Chest Imaging Refresher

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I have no relevant disclosures for this talk

Thank you to the UVA Department of radiology website

Also to Drs. Rydzak and Primack OHSU Thoracic radiology

Also to RadiologyMasterClass.co.uk 

Learning Objectives

- Review chest x-ray techniques
- Quick blurb on basic approach to the interpretation
- Review thoracic imaging anatomy
- Define chest imaging terminology
  - Patterns
  - Distribution
- Review some cases!

First, a comment on technique

- Best technique as PA and lateral
- Radiation source positioned at the patient's back (posterior)
- Plate is in front of the patient (anterior)
- PA images will deliver higher quality and sharper images

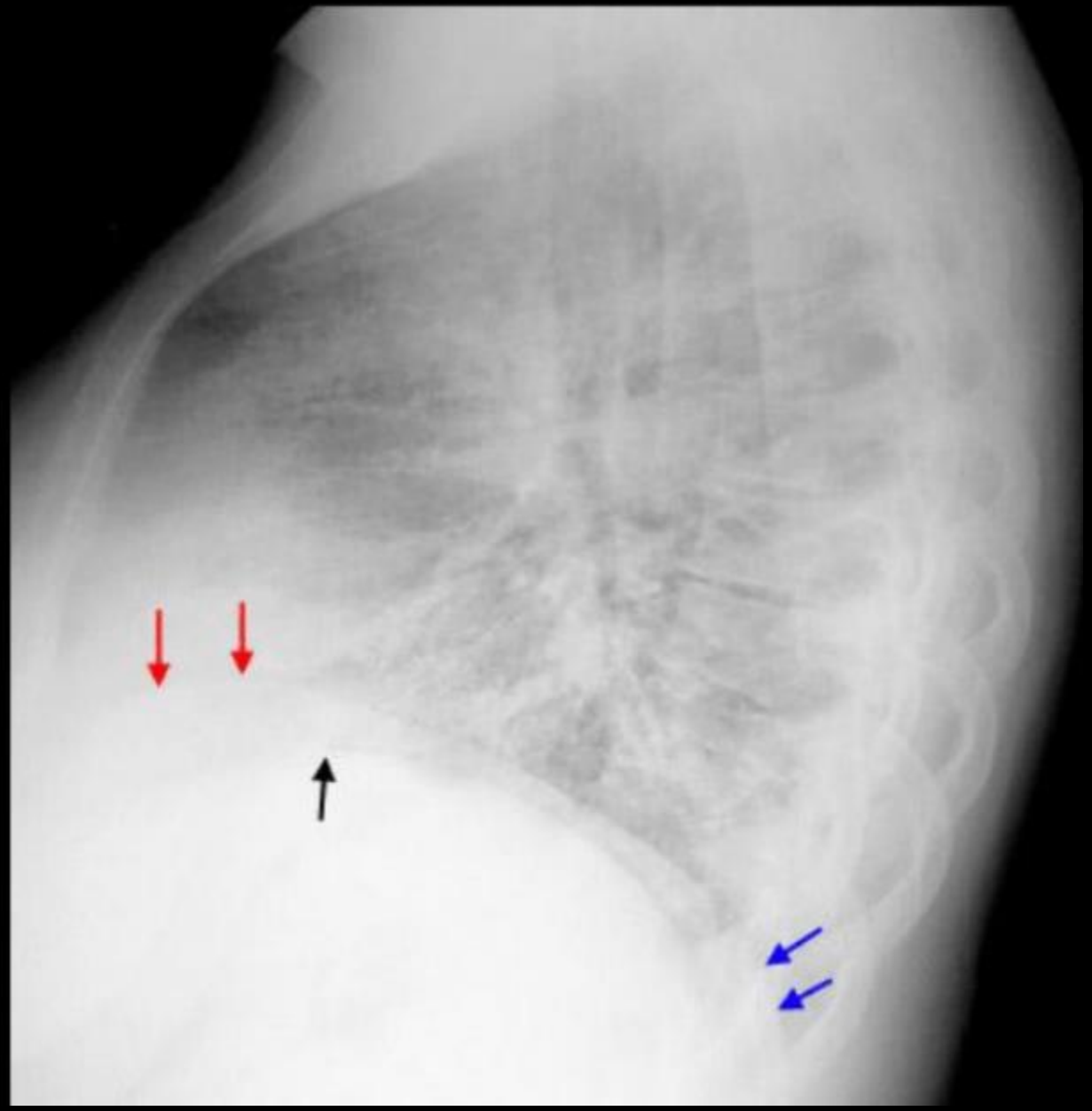
This is the simulated patient in PA (posterioranterior) position.
Note that the x-ray tube is 72 inches away.

First, a comment on technique

- Best technique as PA and lateral
- Radiation source is positioned on the patient's right side
- Plate is to the patient's left side
  - Right to left

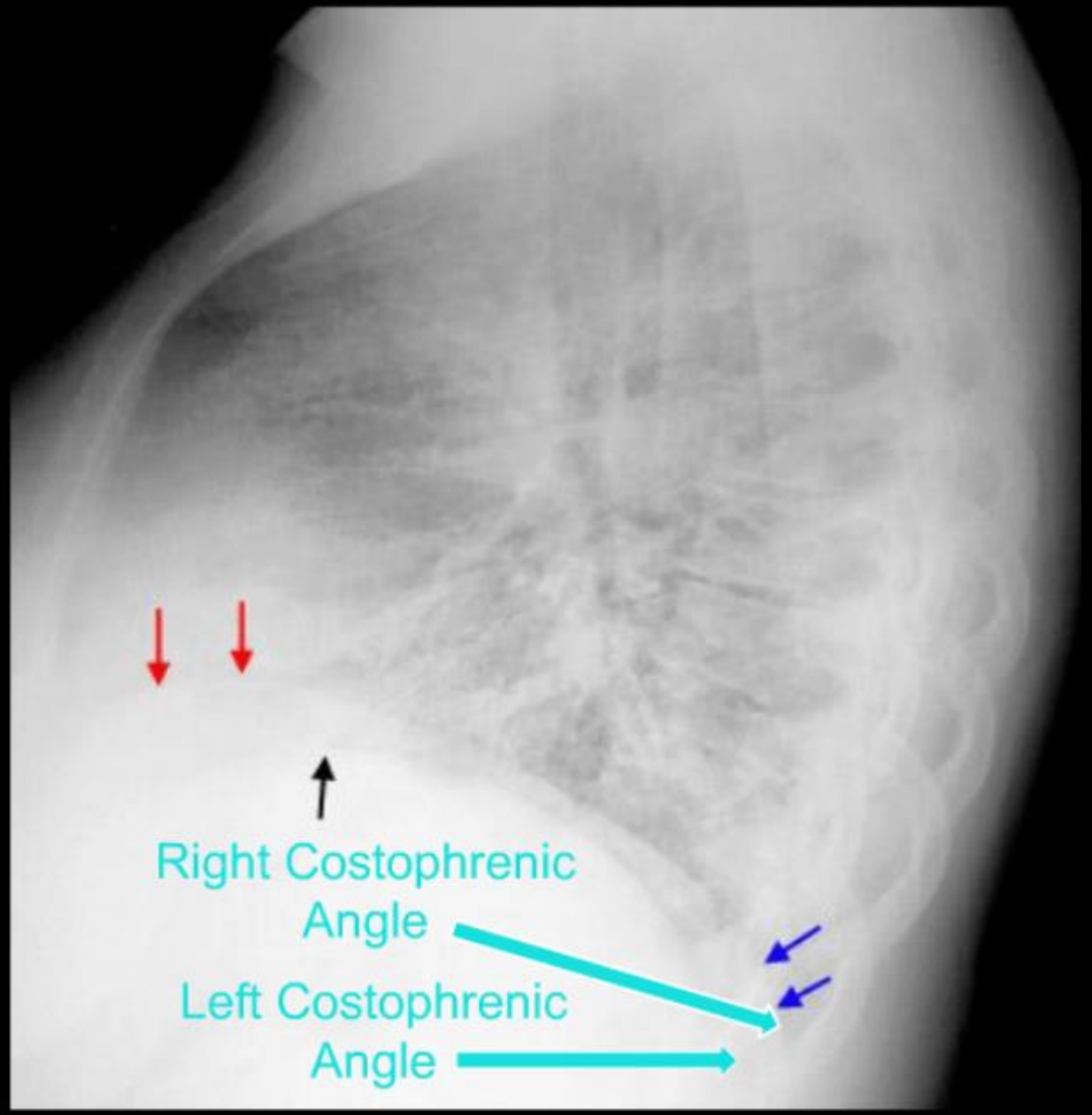
Lateral CXR

- LEFT hemidiaphragm is usually lower than the right
- The right diaphragm (red arrows) continues anteriorly; it also ends near the wider, posterior right sided ribs (blue arrows)
- The left diaphragm disappears (black arrow) because it blends with the heart



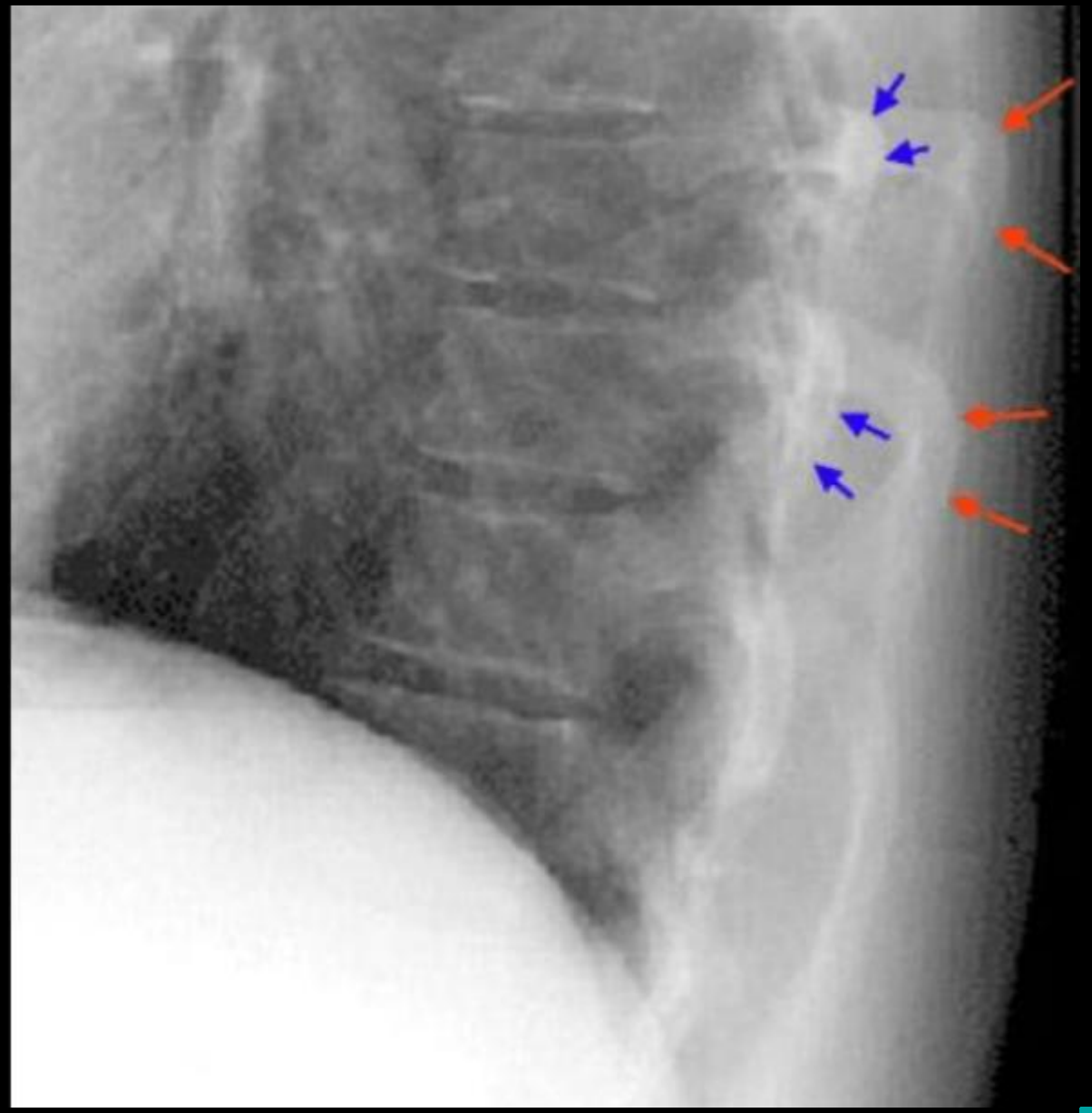
Lateral CXR

- Costophrenic angles
  - Angle made by the contour of the diaphragm and the ribs
- The LEFT costophrenic angle will appear lower because the diaphragm is lower on the left



Lateral CXR

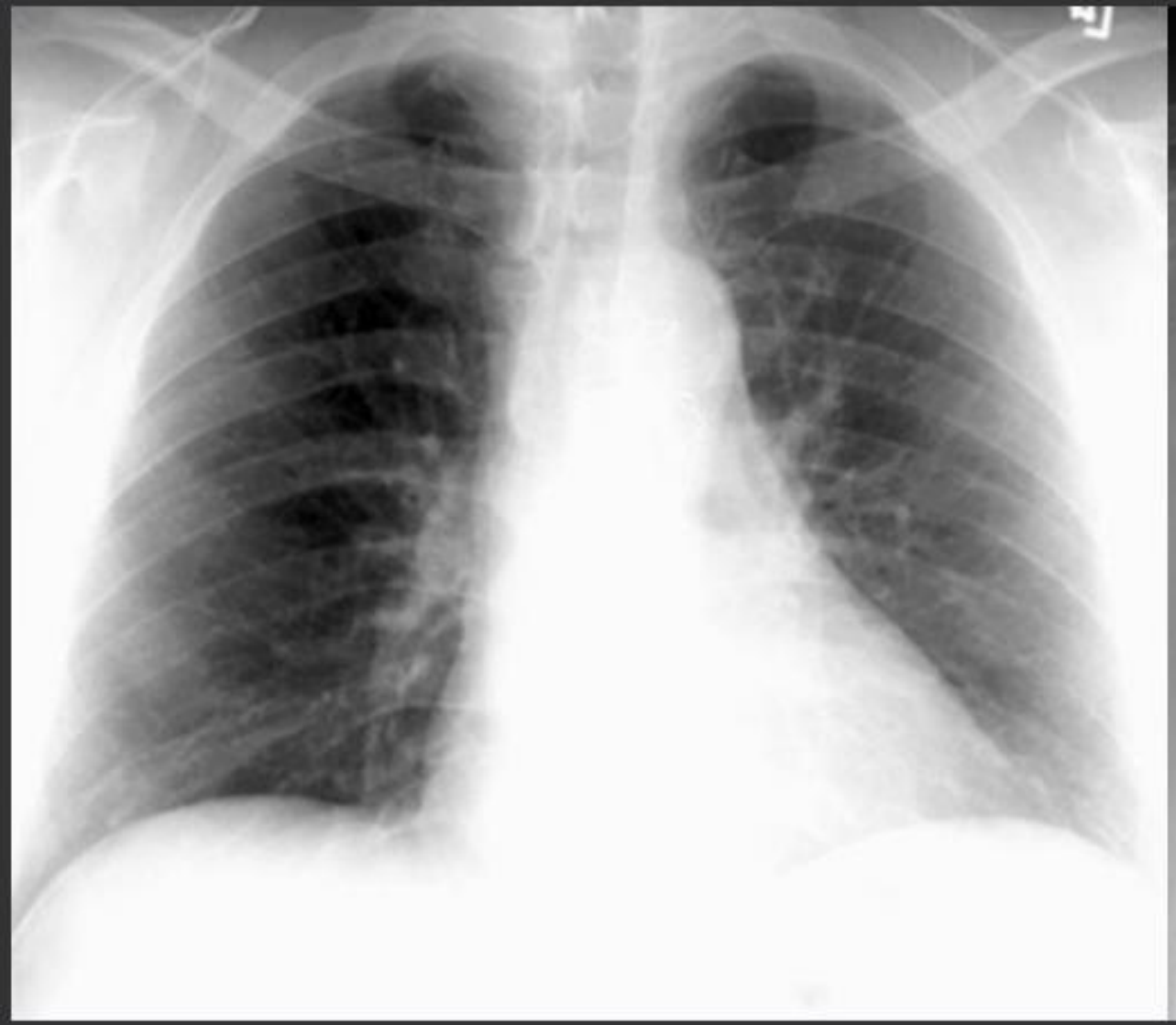
- On the lateral, the RIGHT ribs will be more posterior and larger (red arrows)
- The LEFT ribs will be slightly more anterior and smaller (blue arrows)

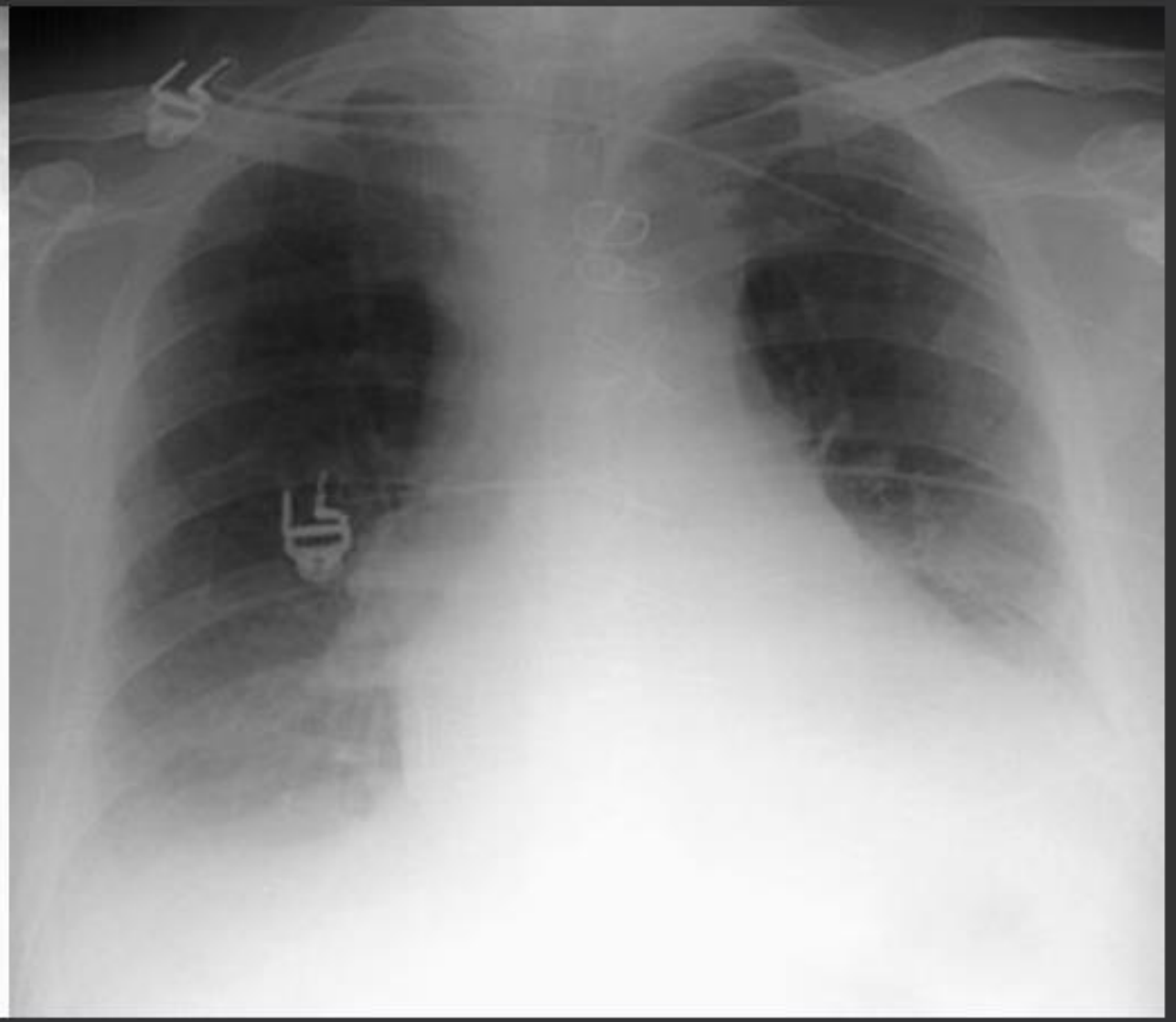


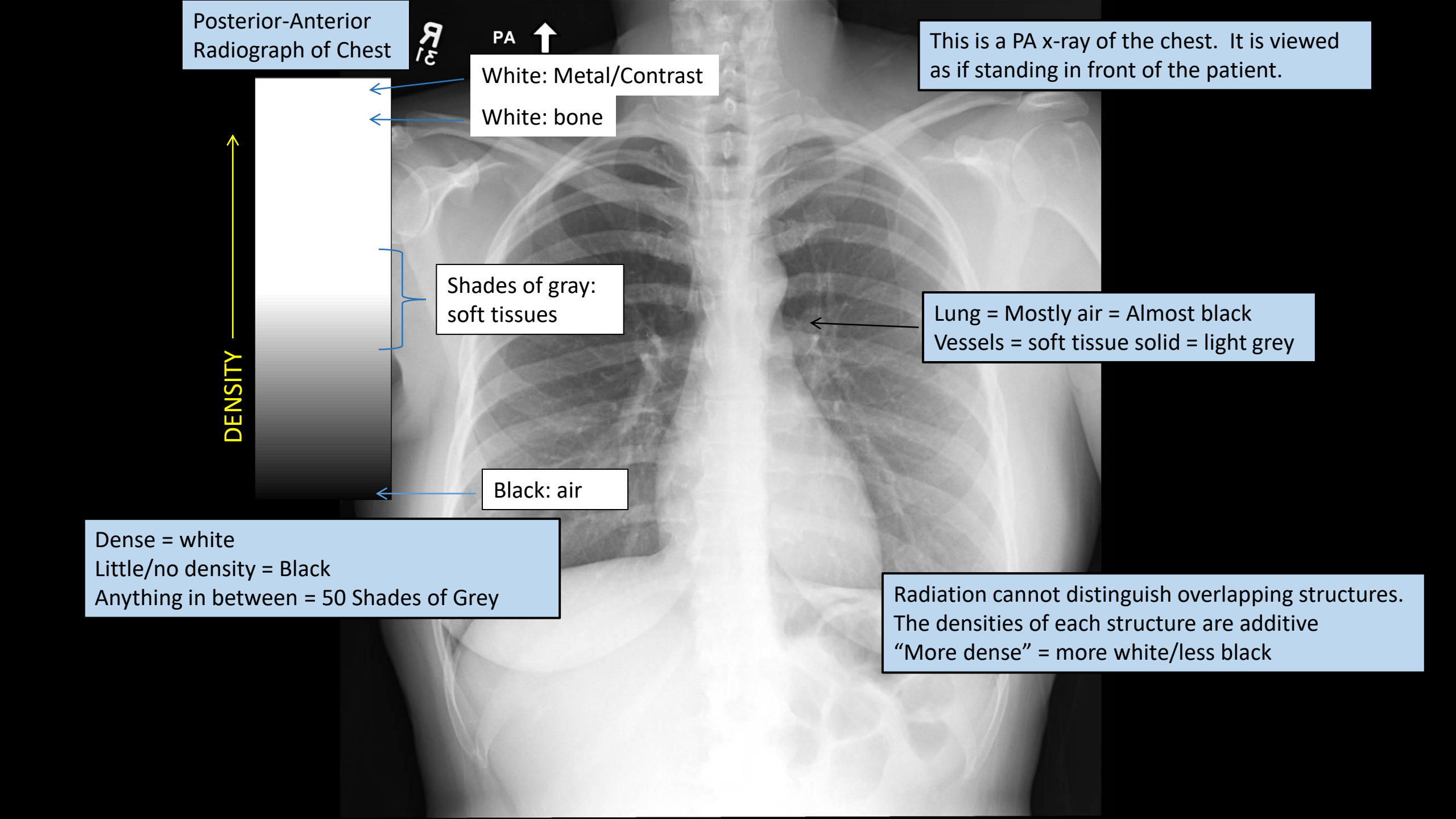
PA image

- Hospitalized, ill patients sometimes cannot easily or safely stand
- AP images will be more blurry than PA images
- Can still interpret!

Radiation source is closer to patient that PA






Posterior-Anterior Radiograph of Chest
PA
White: Metal/Contrast
White: bone
DENSITY
Shades of gray: soft tissues
Black: air
This is a PA x-ray of the chest. It is viewed as if standing in front of the patient.
Lung = Mostly air = Almost black
Vessels = soft tissue solid = light grey
Dense = white
Little/no density = Black
Anything in between = 50 Shades of Grey
Radiation cannot distinguish overlapping structures.
The densities of each structure are additive
“More dense” = more white/less black

Reading Chest Radiographs….

Is there a right way?

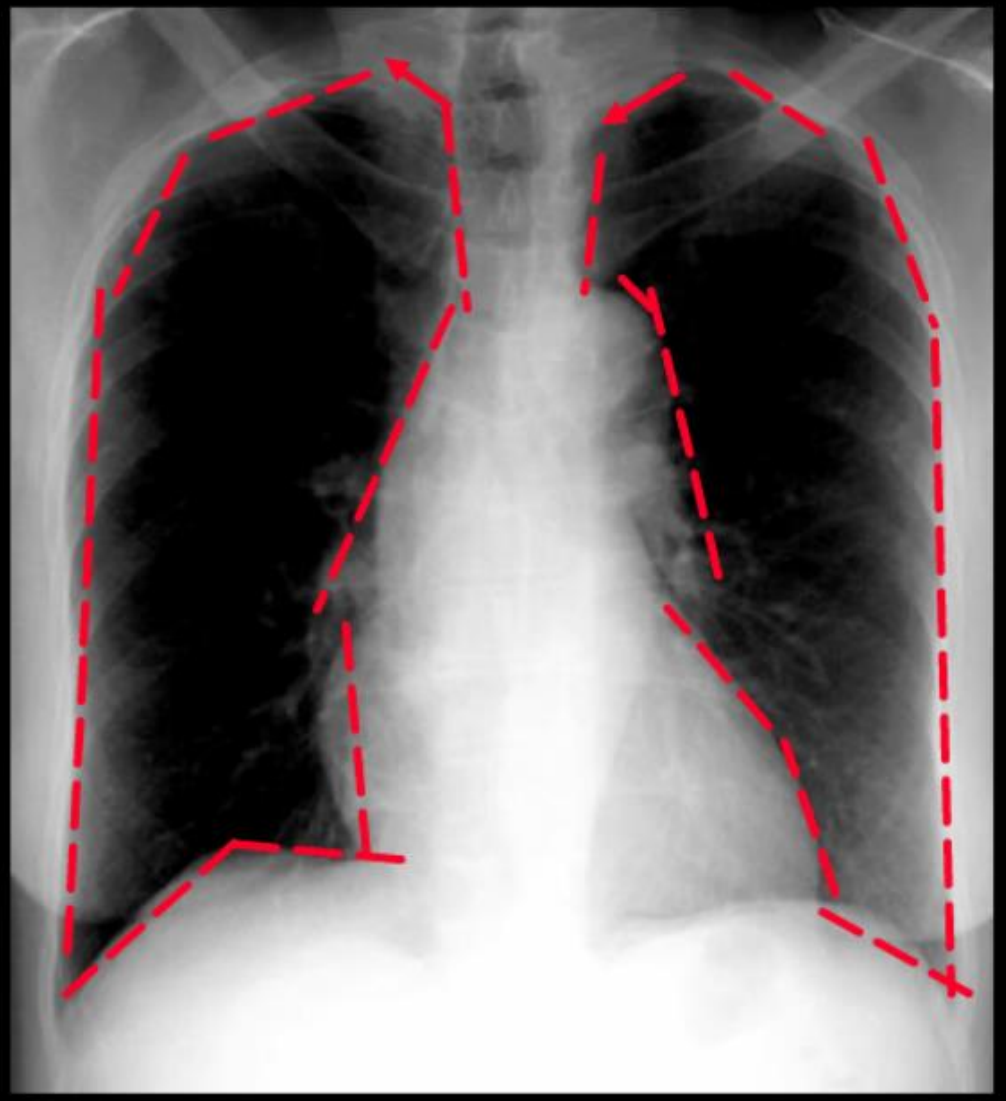
- Avoid “the Gaze”
  - Examine all areas and structures
  - Match your patient’s symptoms for possible causes
- Have a systematic approach
  - Avoids missing something
  - Don’t stop till you are done
    - “Satisfaction of search” – finding one thing and then stopping your process

Mnemonics?

