



# Chest Radiography 101

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# Disclosures and Funding

## + CareDx, Inc. →

- PI on IIT “dd-cfDNA as a Biomarker for CLAD”
- PI on IIT “dd-cfDNA to Assess Recovery from Acute Cellular Rejection”
- Site PI and Steering Committee Member on TEAMMATE Study
- Member, National Scientific Advisory Committee
- Speaker fees

## + Veloxis Pharmaceuticals →

- PI on IIT “Early Use Envarsus Post- Lung Transplant to Mitigate Side Effects.”

## + NIAID 1U01AI167789-01 →

- VUMC Site PI on “Comparison of High Dose vs. Standard Dose of Influenza Vaccines in Lung Allograft Recipients.”



# Objectives

- 1) An Introduction to CXR Interpretation
- 2) Computed Tomography of the Chest
  - Lung Structure
  - Common findings

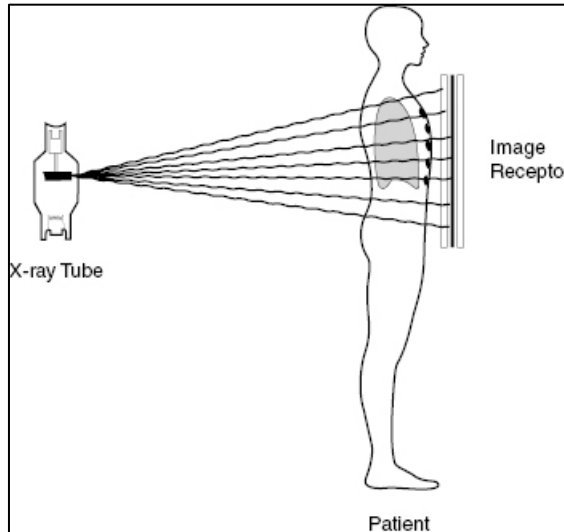


# Caveats

- 1) I am NOT a certified radiologist
- 2) I have never taught radiology interpretation in a large forum before
- 3) CXR Interpretation is like making a grilled cheese sandwich
- 4) Have a methodology and use it every time (consciously or subconsciously)



# Xray Principles / Theory



Radiologykey.com



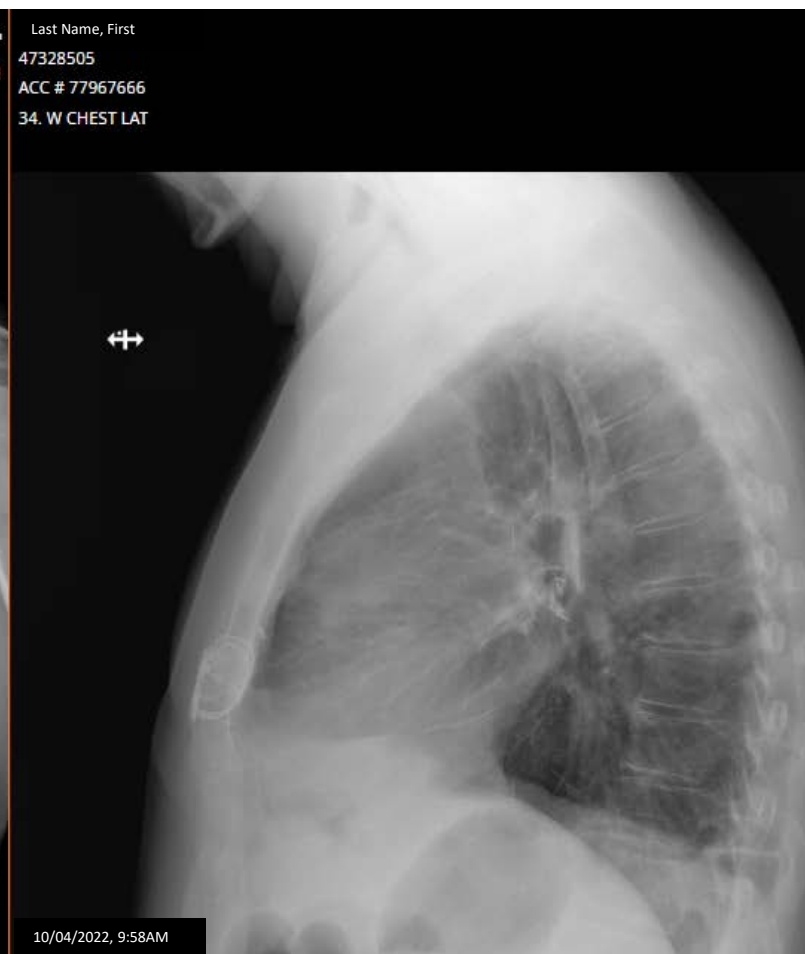
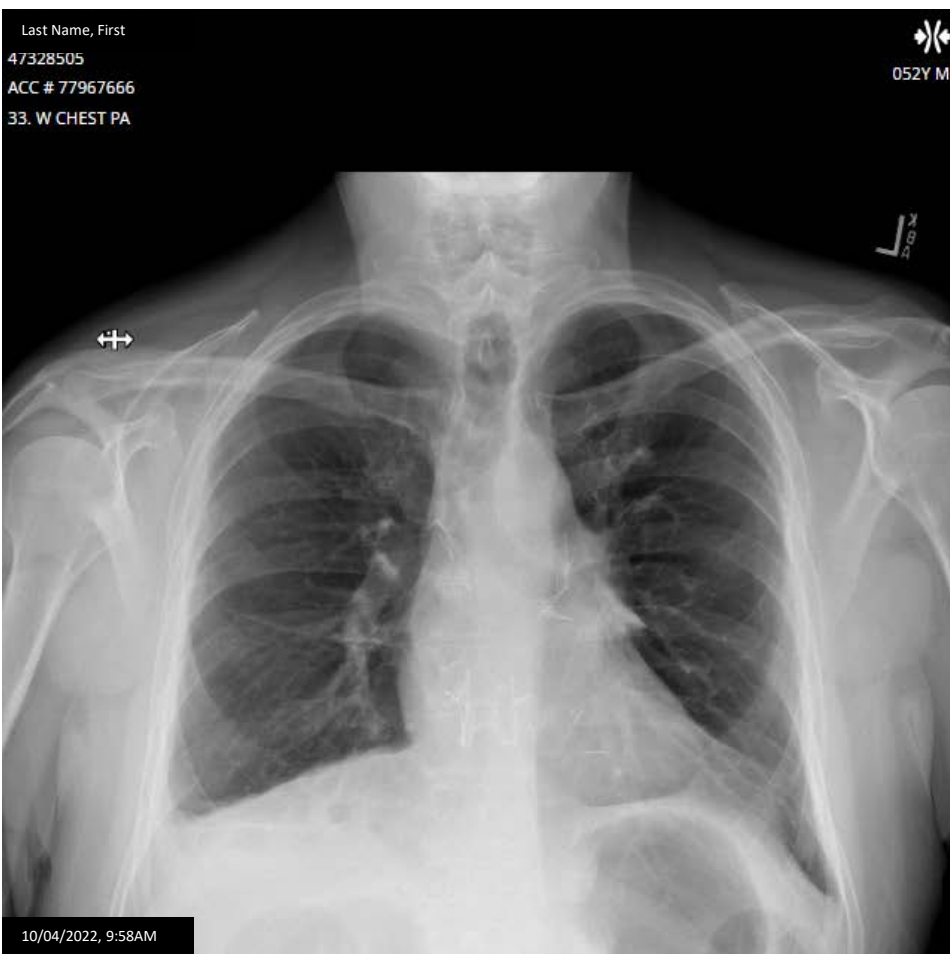
Mrs. Roentgen's hand. Circa 1885

www.teamrads.com

- + Electromagnetic radiation that passes through tissues.
- + X-rays “cast shadows” on a film.  
Help assess radiodensities of structures
- + Radio-dense = Fewer beams pass through structure.  
Appear white (“high attenuation”).  
Example: bone
- + Radio-opaque = More beams pass through structure.  
Appear dark (“low attenuation”).  
Example: air
- + **“ 1-view is no view”**



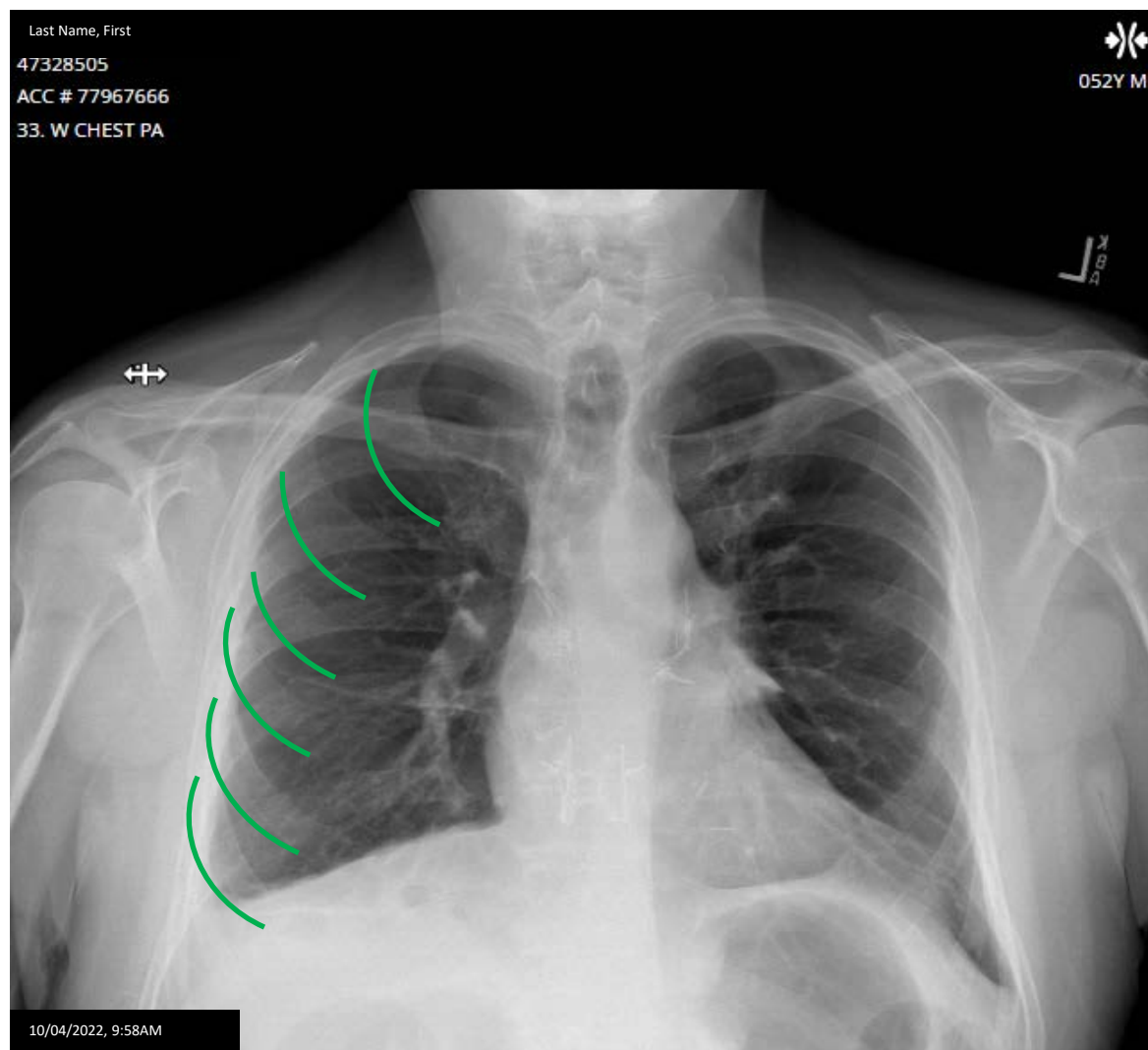
# Initial Steps → The 4-ations: **Identification**



