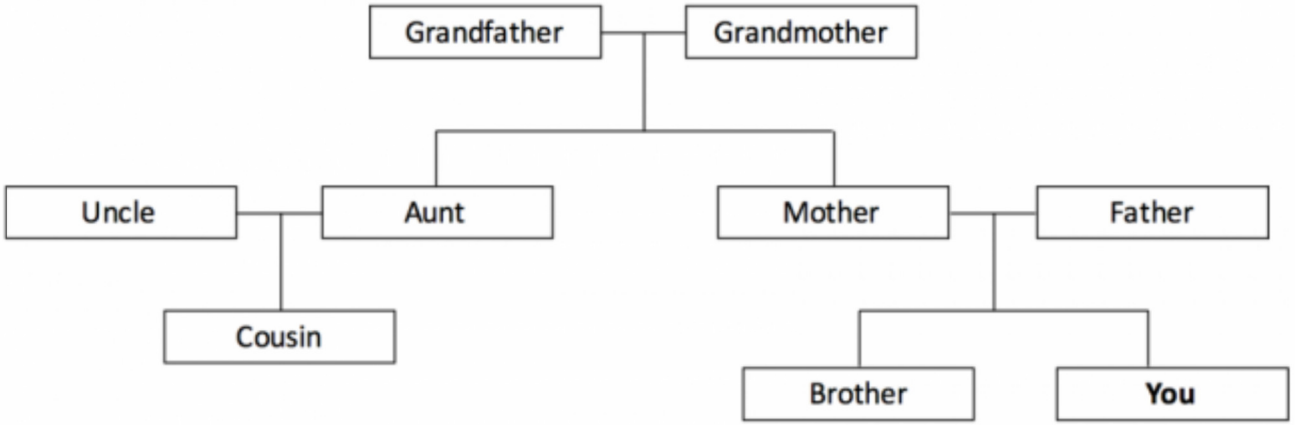
Obstructive Sleep Apnoea

- Increased risk of perioperative complications
  - (hypoxia, pneumonia, difficult intubation)
- General anaesthesia, sedation & analgesia increase the pathology
- Sleep disruption in the postoperative period
- Rebound REM sleep worsens OSA
- Pre-operative use of CPAP

STOP BANG questionnaire

- Do you **S**nore loudly?
- Do you often feel **T**ired, fatigued, or sleepy during the day?
- Has anyone **O**bserved you stop breathing during your sleep?
- Do you have or are you being treated for high blood **P**ressure?
- Do you have a **B**ody mass index more than 35 kg/m^2?
- **A**ge over 50 years old?
- **N**eck circumference > 40 cm?
- Are you of male **G**ender?

High risk of OSA; answering Yes to three or more questions. Low risk of OSA, answering yes to less than three items. Adapted from Chung, F et al. Anesthesiology. 2008;108:812–821.



Family history

- Asthma
- Atopic conditions
  - Eczema
  - Hay fever

Occupational History

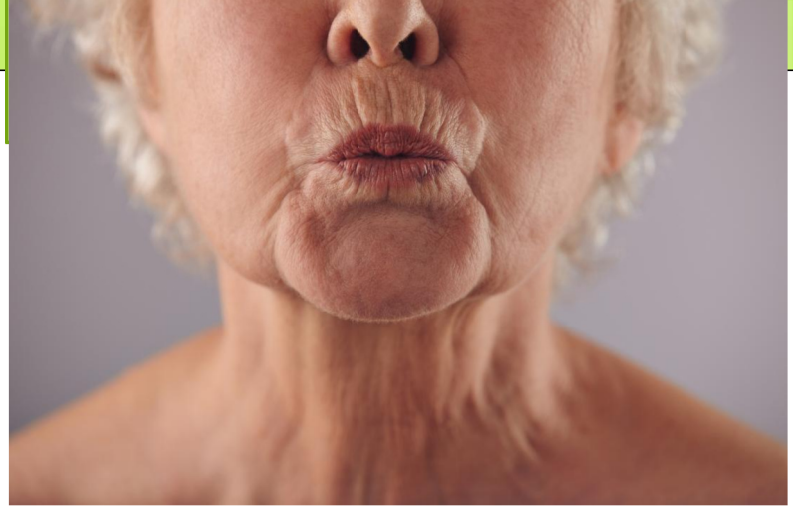
- Occupational asthma
- Painters, wood workers
- Asbestosis
- Chronological relationship to symptom & work

High Surgical risk

- Thoracic surgery
- Aortic aneurysm repair
- Abdominal (upper > lower) surgery
- Neurosurgery
- Vascular surgery
- Head & neck surgery
- Prolonged surgery (>2 h)
- Emergency procedures

General Assessment

- Appearance
- Alertness
- Nourishment
- Use of inhaler, nebulizer, oxygen mask, CPAP



- Breathlessness while walking, talking
- Coughing, wheezing
- Pursed lip breathing
- Use of accessory muscles of respiration

Pallor

Cyanosis

Oedema

Tobacco staining

Clubbing

- Warm hands
- Bounding pulse
- Tachycardia
- Ectopic beats
- Pulsus paradoxus

- Fine tremor
  (β2 agonists)
- Flapping tremor
  (hypercapnia)

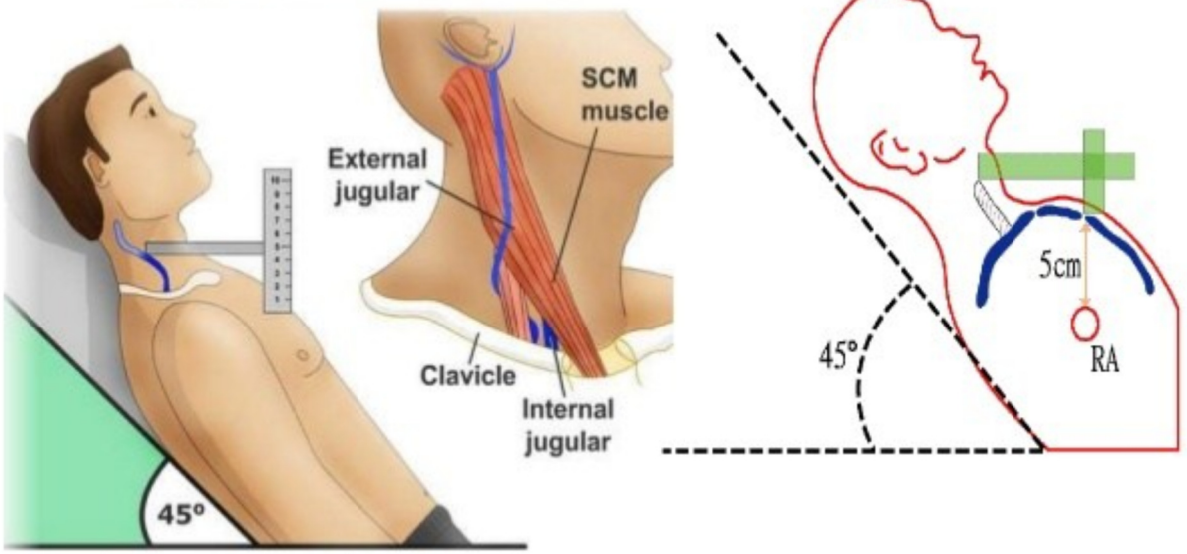
Respiration

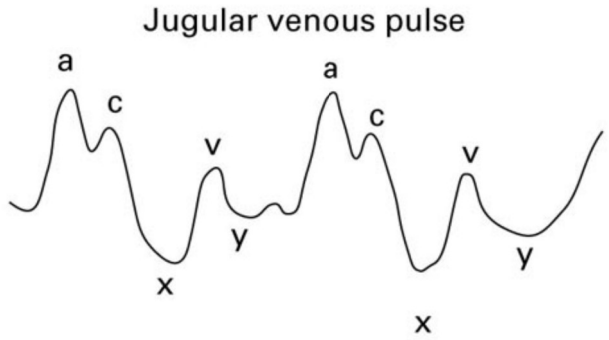
- Rate and pattern of respiration
- Normal respiratory rate in adult:14-16/min.
- Tachypnoea
- Cheyne-Stokes breathing
  - Asymmetrical chest expansion may indicate
    - Pneumothorax
    - Rib fracture
    - Severe pneumonia
    - Atelectasis

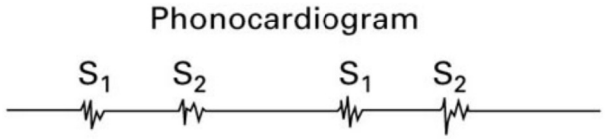
- Raised JVP seen in
  - Cor pulmonale
  - Right heart failure
  - Signs of cardiac failure