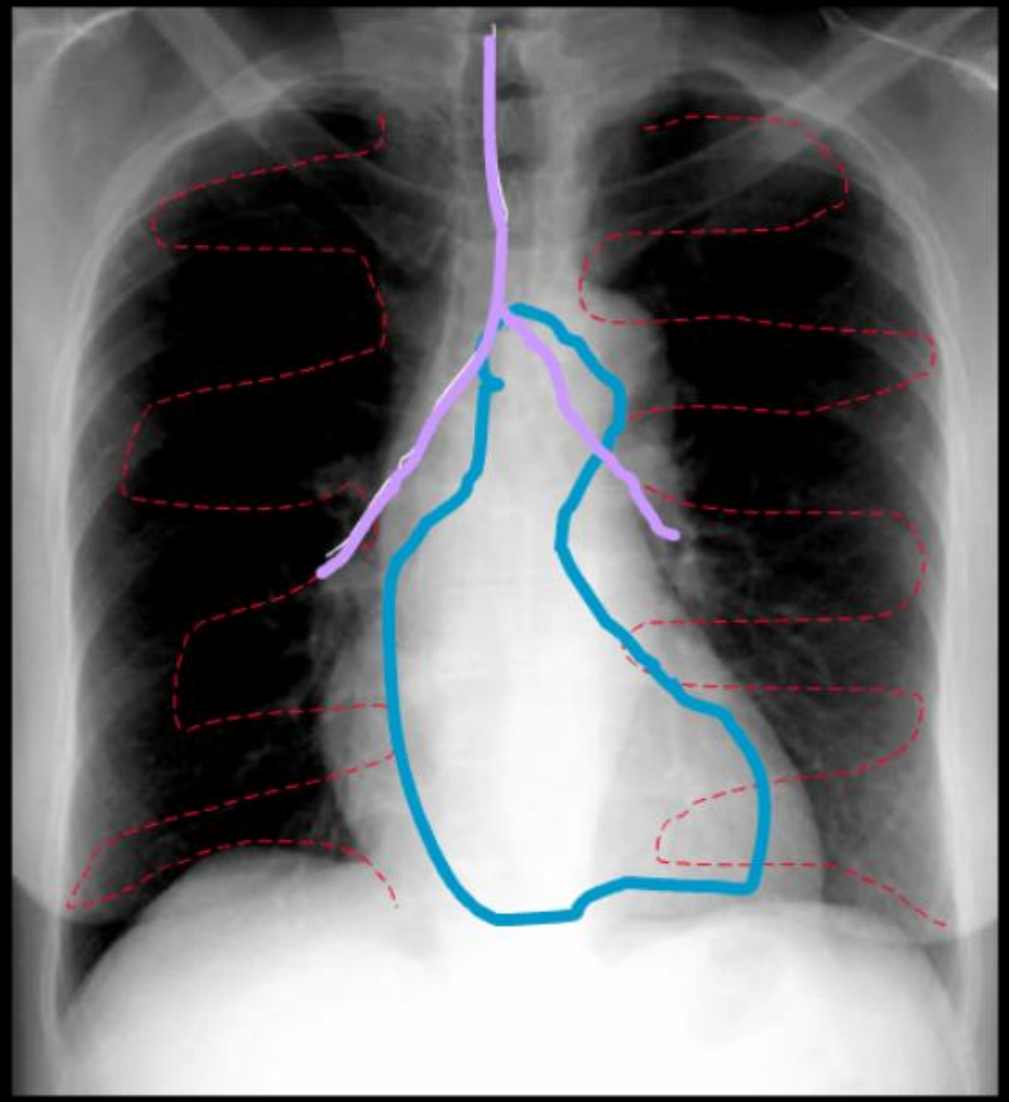
- ABCDEFGH
  - Airways
  - Bones
  - Cardiac silhouette/Costophrenic Angles
  - Diaphragm
  - Edges of fields (pleura) and Extrathoracic structures
  - Fields of lungs
  - Gastric bubble
  - Hilar regions
- Be cautious…
  - Easy to forget
  - May not be necessary as you advance in your skills
  - Be systematic

V	VASCULAR
I	INFECTIONS
N	NEOPLASTIC
D	DEGENERATIVE
I	INTOXICATION
C	CONGENITAL
A	AUTO-IMMUNE
T	TRAUMATIC
E	METABOLIC (ENDOCRINE)

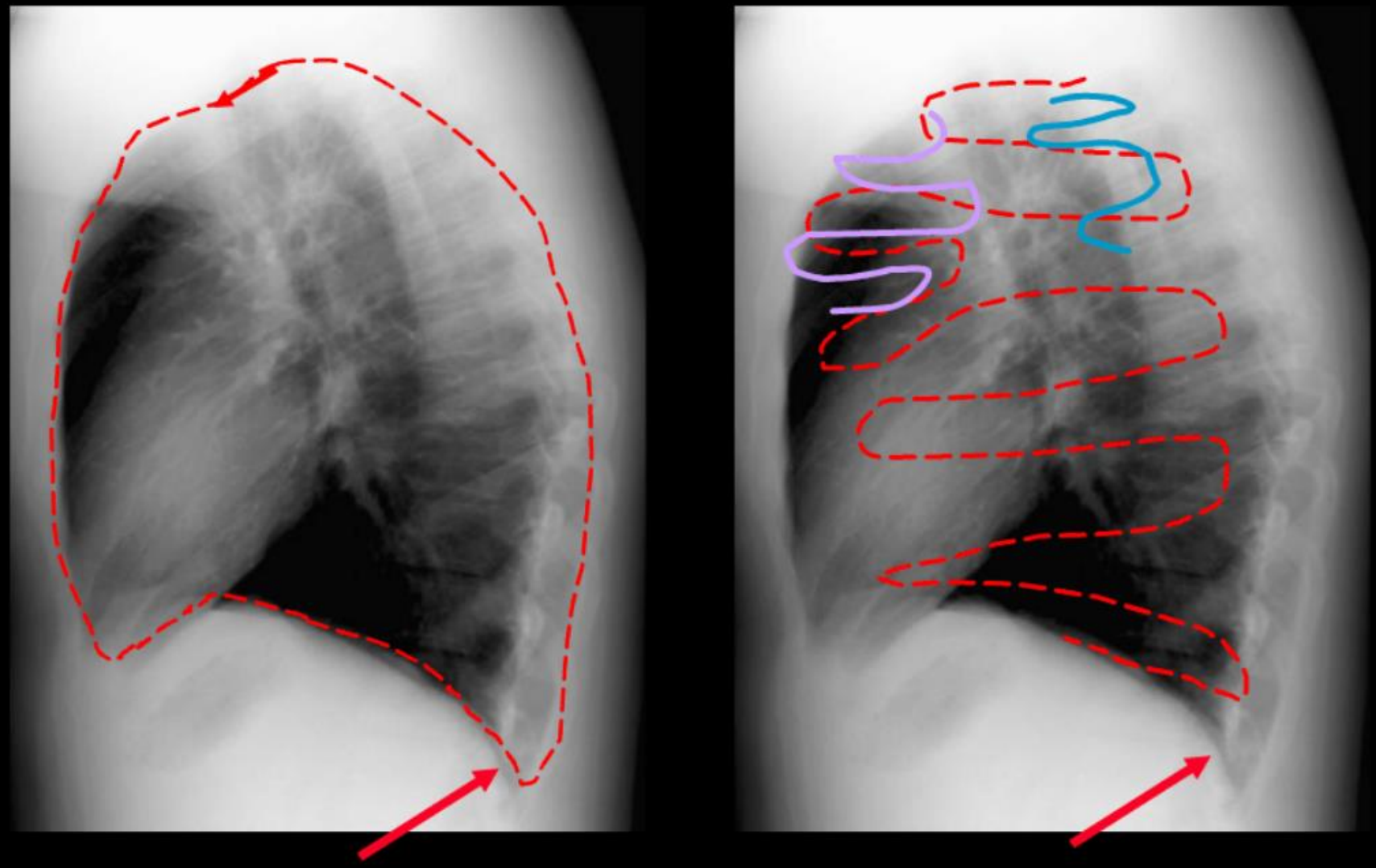
Trace the soft tissues/lung margins with your eyes



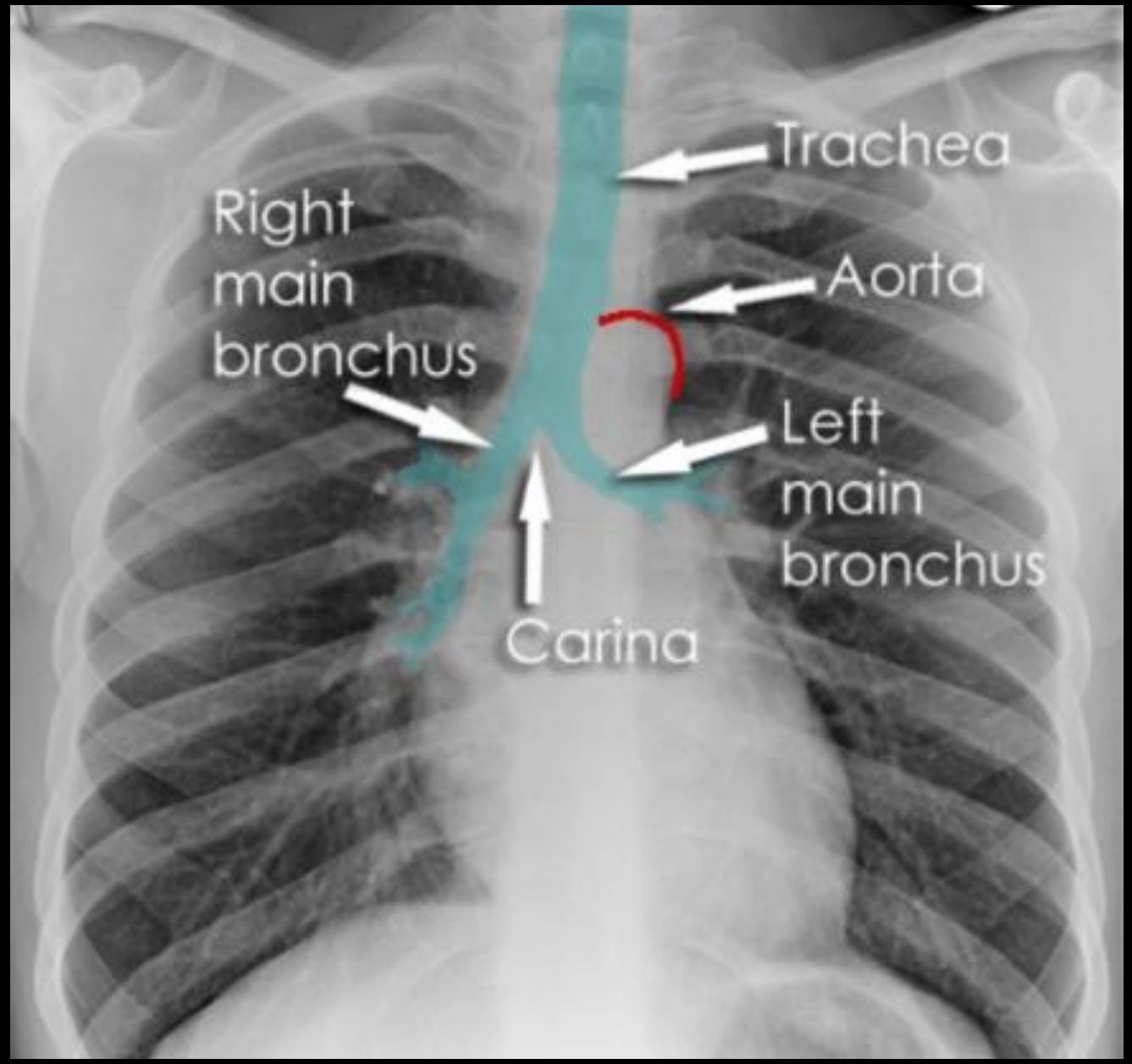
Scan/trace the trachea, heart and lungs



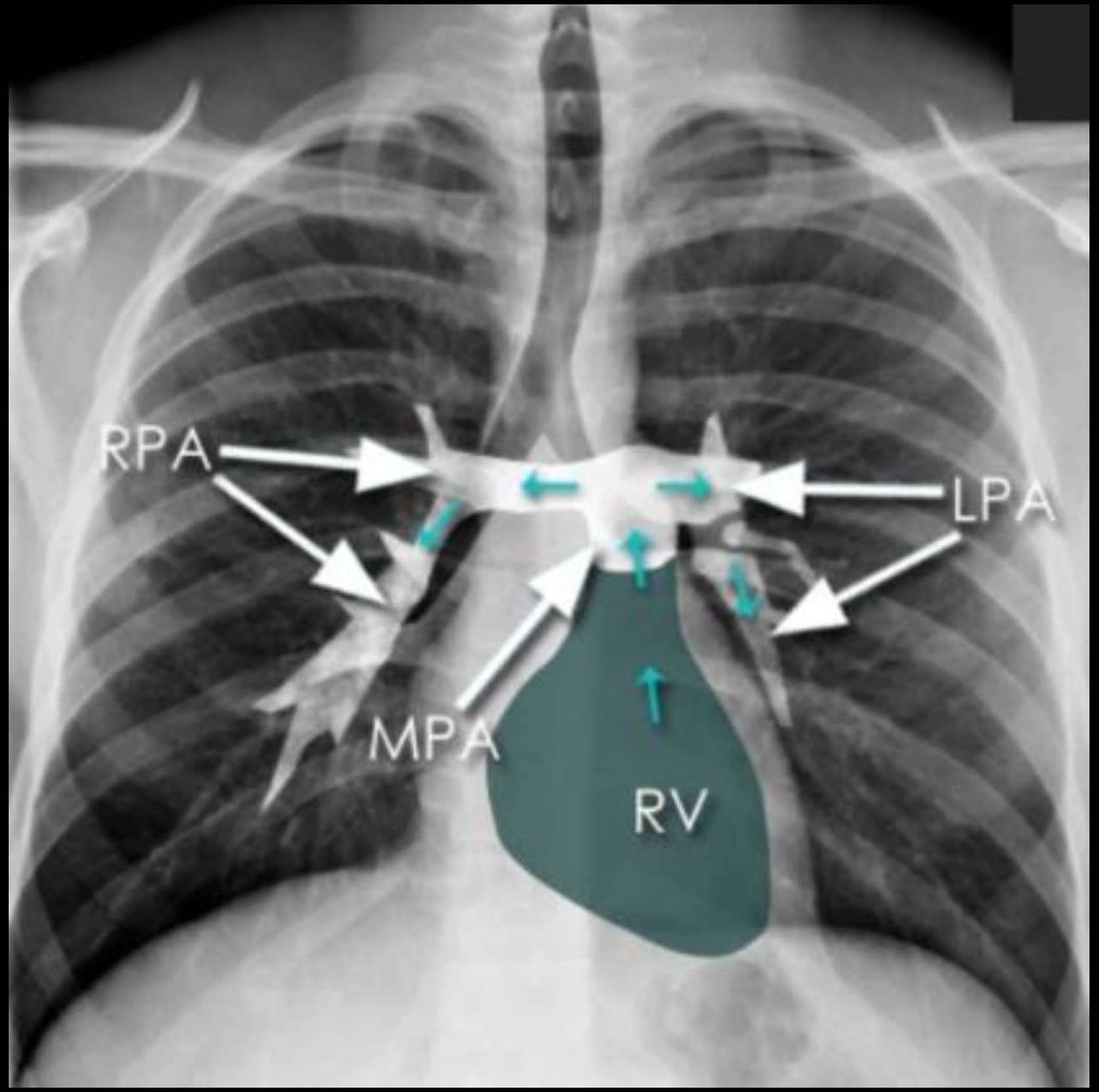
Lateral: Margins, costophrenic angles, lungs



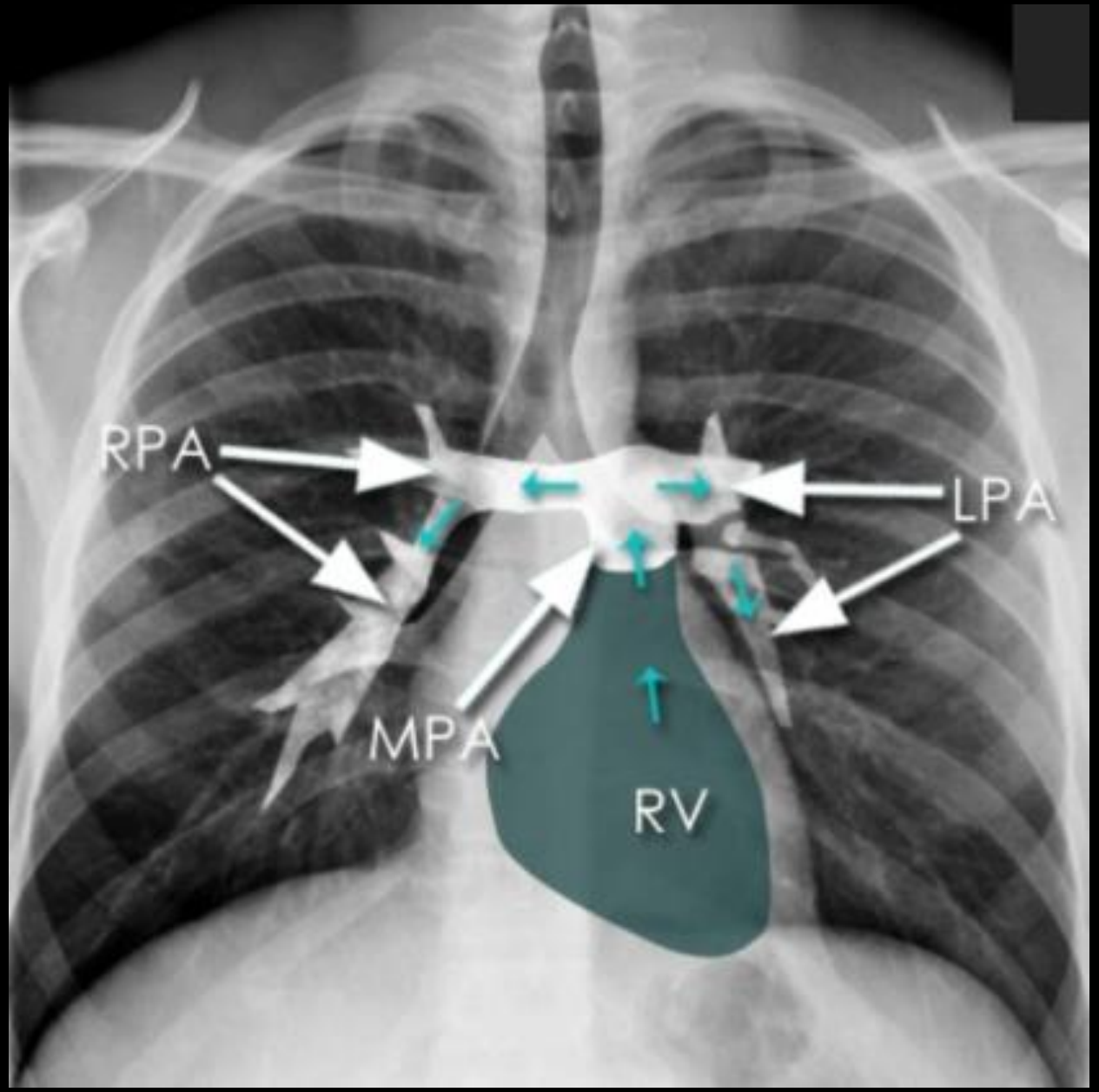
1. Trachea
2. Hila = PAs/LNs/bronchi
3. Lungs
4. Hemidiaphragms
5. Heart
6. Aortic Arch
7. Ribs
8. Scapulae
9. Breasts
10. Bowel gas



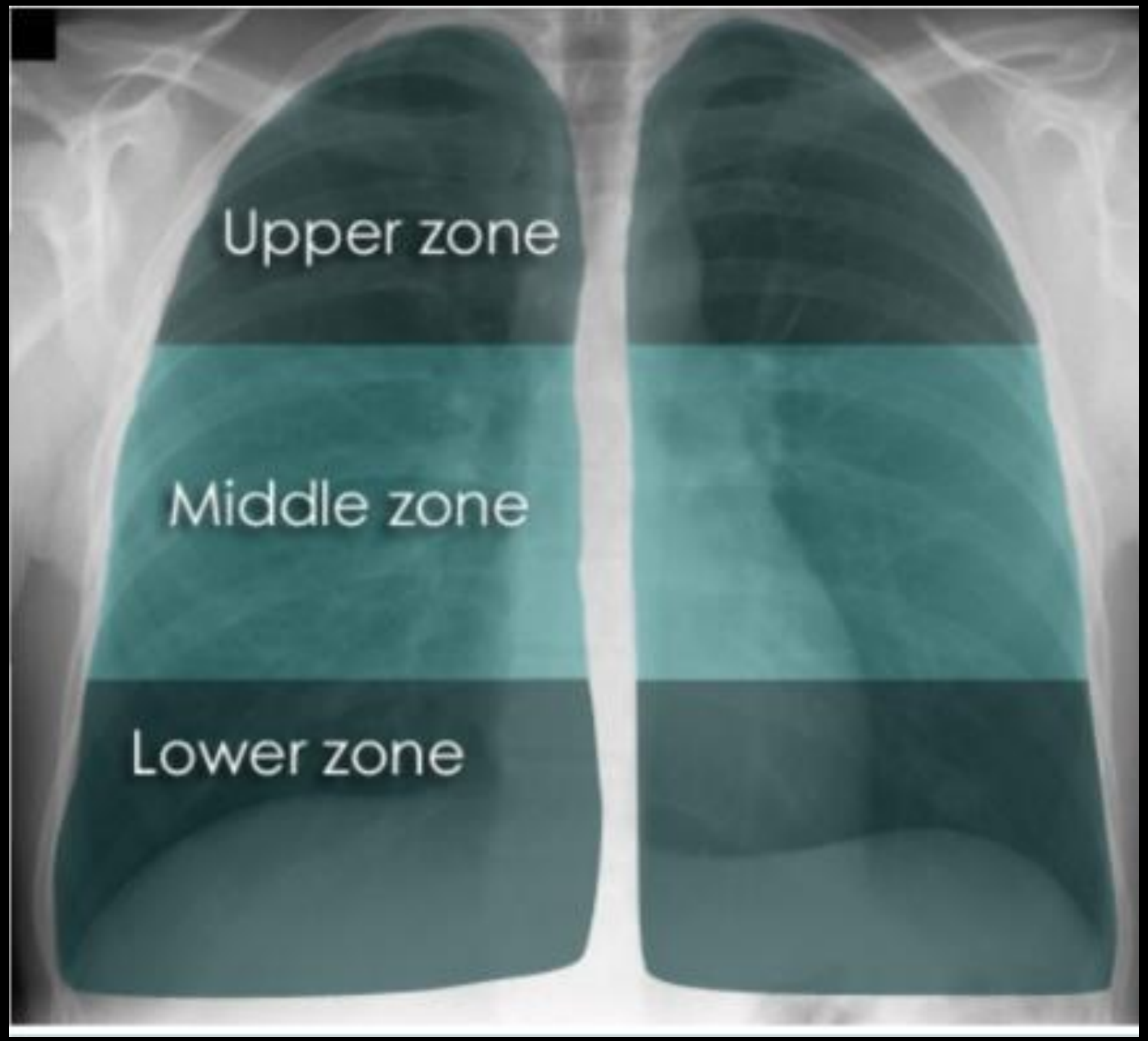
- The trachea and main bronchi are visible and branch at the main carina
- The trachea passes to the right of the aorta arch and so may be slightly off mid-line to the right



- Deoxygenated blood (blue arrows) moves from the right ventricle (RV) to the main pulmonary artery (MPA)
- Note the RV does not compose either heart border
- The MPA divides in the left (LPA) and right (RPA) through the hila and into the lungs to receive oxygenated blood