- 1) Correct Patient Name
- 2) Correct Date and Time
- 3) Understand Study Type
- 4) Left and Right



# Initial Steps → The 4-ations: **Inspiration**



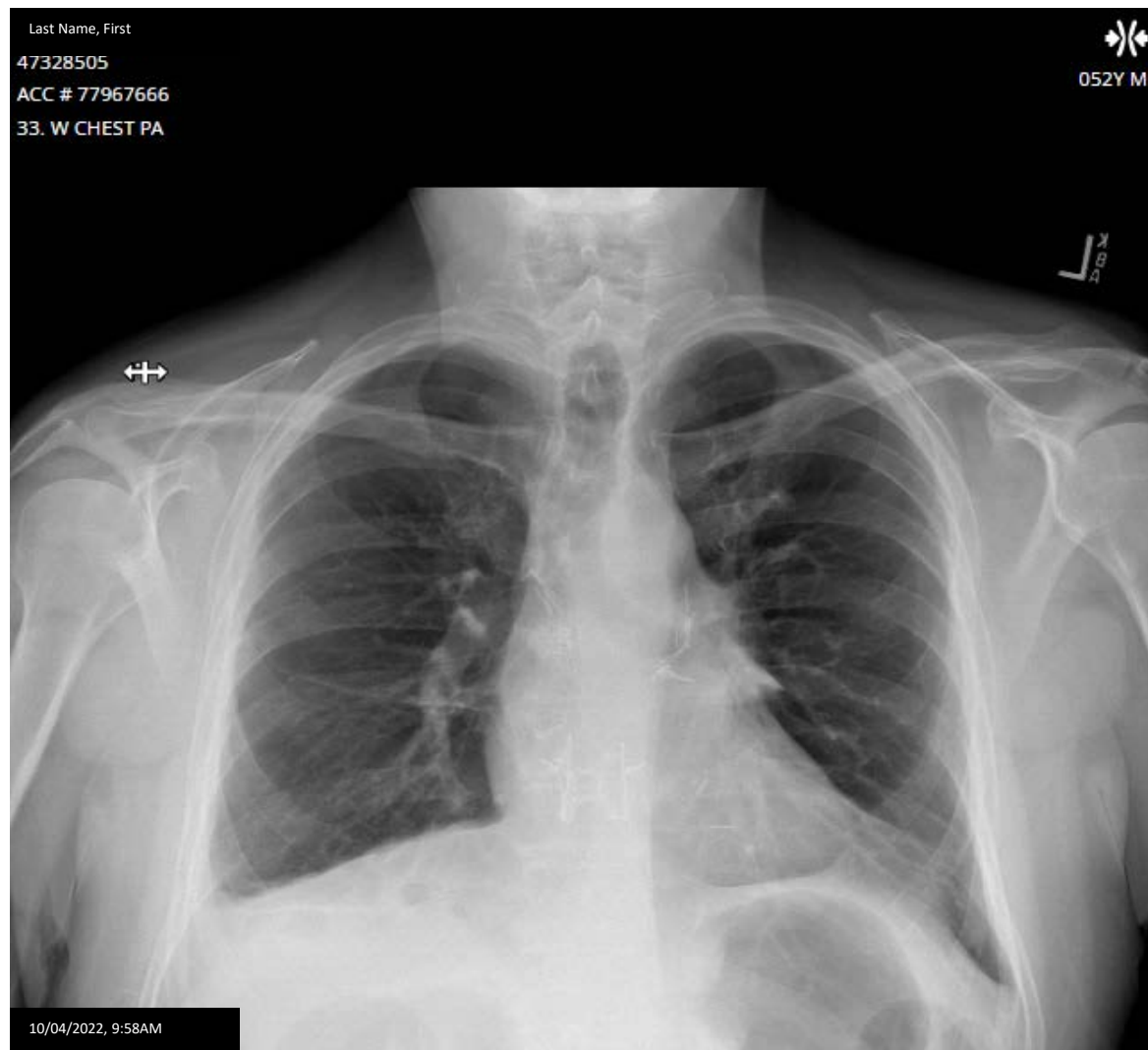
Diaphragm should be  
at the level of the  
6<sup>th</sup> anterior rib  
or 10<sup>th</sup> posterior rib

**Otherwise:**

- a) Atelectasis
- b) Vascular Crowding



# Initial Steps → The 4-ations: **Rotation**



Spinous processes  
should be equidistant  
from the  
clavicular heads

CXR beams  
should be  
perpendicular to  
chest wall





# Initial Steps → The 4-ations: **Penetration**

## Exposure Quality:

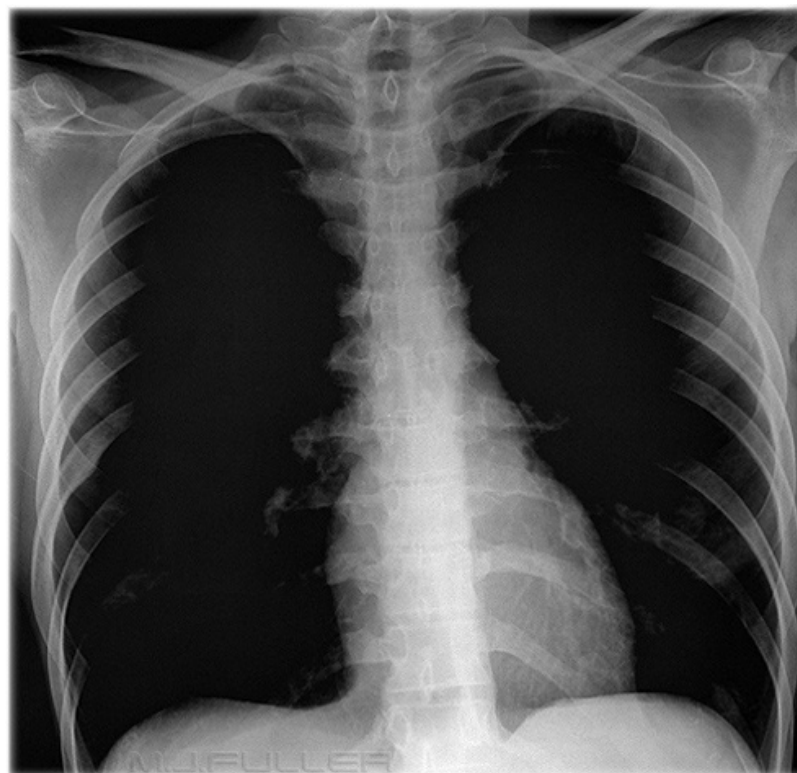
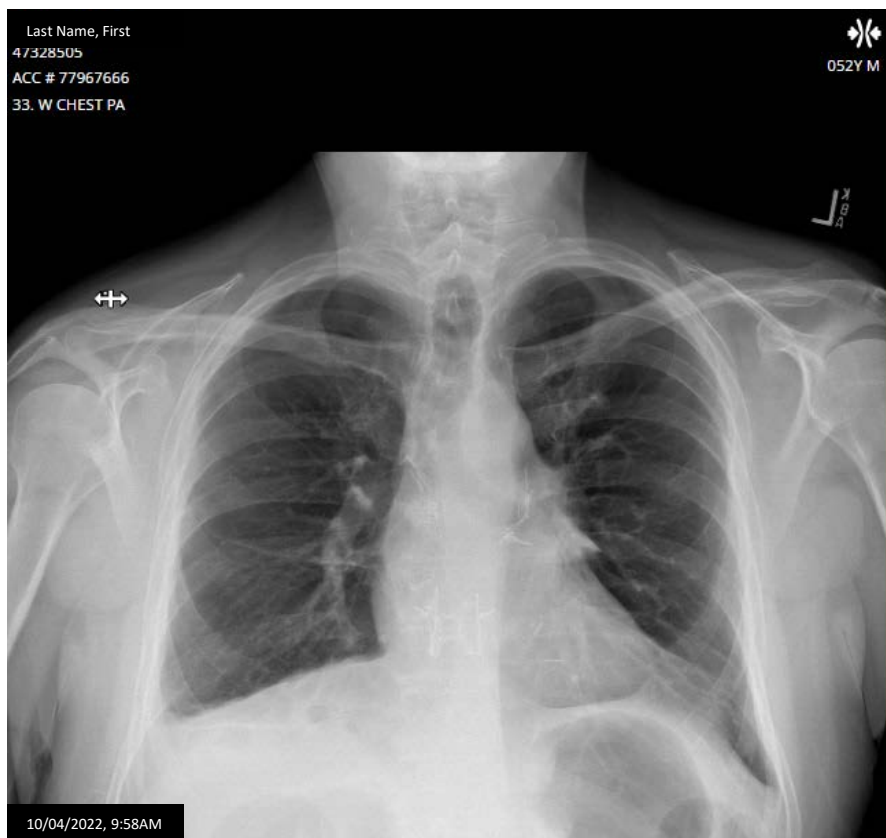
Retrocardiac vertebrae should be faintly visible

## Over-exposed:

Too powerful Xray beams.  
Heart and structures are too lucent.  
Aerated portions are too dark, and you may miss small blood vessels.

## Under-exposed:

Too weak Xray beams.  
Cardiac structures are opaque.  
Lungs are whiter / denser than they should be.





