



Brigham and Women's Hospital

Founding Member, Mass General Brigham

Chest X-Ray Interpretation for the Boards

R. Elaine Cagnina, MD, PhD

Associate Physician

Division of Pulmonary and Critical Care Medicine

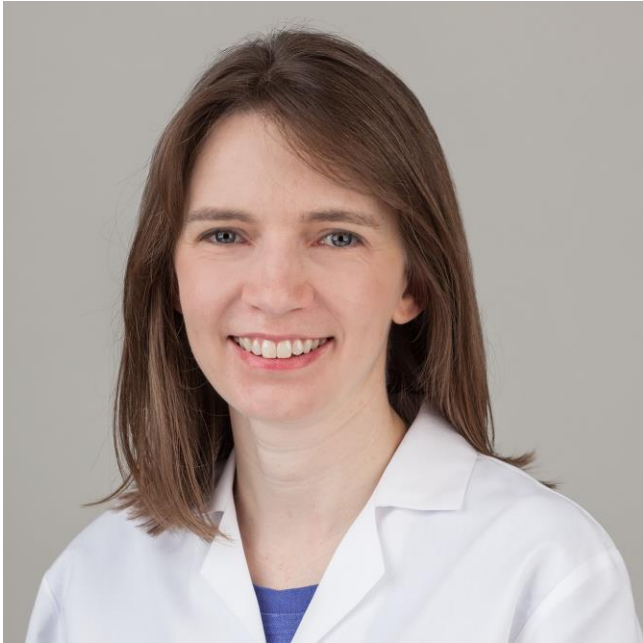
Brigham and Women's Hospital

Instructor of Medicine

Harvard Medical School



Elaine Cagnina, MD, PhD



- University of Virginia Medical Scientist Training Program
- Medicine Residency @ University of Virginia
- Pulmonary and Critical Care Fellowship @University of Virginia
- Instructor of Medicine @ HMS
- Medical Director, Medical ICU, BWFH
- Associate Director, Adult Cystic Fibrosis Program at Boston Children's and Brigham and Women's Hospitals

DISCLOSURES

I have no relevant financial relationships with ineligible companies.



OBJECTIVES / OUTLINE

Basic CXR interpretation and anatomy

Review specific pathologies

Mediastinal and Hilar findings

Pneumothorax

Pleural disease

Pulmonary edema (cardiogenic, non-cardiogenic)

Pneumonia

Tuberculosis

Chronic lung disease (ILD, COPD, CF)

Pulmonary Embolism

Occupational Lung Disease

High yield "buzzword" diagnoses

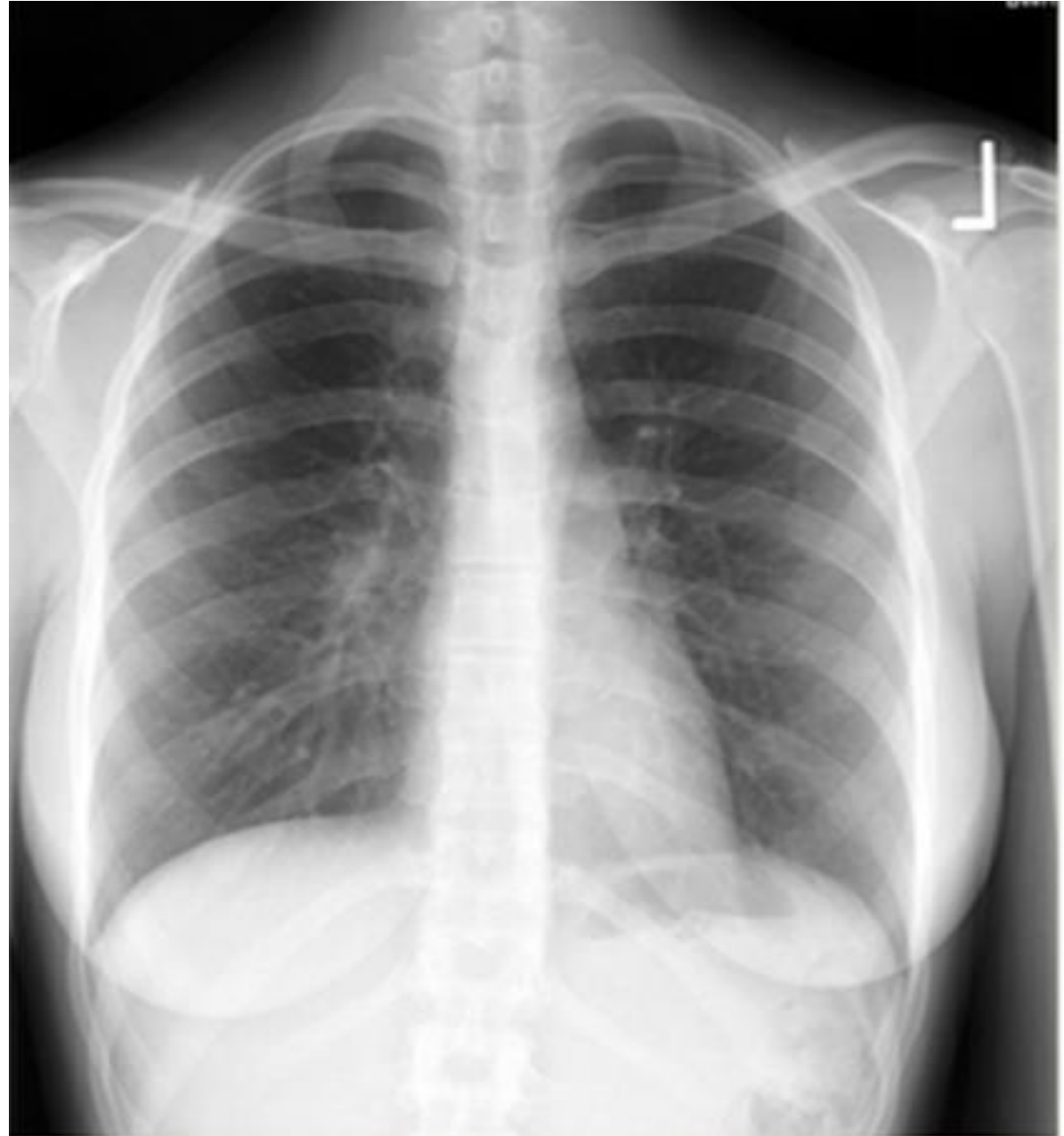


Basic CXR Interpretation

Before you start . . .