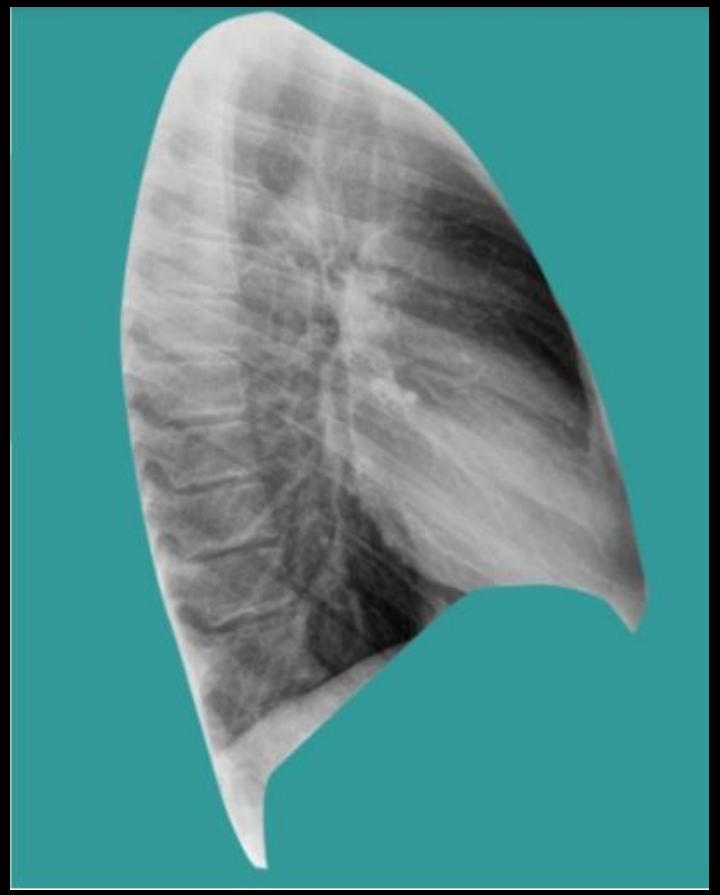


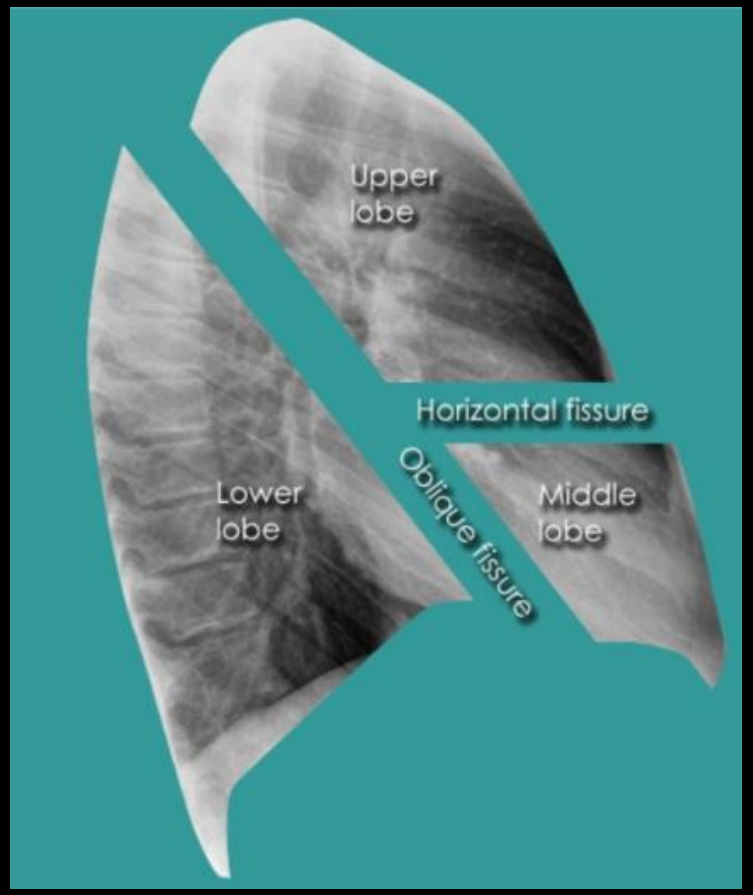
- The LPA hooks posteriorly over the left main bronchus
- The RPA lies in front of the right main bronchus
- Hila are composed of main bronchi, MPA, RPA, LPA, and lymph nodes
- Left hilum is higher than the right hilum



- Many radiologists refer to “upper”, “mid” and “lower” lung zones. ☹ No standards
- Some recommend dividing into zones when interpreting (less likely to miss details?)
- Note lower zones dips well behind the hemidiaphragms

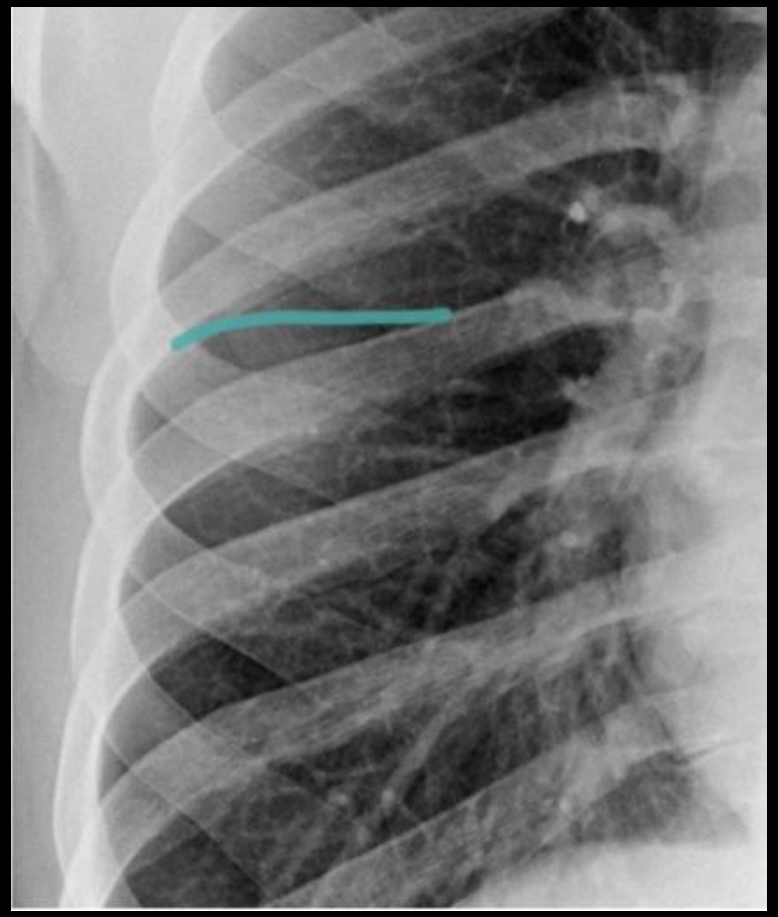
- Pleural (visceral and parietal) wraps around the entirety of the lungs
- Generally should not see unless there is a problem





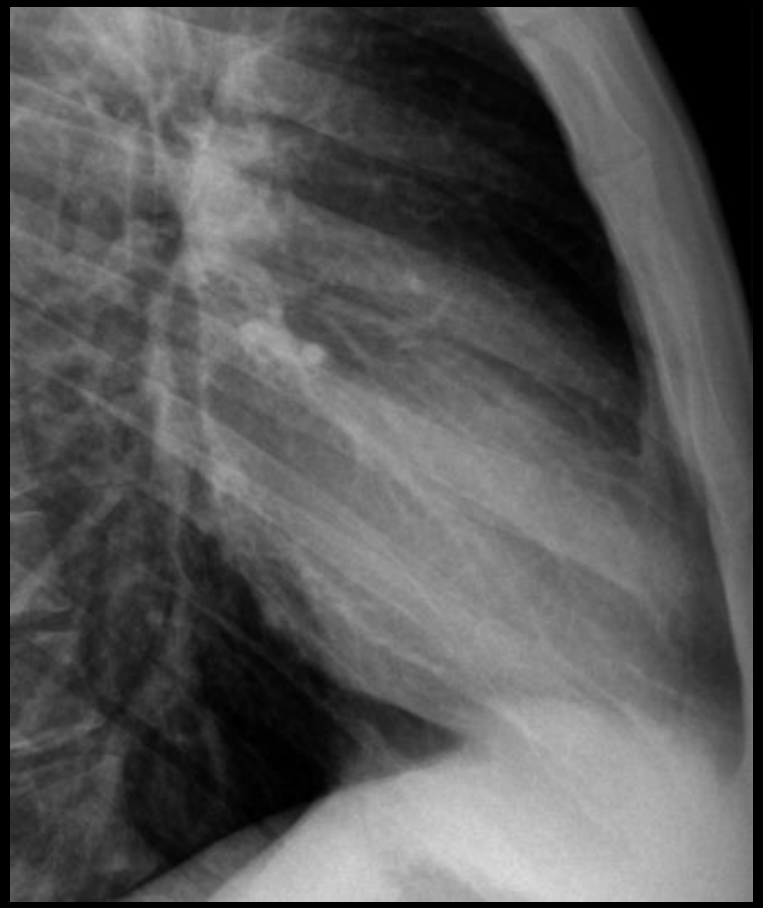
Right Lung

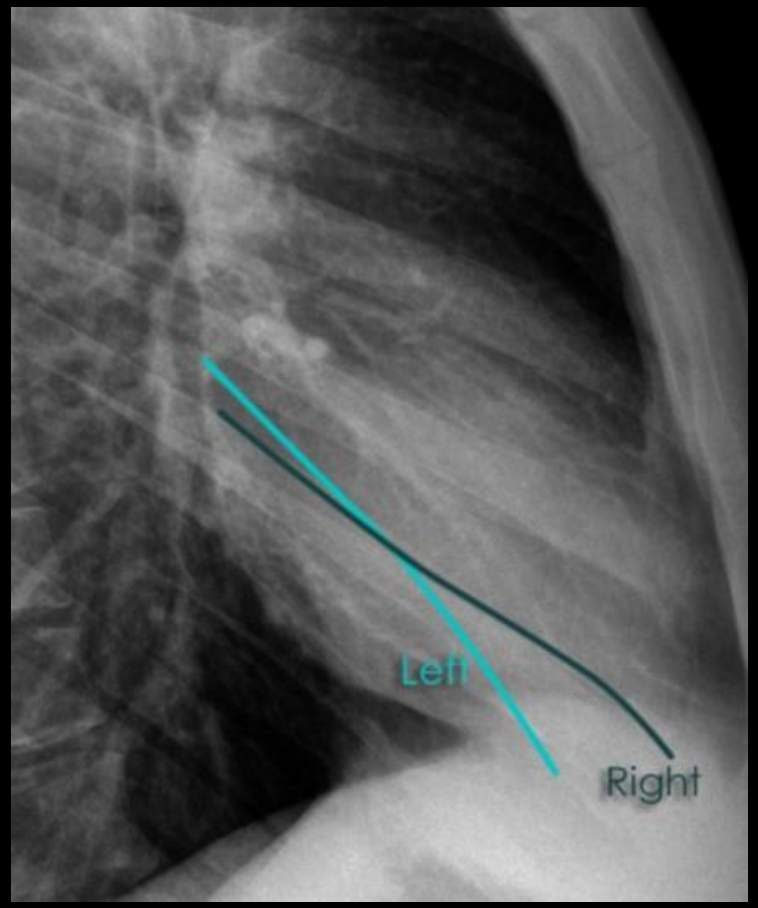
- 3 lobes
- 2 fissures
  - Oblique – Major
  - Horizontal – Minor
    - Not on left



Minor Fissure

- Separates RML from RUL horizontally
- Seen a little better on lateral
- Barely perceptible when no pathology

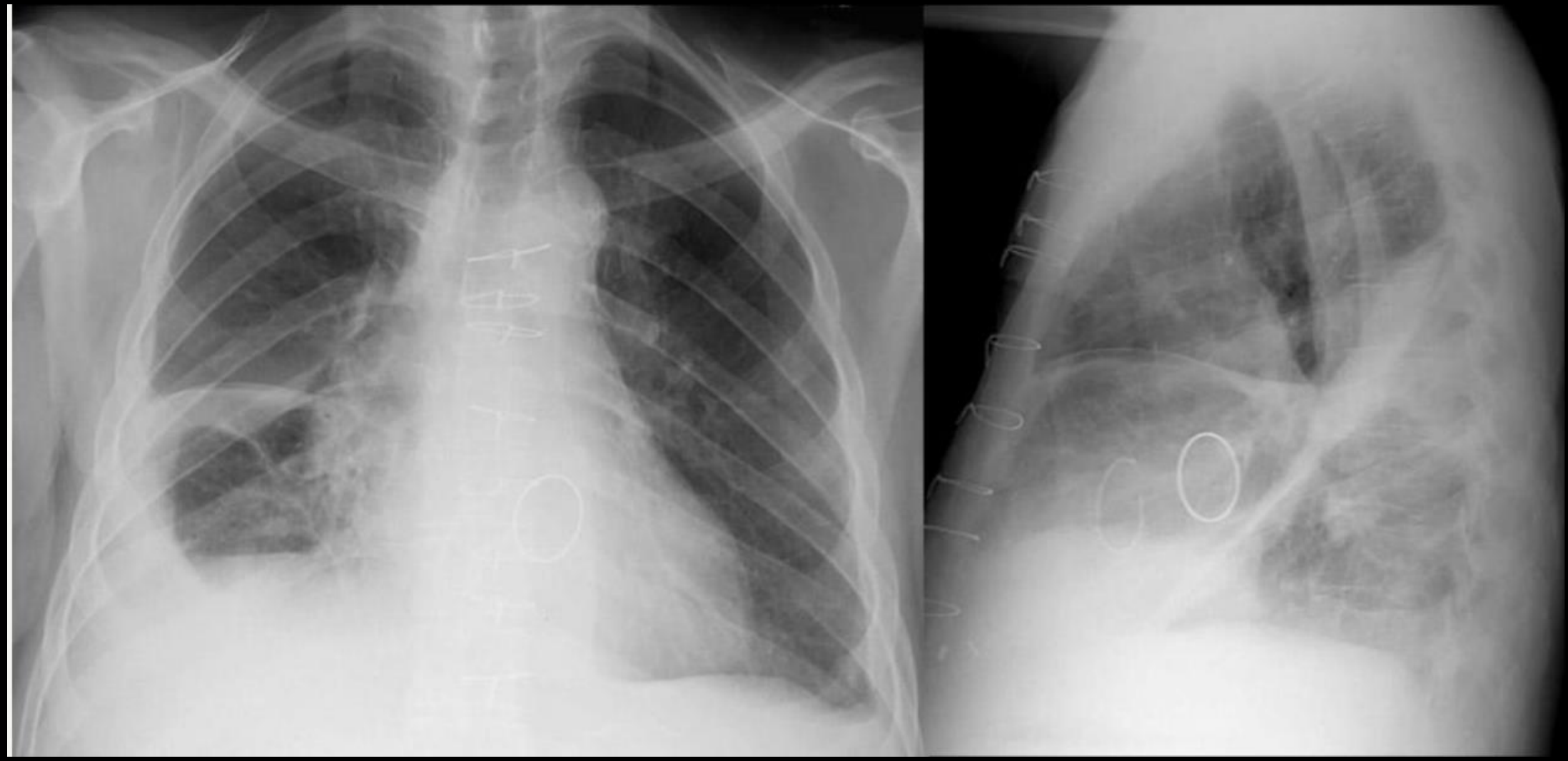




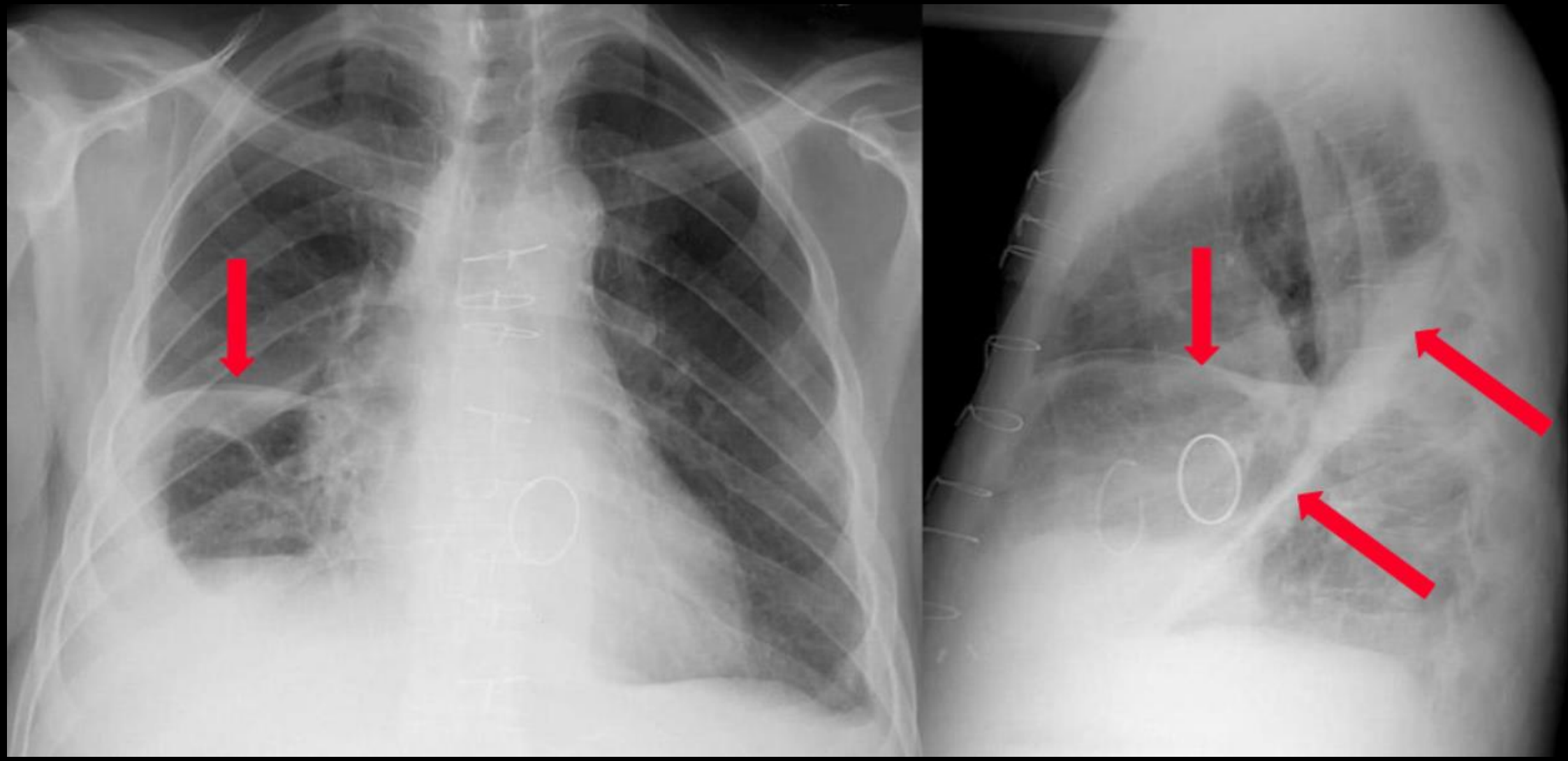
Major Fissures

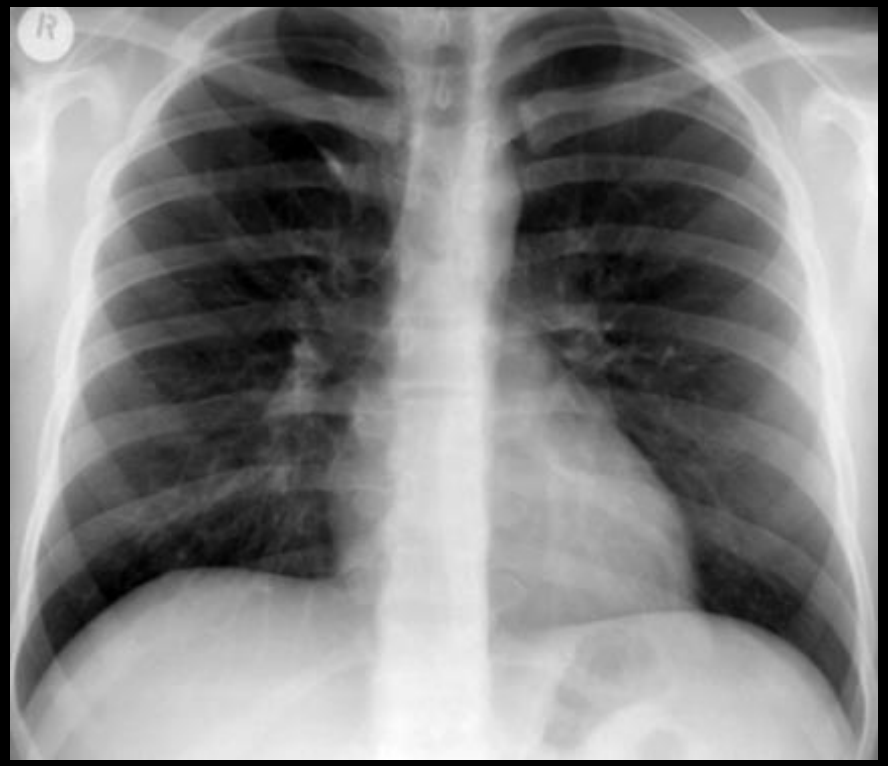
- Separates RLL from RUL and RML
- Separates LUL and Lingula from LLL
- Much easier on lateral
- Barely perceptible when no pathology

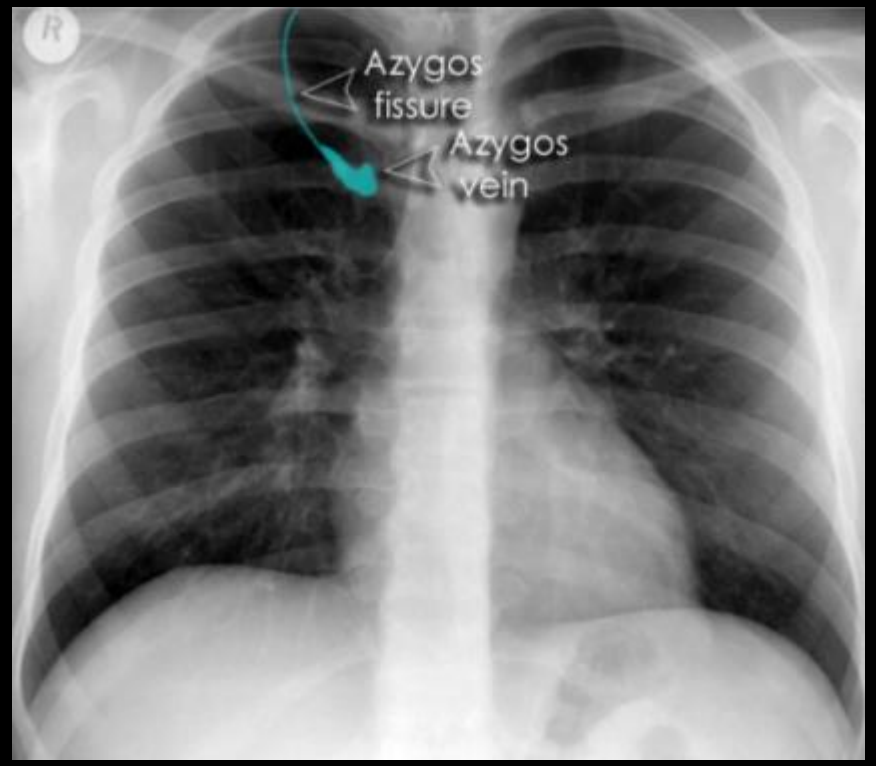
Locate the fluid in the fissures….



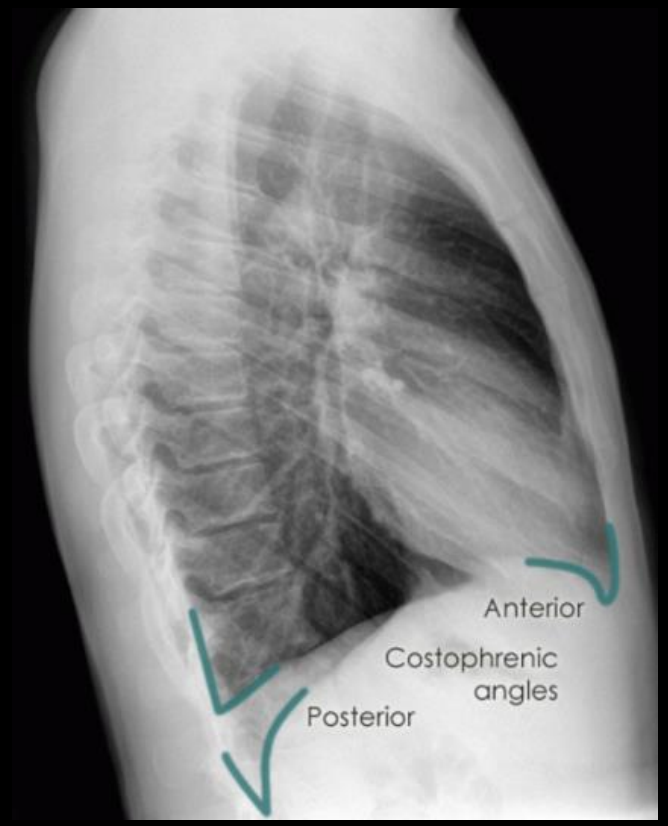
Locate the fluid in the fissures….