# Identify / Assess Hardware

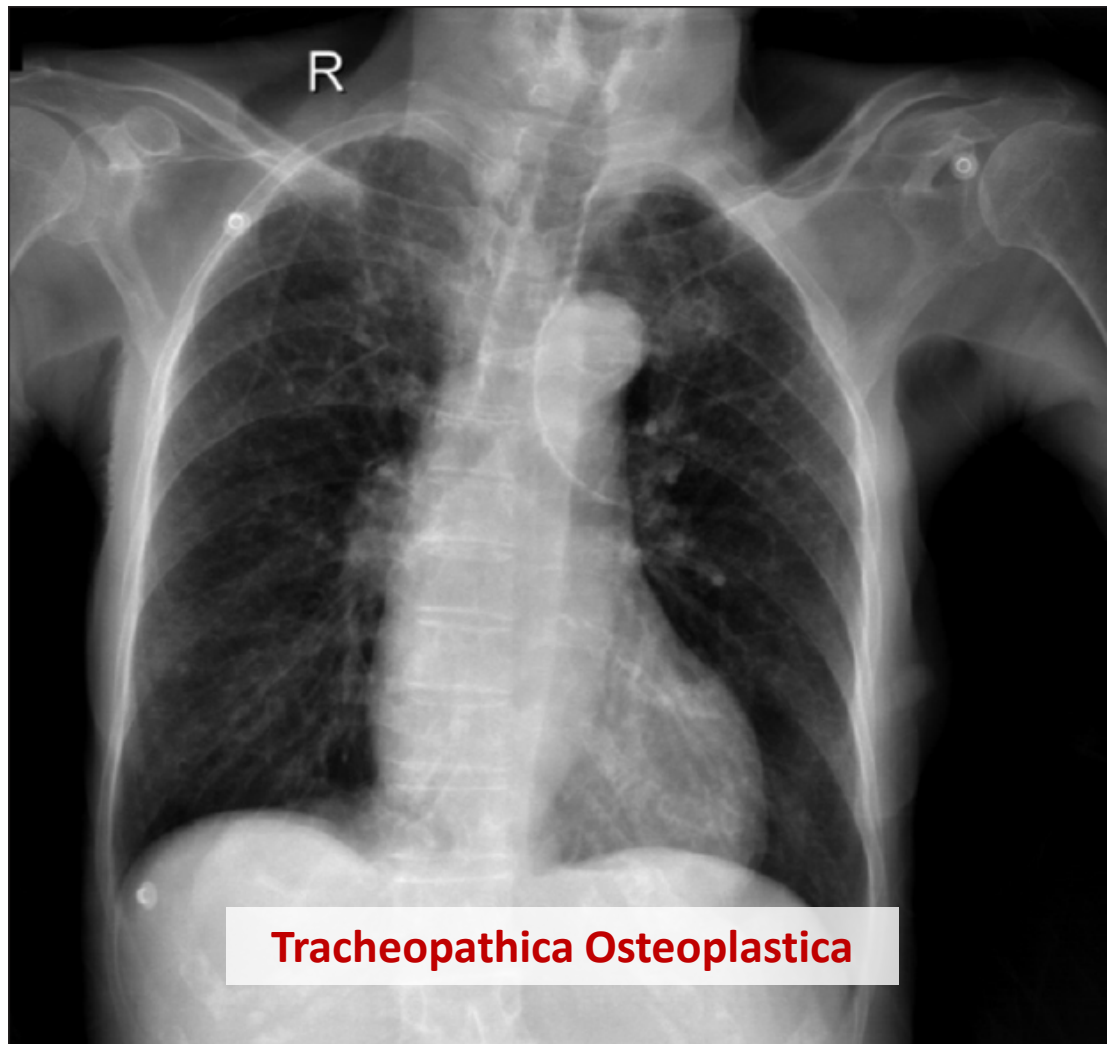


## Common Hardware to Identify

- 1) Endotracheal tubes**
  - Position → subclavicular, 3-5cm above carina
  - Cuff inflation
  
- 2) Chest / Thoracotomy tubes**
  
- 3) Intravascular Objects**
  - CVCs, PICC lines, Portacaths
  - ECMO cannulaes
  - Swann-Ganz (PA) Catheters
  
- 4) Feeding tubes**
  - Subdiaphragmatic
  
- 5) Pacemakers and ICDs**



# Important Thoracic Structures: Airways



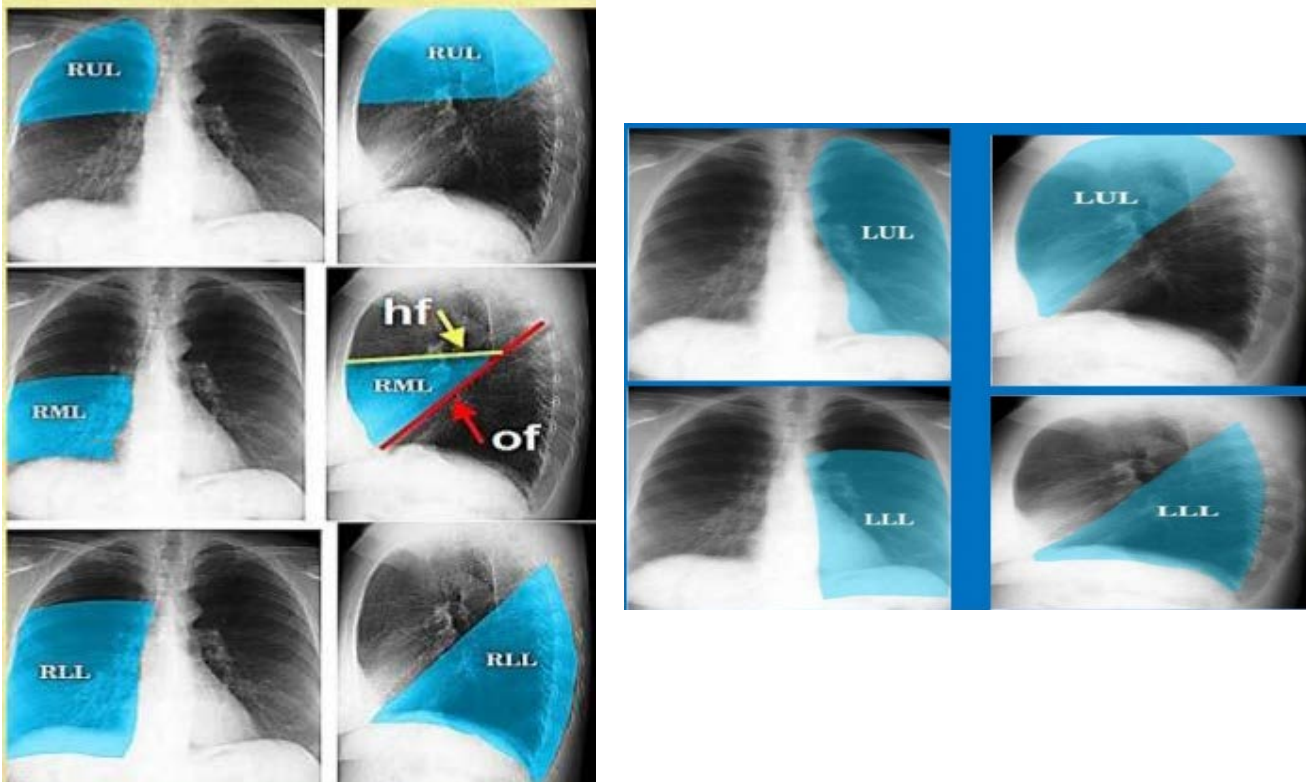
## Airways

- 1) **Trachea**
  - Midline?
  - Calber
  - Well-aerated?
  
- 2) **Main Carina**
  - Widened (“Splayed” is  $> 100$  degrees)
  - Narrowing?
  
- 3) **Main bronchi**
  - Narrowing?
  - Intraluminal objects?



# Important Thoracic Structures: “Breathing” (Lung Parenchyma, Hilar Structures, & Pleura)

## Lung Lobar Anatomy



## Hilum



- 1) Pulmonary arteries and veins  
(Right < 16mm, Left < 18mm)  
Matthay RA, et al. Invest Radiol 1981; 16(2): 95-100
- 2) Mainstem bronchi
- 3) Hilar lymph nodes

(Courtesy of RK Sristava on [www.slideshare.net](http://www.slideshare.net))



# Important Thoracic Structures: “Breathing” (Lung Parenchyma & Pleura)



## Pleural Space

- + Invisible on a CXR (normally)
- + Assess costophrenic angles
- + Look for layering
- + Lateral (2 view) films help
- + When in doubt, perform an ultrasound





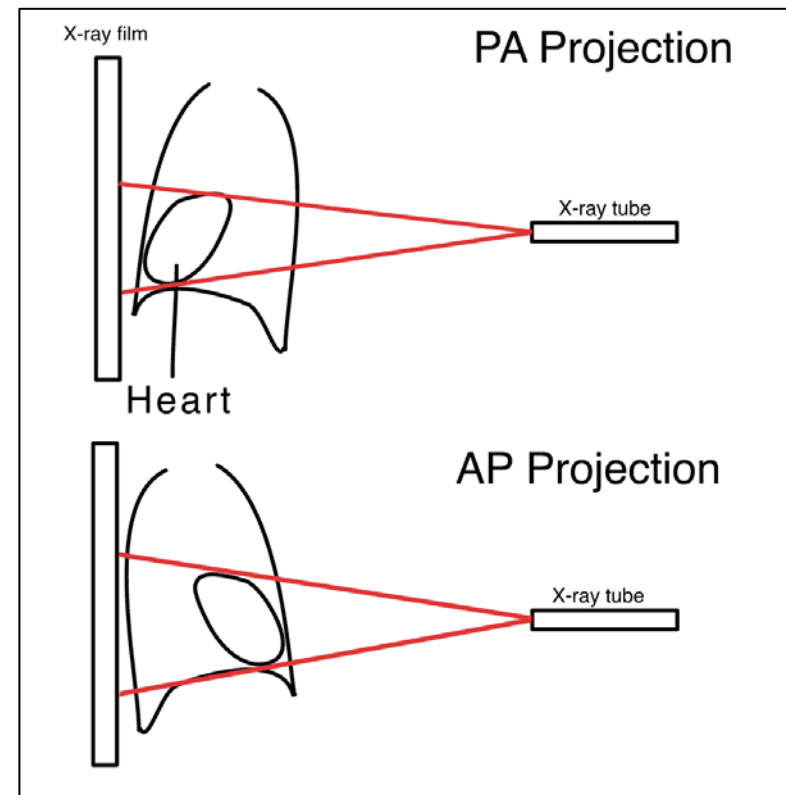
# Important Thoracic Structures: **Cardiovascular**



[www.heart.thecommonvein.net](http://www.heart.thecommonvein.net)

## Important CV Structures

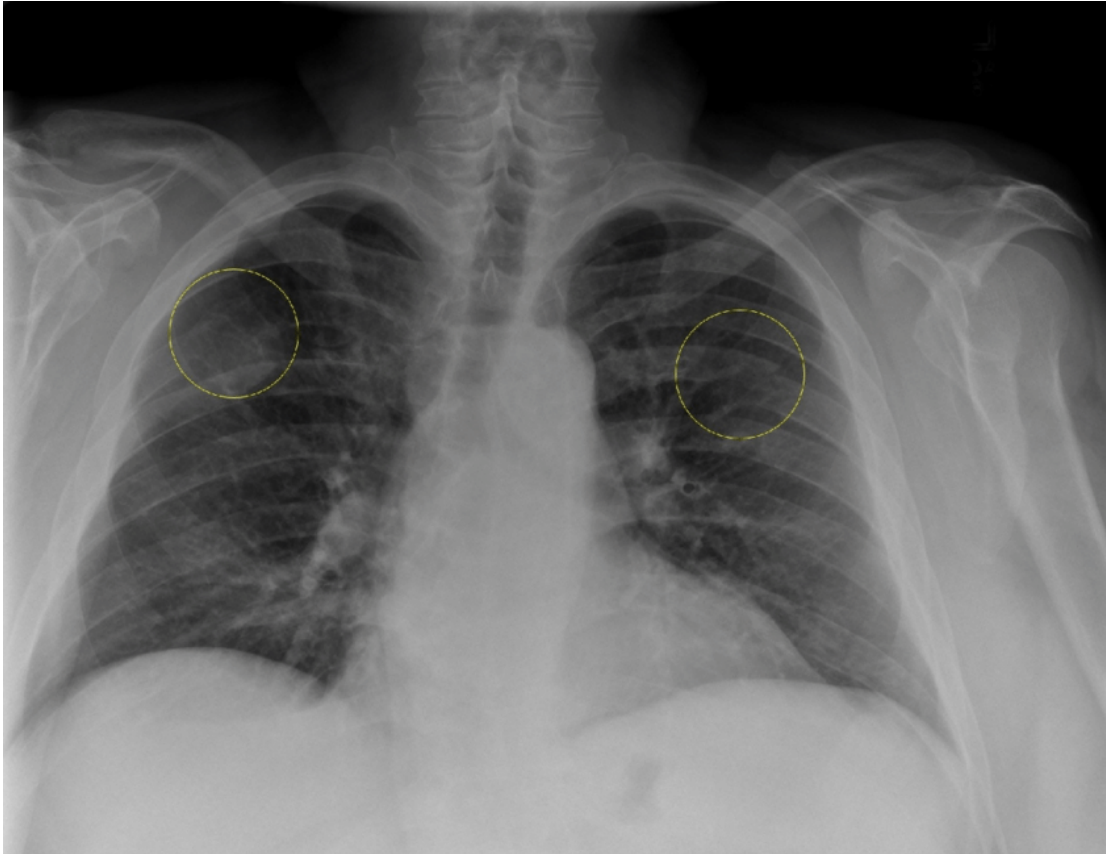
- + Aortic Knob / Notch
- + Ascending aorta
- + Heart borders → **cardiac silhouette ½ of diaphragm width**
- + Assess for “peri-hilar” vascular engorgement / congestion