Know what you are looking at and assess the quality of the film.

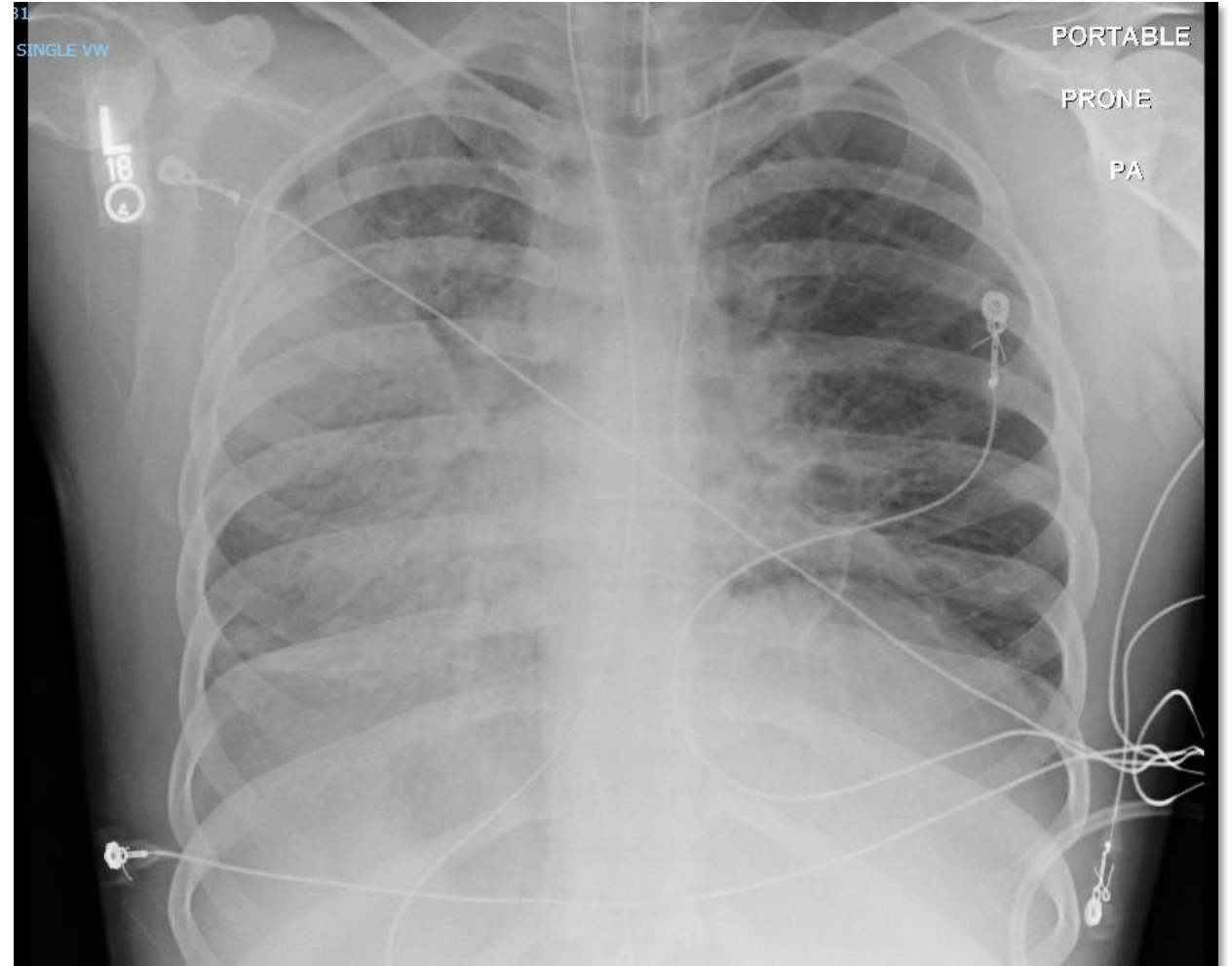
- AP or PA film? (cardiac silhouette will look larger in AP film. If unlabeled, assume PA)
- Orientation (occasionally you will find a supine film)
- Penetration
- Rotation
- Inspiration
- Projection (did they shoot it from the bottom of the bed for an inpatient film?)