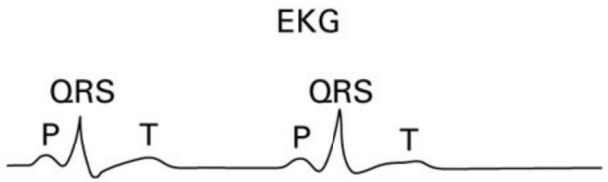
Jugular Venous Pulse

Jugular Venous Pulse



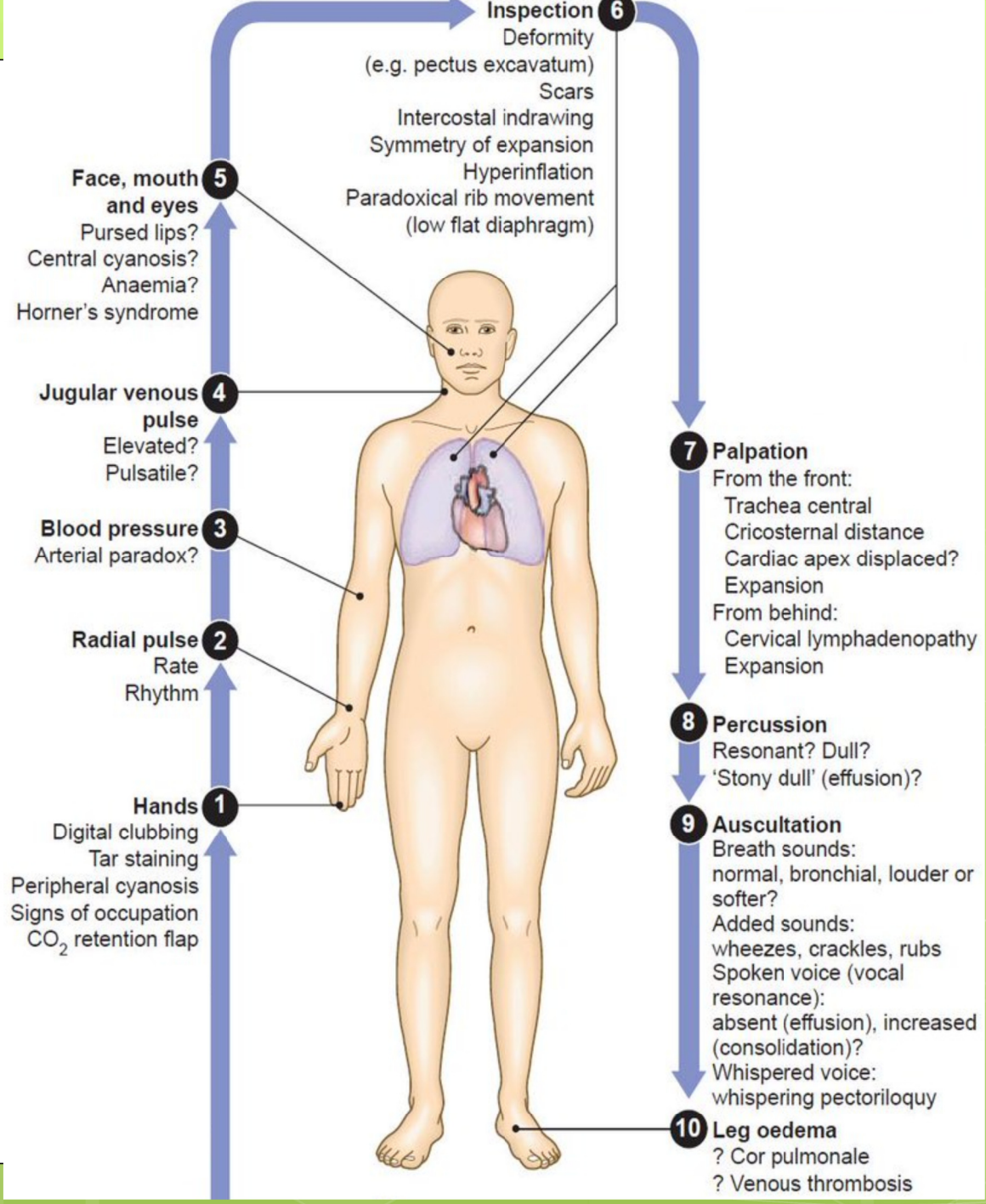






Examination of chest

- *Inspection*
- *Palpation*
- *Percussion*
- *Auscultation*



Inspection

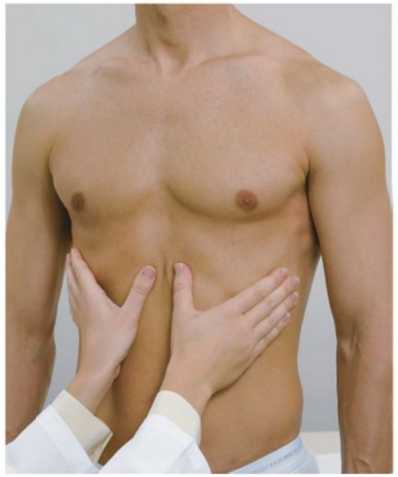
- Observe shape of the chest
- Bilaterally symmetrical
- Equal movements
- Retraction / bulging of interspaces
- Paradoxical movements
- Scars, sinuses, lumps
- Chest wall abnormalities

Palpation

Hands placed at the same level with thumbs over the sternum anteriorly or the spine posteriorly
Patient should be seated upright or prone or supine

- Temperature
- Swelling
- Tenderness
- Crepitus
- Lymph nodes
  - Supraclavicular
  - Cervical
  - Axillary

Cardiac impulse



Chest expansion

Trachea

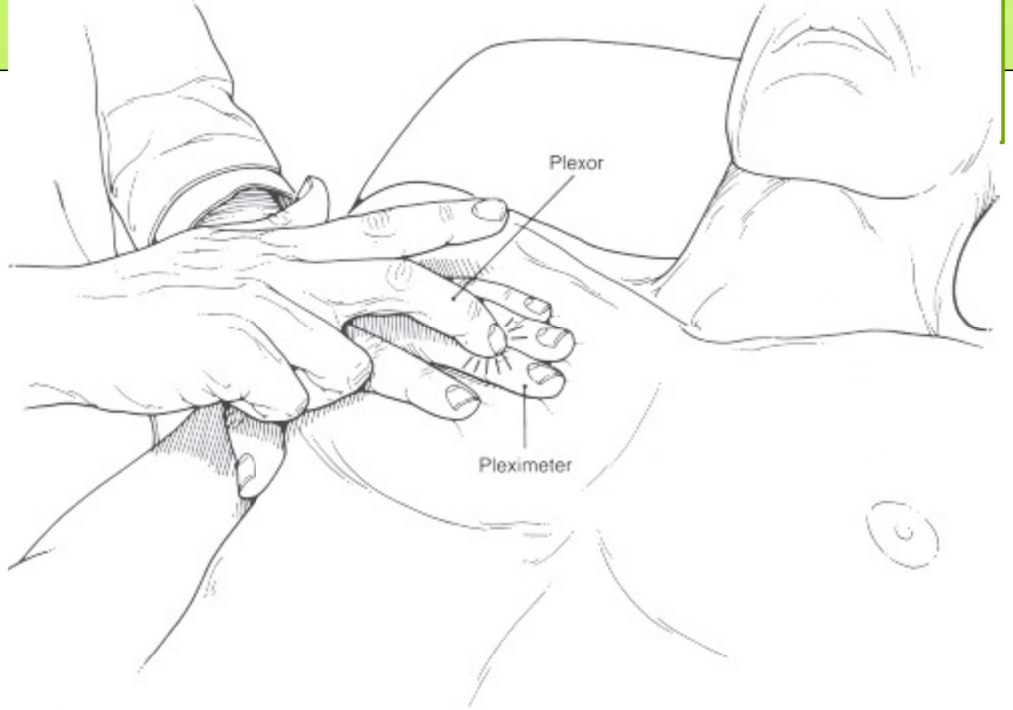
- Midline
- Slightly moveable
- Displacement to either side

Vocal Fremitus

- Vibration felt on the chest during phonation
- Solid areas will have increased vibration
- Air-filled areas will have less vibration

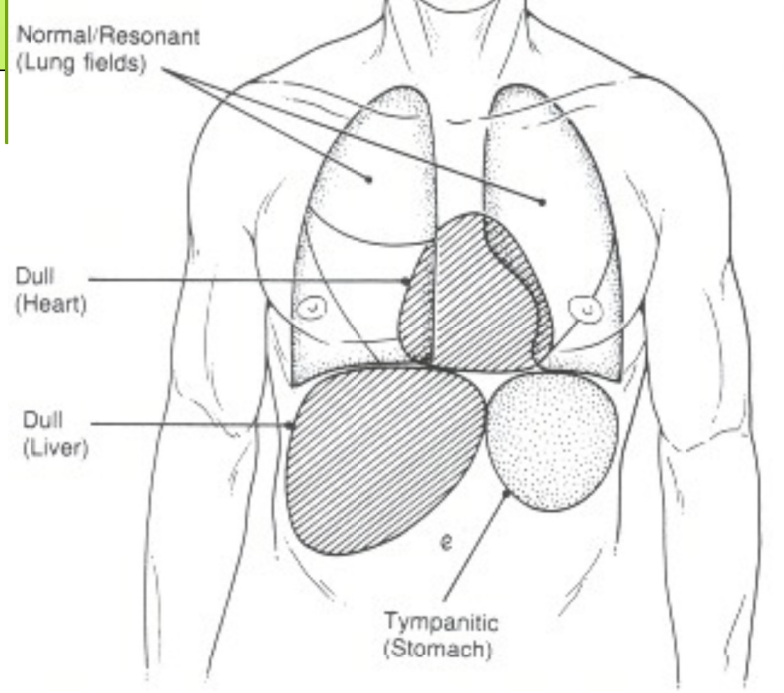
Percussion

- Determine the density of underlying tissue
- Position of diaphragm
- Compare percussion note on either side
- Dullness over fluid or solid tissue
- Hyper resonance in emphysema / pneumothorax
- Percuss over clavicles and axillae