[www.almostdoctor.com](http://www.almostdoctor.com)



## Important Thoracic Structures: “Disability” (Bones & Soft Tissue)



### Look at the Bones:

- 1) Pneumothorax risk
- 2) May limit ventilation (especially flail chest)

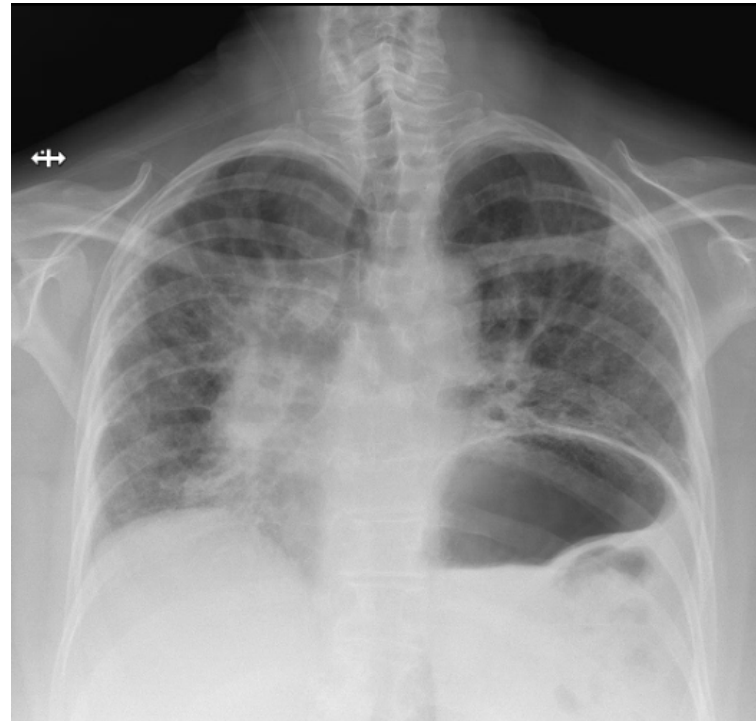


# Important Thoracic Structures: **Everything Else**



[www.svuhradiology.ie](http://www.svuhradiology.ie)

Pneumoperitoneum



Elevated hemidiaphragm /  
Diaphragm paresis



[www.radiologykey.com](http://www.radiologykey.com)

Abnormal Hilum

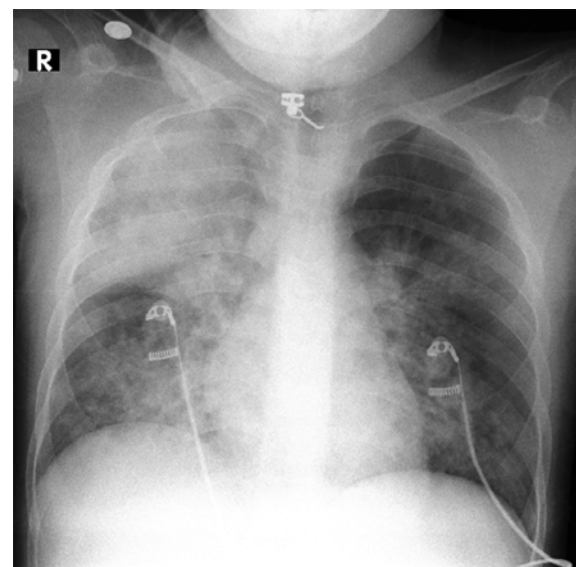
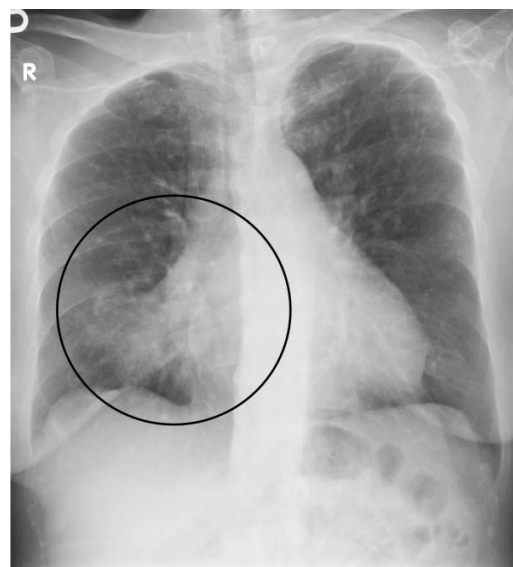
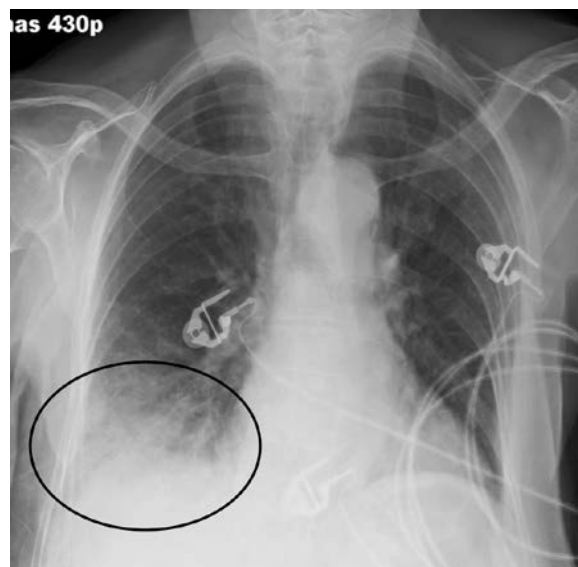




# Shadows Can Be Helpful: The Silhouette Sign

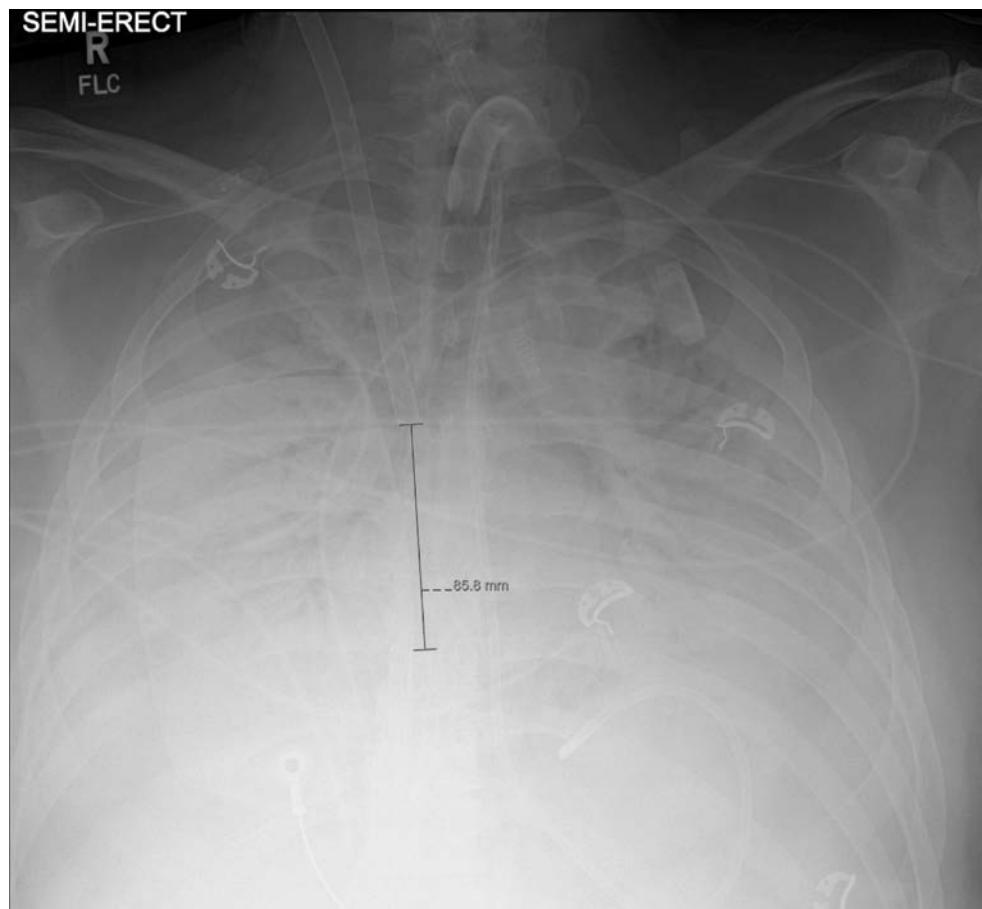
Loss of normal borders in the thorax (especially heart and aorta),  
due to a new adjacent radio-dense process.

Particularly useful for localizing lesions





# Alveolar vs. Interstitial Abnormalities





## Describe the findings → Case 1

62yo M s/p DDRT in 2017 for diabetic and hypertensive nephropathy.

Managed on Tacrolimus (goal trough 6-8 ng/mL), MMF 500mg bid, Prednisone 5mg daily.

Had URI Sx x 2 weeks.

Then progressive malaise, 2 days fever, increased sputum production, dyspnea and scant hemoptysis.