Both have L sided cardiac silhouette



Situs inversus



Prone ARDS

Chest X-ray Interpretation: Lung Parenchyma Last Method

1. OUTSIDE

Start at the periphery and move inward

1 SOFT TISSUE AND BONES

- Soft tissues (masses, swelling)
- Clavicles
- Ribs
- Scapulae
- Spine



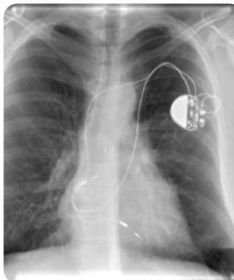
2 DIAPHRAGMS AND ABDOMEN

- Diaphragm contours (right vs left)
- Costophrenic angles
- Subdiaphragmatic free air
- Upper abdomen (bowel gas pattern)



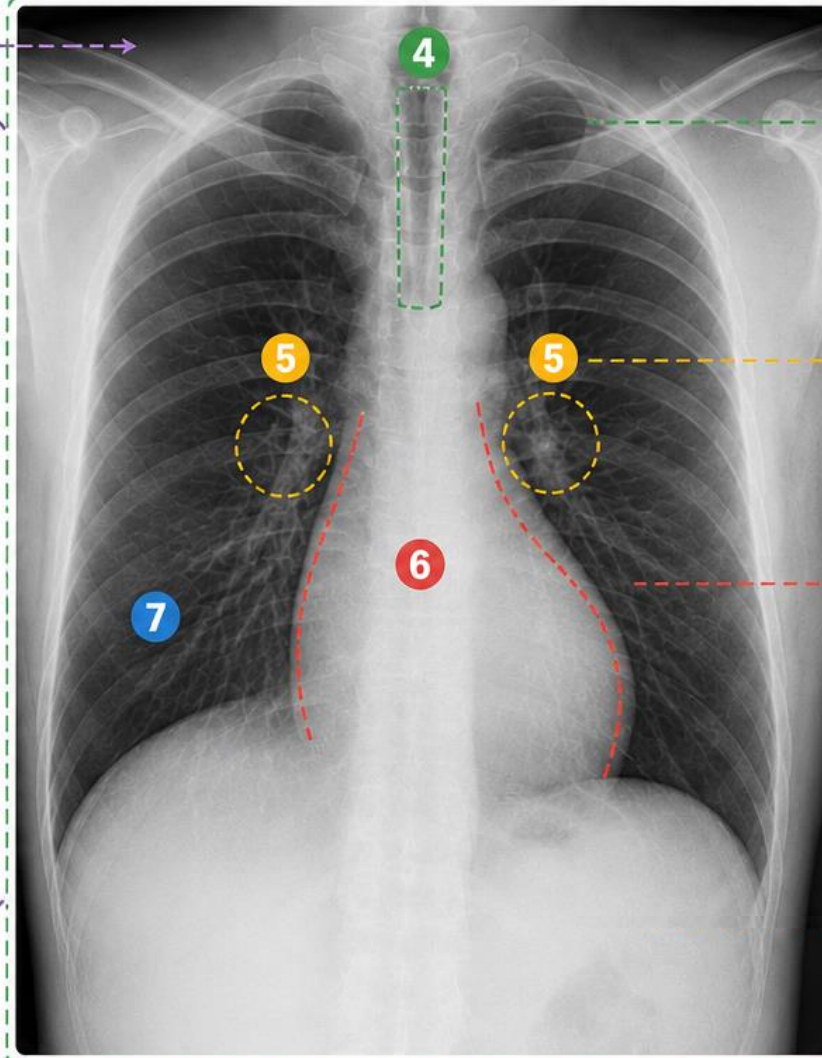
3 LINES, DRAINS, AIRWAYS

- Endotracheal tube
- Central lines
- Chest tubes
- Pacemaker/ICD leads



2. MIDDLE

Move to the central structures



3. LUNG FIELDS

Finally, systematically evaluate the lung fields

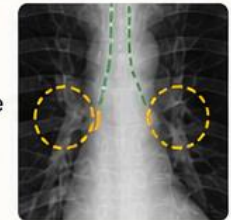
4 TRACHEA

- Midline?
- Deviation
- Tracheal contour



5 AORTIC KNOB AND MEDIASTINUM

- Aortic knob contour and size
- Mediastinum width
- Hilum symmetry
- Pulmonary vasculature



6 CARDIAC BORDER

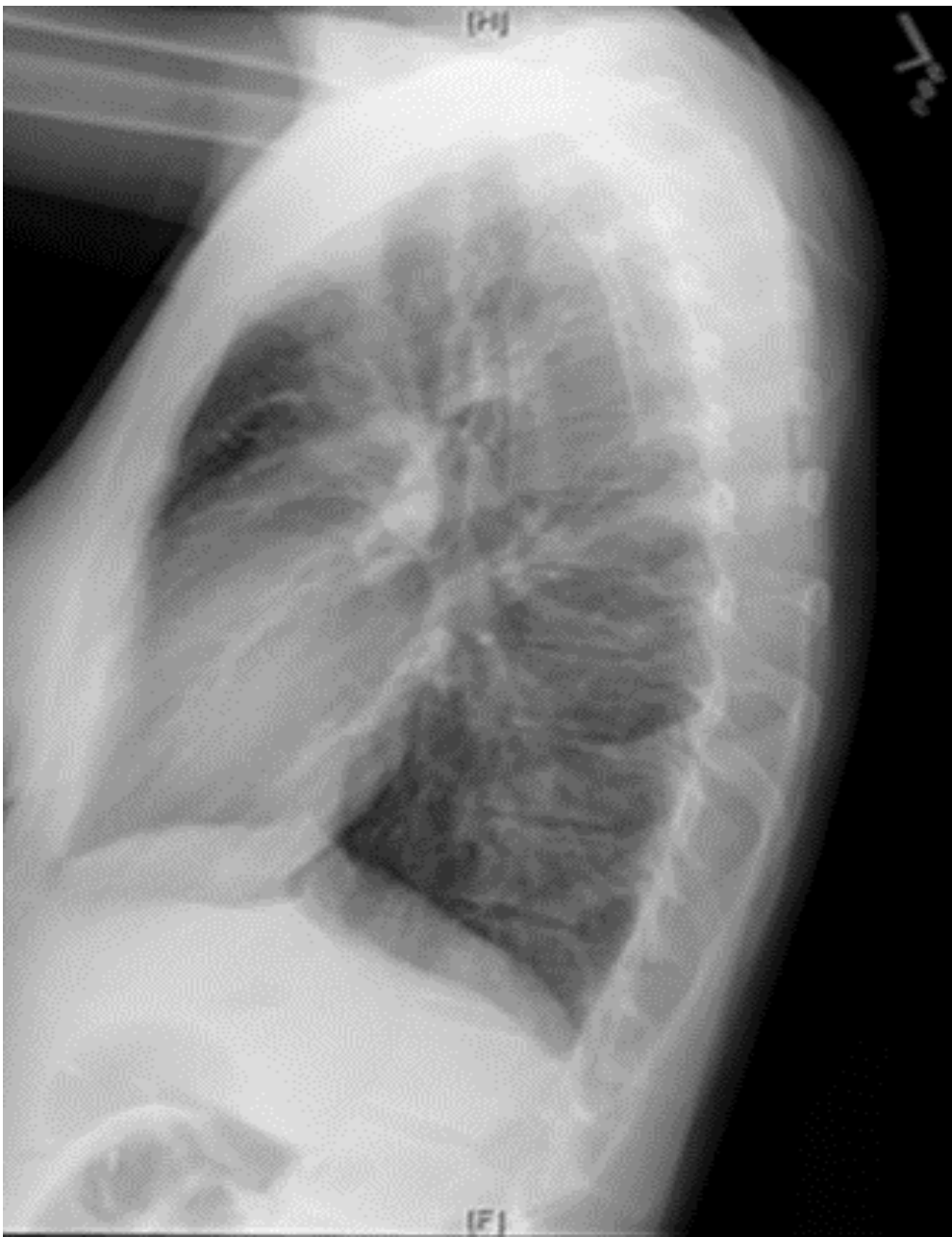
- R (right) heart border
 - Normal vs prominent
- L (left) heart border
 - Normal vs prominent
- Cardiac size