Technique for percussion

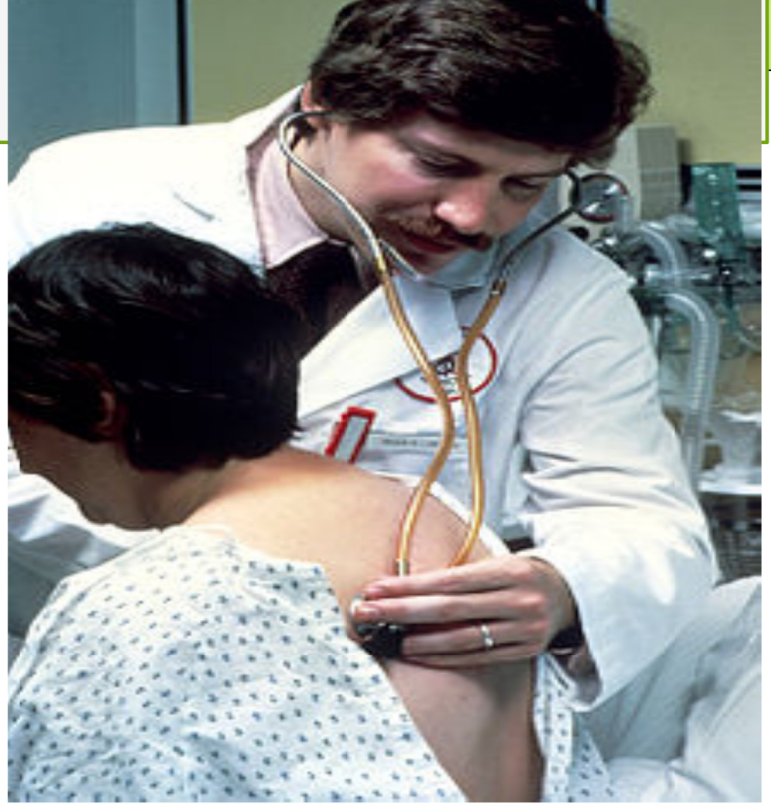
The percussing finger (plexor) should be sharply struck against the distal interphalangeal joint of the middle finger of the opposite hand (pleximeter). The motion should be generated at the wrist rather than with the whole arm.



Location of percussion notes

Normal resonance over the anterior and posterior lung fields
Dull percussion note over the heart and liver
Stomach may produce hyperresonant (tympanitic) note

Auscultation



- Ask the patient to breathe slow & deep
- Compare either sides

- **Vesicular breath sounds:** Soft, generated by airflow of normal lungs
- **Bronchial breath sounds:** Normally heard over the larger airways and trachea. Bronchial breath sounds over lateral or posterior chest wall may indicate consolidation, as in pneumonia
- **Broncho-vesicular breath sounds:** Normally heard between the scapulae (abnormal if heard over peripheral lung fields). Indicate dense lung tissue, due to consolidation, infection, or compression

Adventitious (added) sounds

- *Crackles*
- *Wheezes*
- *Pleural rub*
- *Vocal resonance*

Crackles

- Caused by small airways reopening as the chest wall expands, forcing air through passages narrowed by fluid, mucous, or pus
- Heard mostly in the bases due to hypoventilation
- Fine crackles in pulmonary edema
- Those heard at the beginning of inspiration is common in COPD
- Localised coarse crackles indicate bronchiectasis

Wheezes

- Musical sounds due to airway narrowing particularly heard during expiration
- Characteristic of asthma and COPD
- Unilateral wheeze may be due to compression from a tumour or foreign body

Stridor (often inspiratory & expiratory and usually loudest over the trachea)

Due to laryngeal narrowing or localised narrowing of trachea or large airways

Serious condition, requiring urgent intervention

Pleural rub

- Due to pleural inflammation
- Creaking or rubbing character
- Often associated with pleuritc pain

Vocal resonance

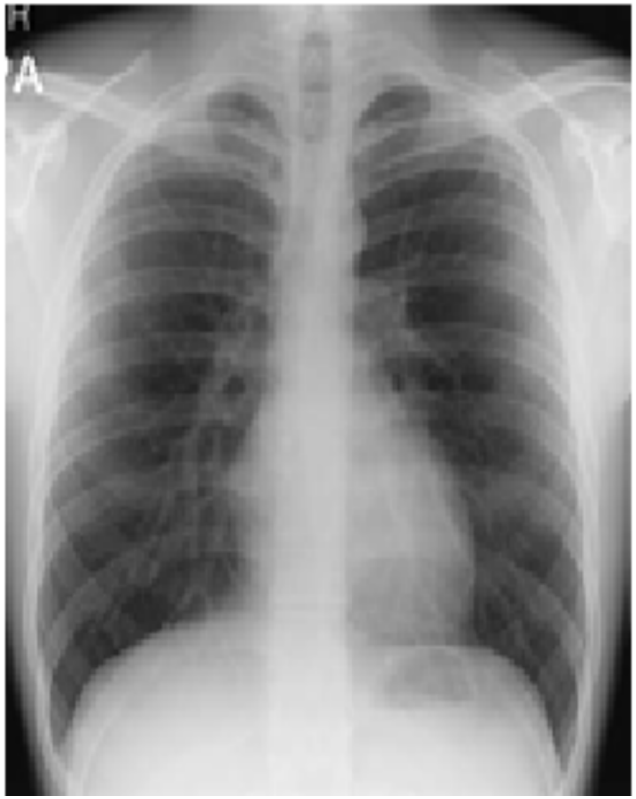
- Vibration transmitted to the chest from the vocal cords as the patient phonates
- Compared in either side
- In consolidation, vocal resonance is increased, as the lungs conduct sound better than air filled lungs
- In such cases, when patient whispers the sounds are heard clearly: ***Whispering pectoriloquy***
- ***Aegophony:*** Increased resonance often in consolidation and fibrosis due to enhanced transmission of high-frequency sound across fluid

Chest radiograph

- Not indicated in healthy patients
- Important in patient with respiratory symptoms.
- Previous film for comparison
- American College of Physicians (ACP) recommends chest radiograph in patients with cardiopulmonary disease &above 50 years, Severe obesity (BMI ≥40 kg/m^2), undiagnosed heart failure, cardiac chamber enlargement or pulmonary hypertension

Chest radiograph

PA view	AP view
• Most commonly taken view • The patient stands in full inspiration • Beam enters 6 feet from the back • Scapulae seen in the periphery • Clavicles project over the lung fields • Posterior ribs distinctly seen	• ICU patients, neonates and sick • Beam enters anteriorly • Generally taken supine • Lung fields look smaller • Magnified cardiac shadow • Widened mediastinum • Scapulae seen over the lung fields • Clavicles appear higher • Anterior ribs distinct and horizontal



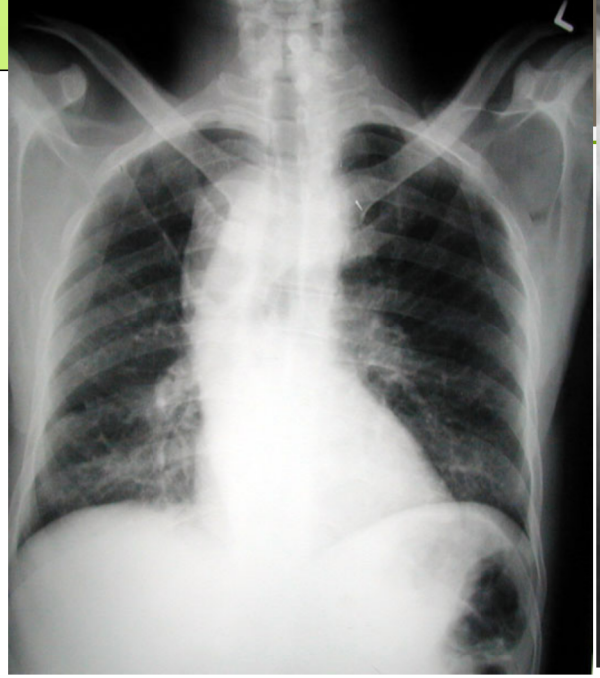
Radio opacity

- Air: black
- Less dense tissues (fat) Radiolu
  darker
- Soft tissues (muscle): grey
- Denser tissues (bone)
  Radiopaque: brighter
- Metal: white