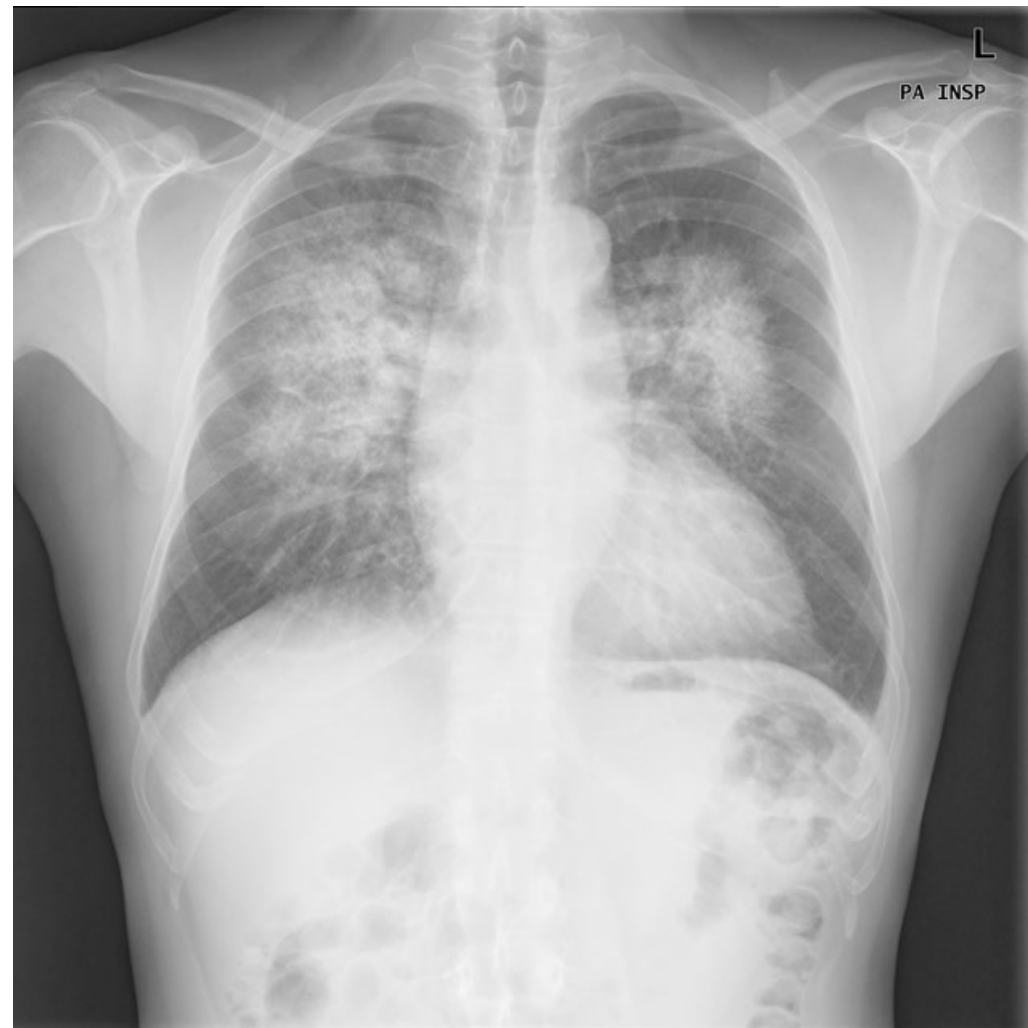




## Describe the findings → Case 2

42yo F referred to nephrology clinic for Malaise, fever and hematuria.

CXR reveals the following:



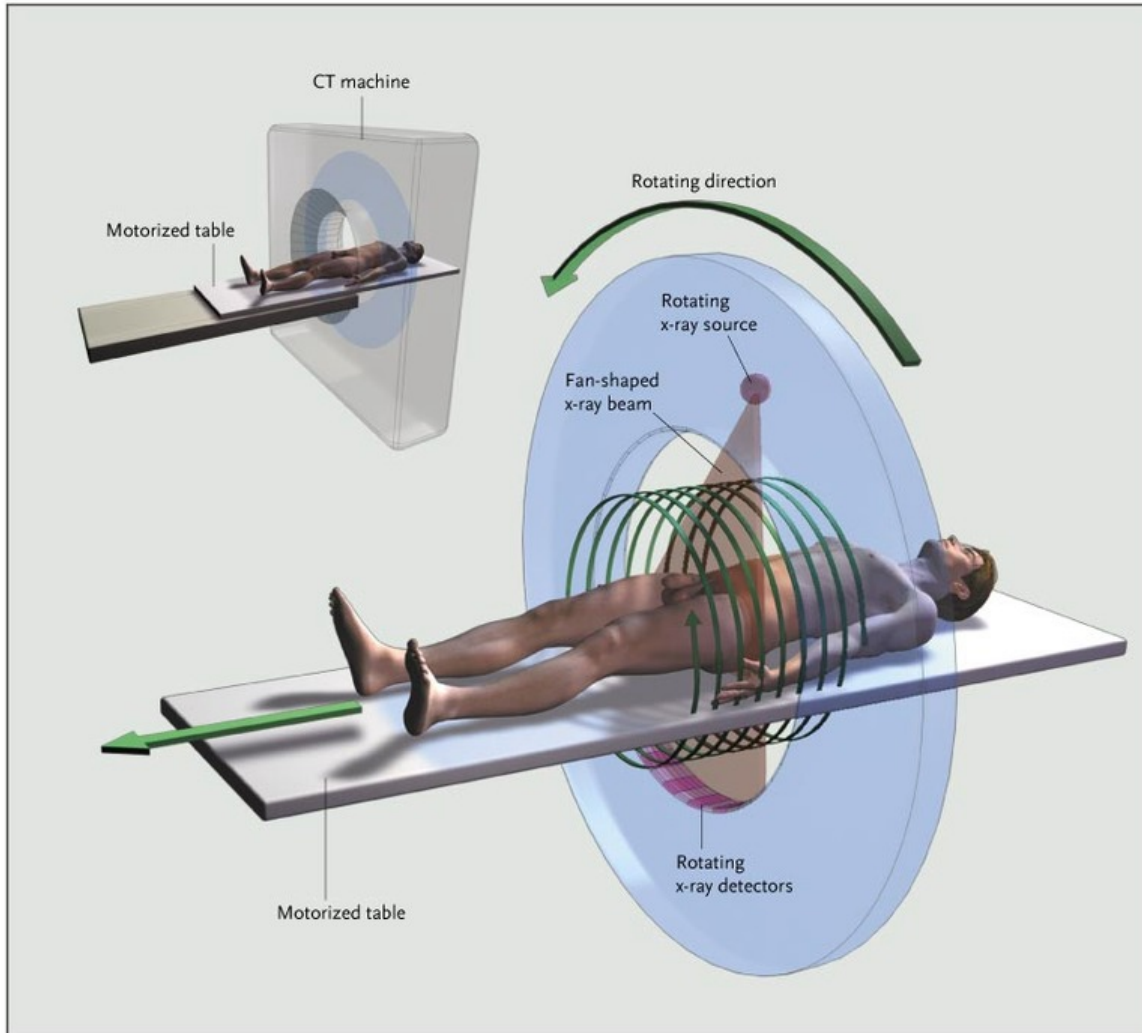


# Objectives

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# X-ray Computed Tomography (CT)

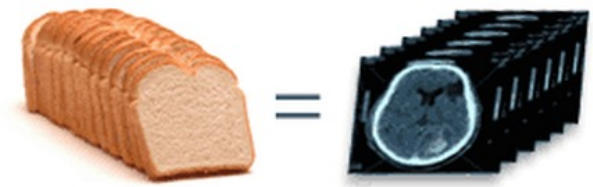


Amalgam of  
X-ray attenuation  
through the  
cross-sectional plane  
of the thorax  
from different rotational angles.