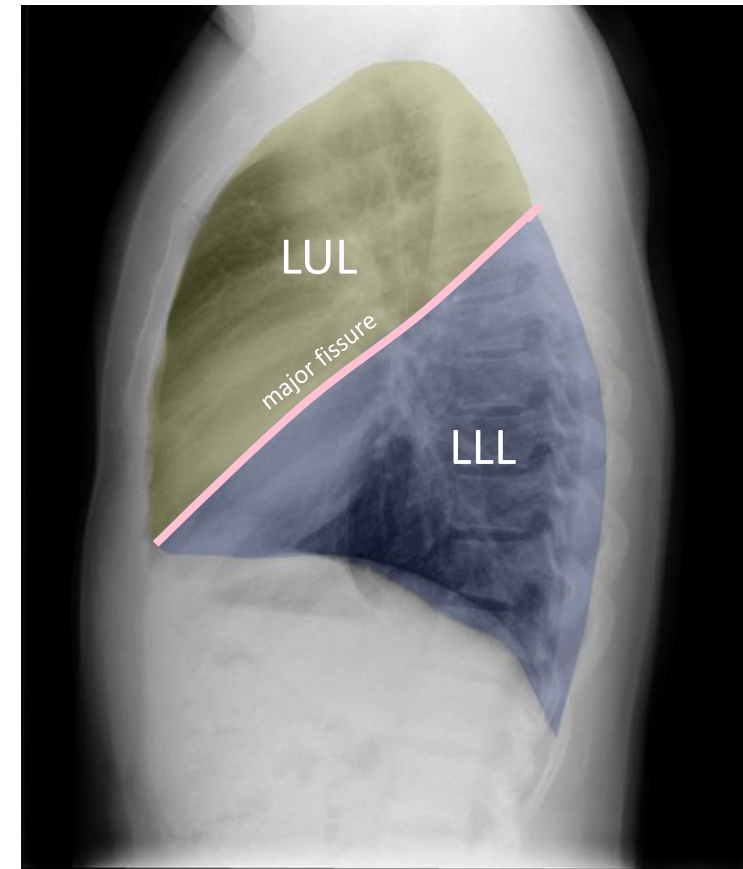
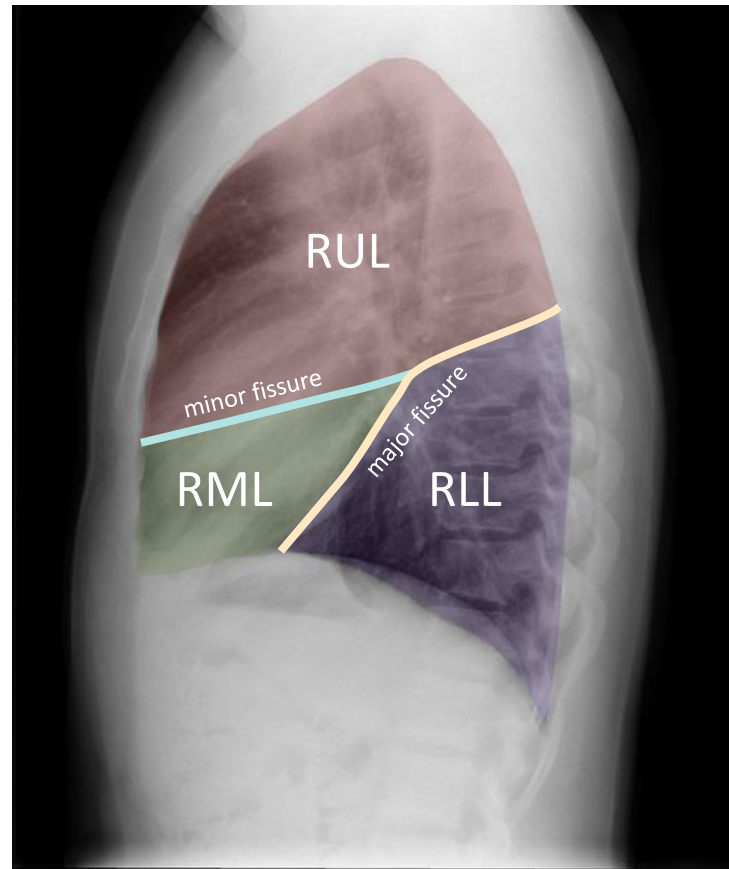
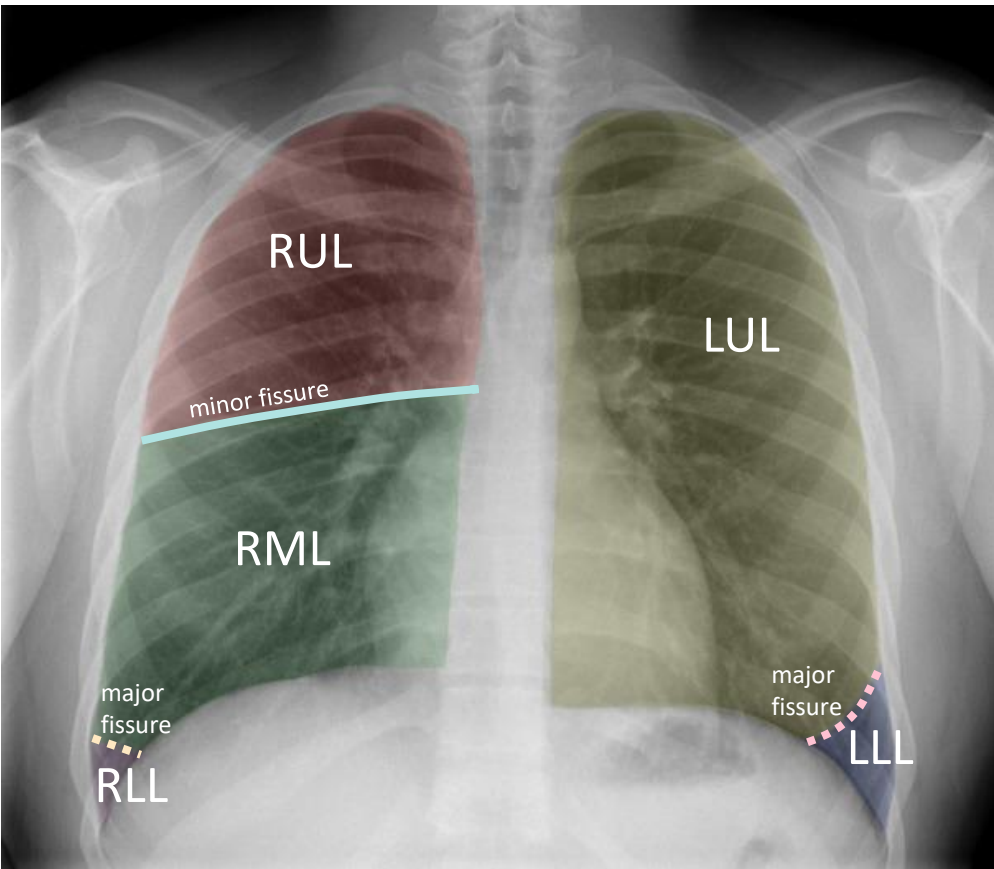
7 LUNG FIELDS