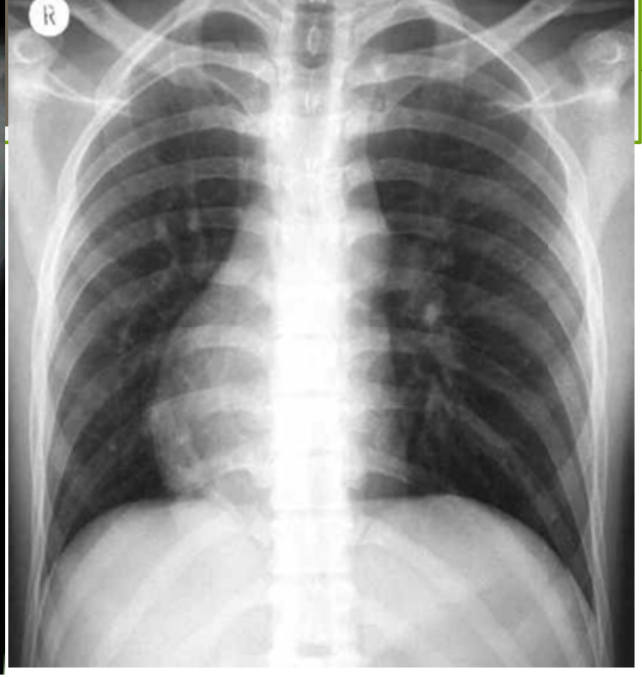
Air **Fat** **Soft tissue** **Bone** **Metal**

Male *Female*

Side Marker

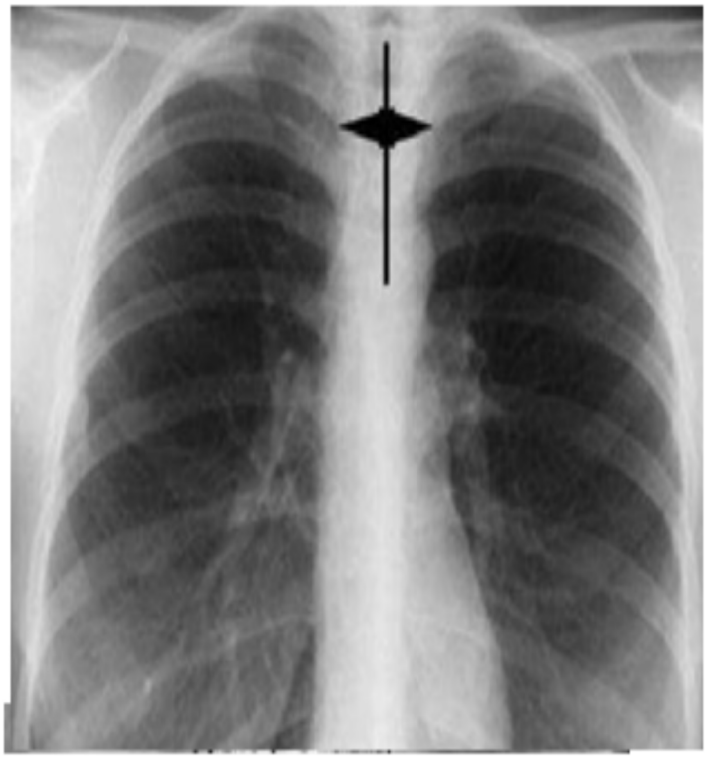


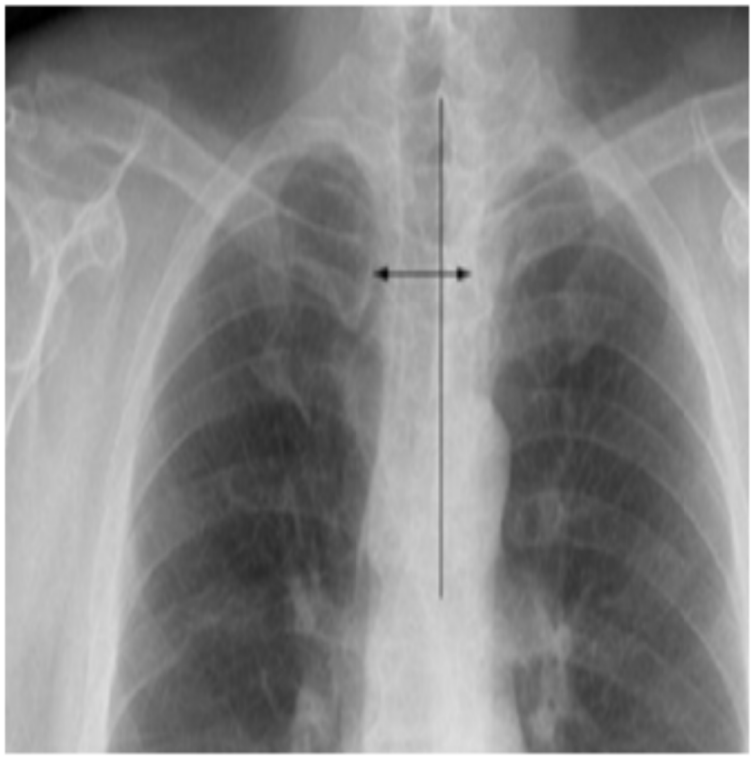
Right Sided Aortic Arch



Dextrocardia

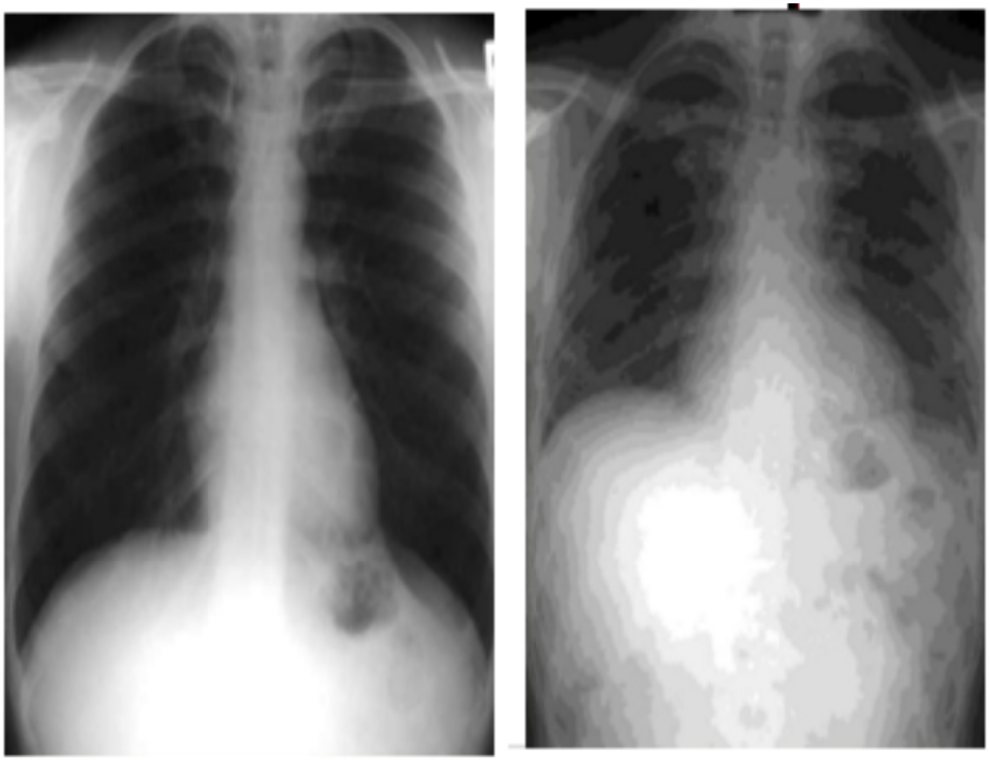
- Check features such as apex of the heart and gastric air bubble
- Gastric air bubble is seen just below the heart on the left side