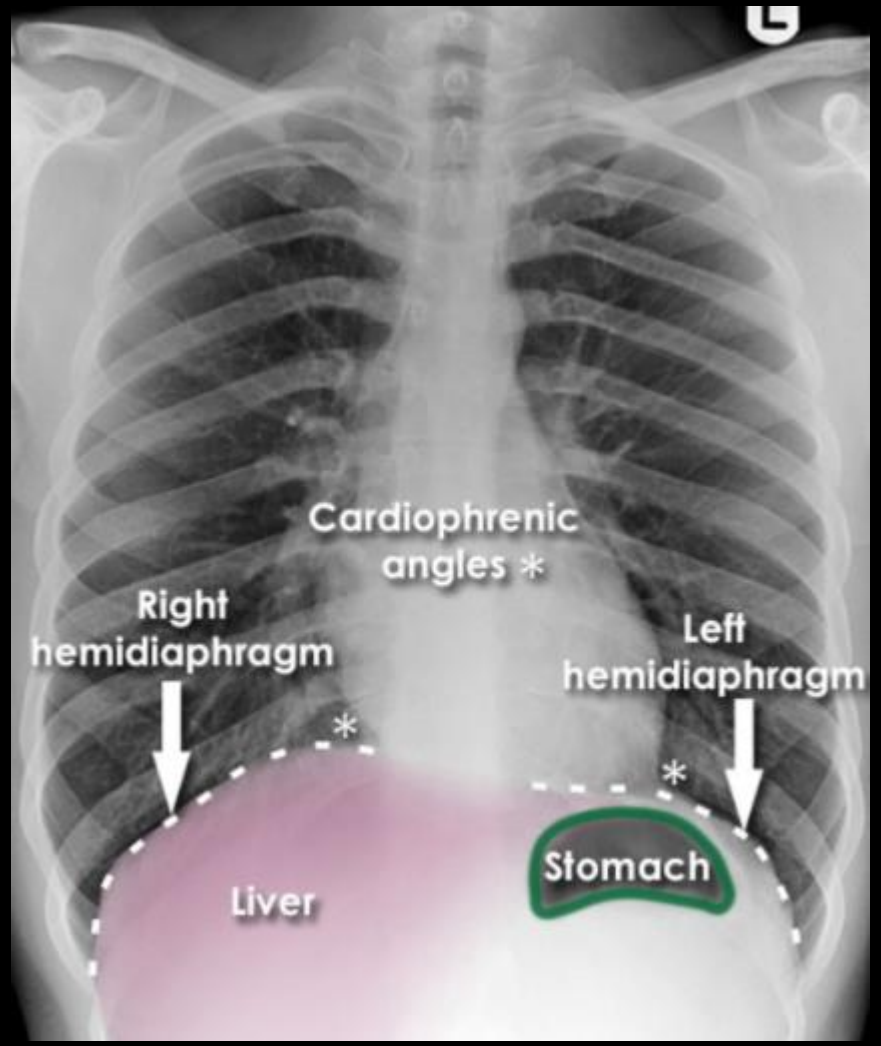




- Accessory fissure occurs if patient has a normal variant accessory lobe (1-2%)
- The azygous vein normally runs along the right side of the mediastinum and hooks anteriorly over the RMB
- If there is an azygous fissure, the vein runs in the lung and is surrounded by pleural (tadpole)

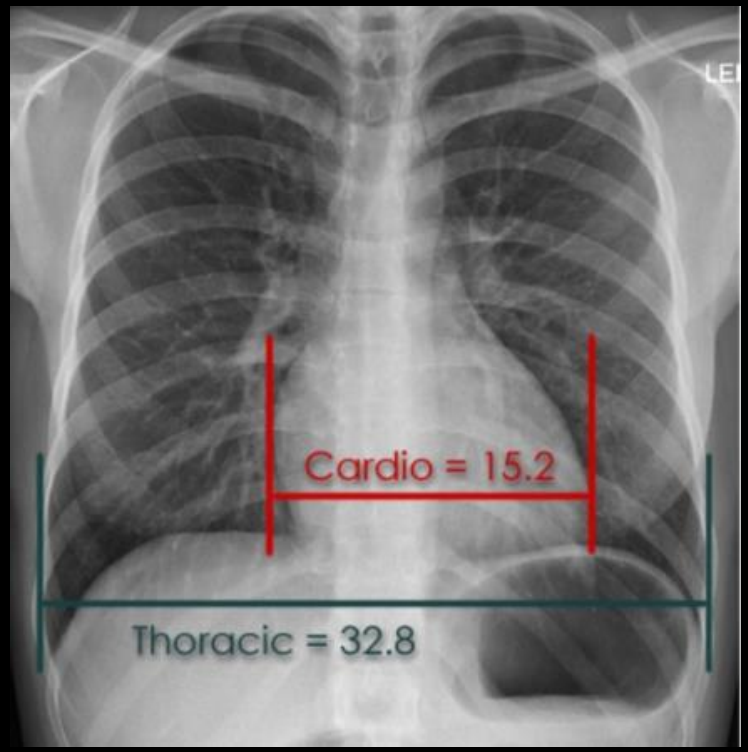


- Contents of the costophrenic (CP) recesses are better seen on lateral where the hemidiaphragm is not obscuring
- The CP angles (CPA) should be sharp. If not ‘something’ is there within or outside the lung abutting



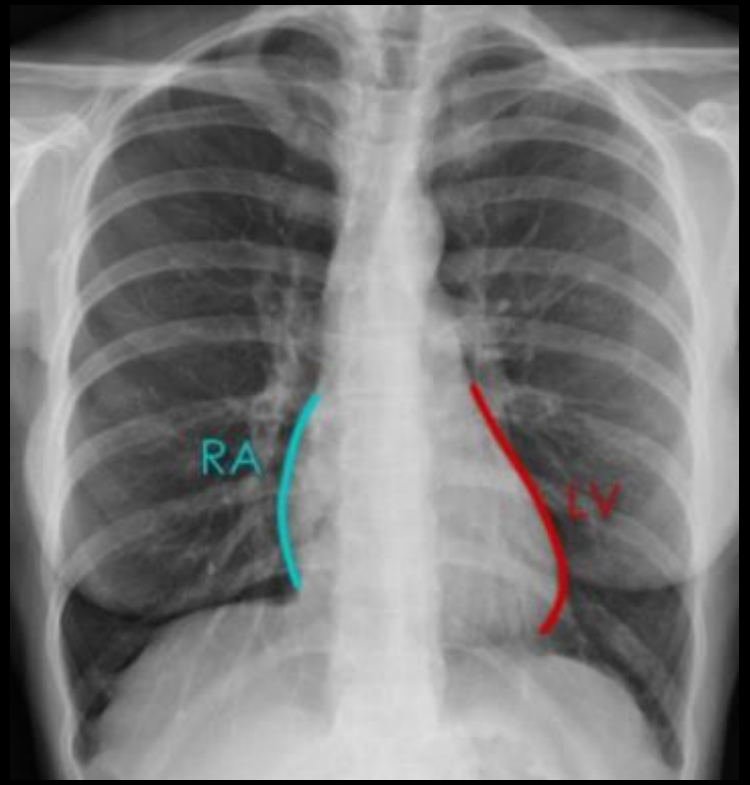
Hemidiaphragms

- Right higher than left
- A lot of lung lives behind medial *cardio*phrenic angle
- Hemidiaphragm goes to spine



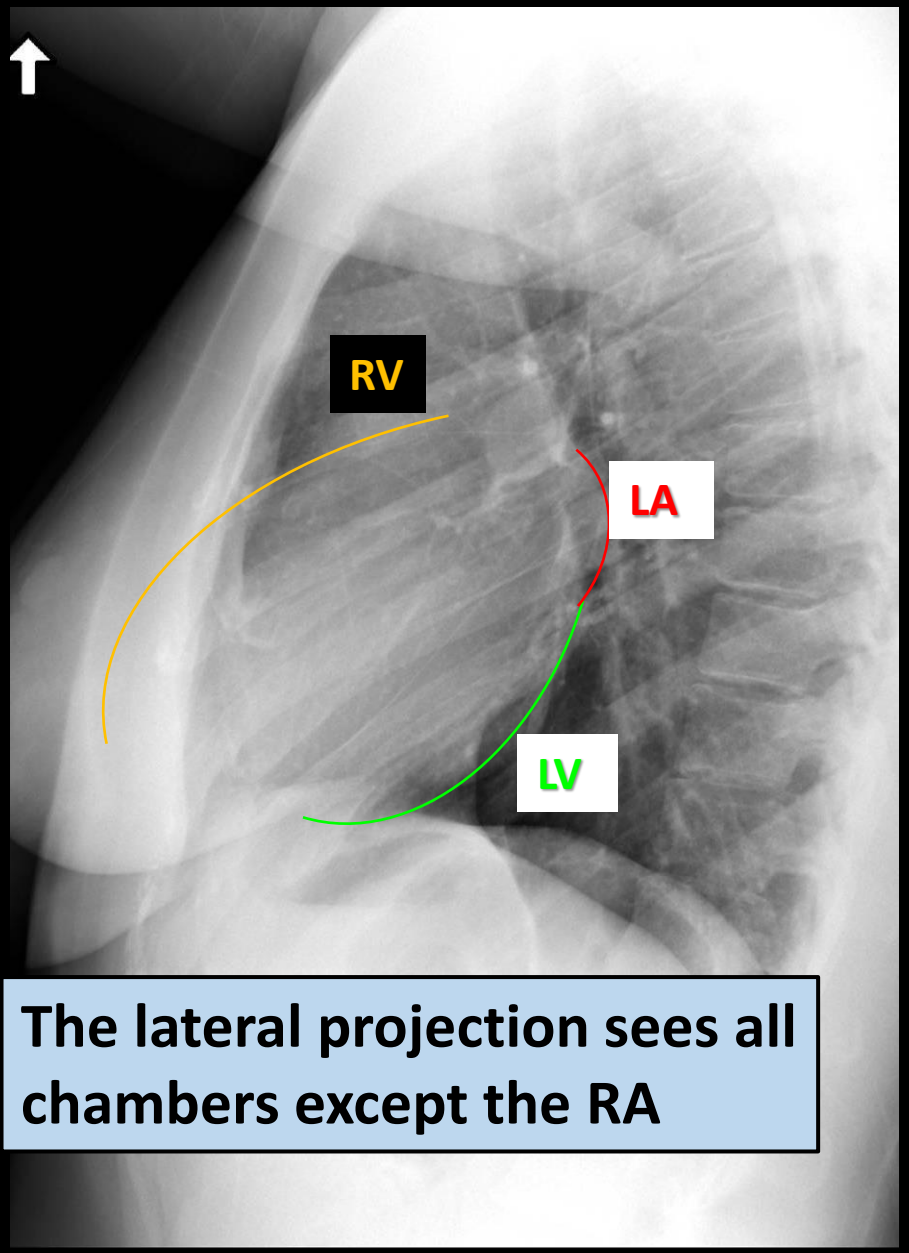
Cardiothoracic ratio (CTR)

- Cardiac size = widest length
- Thoracic width = widest length
- Normal CTR < 0.50 on a PA
  - Sensitivity for rEF = 88%
  - Specificity for rEF = 41%
  - Not useful for HFpEF
- No clear guideline for AP
  - Prior AP may help

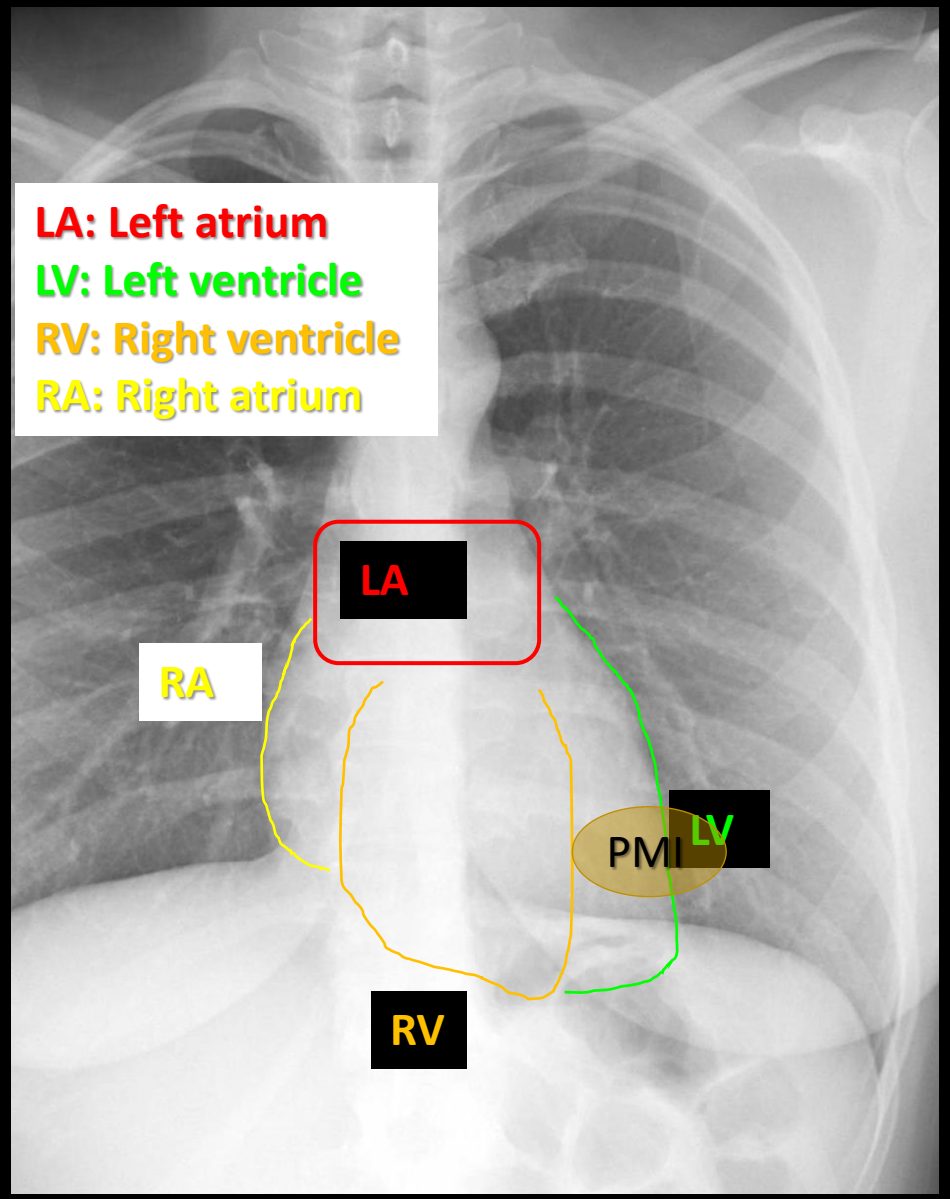


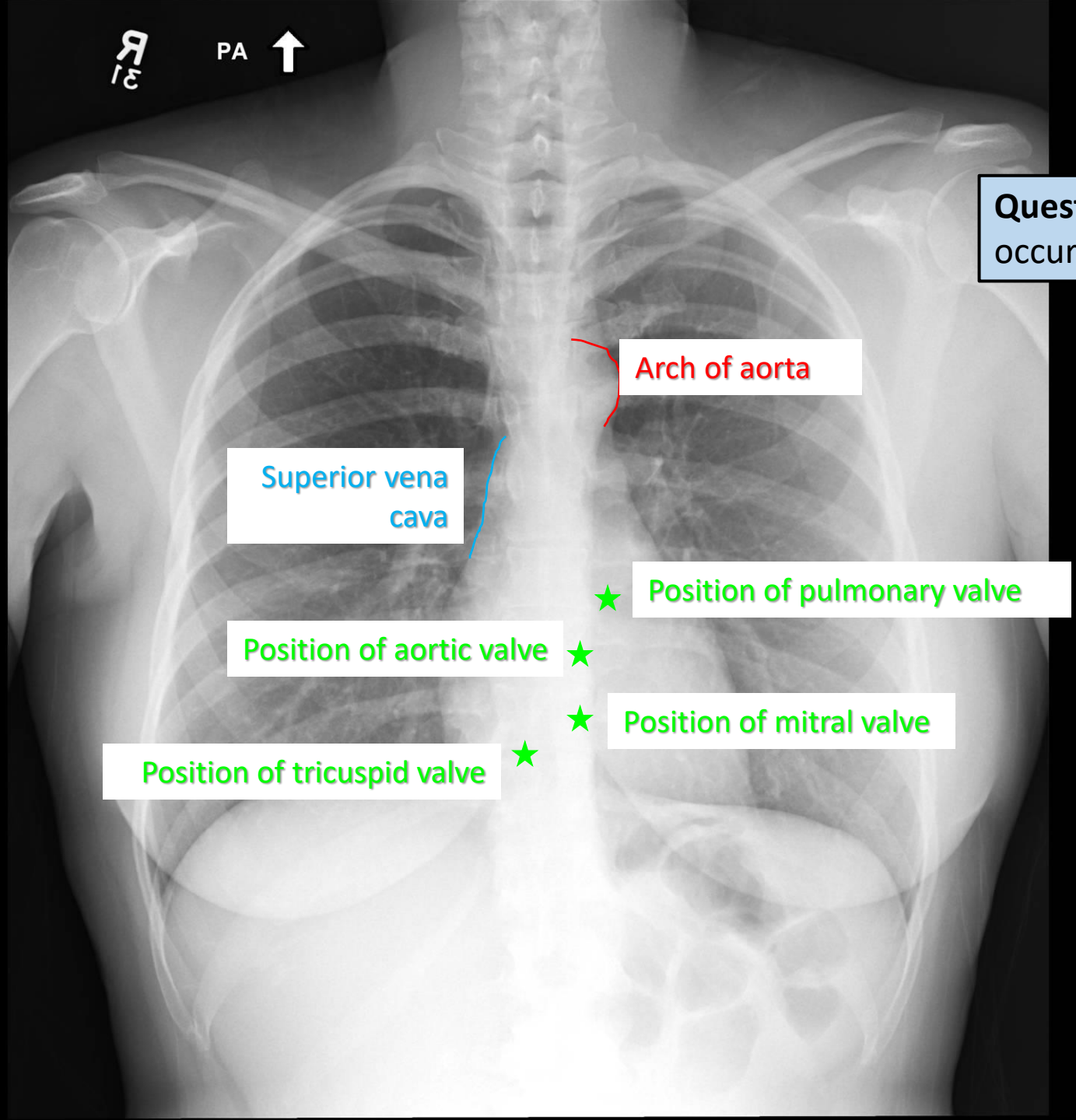
Heart Boarders

- Right heart border = Right Atrium
- Left heart border = Left Ventricle



The lateral projection sees all chambers except the RA

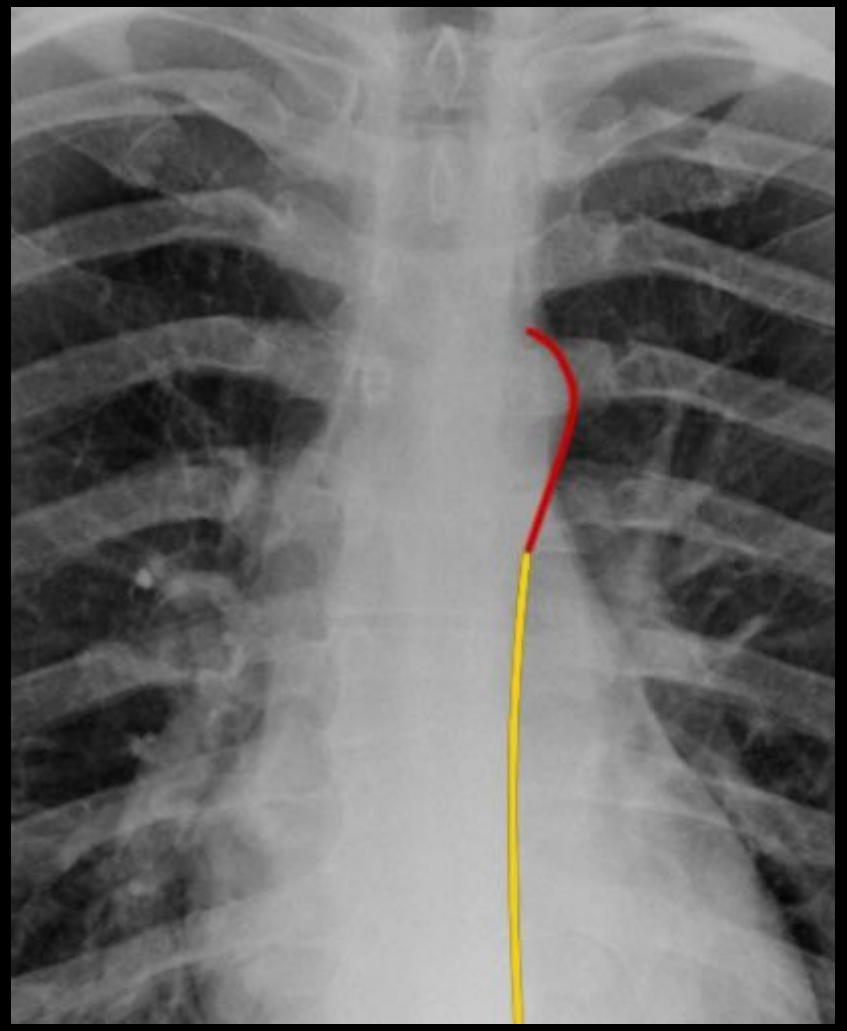




Question: The arch of the aorta occurs at which vertebral level?

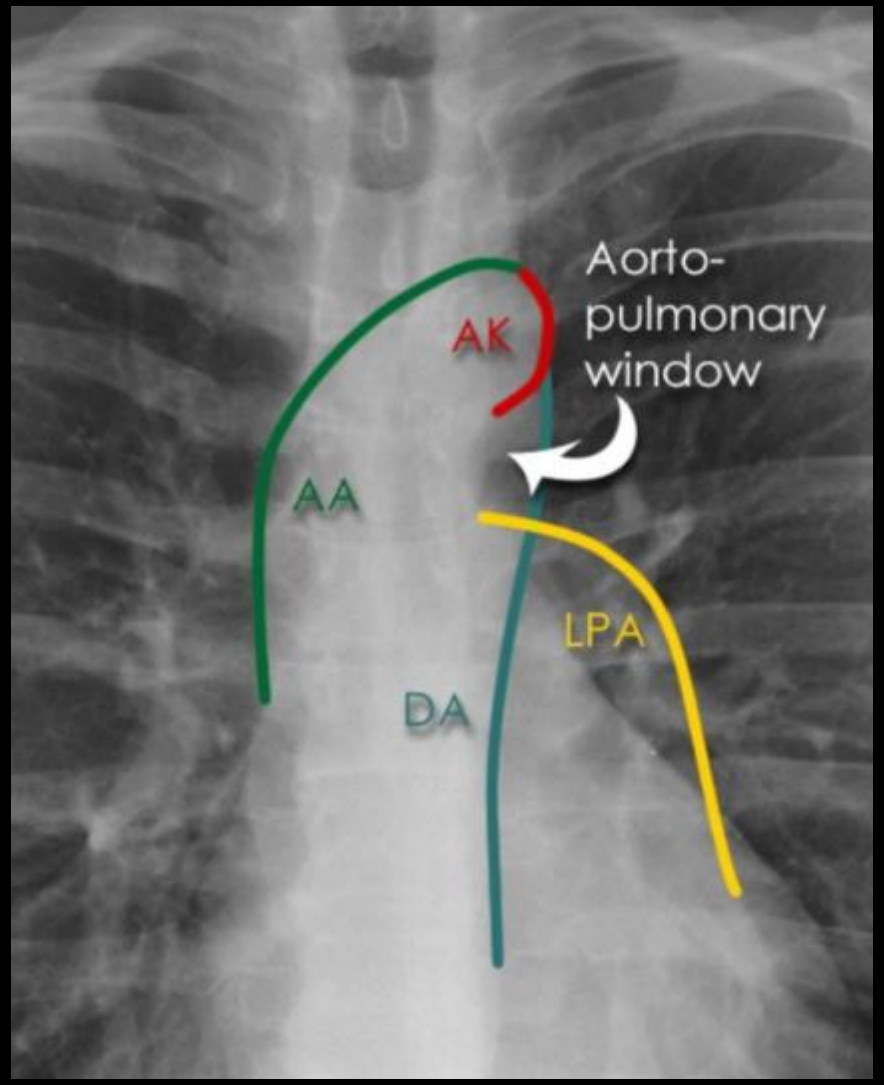
Answer: T4

Bonus: The bifurcation of the trachea (carina) also occurs at this level.



Aortic Arch (red)

- Left lateral aortic edge
- Arched posteriorly over LMB and MPA, LPA
- Descending thoracic aorta posteriorly (yellow)
- Widening or obscuring may convey pathology

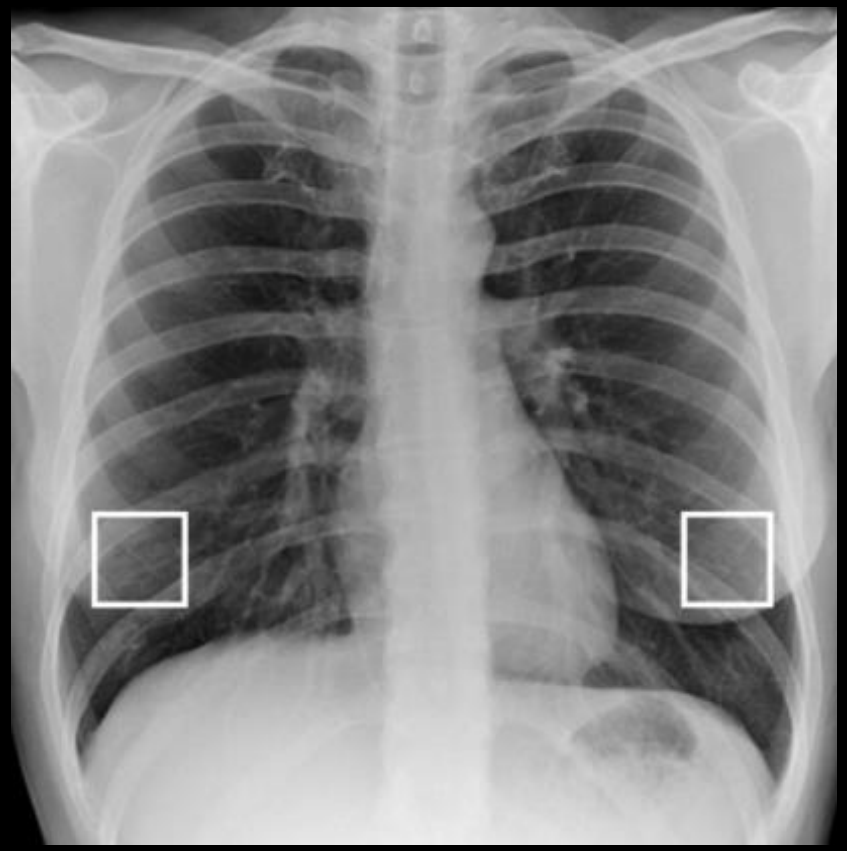


Aorto-pulmonary (AP) window

- Between the aortic arch (AK) and MPA/LPA
- “Filled in” can mean enlarged LN or mass