- Airspace (consolidation)
- Interstitium
- Nodules / masses
- Cavities
- Pleura (effusion, pneumothorax)
- Pulmonary vessels

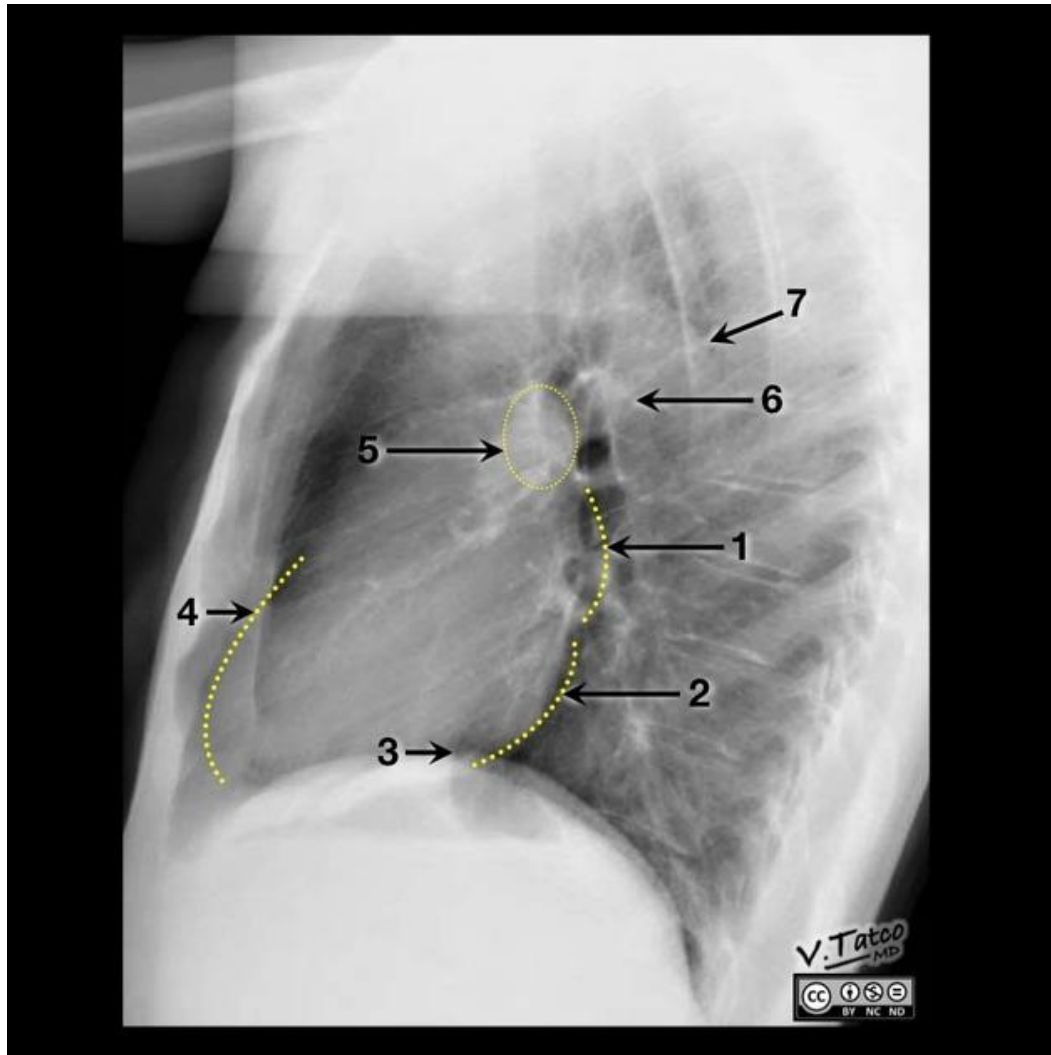




CXR anatomy



Lateral CXR Anatomy

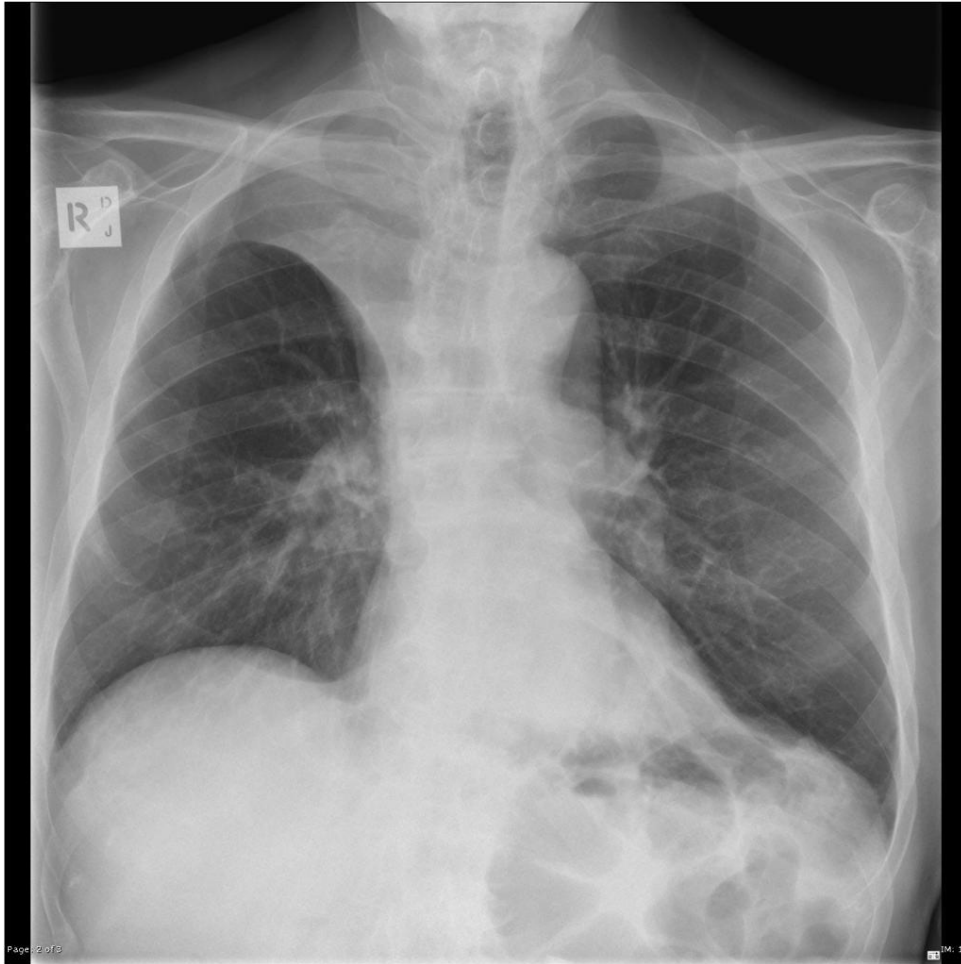


1. Left atrium
2. Left ventricle
3. Inferior vena cava
4. Right ventricle
5. Right pulmonary artery
6. Left pulmonary artery
7. Aorta

Takeaways from lateral view for boards:

- Mediastinal mass
- Mediastinal lymphadenopathy
- Spine sign (lower lobe consolidation)
- Pleural effusion
- Diaphragm contours (flattened in COPD)