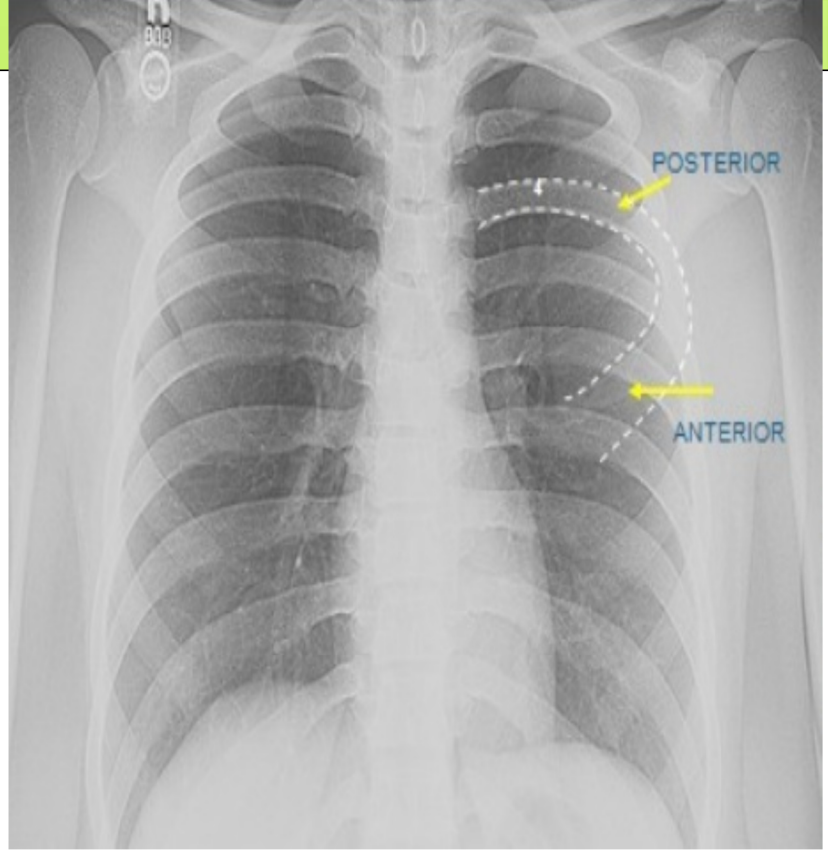


Properly centered & rotated films

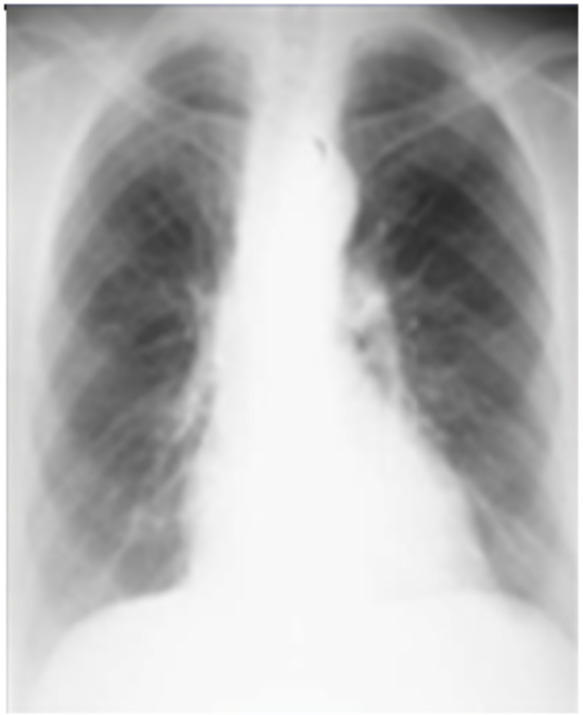
Inspiratory and expiratory films



Timing of Respiration



- Inspiratory films commonly taken
- 6 pairs of ribs are seen anteriorly
- 9 pairs posteriorly above the diaphragm



Underexposed *Overexposed*

Underexposure	Overexposure
White film	Dark film
Lung fields white	Lung fields dark
Cannot differentiate vertebral body from intervertebral space	Shows intervertebral space
Spine not visible	Spine is visible

Pre procedure

Right hemothorax after IJV cannulation

After chest tube insertion

Resolving after1 week

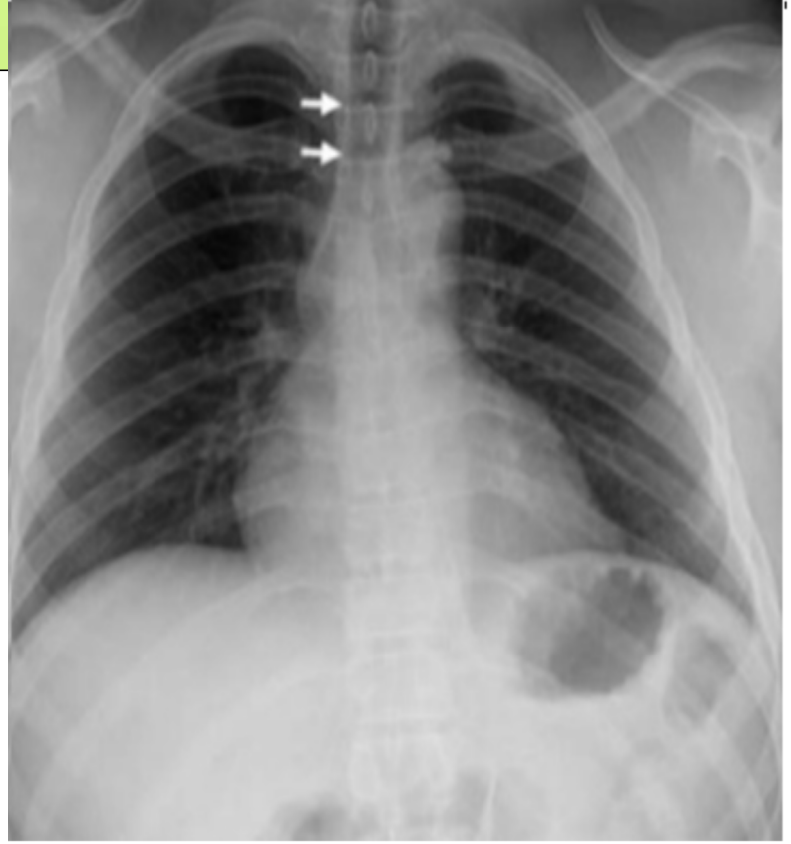
Serial films: Traumatic IJV cannulation

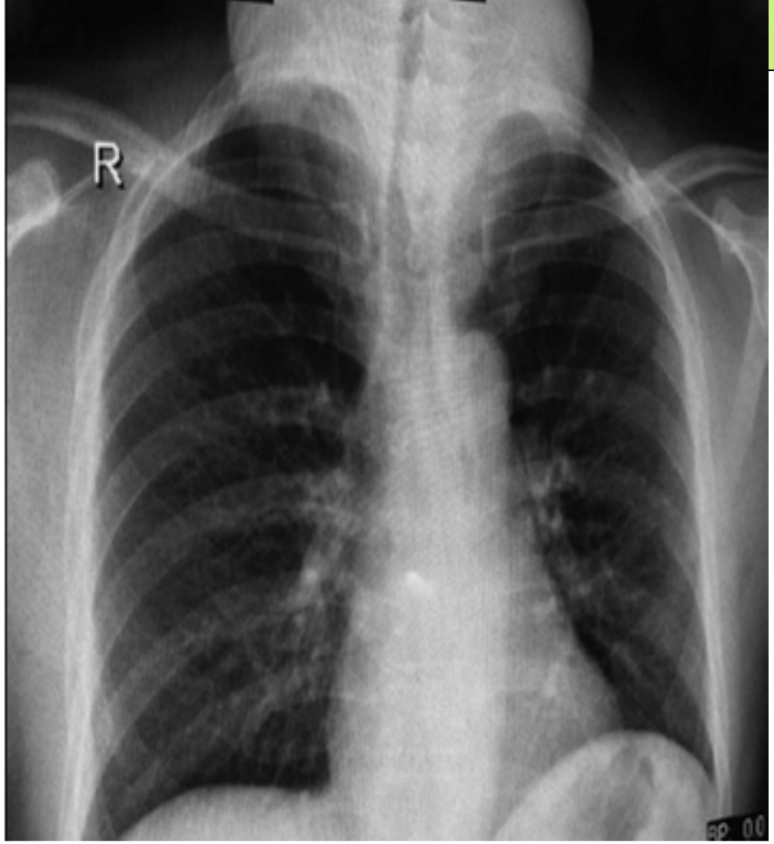
Skin & Soft tissue

Post-mastectomy (Right)

Minimal right pleural effusion

- Breast & nipple shadows
- Mastectomy
- Subcutaneous emphysema
- Lymph nodes
- Other lesions in the soft tissue