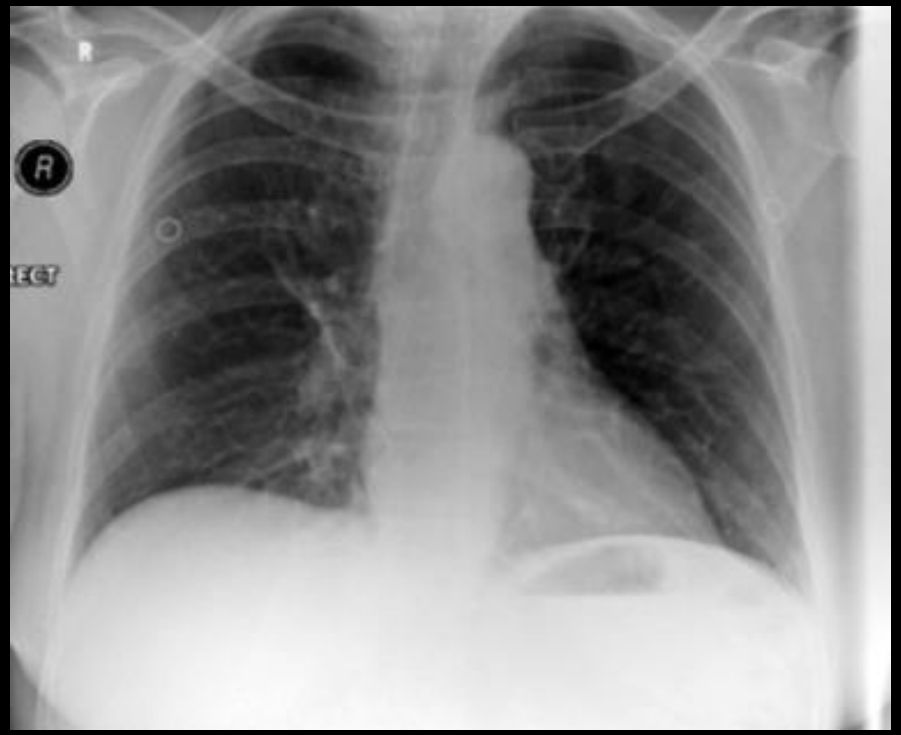
Right para-tracheal stripe

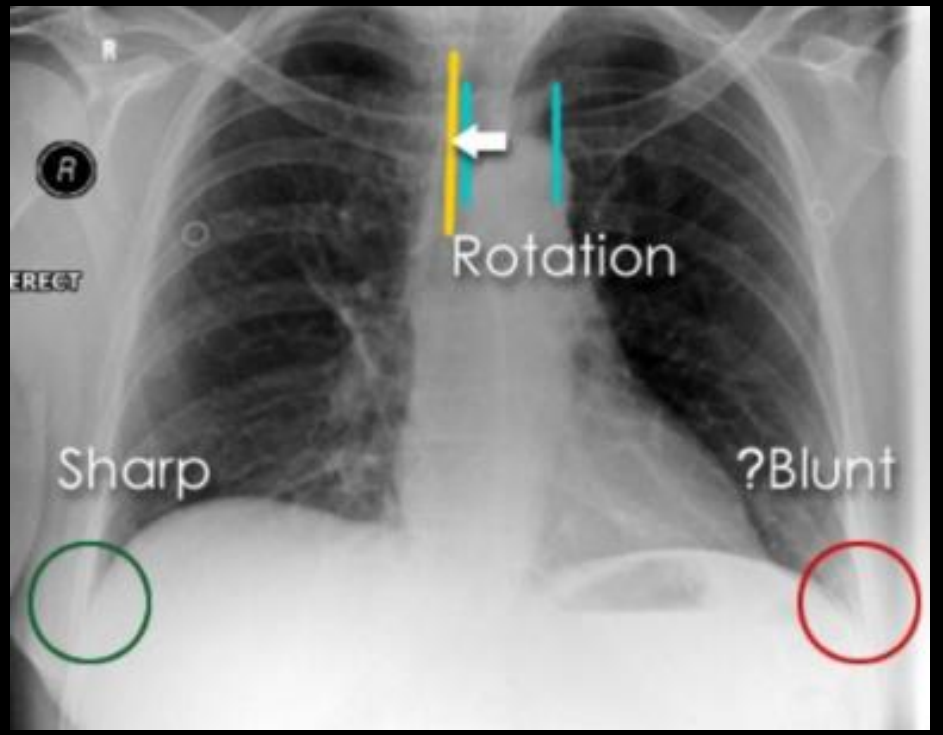
- Clavicles to azygous vein
- Normally thin
  - Right tracheal wall
  - Normal-sized LN
- Azygous vein
  - Plumps up with volume



Breast asymmetry

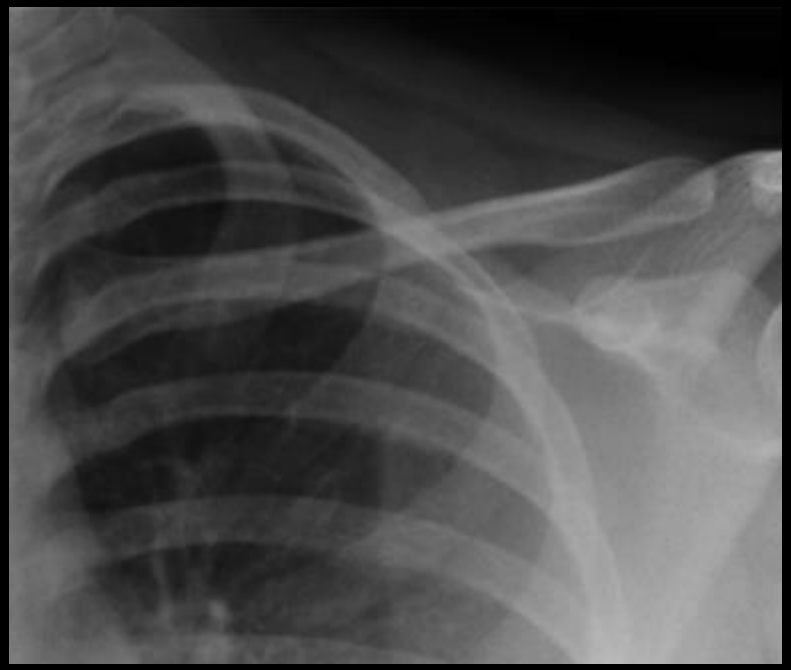
- Example of Not Seeing something
- Densities within the boxes differ
- Asymmetry is common
  - Not necessarily mastectomy

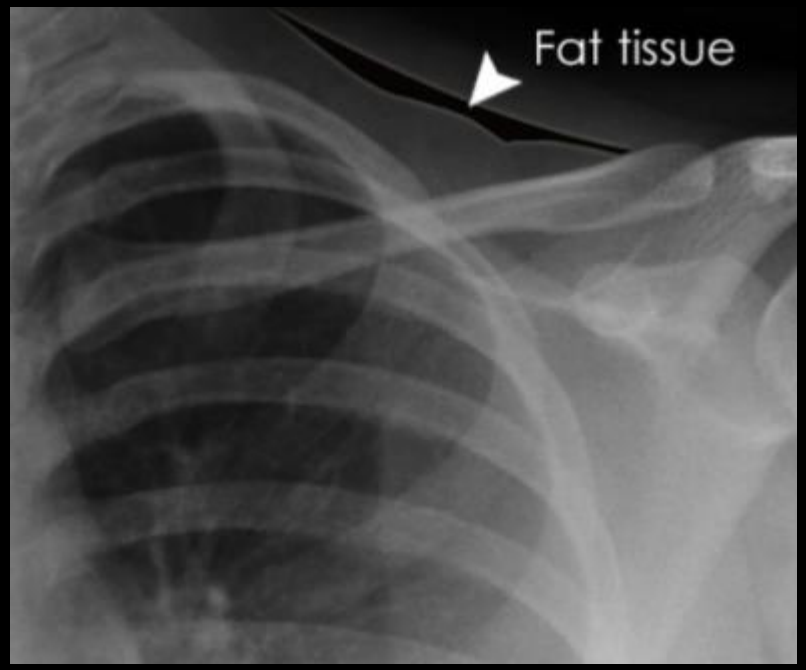




Pseudo-blunting of the CPA

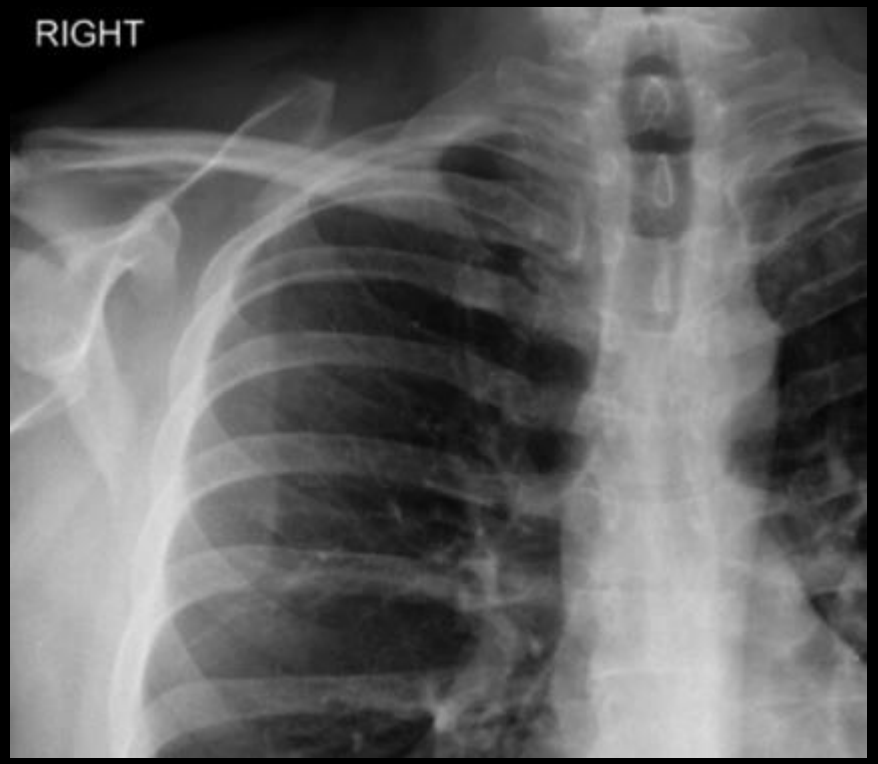
- Rotation results in greater thickness of the breast over the CPA

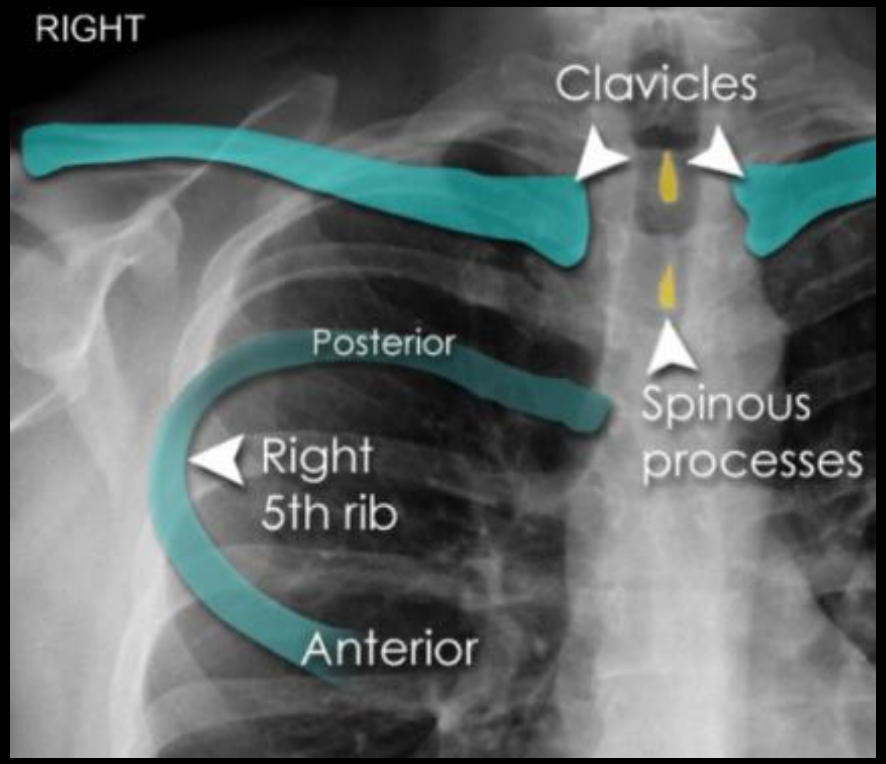




Soft tissue fat

- Normal fat plane between muscle layers
- Fat is less dense than muscle
- Fat is smooth
- Irregular contour may represent pathology





Clavicles, spinous processes and ribs

- Spinous process should line up with the middle of the trachea (rotation)


USE YOUR
WORDS

Thoracic Radiology Terms

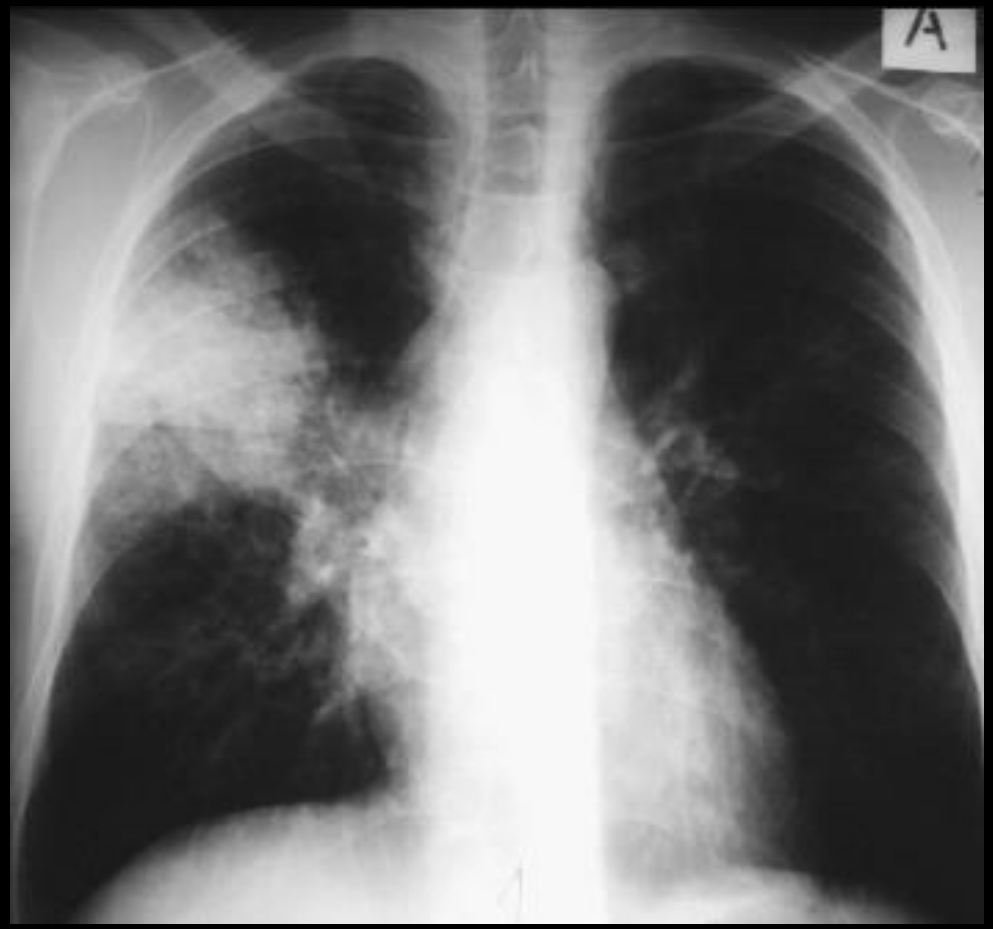
Pattern

- Consolidation
- Air bronchogram
- Ground Glass
- Bronchiectasis
- Nodules/Mass
- ~~Infiltrate~~ “Opacity”

Distribution

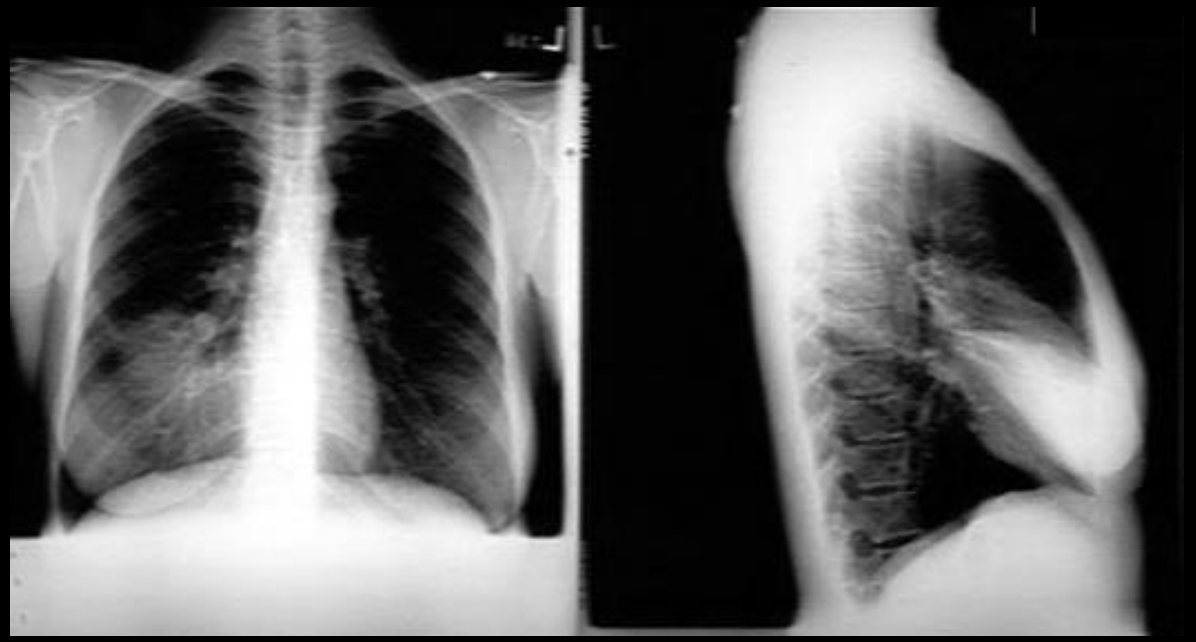
- Upper, mid, lower
- Central/perihilar
- Peripheral
  - Subpleural
- Bronchovascular/Bronchocentric
- Diffuse vs Extensive

Consolidation



- Lobar or segmental density
  - The density should either correspond to a lobe or segment of lung
  - Cannot see pulmonary vessels
- Air bronchogram
  - Suggests alveolar process
- No loss of lung volume
  - Consolidation = alveolar **filling**
  - Atelectasis = alveoli **deflating**

Consolidation – RML. Value of the lateral



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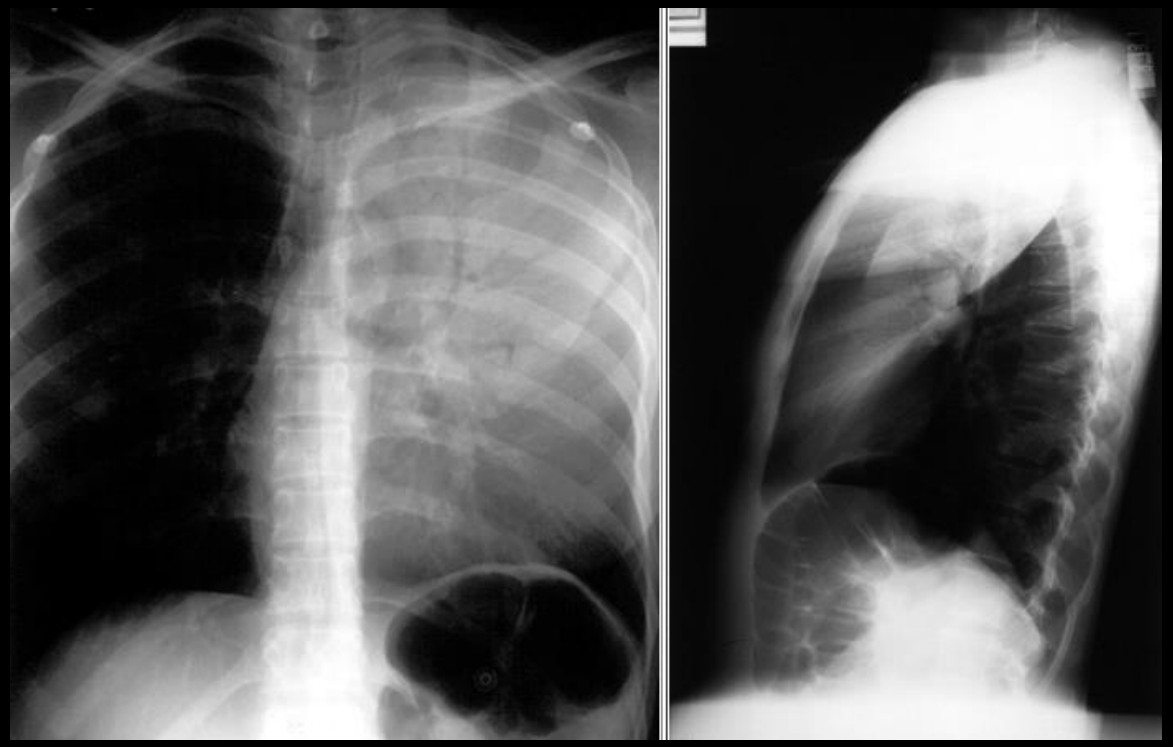
Consolidation – LUL. Value of the lateral



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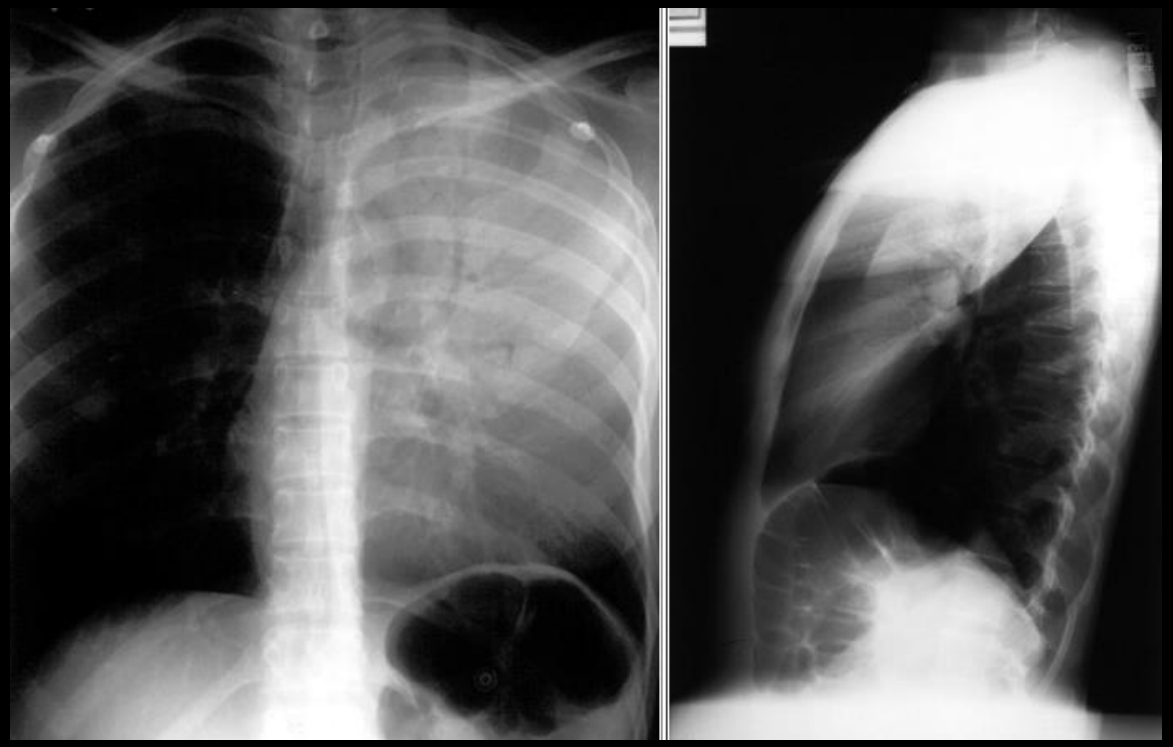
Consolidation – Acute. Differential Diagnosis

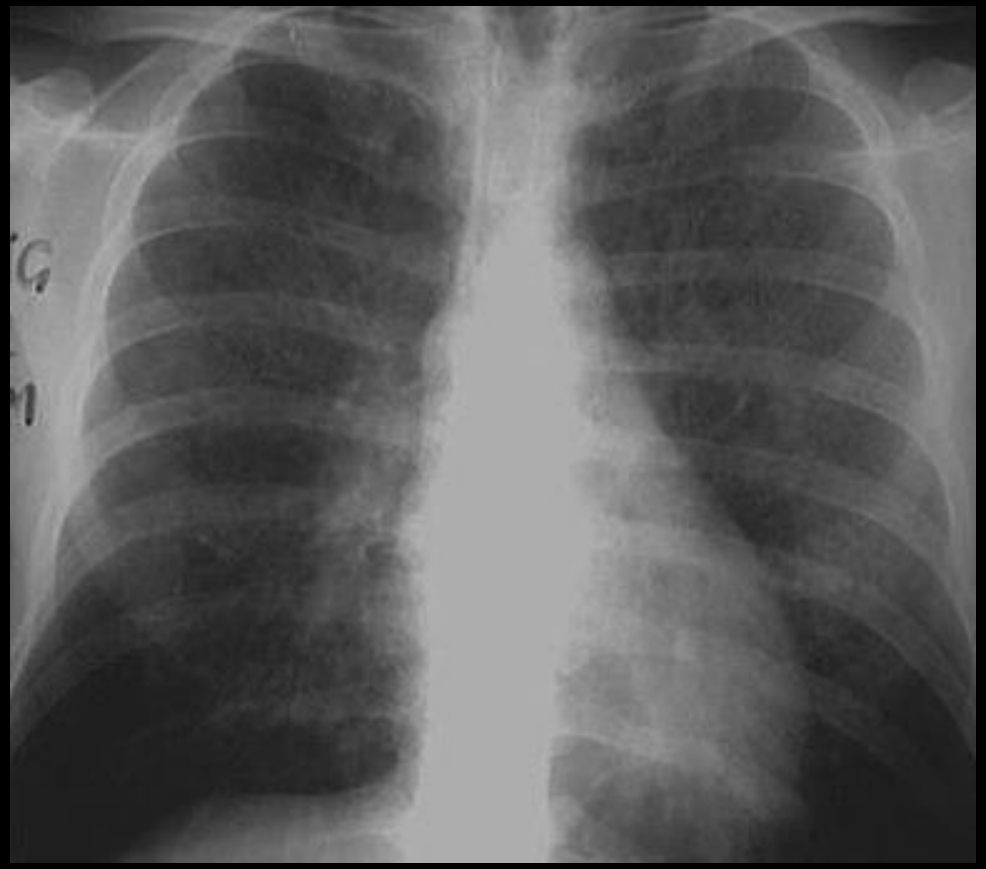


- Causes
  - Blood - uncommon
    - Hemorrhage (rare outside of trauma)
  - Pus – very common
    - Asymmetric or symmetric
    - Pneumonia
  - Water – very common
    - Likely symmetric
    - Cardiogenic edema
    - Non-Cardiogenic edema (ARDS)
  - Cells – very uncommon
    - Drug toxicity
    - Uncommon ILD’s

Ground glass

- Hazy increased lung opacity
- Margins of pulmonary vessels are hazy, but can be seen
- Can be subtle
- Often occurs with consolidation
  - On the spectrum?
  - Pneumonia, diffuse
    - Viral
    - Immunocompromised - PJP
- Similar causes as consolidation
  - “Early stages of consolidation”
  - “Resolution of consolidation”