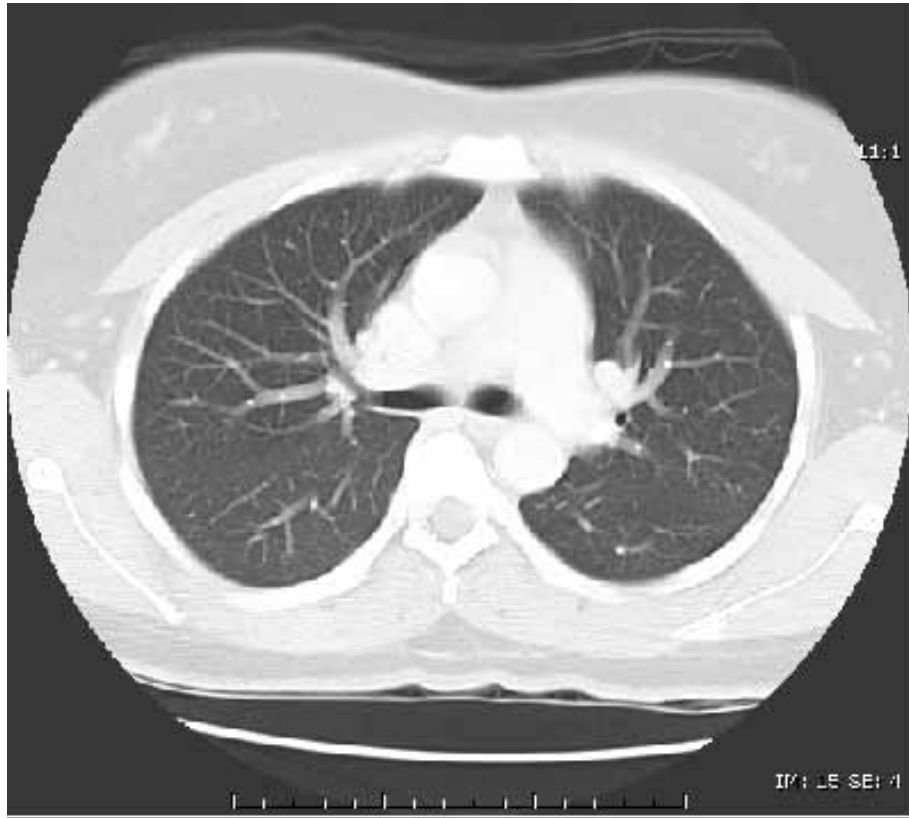




# Computed Tomography (CT)



**Anterior**



**Right**

**Left**

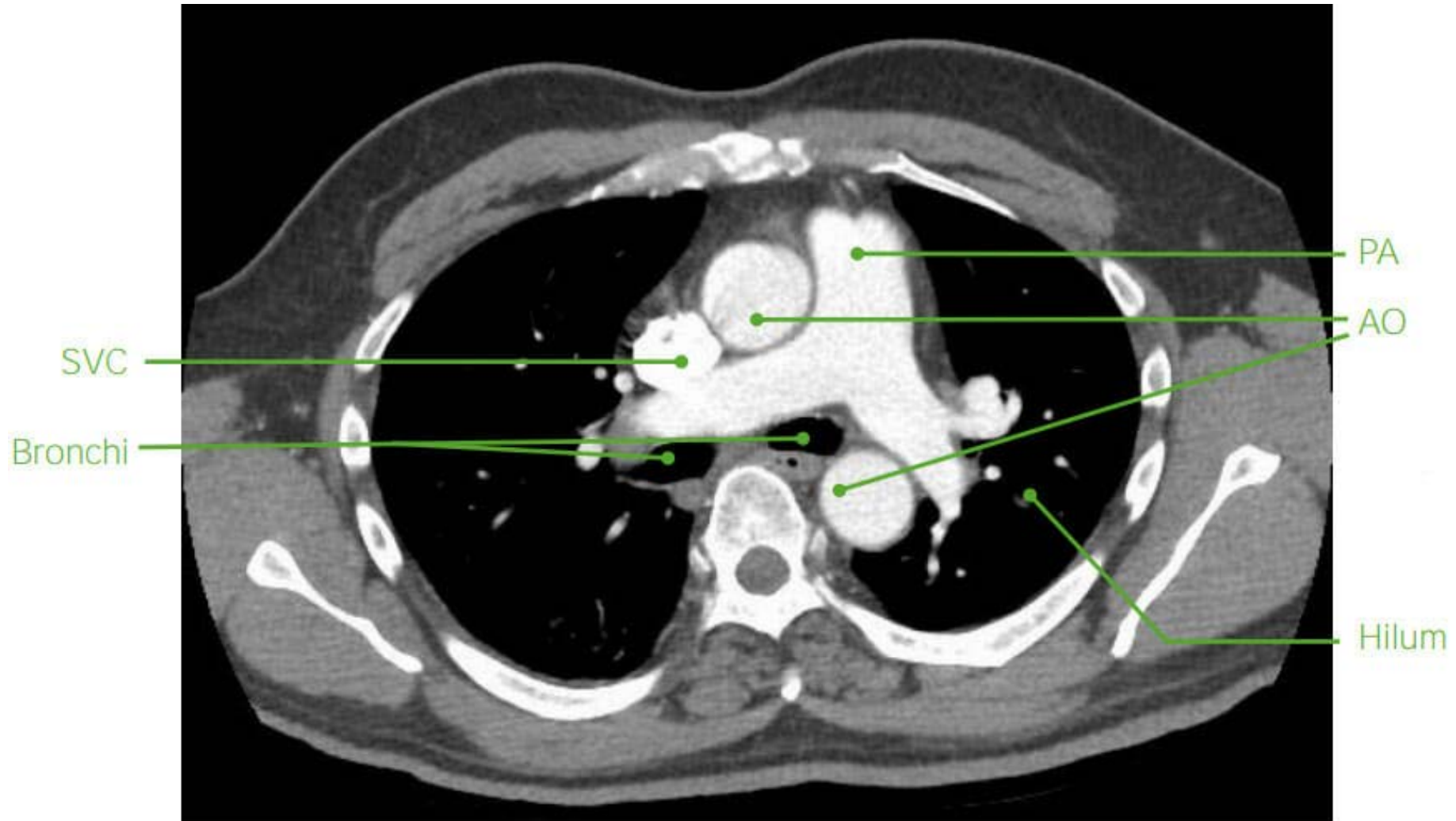
**Posterior**

## Attenuation Pattern:

- 1) High → white (bone)
- 2) Medium → grey (soft tissue)
- 3) Low → black (air)



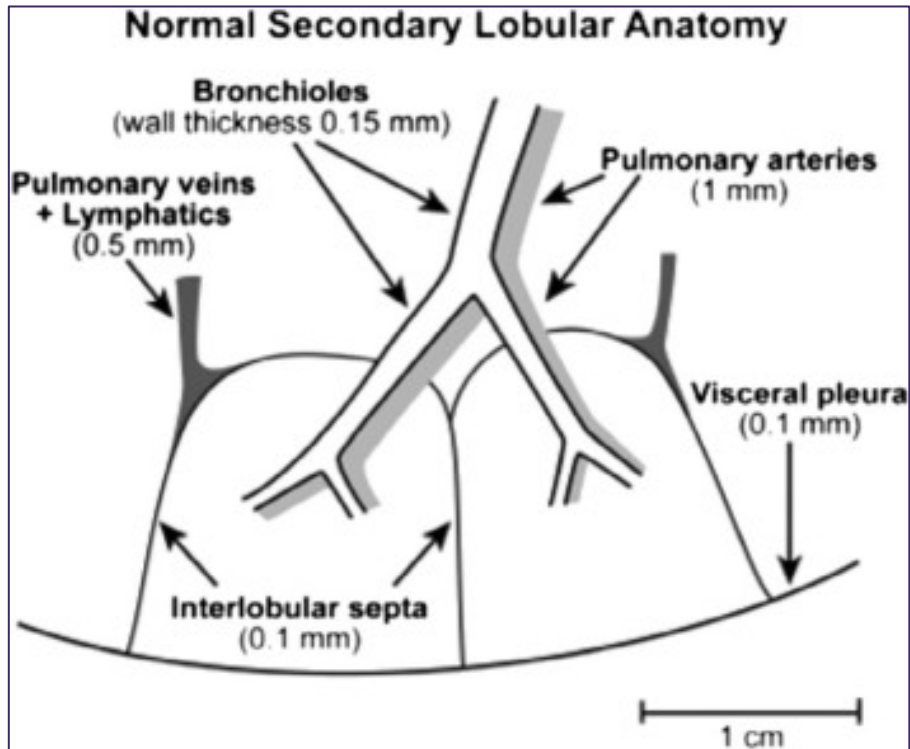
# Important Mediastinal Anatomy on CT Chest



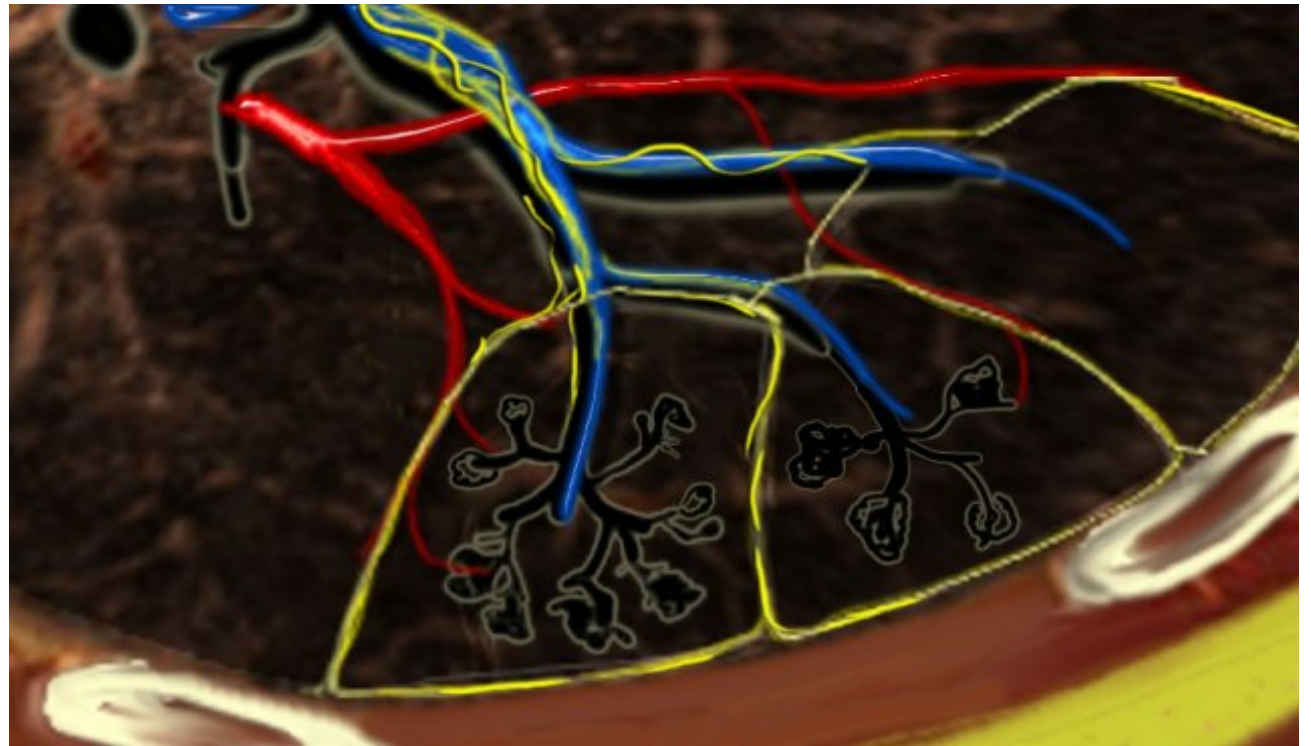




# CT Chest Anatomy: Secondary Pulmonary Lobule



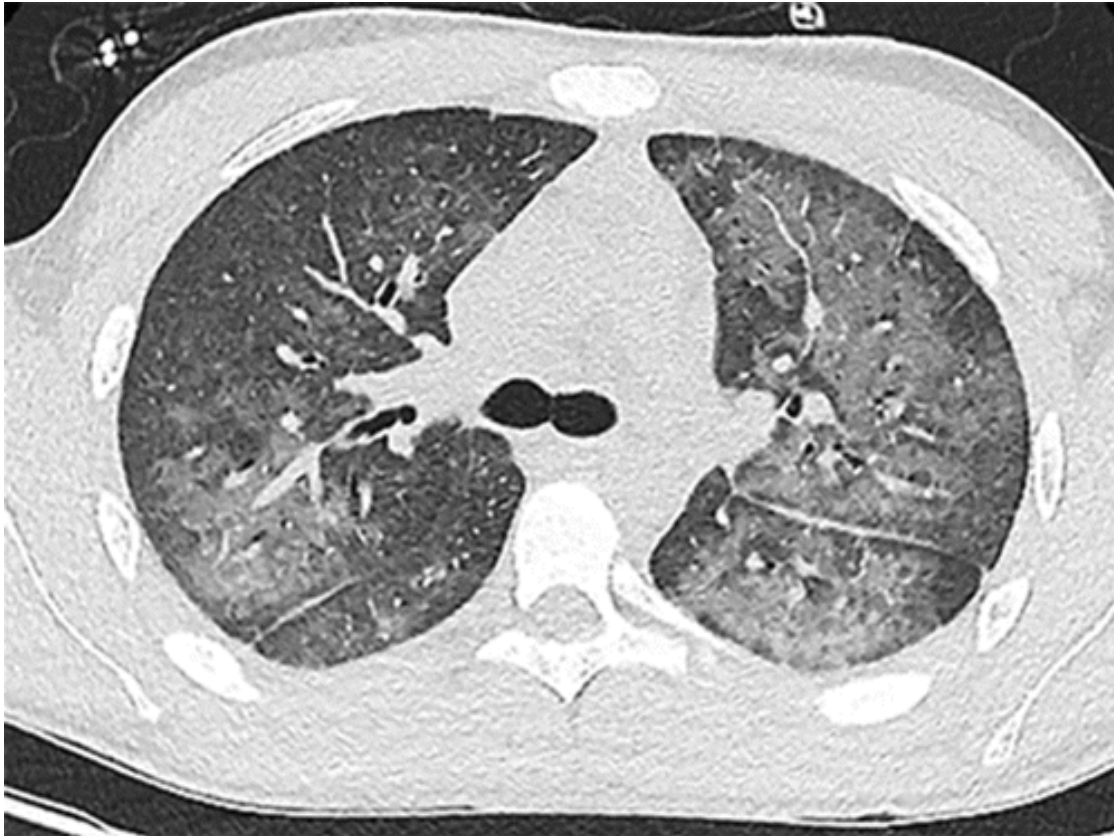
Devakonda, et al. CHEST 2010; 137(4): 938-951



<https://radiologyassistant.nl/chest/hrct/basic-interpretation>



# Common CT Chest Findings: Ground Glass



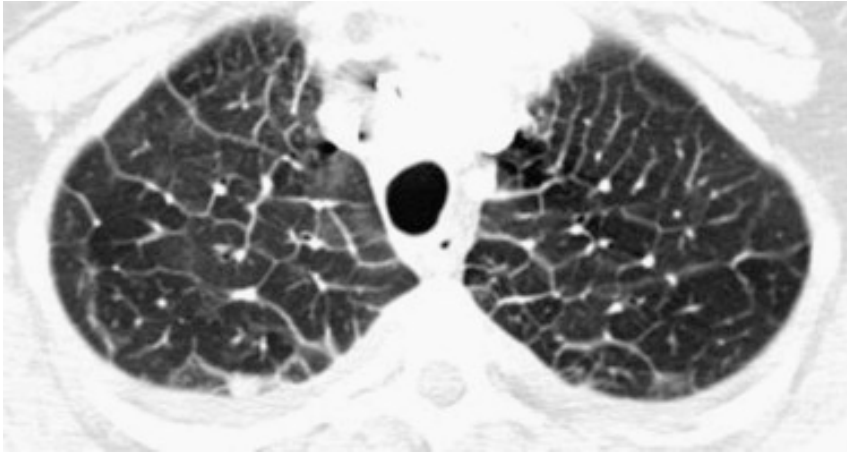
## Ground Glass Opacification

Increased area of attenuation that does not obscure underlying parenchyma or blood vessels