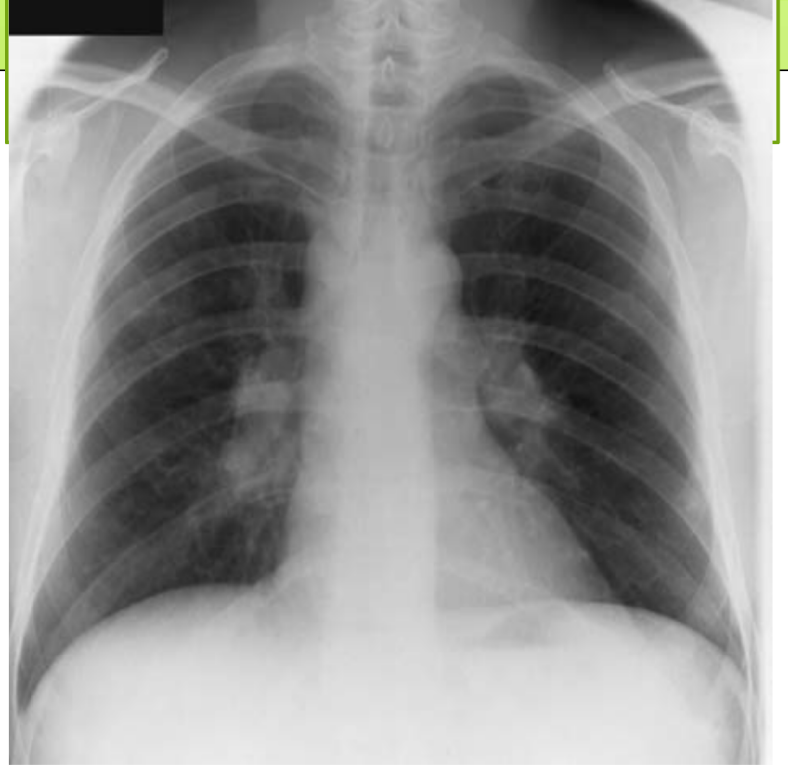


Normal Trachea

Retrosternal Goiter

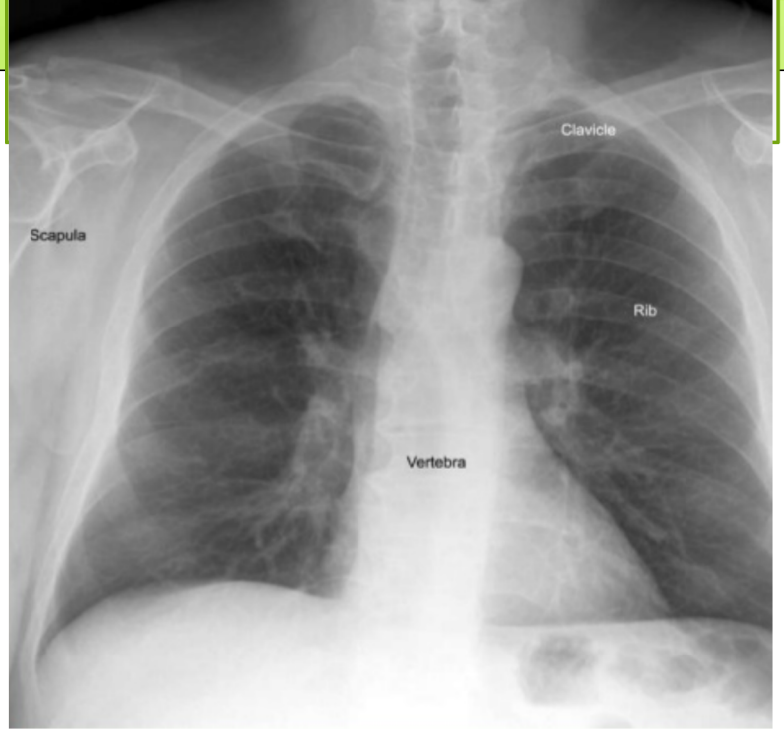
Hilum

Bilateral hilar lymphadenopathy: Sarcoidosis, Lymphoma



- Left hilum normally 1-2 cm higher than right
  - left pulmonary artery is higher
- Enlarged lymph nodes / tumors make hilum bulky
- Hilum can be pulled up or down

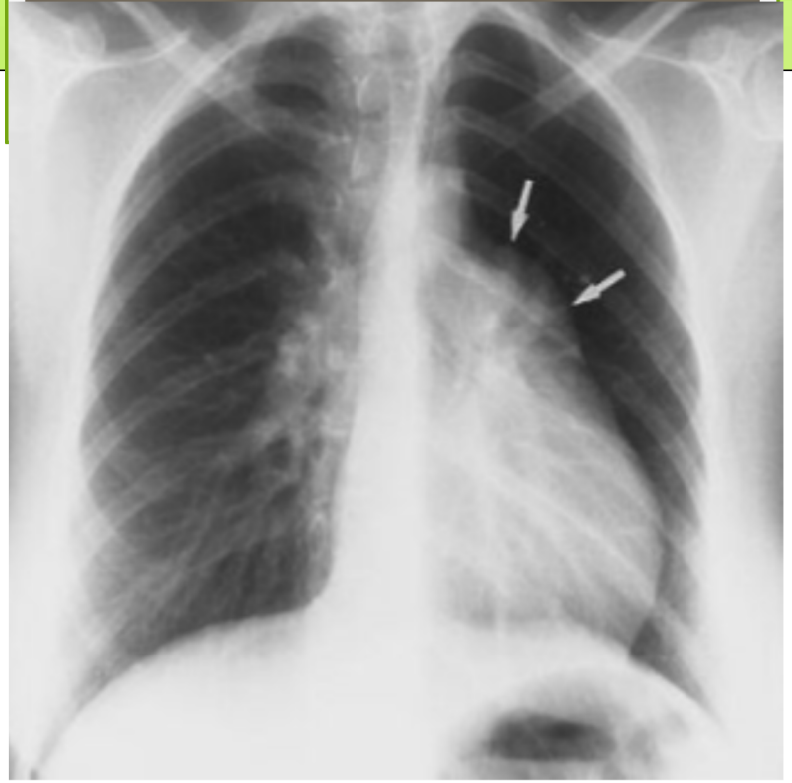
Bony Cage



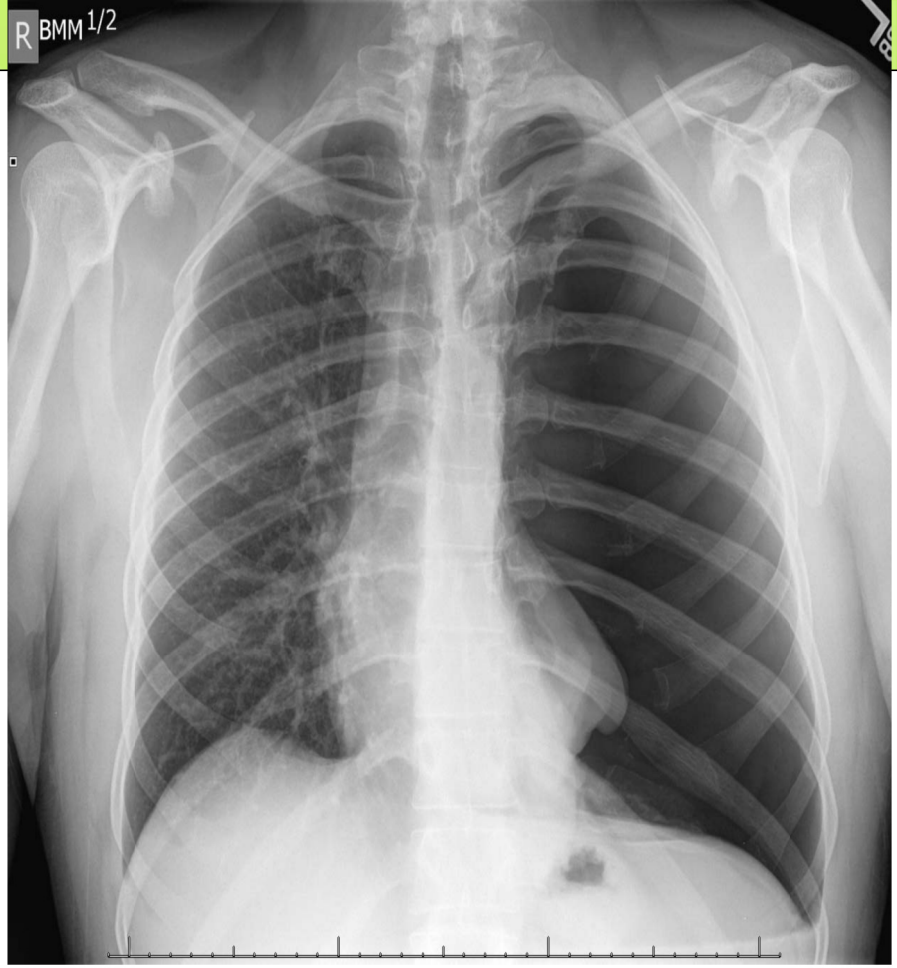
- Check for the ribs, bony cage
- Overall shape, contour
- Vertebral bodies, Sternum
- Clavicles for abnormalities, rotation
- Look for mineralization, lytic lesions or fractures
  - Lytic lesions are less dense and darker
  - Sclerotic lesions are denser and whiter

Mediastinum

Atrial Septal Defect
L to R shunt
Prominent Pulmonary Artery

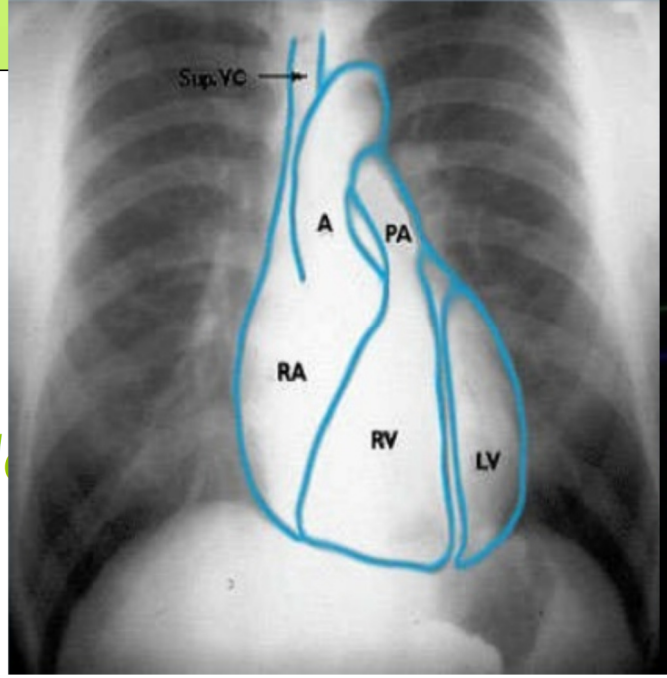


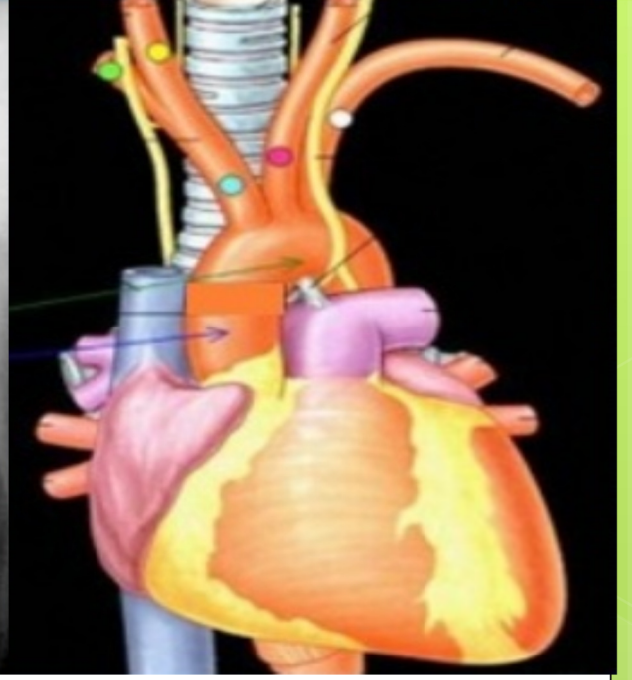
- Assess mediastinum as upper, middle and lower parts
- Aortic arch is the first structure on the left, followed by the left PA
- Branches of PA fan out through the lung
- Pulmonary arteries and main bronchi arise at the left and right hila
- Mediastinum may be pushed or pulled (pneumothorax / collapse)
- Widened mediastinum (mass lesions, rupture of major vessels)