Ground glass



- Hazy increased lung opacity
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- Can be subtle
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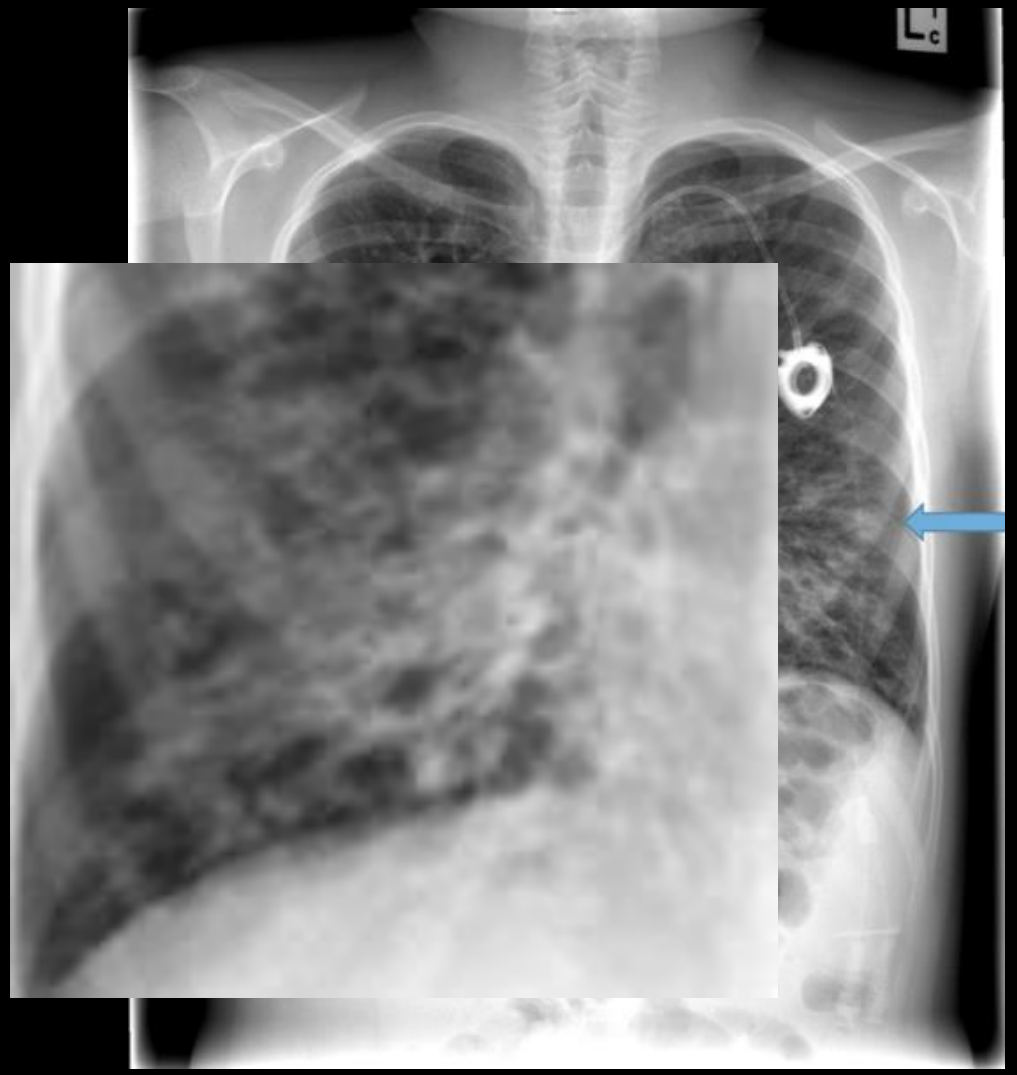
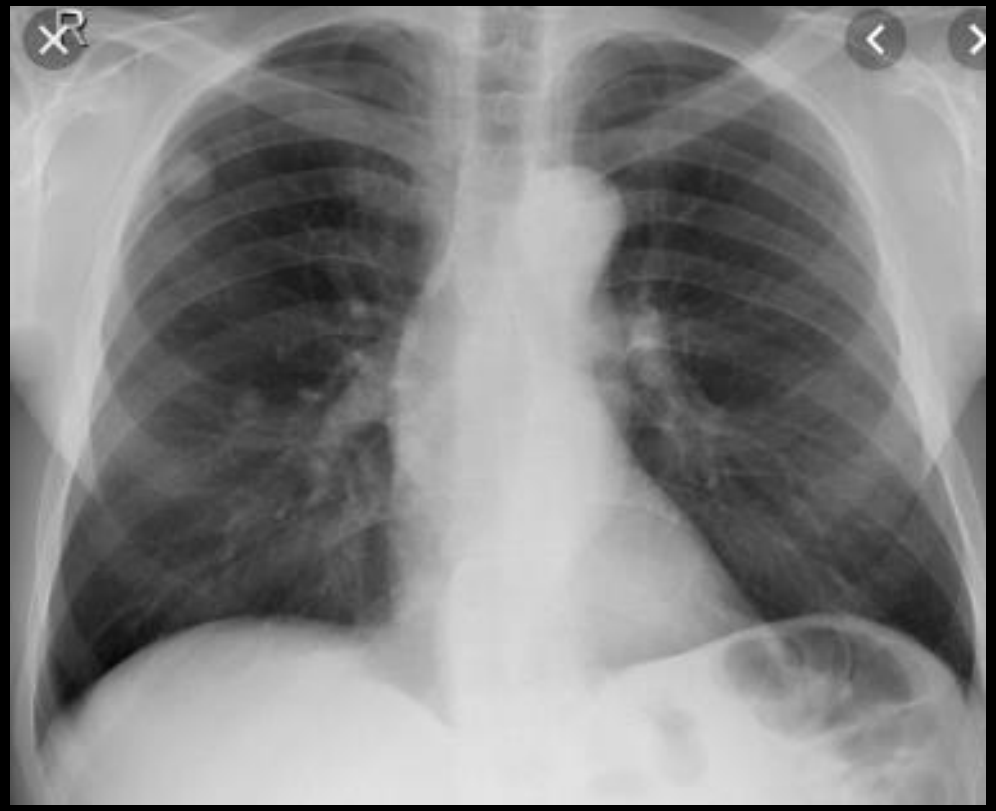
Bronchiectasis



- Dilation of bronchioles
  - Thickened bronchial walls
- Causes
  - Inflammation of the airways (purulent)
    - Immune deficiency?
    - Cystic fibrosis
  - Associated with fibrosis (non-purulent)
    - Traction bronchiectasis

Nodules/Mass



- Round discreet entities
  - Nodule < 3 cm. Really common!
  - Mass 3+ cm. Usually cancer
- Solitary pulmonary nodule
  - Lung cancer
    - Irregular borders
  - Granuloma
  - Hamartoma
  - Infection

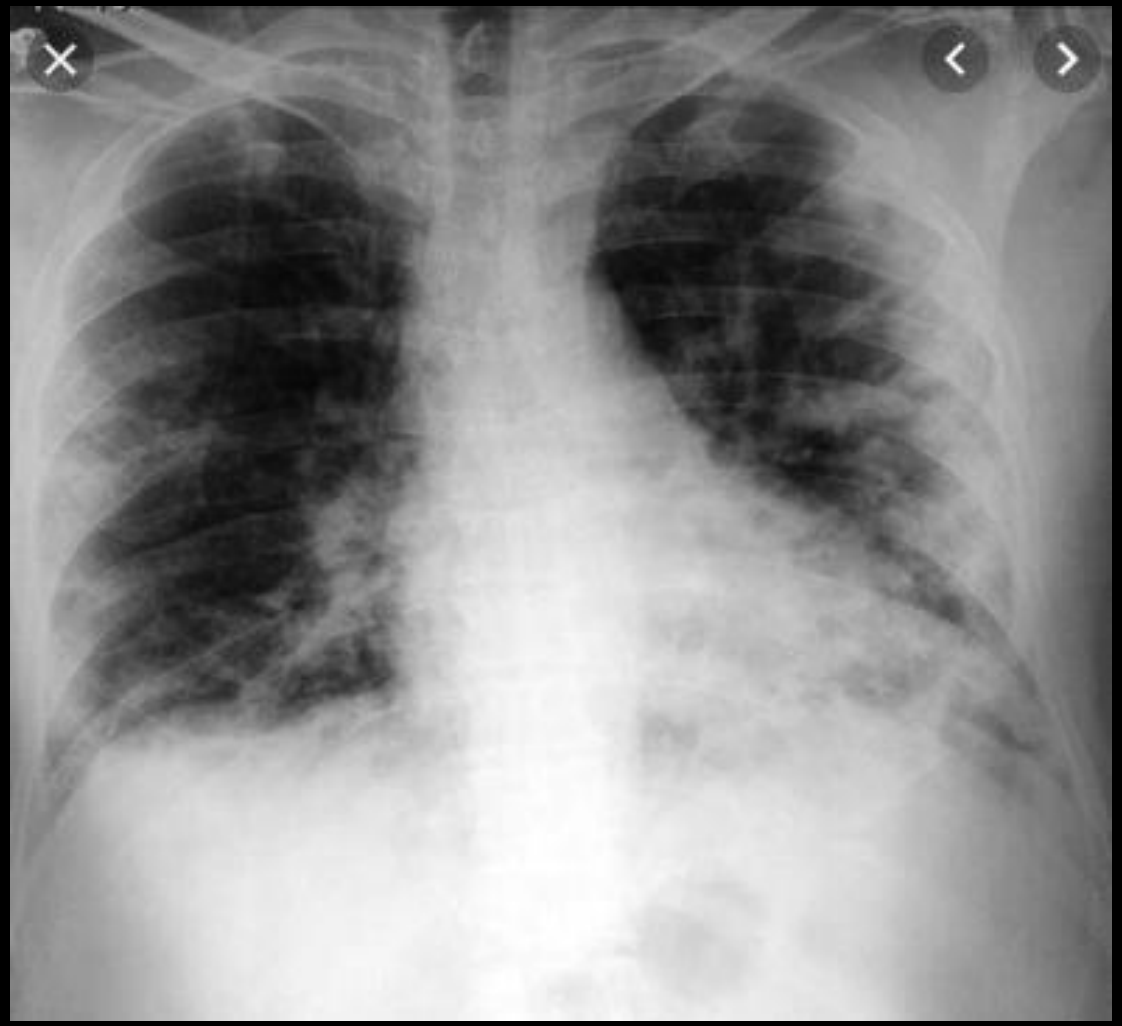
Nodules/Mass

- Round discreet entities
  - Nodule < 3 cm. Really common!
  - Mass 3+ cm. Usually cancer
- Multiple nodules
  - Metastases
    - Smooth, well-circumscribed
  - Opportunistic infection
    - Borders less smooth
    - Fungal
    - Mycobacterial

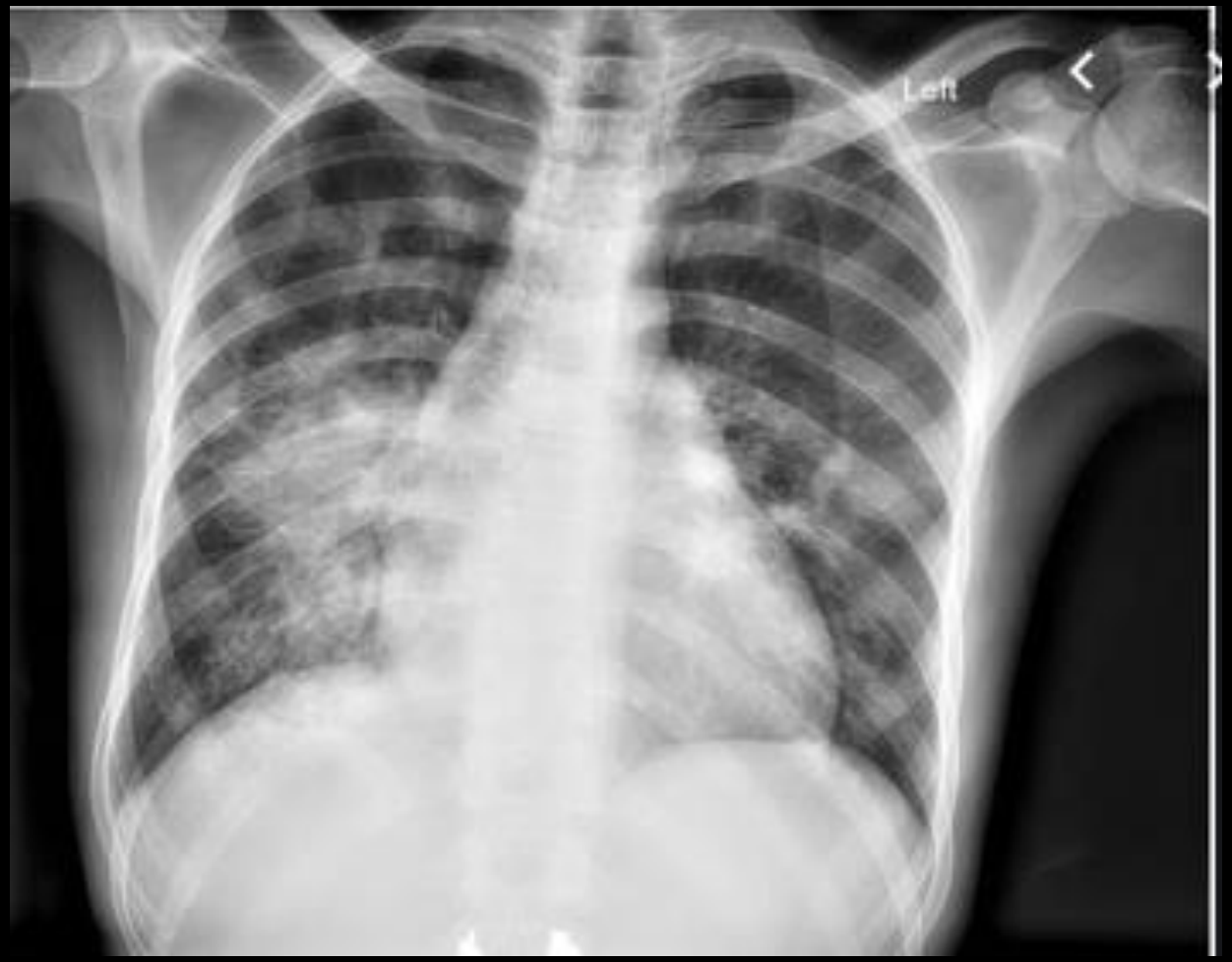
Distribution

Peri-hilar

Peripheral

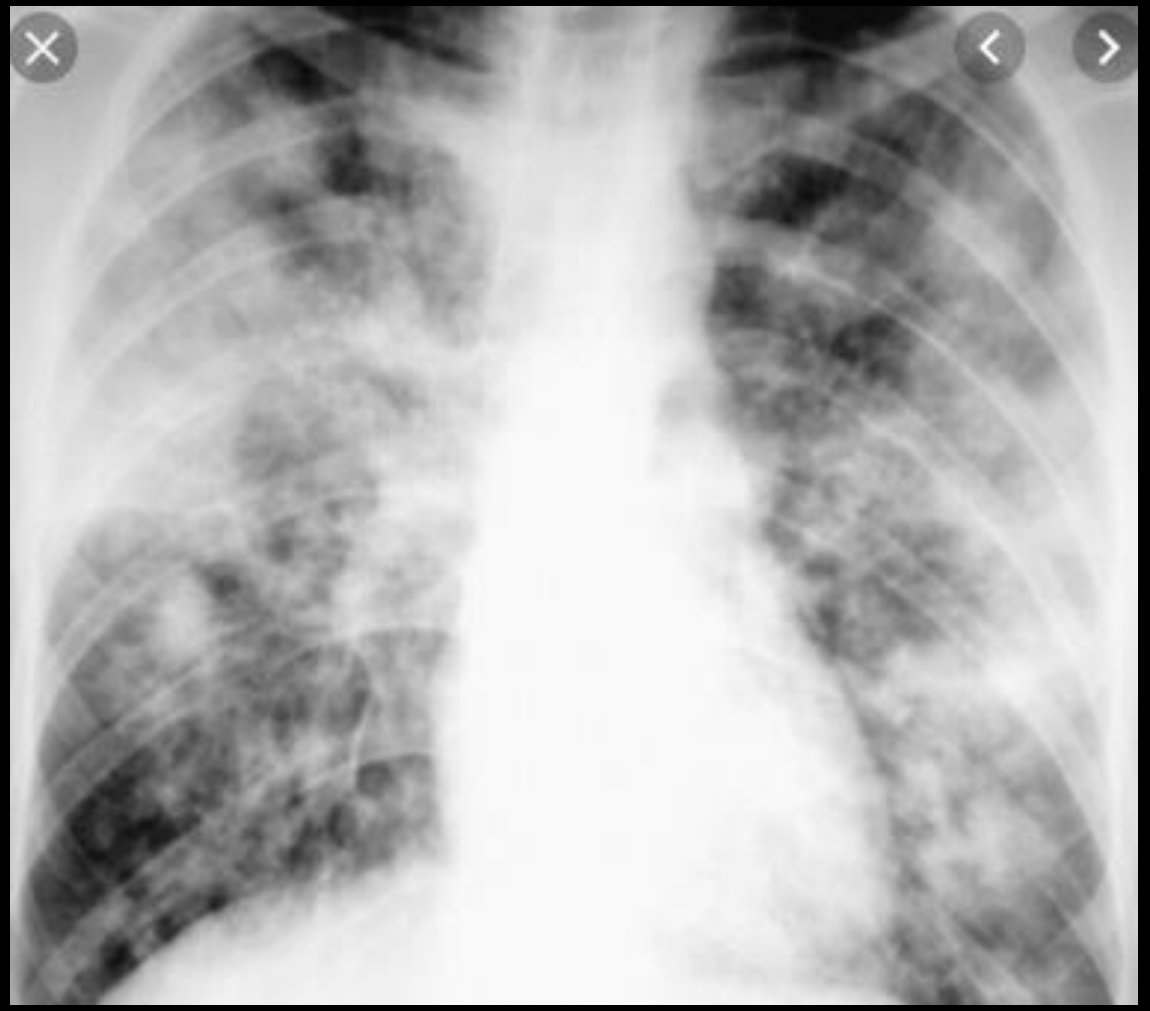


Bronchovascular/Bronchocentric



Diffuse

Extensive



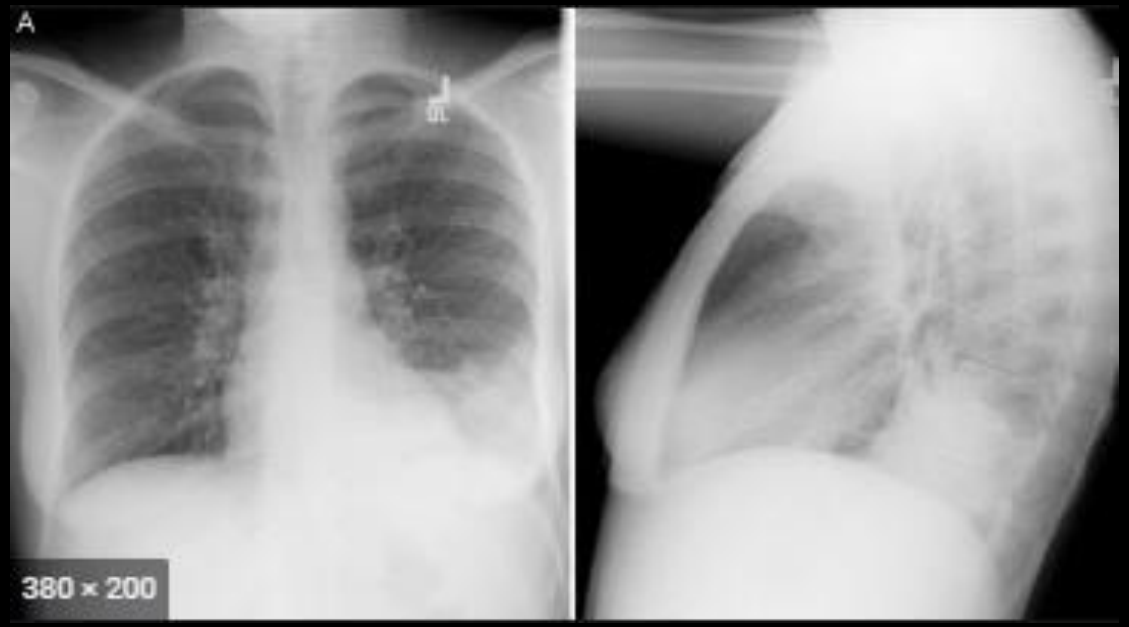
Silhouette Sign

- Things of similar density are indistinguishable when abutting one another
- Left heart border obscured by pleural effusion
  - Fluid density ~ soft tissue density
  - Fluid abuts heart
- Abutting structure can help with location of the abnormality

Silhouette Sign – Where's Waldo?

- AP/PA view
  - Heart
    - Right heart border RML
    - Left heart boarder Lingula
  - Clavicles/Sternum – Anterior portions of chest wall and pleura
  - Right paratracheal stripe- RUL
  - Aortic arch – LUL
  - Left hemidiaphragm/descending aorta – LLL

Silhouette Sign – Where's Waldo?



- Lateral view
  - Posterior heart border/posterior left hemidiaphragm – LLL
  - Anterior right hemidiaphragm- RML
  - Posterior right hemidiaphragm- RLL

Silhouette Sign

- What is silhouetted?
- Where is the abnormality?

Cases

Nodule

- A 59 year old female smoker complains of cough x 3 months. There is occasional clear phlegm.
- 32 pack year smoker
- Works cleaning homes
- No significant family history
- Physical exam is unremarkable
- CXR reveals a left upper lung nodule

Nodule

- What is the next best step in evaluation
  - A. Chest CT with contrast to characterize the nodule and lymph nodes
  - B. Surgical consultation for removal
  - C. CT-guided needle biopsy
  - D. Obtain prior chest imaging for comparison

Old imaging is your best friend!

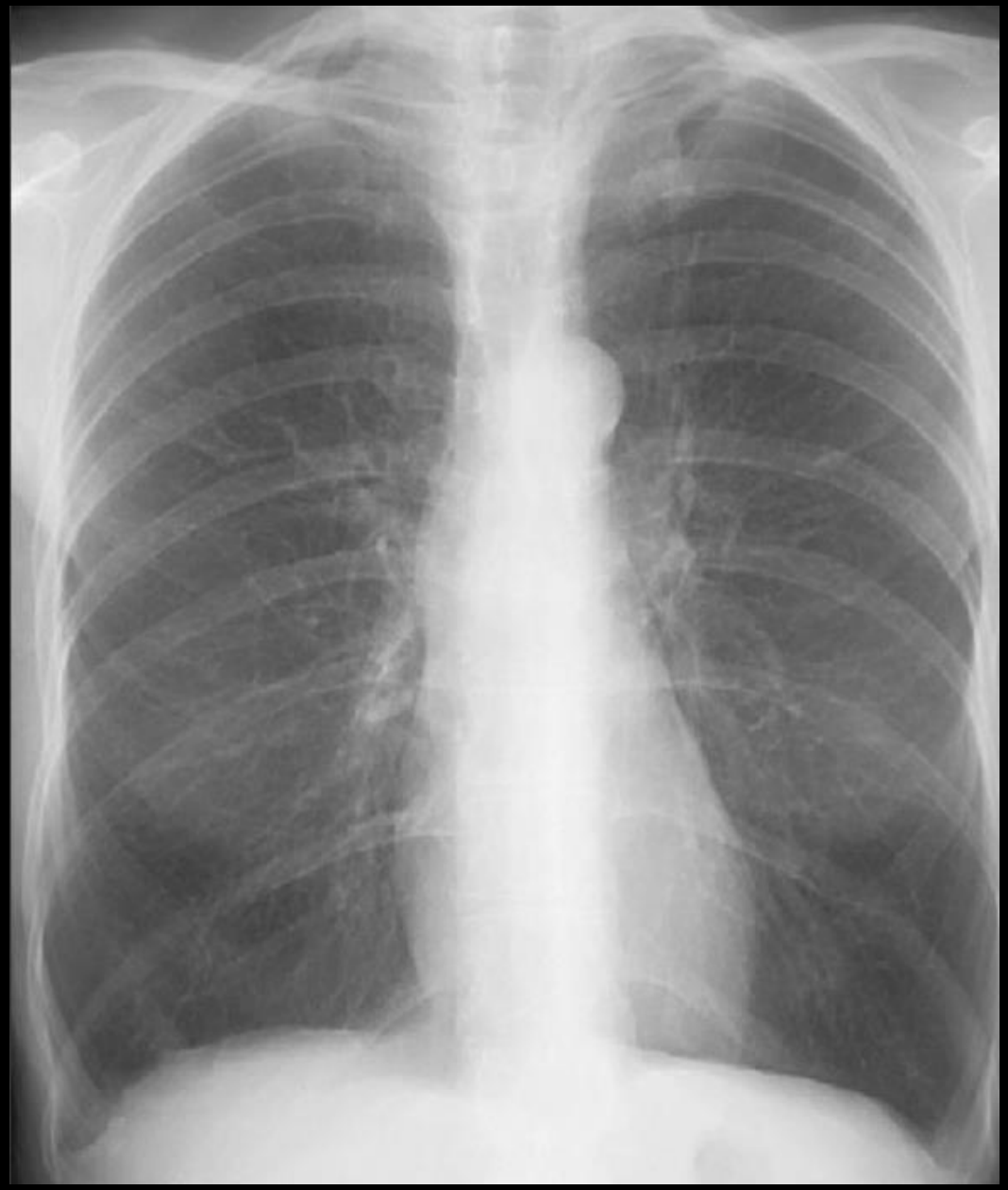
- New versus old
- Stable versus growing
- It’s worth the effort
  - Save unnecessary referrals and procedures
- Patient had nodule on CXR 3 years prior; unchanged

Chronic SOB

- 68 year old gentleman with chronic SOB
  - Dyspnea x 5 years
  - Worsening and now notices when going to the mailbox at the end of the driveway
  - He has occasional mild sputum production and wheezing
  - 45 pack year smoker; down to ½ PPD
  - Exam reveals a thin man, faint breath sounds; no wheezing
  - You order spirometry which reveals
    - FVC 3.00 L, FEV_1 1.80 L; $FEV_1/FVC = 0.60$
  - CXR demonstrates the following