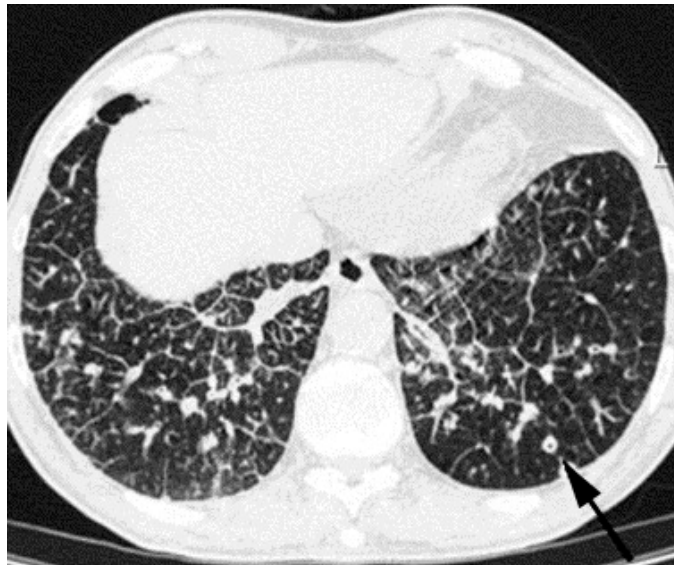
- + Blood
- + Water
- + Purulence
- + Protein



# Common CT Chest Findings: Interlobular Septal Thickening



<https://radiologykey.com/pulmonary-edema/>



Andreu et al. Curr Prob in Dx Radiology. 2004; 33(5): 226-237.

## Interlobular Septal Thickening

Prominence of pulmonary lymphatics and/or venules

### Smooth:

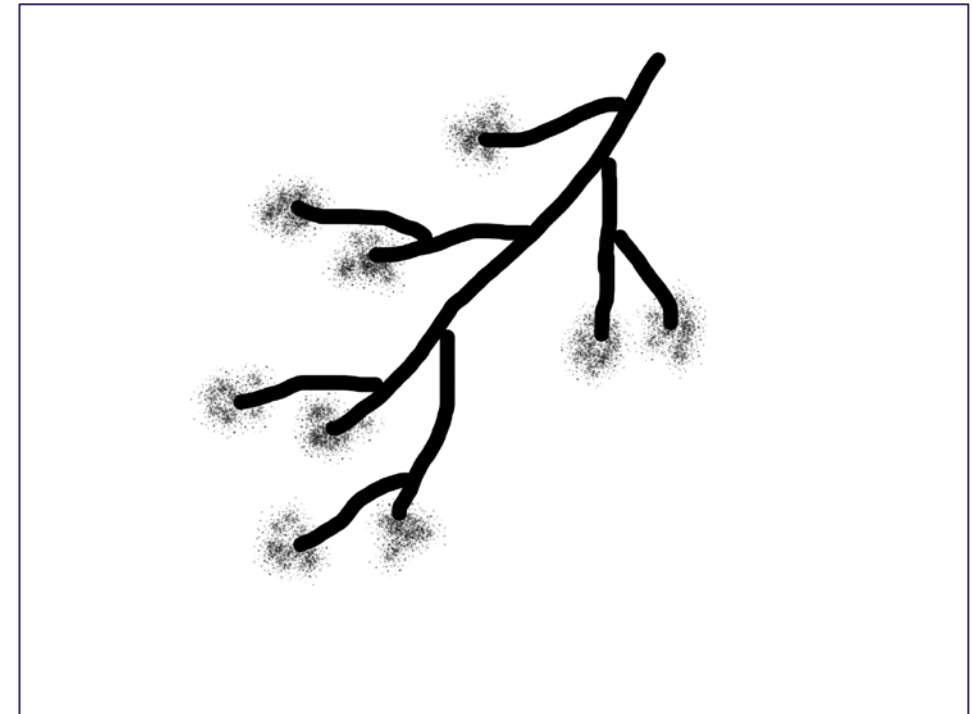
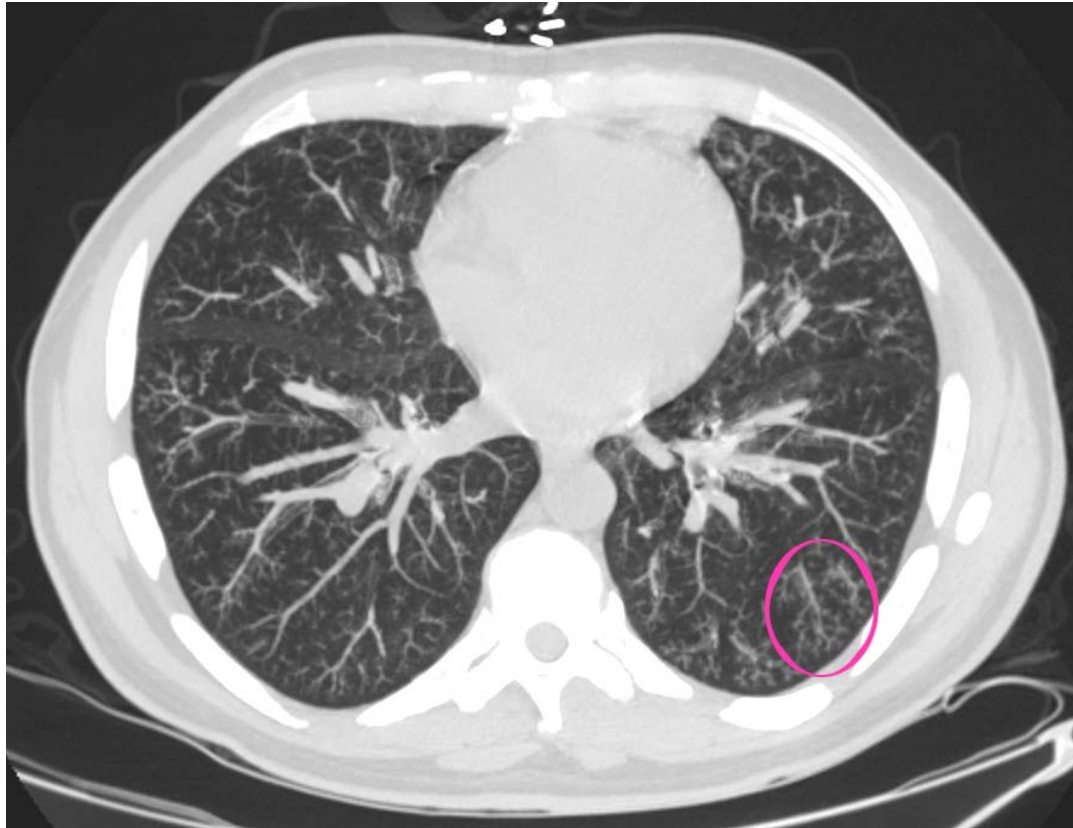
- + Pulmonary edema
- + Lymphangitic spread

### Nodular:

- + Sarcoid
- + Lymphoma
- + Silicosis



# Common CT Chest Findings: Tree-in-Bud

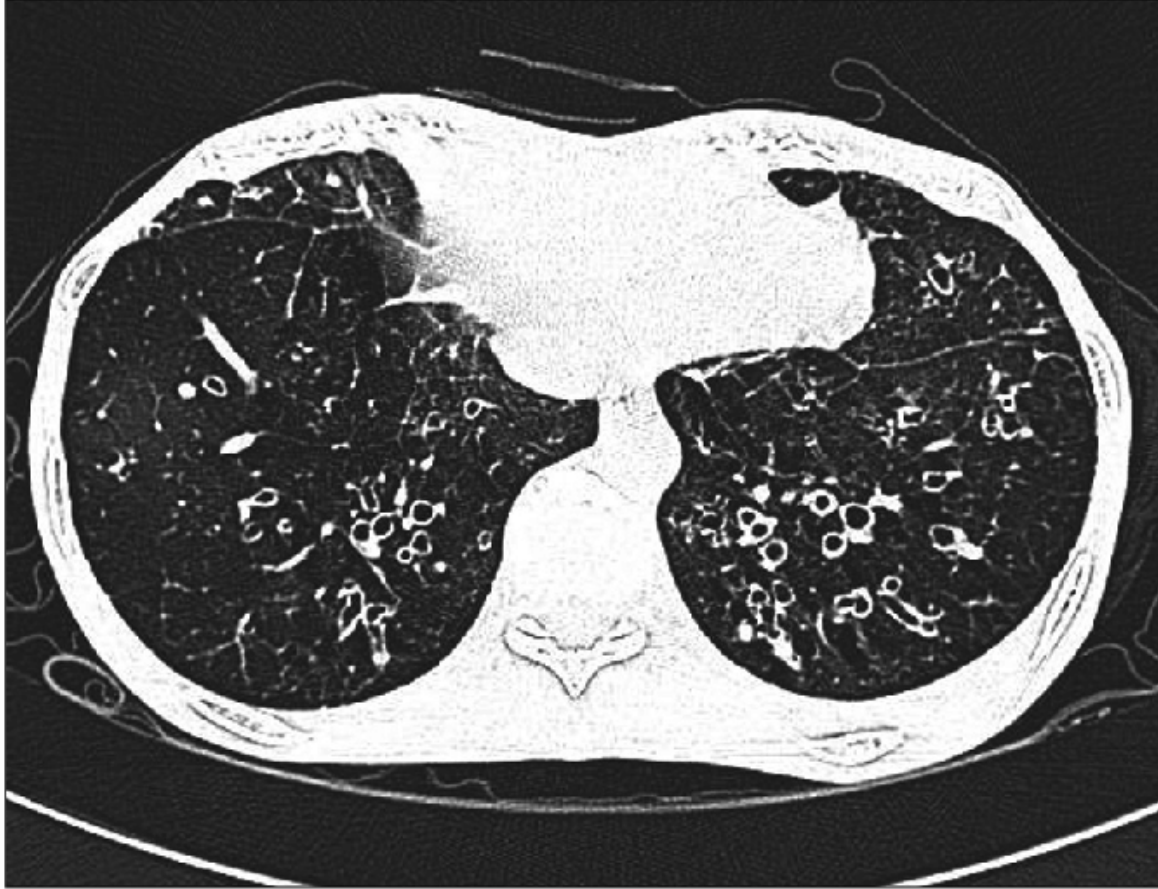


Suggestive of inflammation / decreased attenuation at distal bronchiole (bronchiolitis) or distal arteriole (tumor emboli)