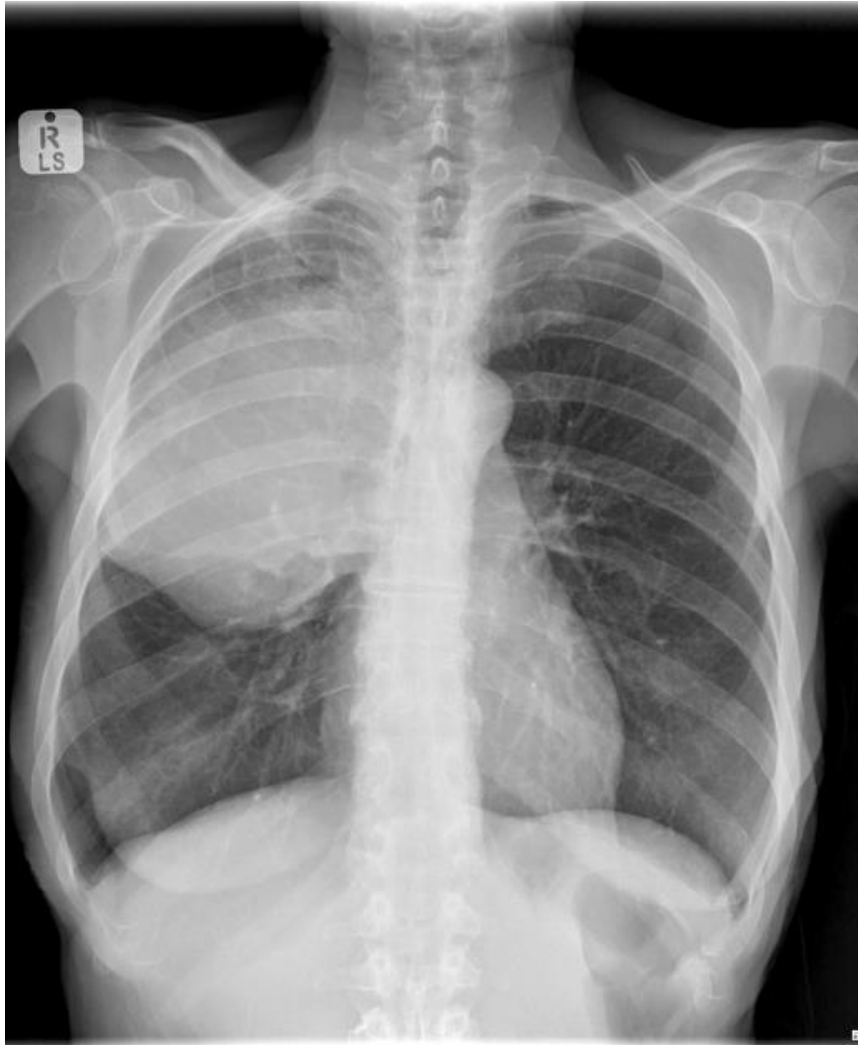
Knowing your anatomy can help identify the abnormality