Chronic SOB

- Hyperinflated lungs
  - Visualize 11 posterior ribs
- Flattened hemidiaphragms

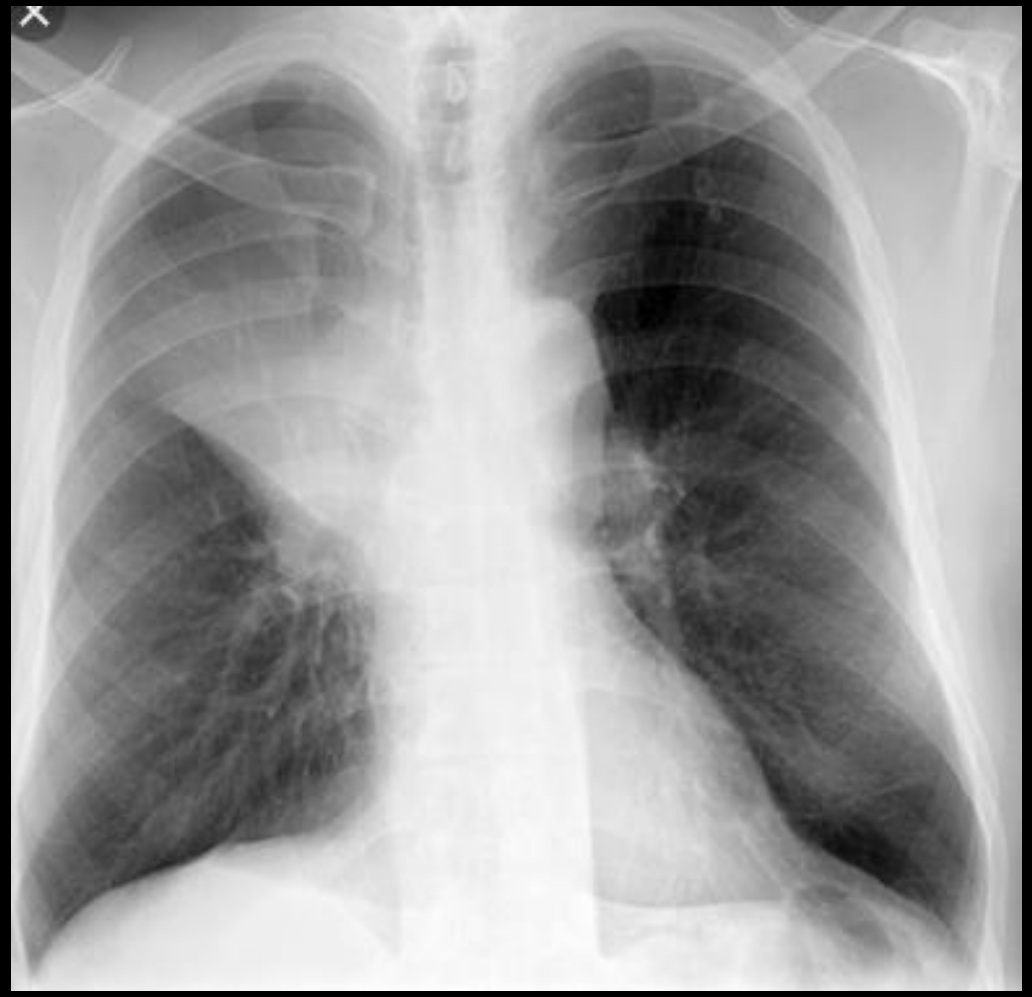


Chronic SOB

- Hyperinflated lungs
  - Visualize 11 posterior ribs
- Flattened hemidiaphragms
- Enlarged retrosternal space
- Clinical, spirometry and radiology findings consistent with:
  - COPD

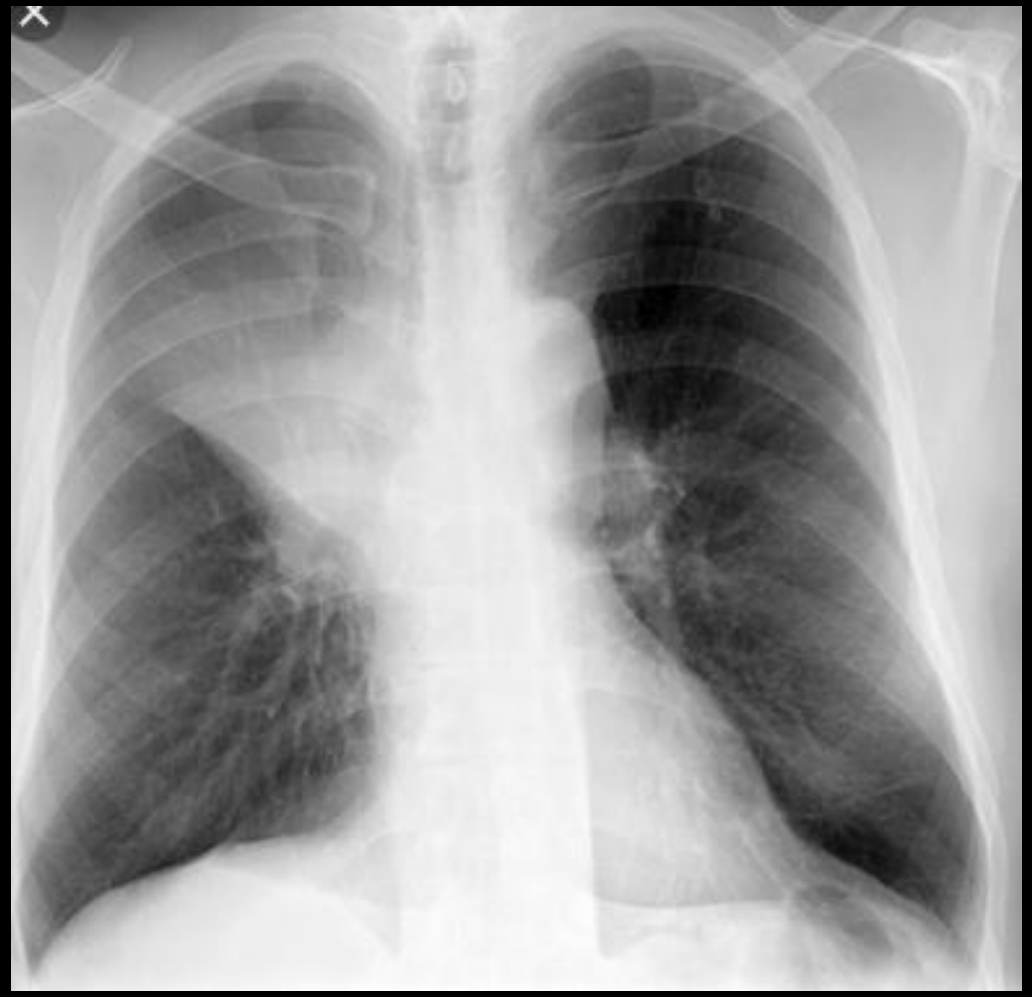
Acute SOB

- 65 year old man comes in with acute SOB
  - No fever or sweats. No viral URI symptoms
  - Chronic cough with intermittent sputum production. Not changed
  - No wheezing
  - No edema
  - PMH – HTN, Diastolic dysfunction, COPD.
  - SH – Smokes 1 PPD



How I would describe the film…

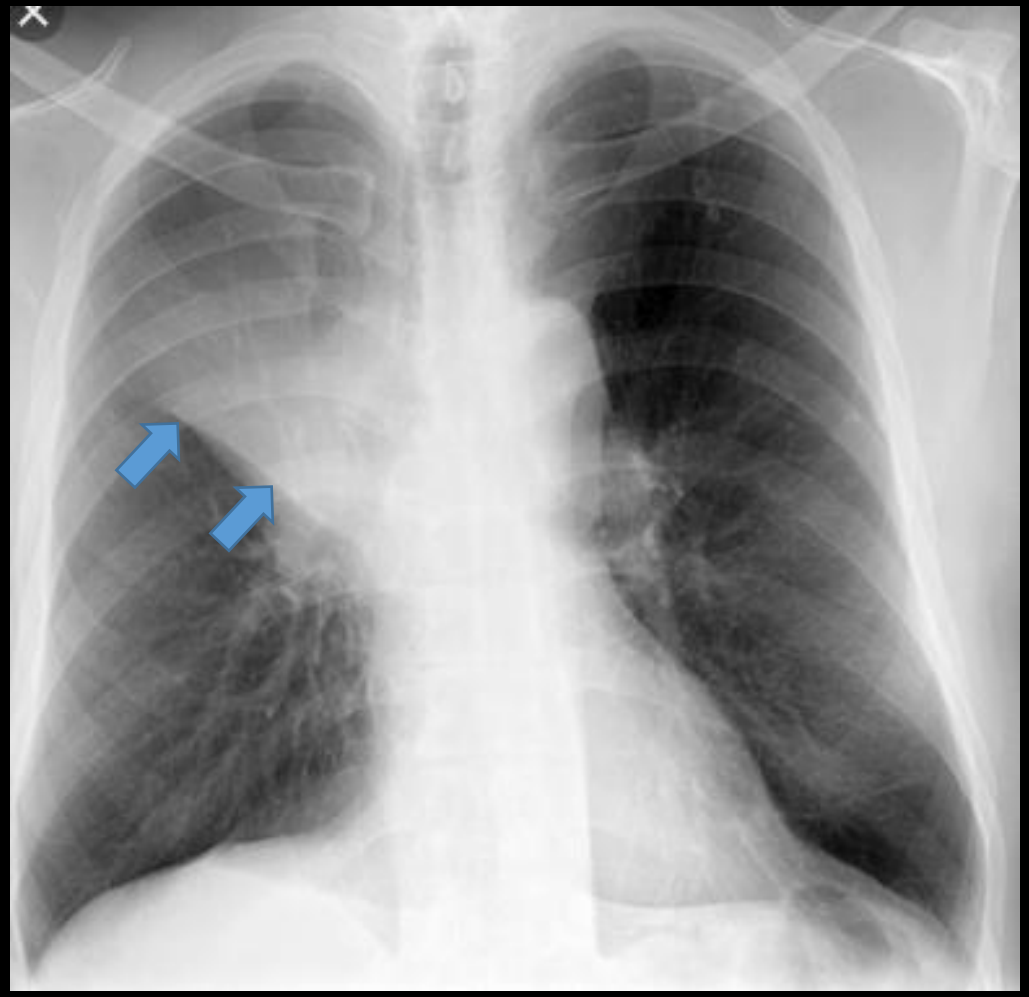
- Pattern
  - Consolidation
    - Fades into ground glass
    - Very linear on one side!
- Distribution
  - Right upper part of the chest
  - Originates from hilum
- Silhouette sign
  - I can’t see some of right hilar structures



Next steps

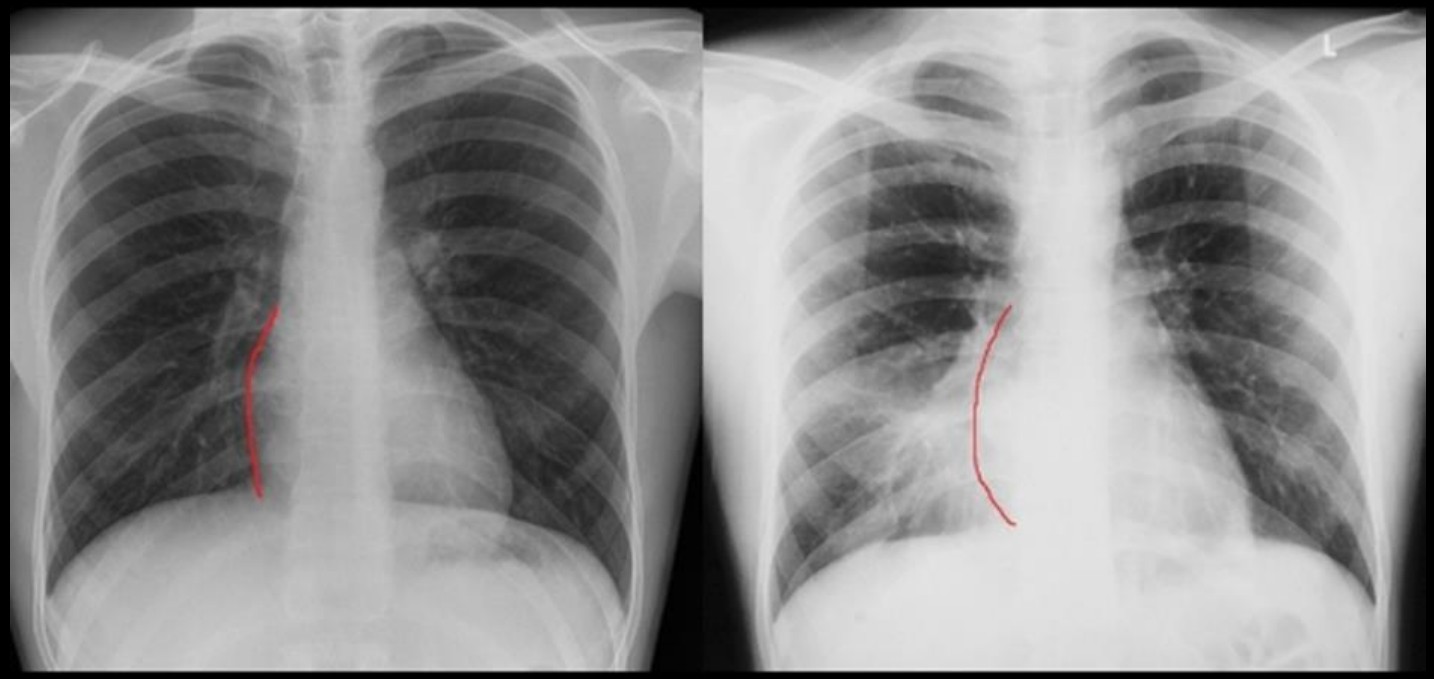
- Which of the following is the appropriate?
- A. Start ceftriaxone and azithromycin
- B. Obtain non-contrast chest CT
- C. Obtain chest CT angiography to assess for PE
- D. Initiate Lasix
- E. Obtain LE dopplers

RUL Atelectasis – RUL mass obstructing RUL bronchus



- Atelectasis
  - Collapse or incomplete expansion of the lung or part of the lung
  - The lung affected will be *more* dense (loss of air)
  - The lung itself will be smaller
    - Loss of air = loss of lung volume
  - Signs of volume loss
    - Fissures pulled
      - Minor fissure in this case
    - Diaphragm pulled up
    - Mediastinal structures shifted toward
  - Answer – non-contrast CT scan

RUL Atelectasis – RML mass obstructing RML bronchus



- Atelectasis
  - Can be subtle
  - RML atelectasis
    - Obscuring right heart border
    - RML bronchus mass noted
  - Lobar atelectasis (larger area)
    - Mucus plug; mass
  - Smaller areas of lung
    - More likely benign

Case

- 72 year old man c/o SOB and increasing LE edema x 1 week
  - Known CHF
  - 10 pound weight gain x 2 weeks
  - Mild wheeze
  - Sleeping with 3 pillows; baseline is 1-2 pillows

Case

- Pattern
  - Ground glass and consolidation
- Distribution
  - Diffuse
- Other findings
  - Enlarged cardiac silhouette
  - Hemidiaphragms silhouetted
  - Costo- and cardiophrenic angles blunted

Case

- Pattern
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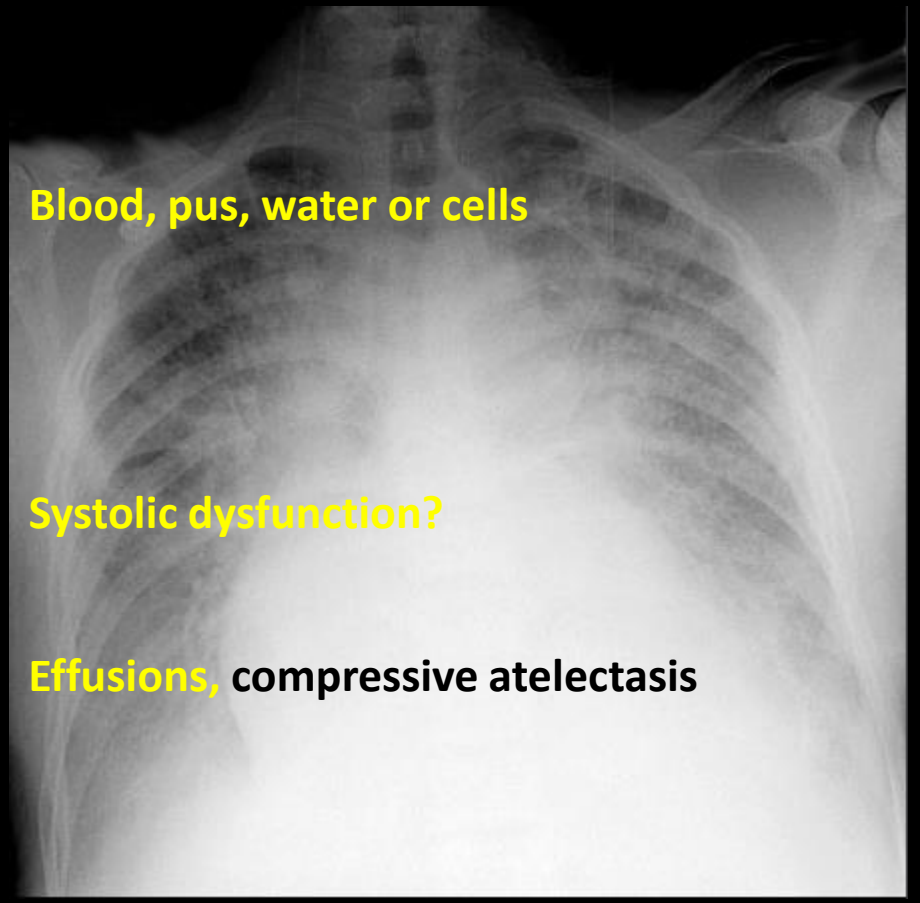
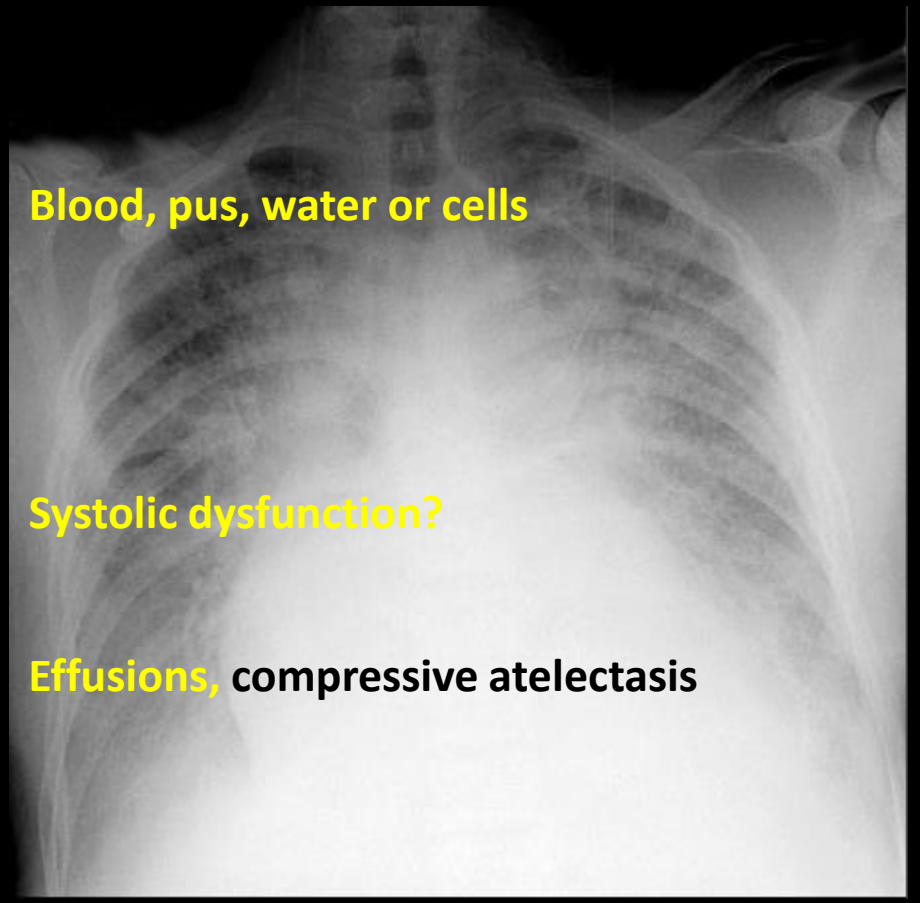
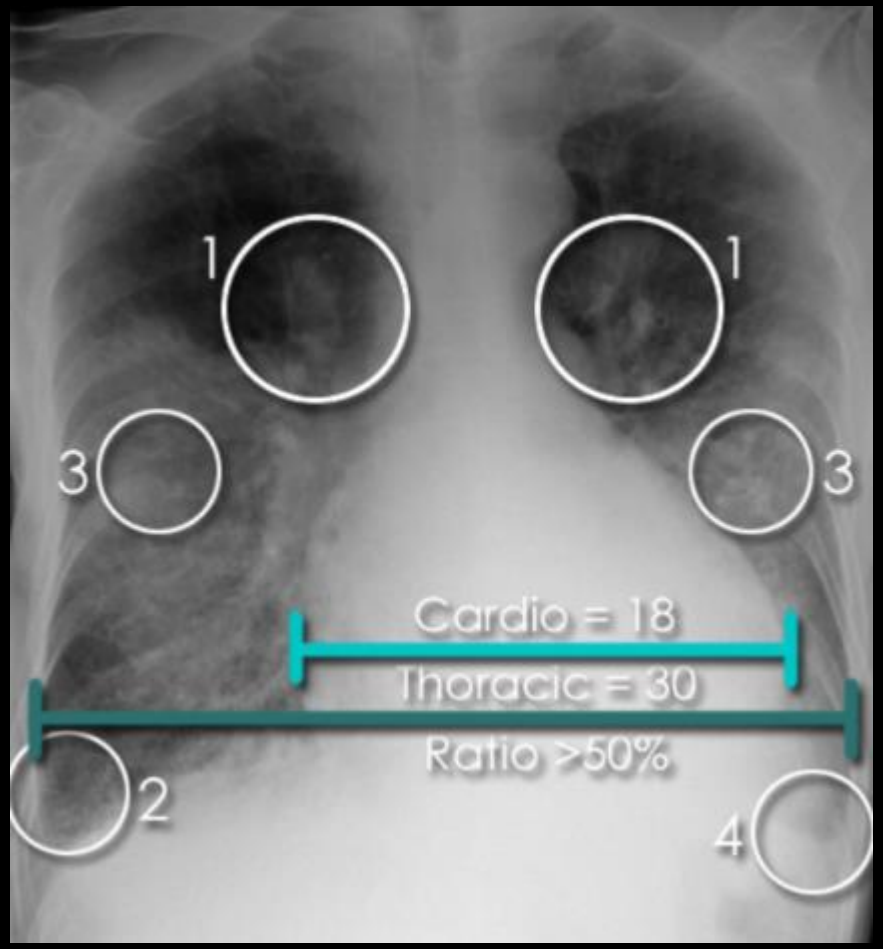


Case – Congestive Heart Failure

- Pattern
  - Ground glass and consolidation
- Distribution
  - Diffuse
- Other findings
  - Enlarged cardiac silhouette
  - Hemidiaphragms silhouetted
  - Costo- and cardiophrenic angles blunted

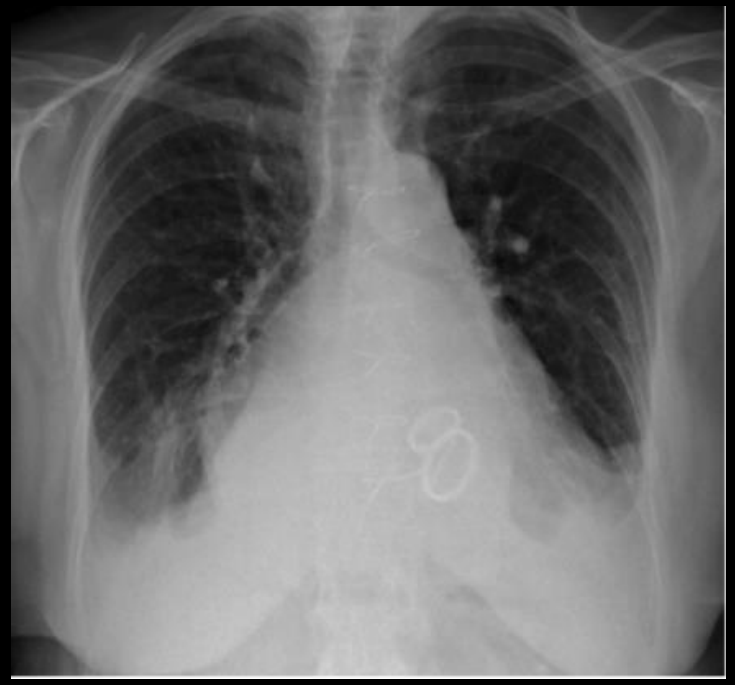


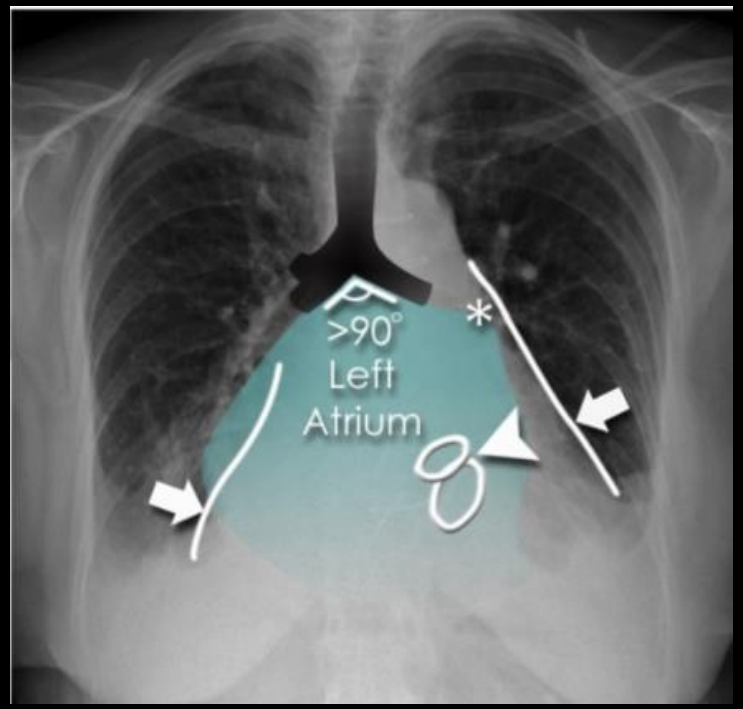
Congestive heart failure



- Cardiomegaly
- 1. Upper vessel enlargement = pulmonary venous hypertension
- 2. Septal lines (Kerley B)
- 3. Consolidation = edema
- 4. Blunting costophrenic angles = effusions +/- some atelectasis