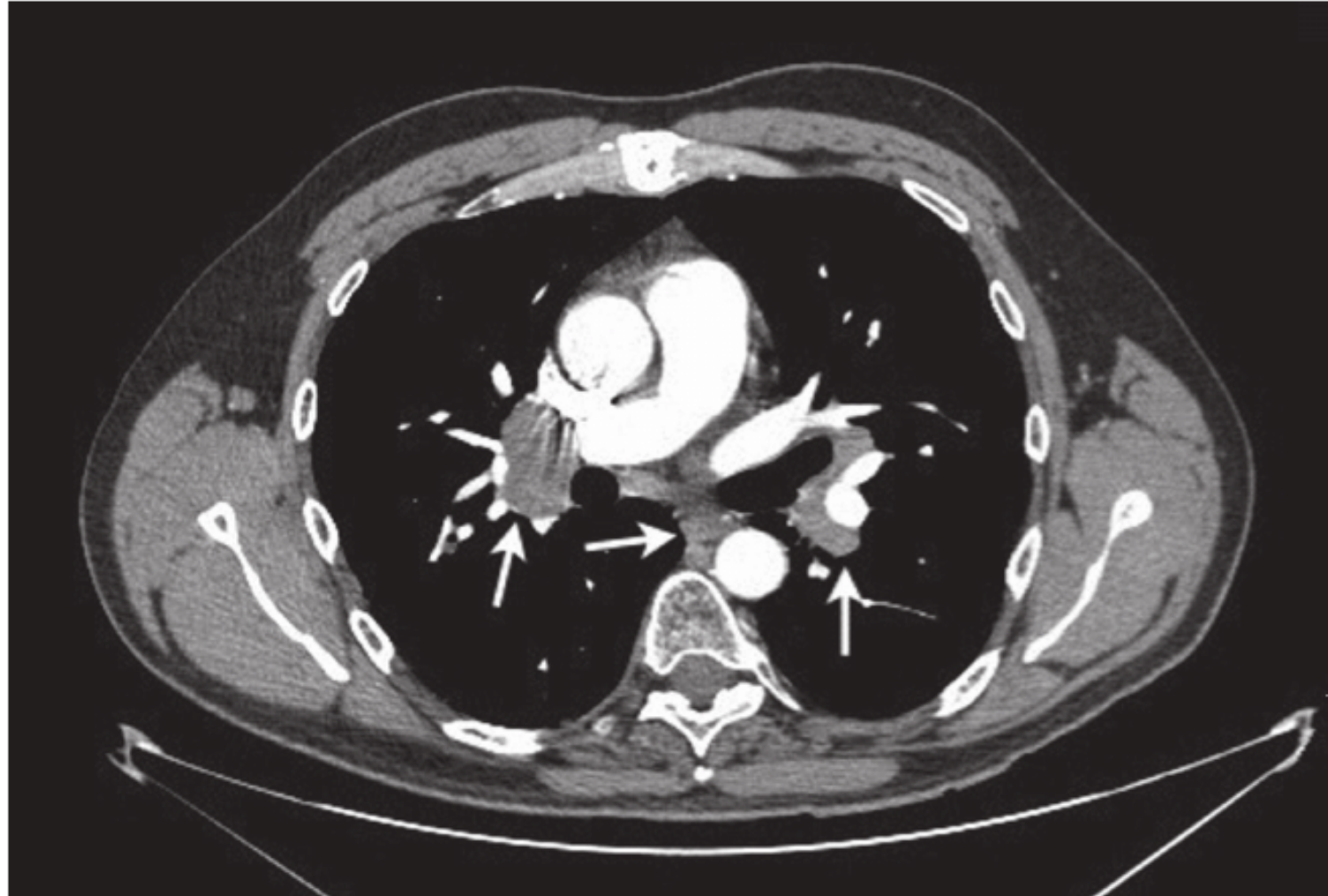


# Common CT Chest Findings: Bronchitis / Bronchiectasis





# Common CT Chest Findings: Lymphadenopathy

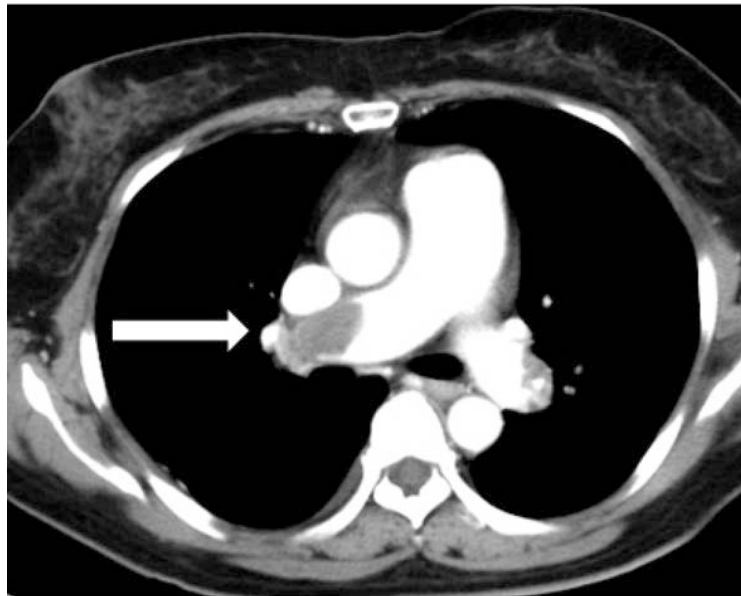




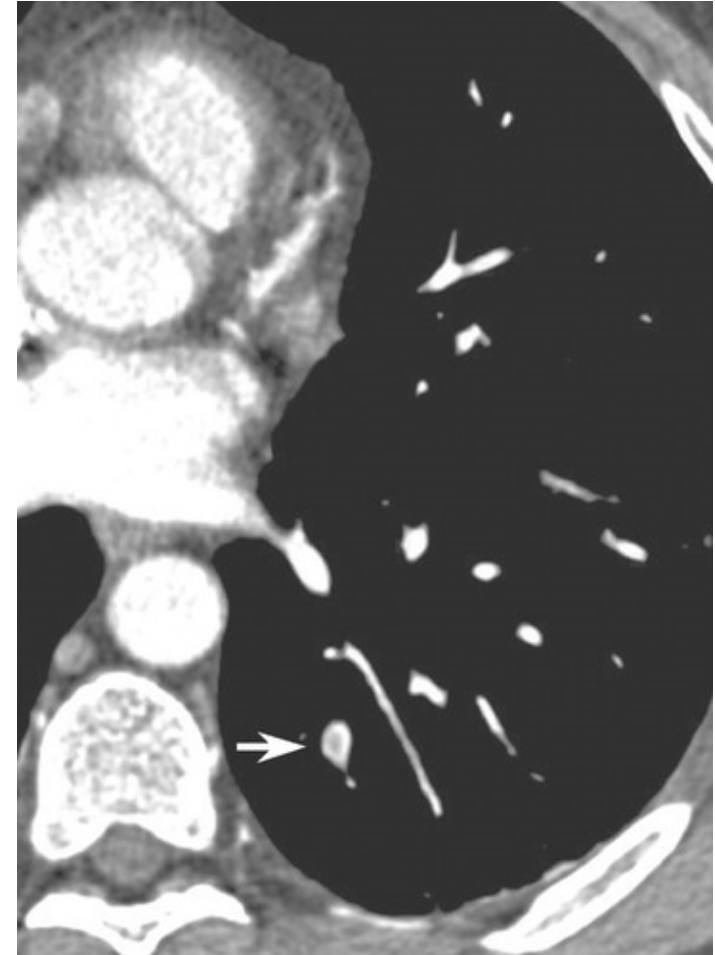
# Common CT Chest Findings: Pulmonary Embolism



Eng, et al. Singapore Med J. 2009; 50(4): 403-6



Yoon, et al. Korean Circ J. 2011; 41(7): 356-362



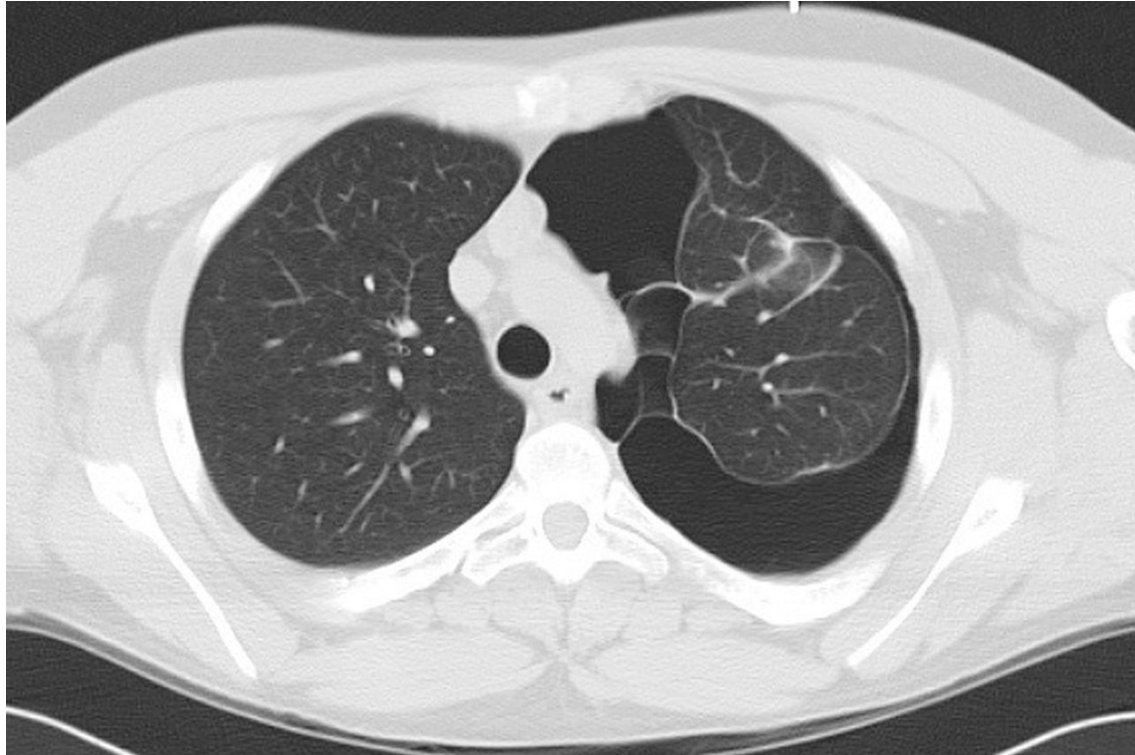
Schoepf, et al. Circulation. 2004; 109): e220-221





# Common CT Chest Findings: Pleural Disease

Pneumothorax



Geake, et al. Eur Resp Review. 2014; 23: 145-147.

Pleural Effusion (Loculated)



Hooper, et al. BMJ Thorax. 2010; 65 (Supp 2): 4-17





Imaging is enhanced by having clinical context.  
It is not a substitute.



# THANK YOU!

## Transplant Pulmonologists

David Erasmus, MD- Medical Director  
Anil J. Trindade MD – Assoc. Med Director  
Ivan M. Robbins, MD  
Katie A. McPherson, MD  
Stephanie Norfolk, MD  
Ciara Shaver MD, PhD

## Transplant Surgeons

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Matthew Bacchetta MD, MBA – VLI Surgical Director  
Caitlin T. Demarest, MD, PhD  
Erin Gillaspie, MD  
Eric Grogan, MD



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<https://www.vanderbilthealth.com/program/lung-transplant>