RUL collapse – mucous plug, obstructing mass

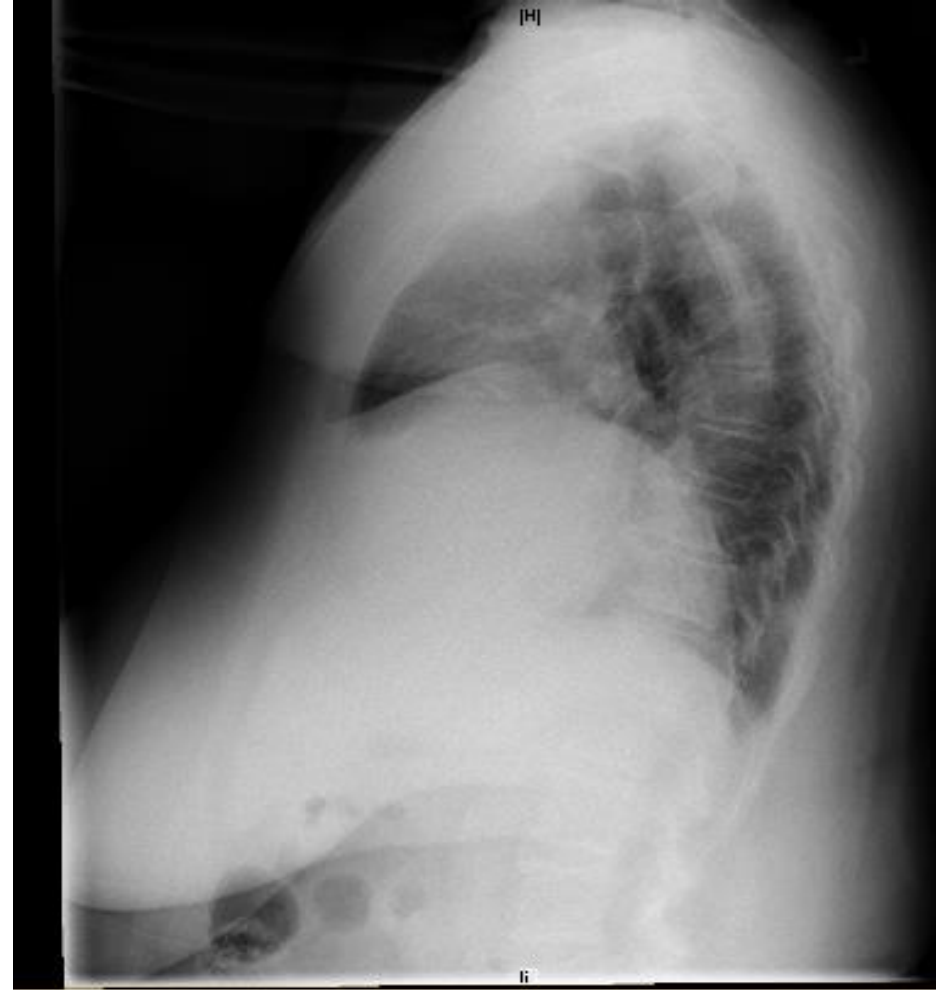
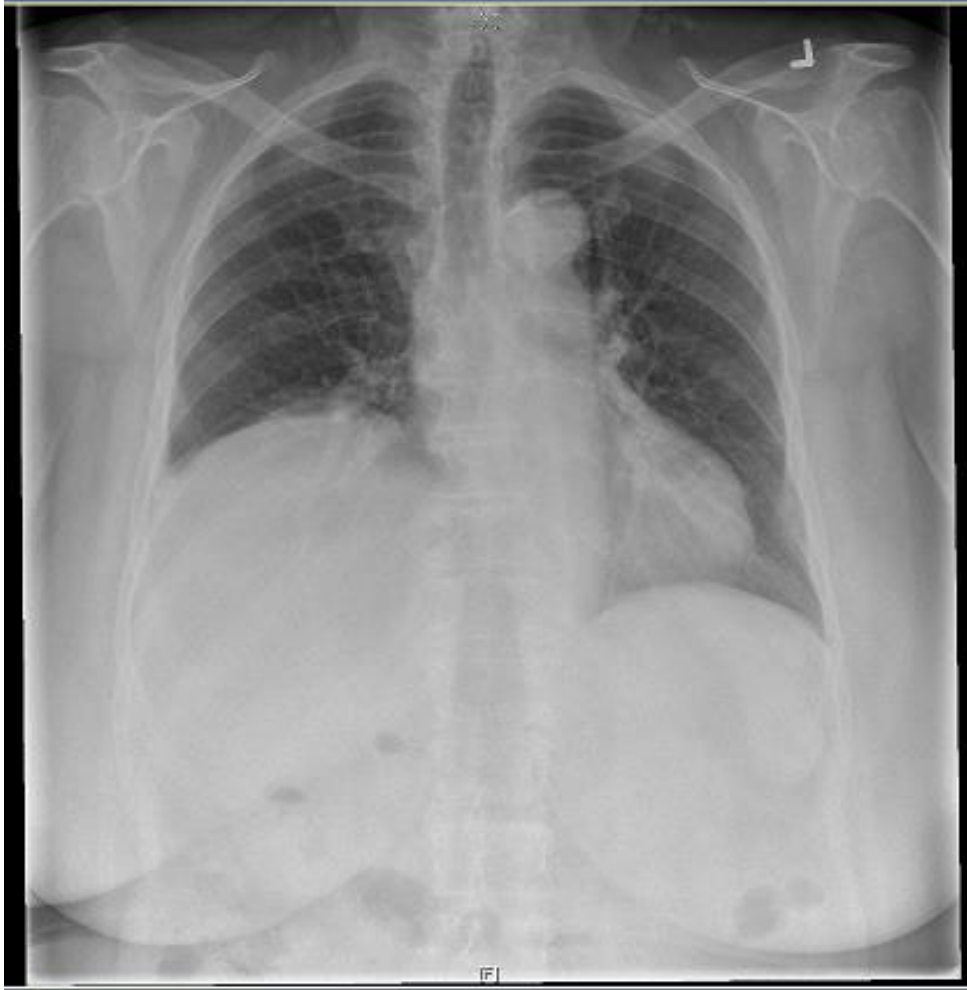