Other heart stuff…



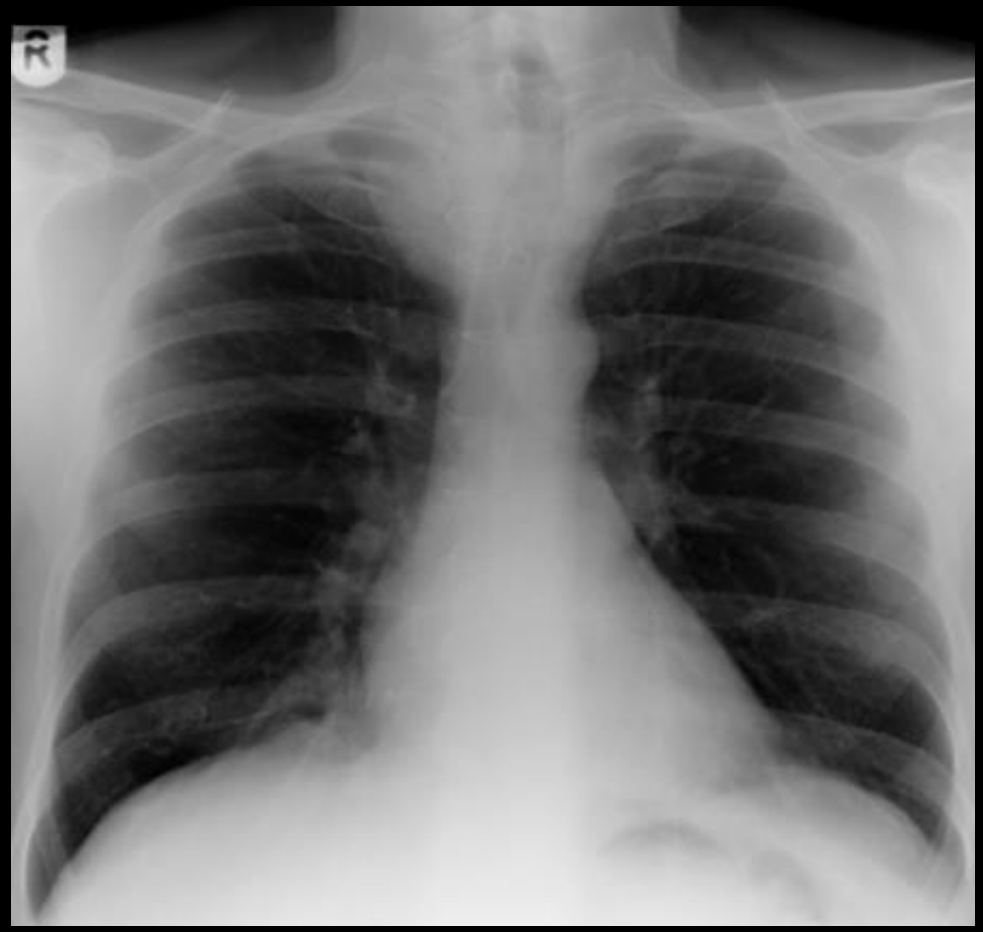


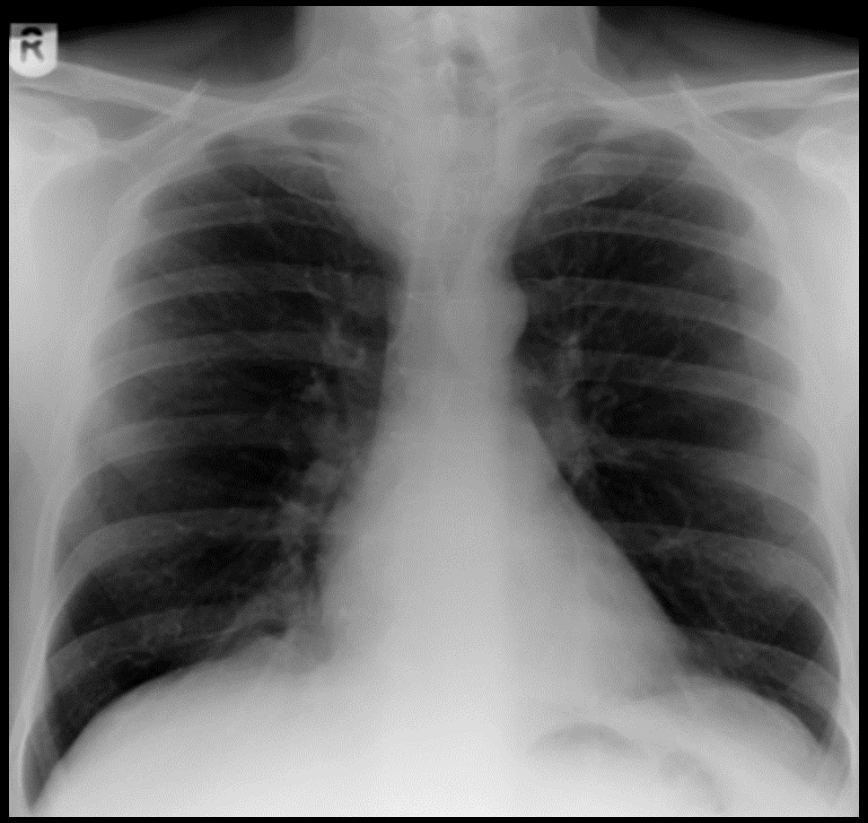
Left atrial enlargement

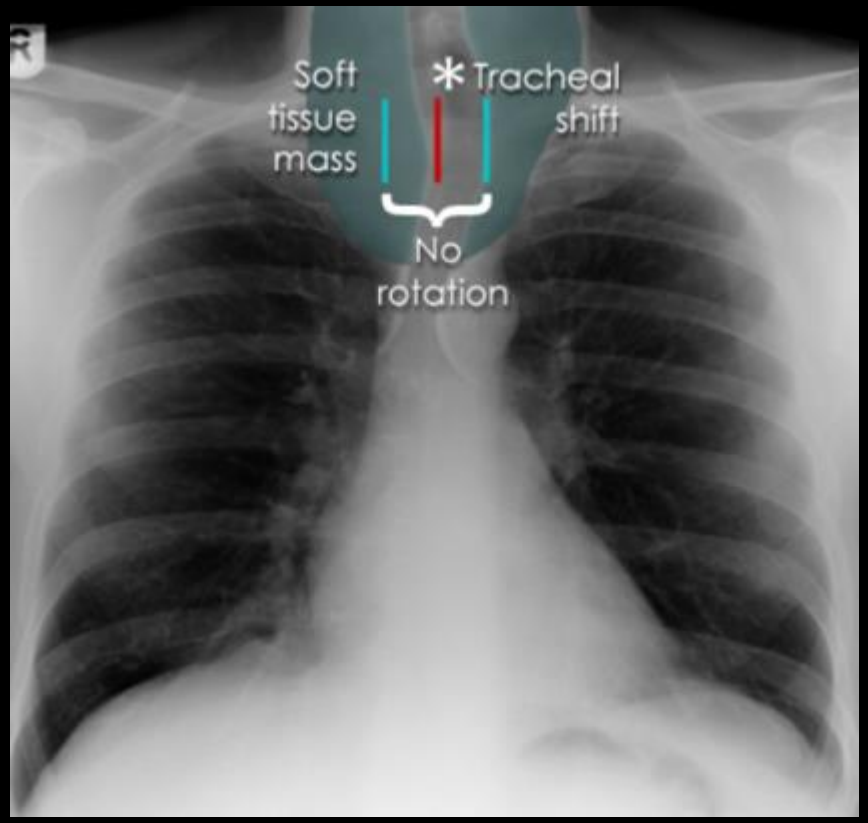
- Heart borders noted
- "2nd" right heart boarder = L atrium
- Main carina splayed > 90 degrees
  - LAE or subcarinal node

Weight loss

- 61 year old veteran comes to ED due to 15 pound weight loss.
- He states he is hungry but having difficulty swallowing food.
- He appears mildly malnourished and his pants are loosely fitting.

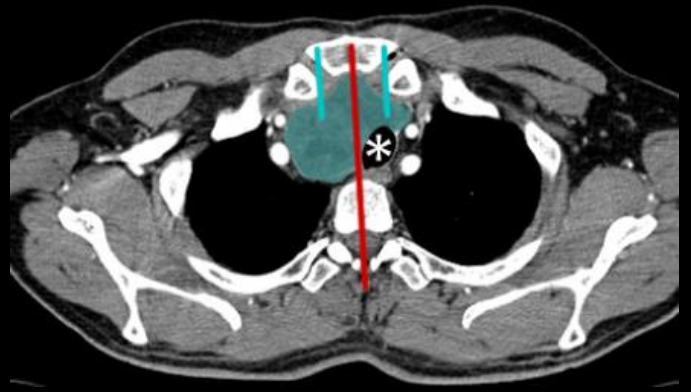






Soft Tissue Mass

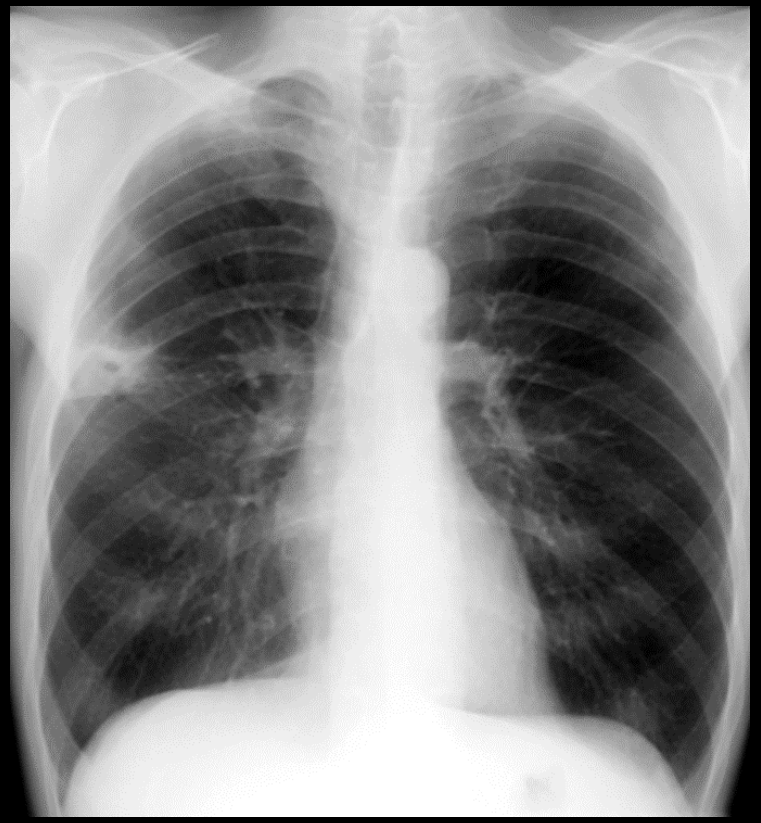
- Tracheal displacement to the left. Compressing esophagus
- Close look at trachea and spinous processes suggest NO rotation

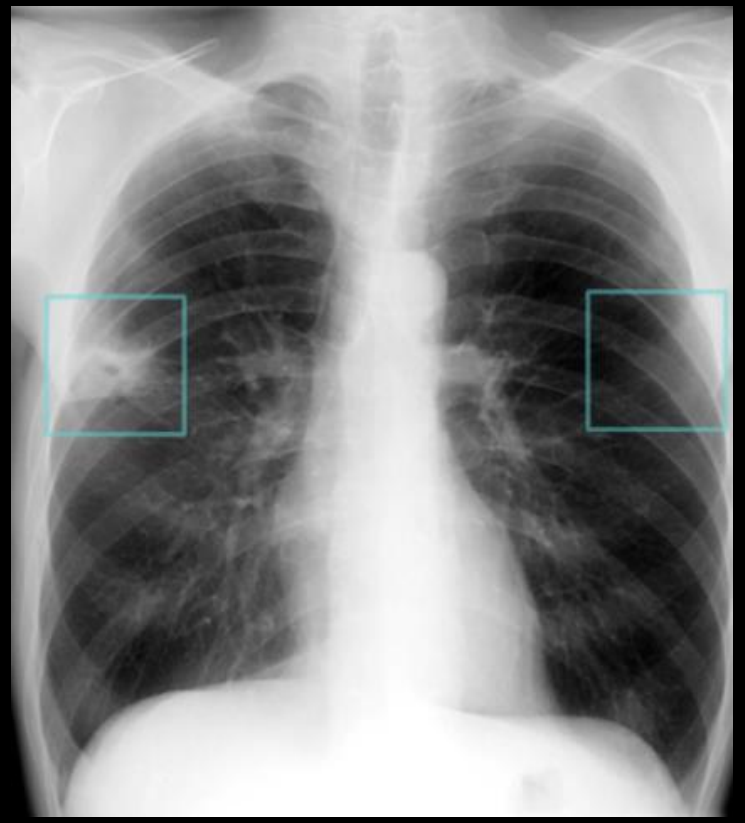


“I got a fever”

- 26 year old woman
- 5 days of fever, chills and sweats
- Mild decrease in appetite
- Minor cough, not productive
- IVDU
- Today, she came to ED because of pleuritic chest pain on the right side

- What is the best action at this time?
  - A. Echocardiogram
  - B. Chest CTA to assess for PE
  - C. Chest tube placement
  - D. Azithromycin x 5 days with close PCP follow up
  - E. Ibuprofen and more Cowbell



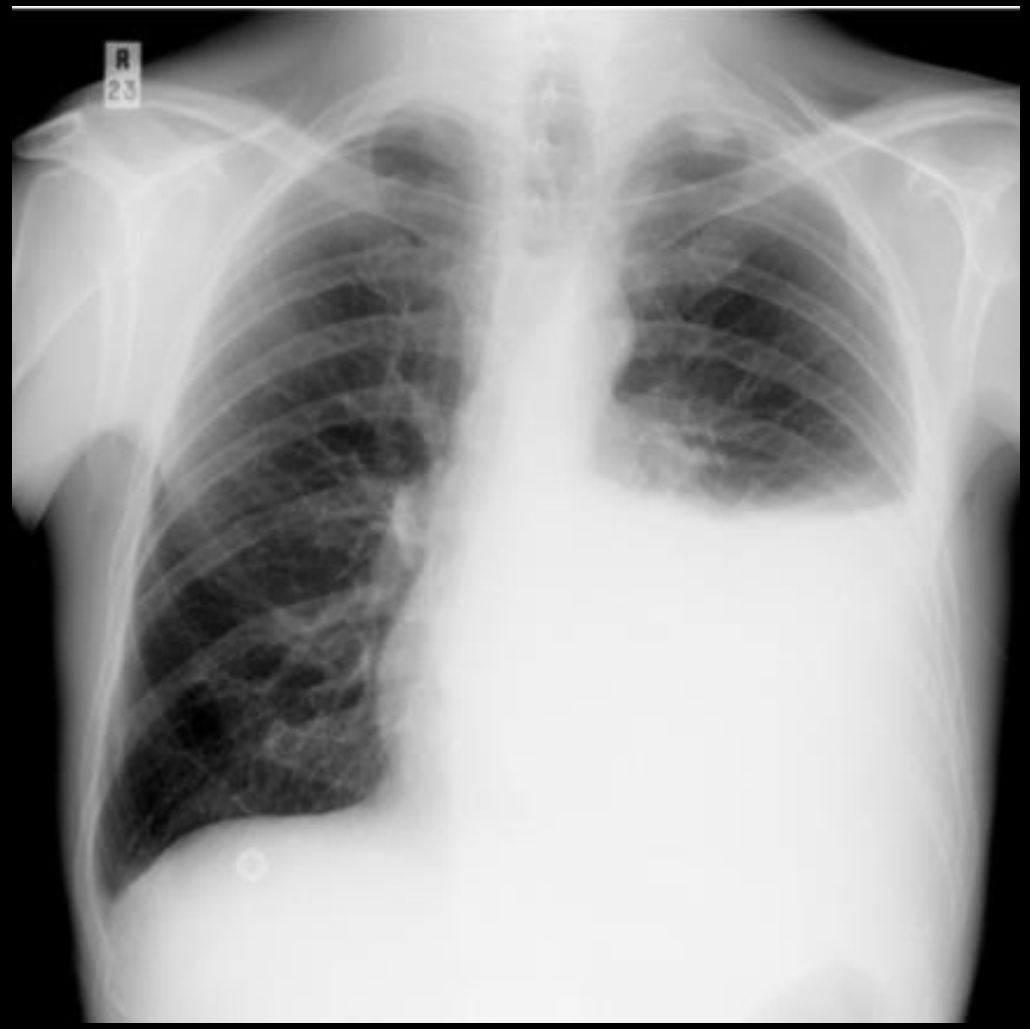


Unilateral Mid-lung zone abnormality

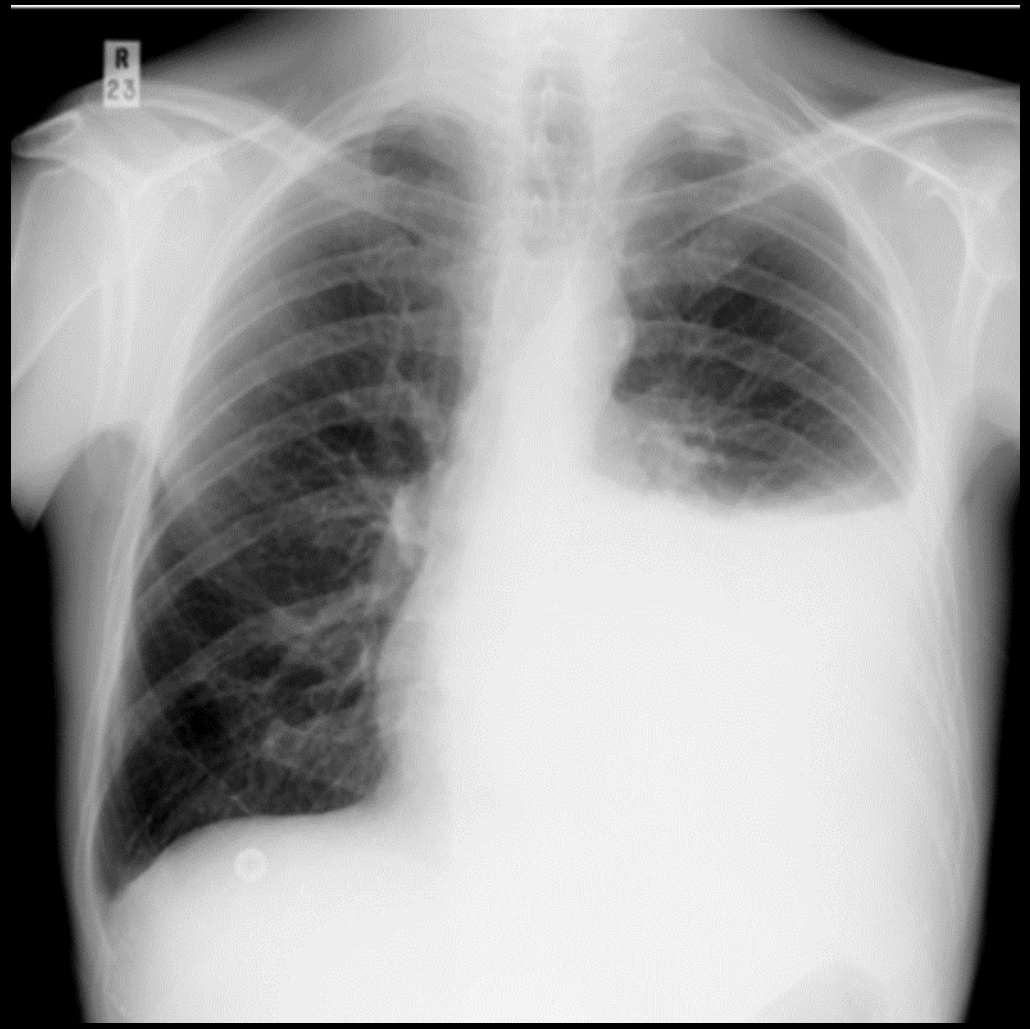
- Peripheral ill-defined nodule/cavitation?
- Otherwise normal
- Diagnosis – Septic emboli from right sided **endocarditis**

Final Case: SOB x 6 weeks

- 35 year old man has had fevers, SOB and weight loss over the last 6 weeks
- He has to stop on the 2nd floor of his apt building (normally no issues to get to 4th floor).
- Lost 10 pounds



Case – CXR assessment

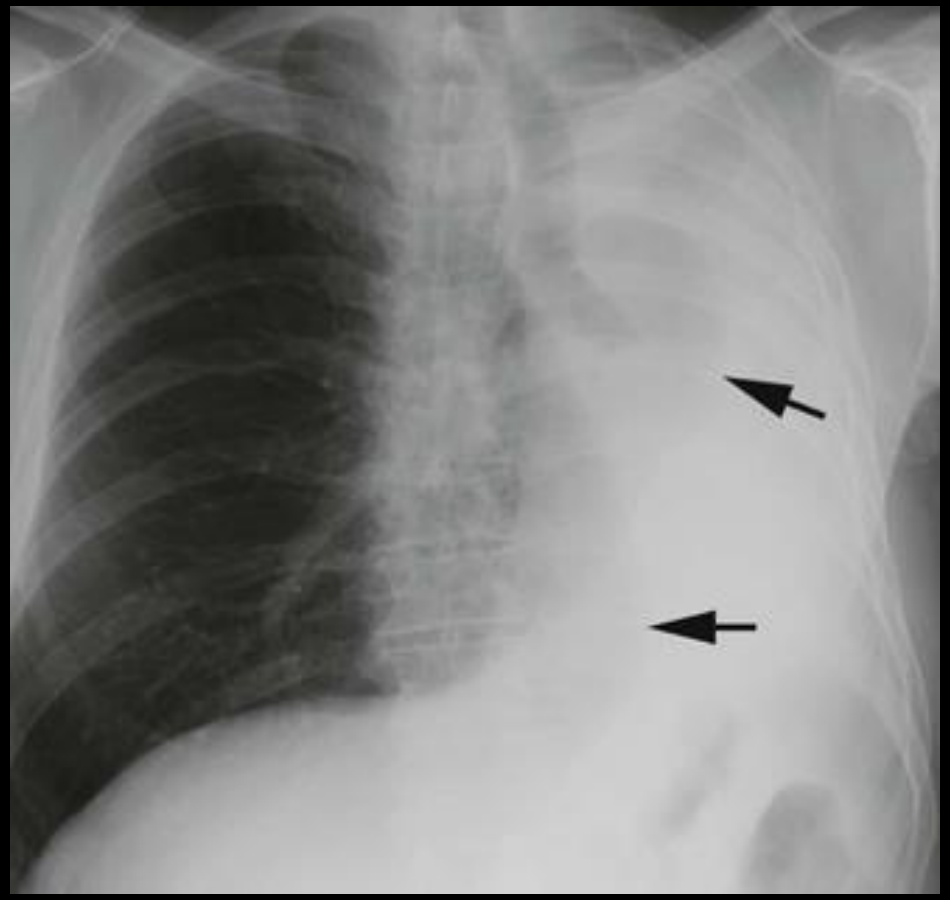


- Very dense opacity in left lower chest
- Curvilinear border superiorly
- Pleural effusion or LLL atelectasis?

Case – Large pleural effusion

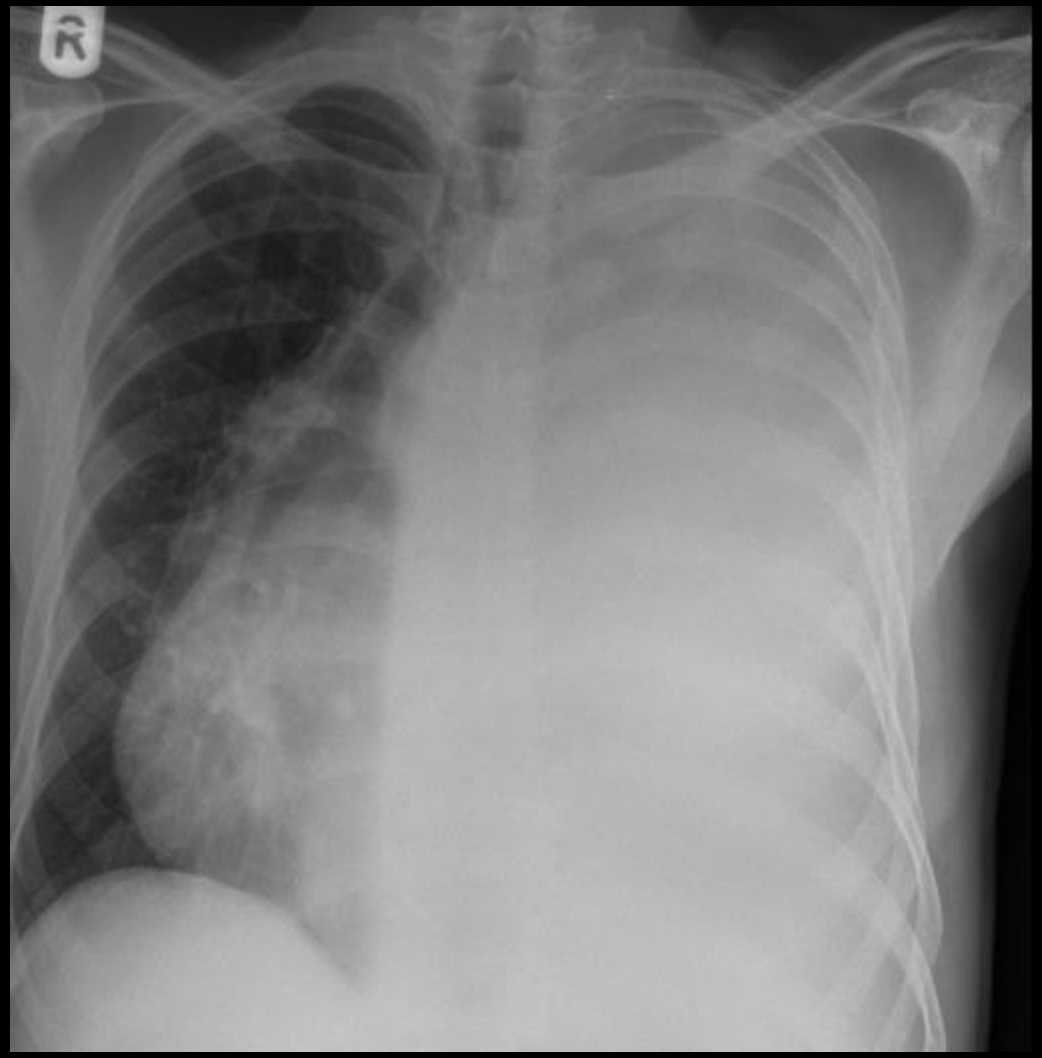
- Effusions
  - Mass effect – pushes thoracic structures away
  - Meniscus sign superiorly suggest fluid
- Atelectasis
  - Volume loss – pulls thoracic structures toward
  - Lobar collapse can result in sharp linear edge to dense, deflated lung
- Diagnosis – Large left pleural parapneumonic effusions. Chest tube placed

White out



- Atelectasis
  - “White out” on left side of the chest
  - Thoracic structures shifted TOWARD the atelectic area
    - Volume loss

White out



- Massive pleural effusion
  - “White out” on left side of the chest
  - Thoracic structures shifted AWAY from the effusion
    - Mass effect

Thank you!!!
Please send me an email if you have any questions
alladag@ohsu.edu