Left Pneumothorax
with
Mediastinal shift

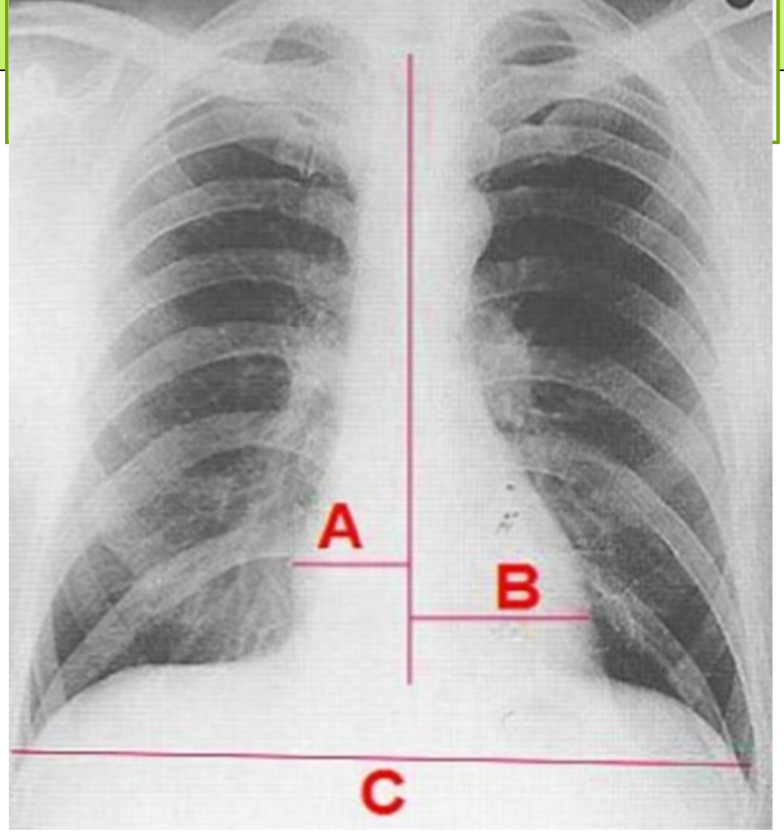
Cardiac Shad
(PA film)





- Look for the position, size, borders, chamber enlargement
- Right border → Right atrium, above it, SVC
- Left border → Pulmonary artery above, LV below
- Left atrium and right ventricle not normally visible

Cardio-Thoracic Ratio



- Measured on PA chest x-ray
- Maximal horizontal cardiac diameter to Maximal horizontal thoracic diameter
- Normal should be less than **0.5**

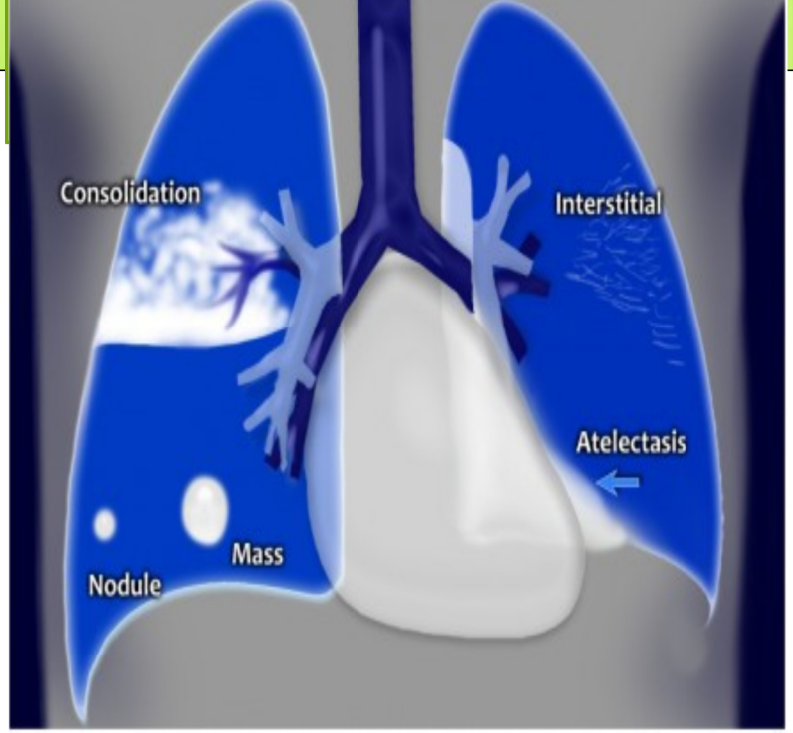
Diaphragm

- Right dome 2.5cm higher than left
- Bilaterally flattened: COPD
- Diaphragm masked in infiltration, effusions
- Air under diaphragm: abdominal viscus perforation
- Elevated hemidiaphragm
  - phrenic nerve palsy, reduced lung volume (collapse, atelectasis, lobectomy), abdominal pathology (subphrenic abscess, tumor)

Cardiophrenic & Costophrenic Angles

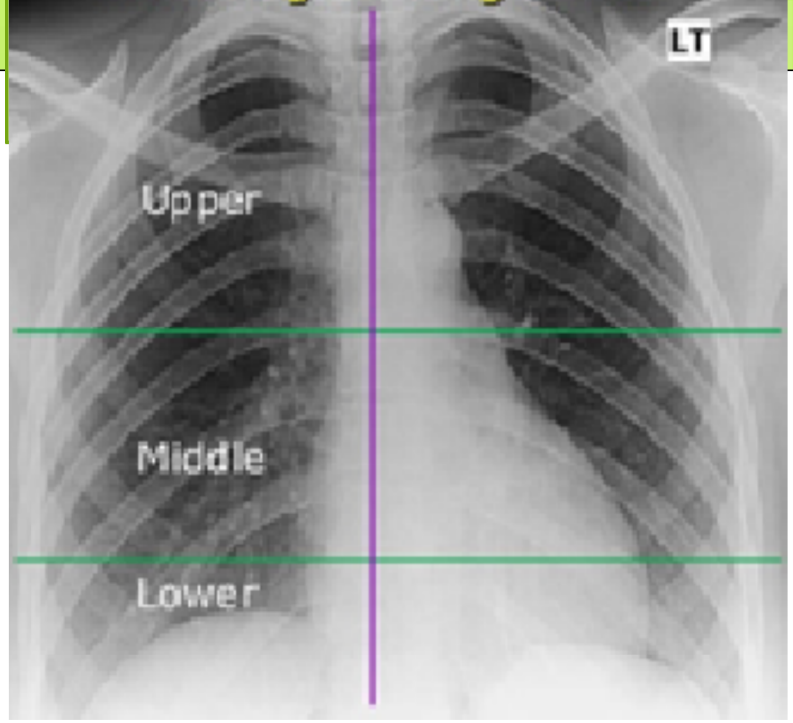
- Normally clear and sharp
- Look for blunting / opacities (effusion)
- 100 ml fluid to blunt costo-phrenic angle
- Large one produce an angle concave upwards
- Hydropneumothorax, air-fluid level in erect film

Lungs



- Check both lungs, starting at the apices down
- Compare left with right at the same level
- Periphery has few lung markings
- Disease of air spaces / interstitium increases opacity
- Air bronchogram: consolidation
- Opacification : consolidation, effusion, collapse, pneumonectomy

Lung fields



- Evaluate lung fields
  - Upper (above anterior end of 2nd rib)
  - Middle (between 2nd & 4th ribs)
  - Lower (below 4th rib)
- Compare both sides
- Symmetry, vascularity, mass, nodules, infiltrations

Congestive Heart Failure

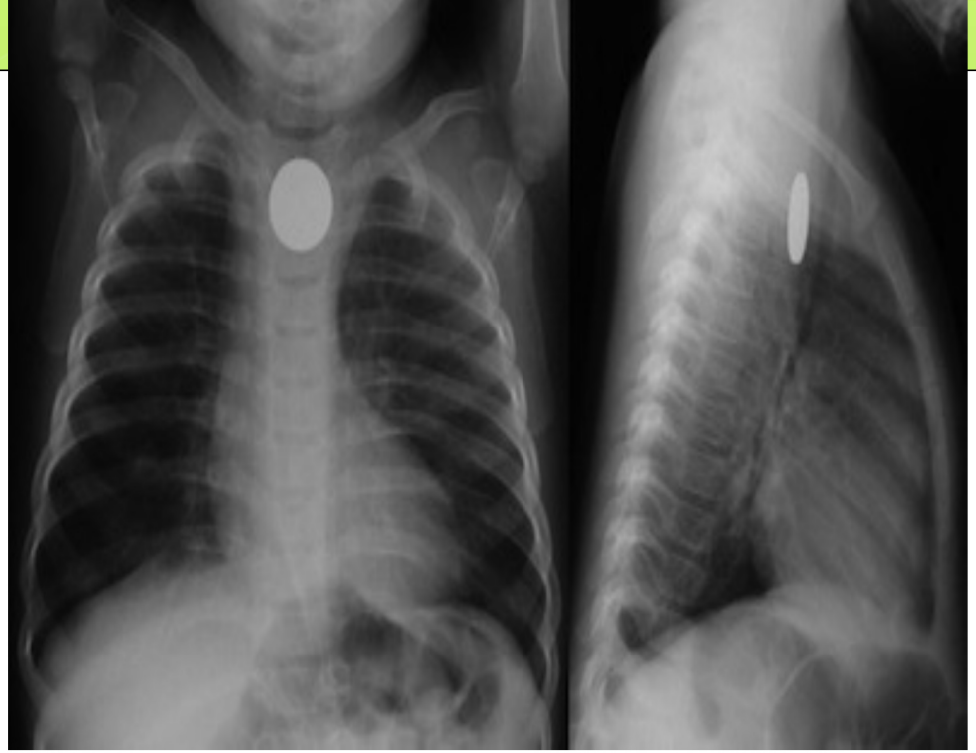
A - Alveolar oedema

B - Kerley B lines

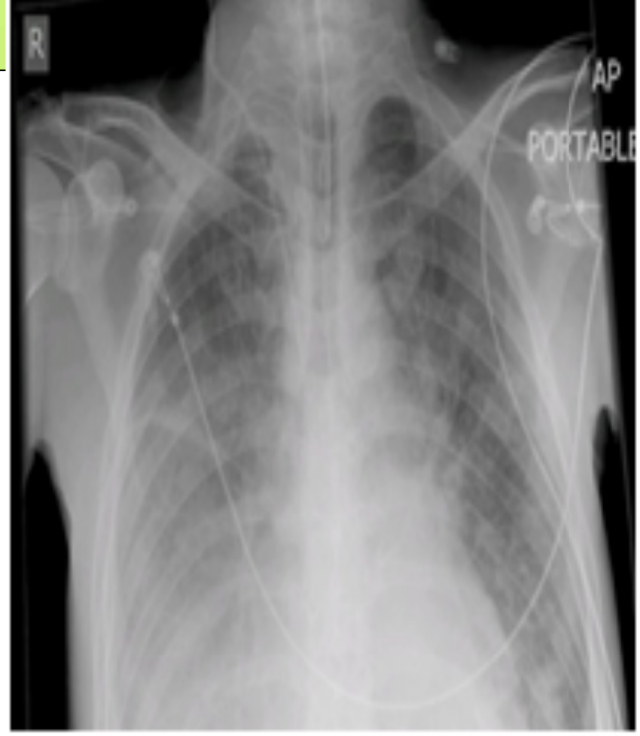
C - Cardiomegaly

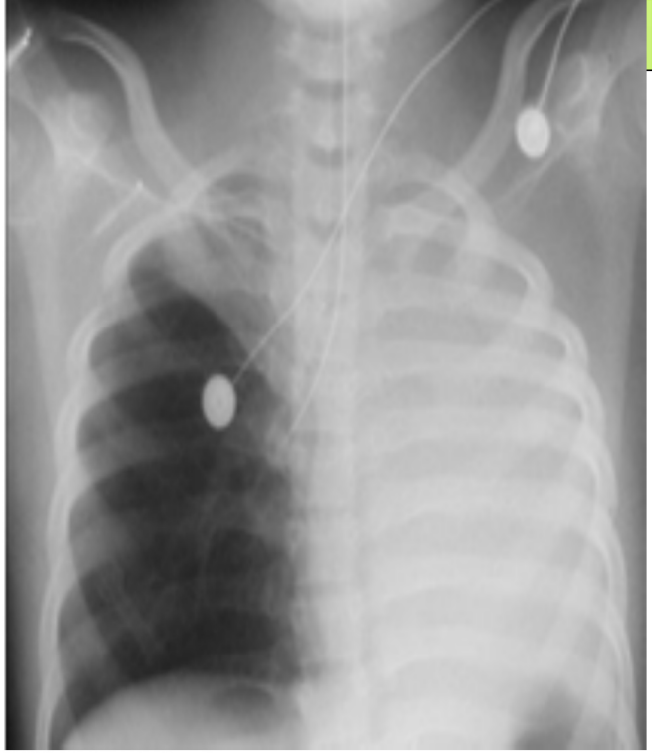
D - Dilated upper lobe vessels

E - Pleural effusion



Foreign Body





Endotracheal tube

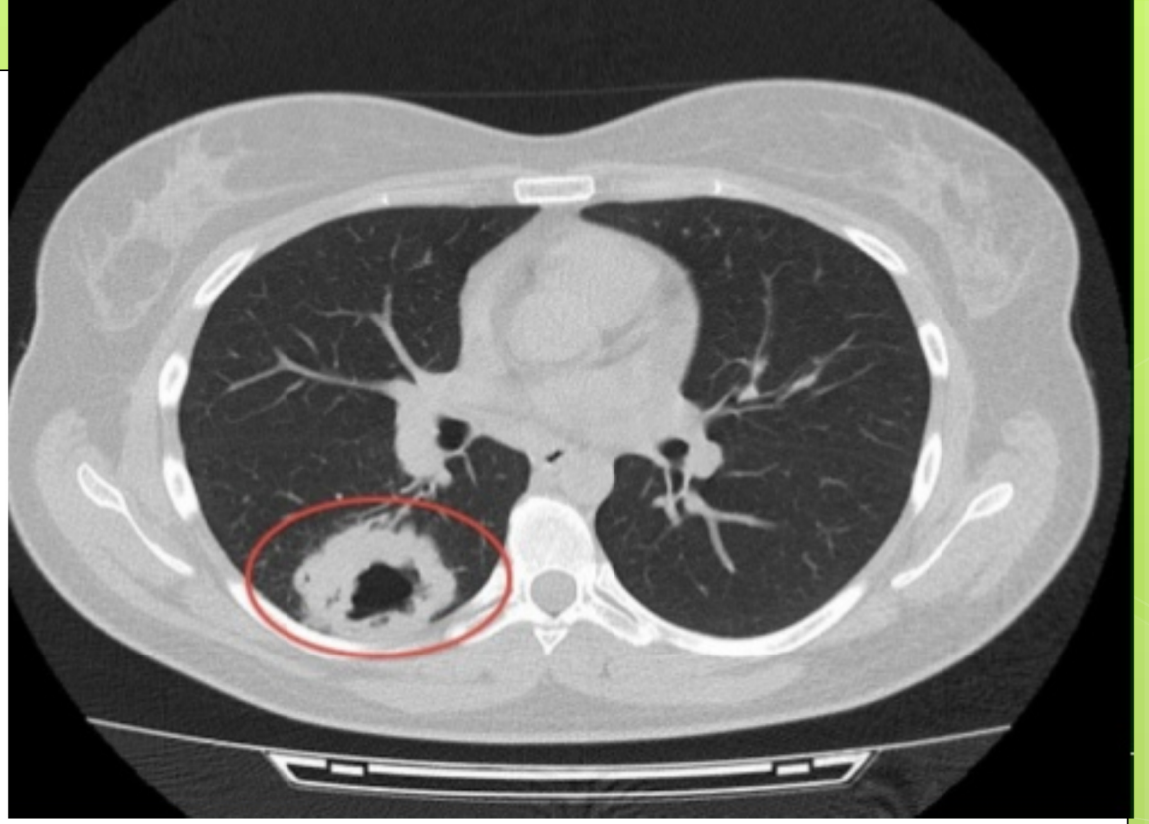
Normal position

Right endobronchial intubation causing opposite lung collapse

Therapeutic Devices

CT Thorax

- Chest radiograph: shadows of all depths superimposed on one another
- Computerised tomography (CT) scan: series of cross-sectional views (slices) at various levels
- Techniques available for 3D representation
- Ultrasonogram reveals less details than CT scan
- Does not expose to radiation
- Provides real-time image



CT Scan

MRI scan

- Magnetic resonance image (MRI) scan assist in defining the extent and severity of lesion
- MRI and CT scan may provide information that will assist anesthesia providers in their planning (sizing the trachea, plan for a double lumen endotracheal tube)

Conclusion

- A complete history and physical examination are most important in respiratory system evaluation.
- Chest radiograph and CT scan has now become important extension of the clinical examination in evaluating these patients preoperatively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