Knowing your anatomy can help identify the abnormality



RUL squamous cell cancer with bulging R minor fissure

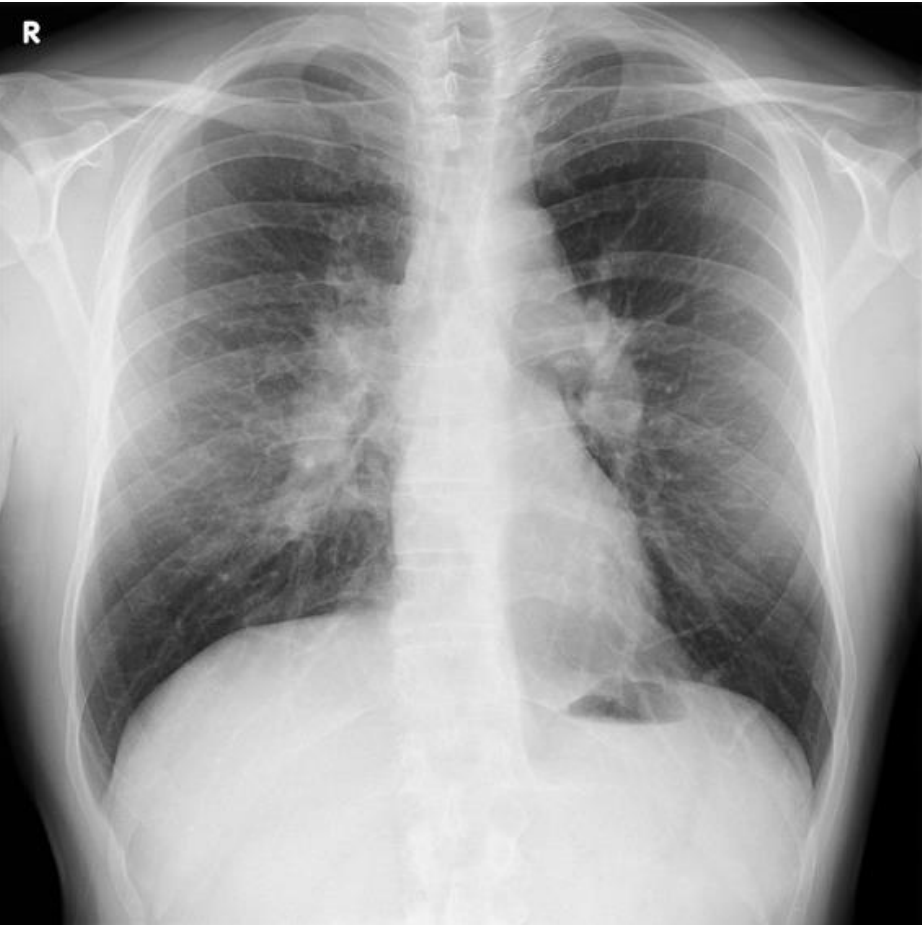
Knowing your anatomy can help identify the abnormality



R hemidiaphragm paralysis



Mediastinal and Hilar Pathology

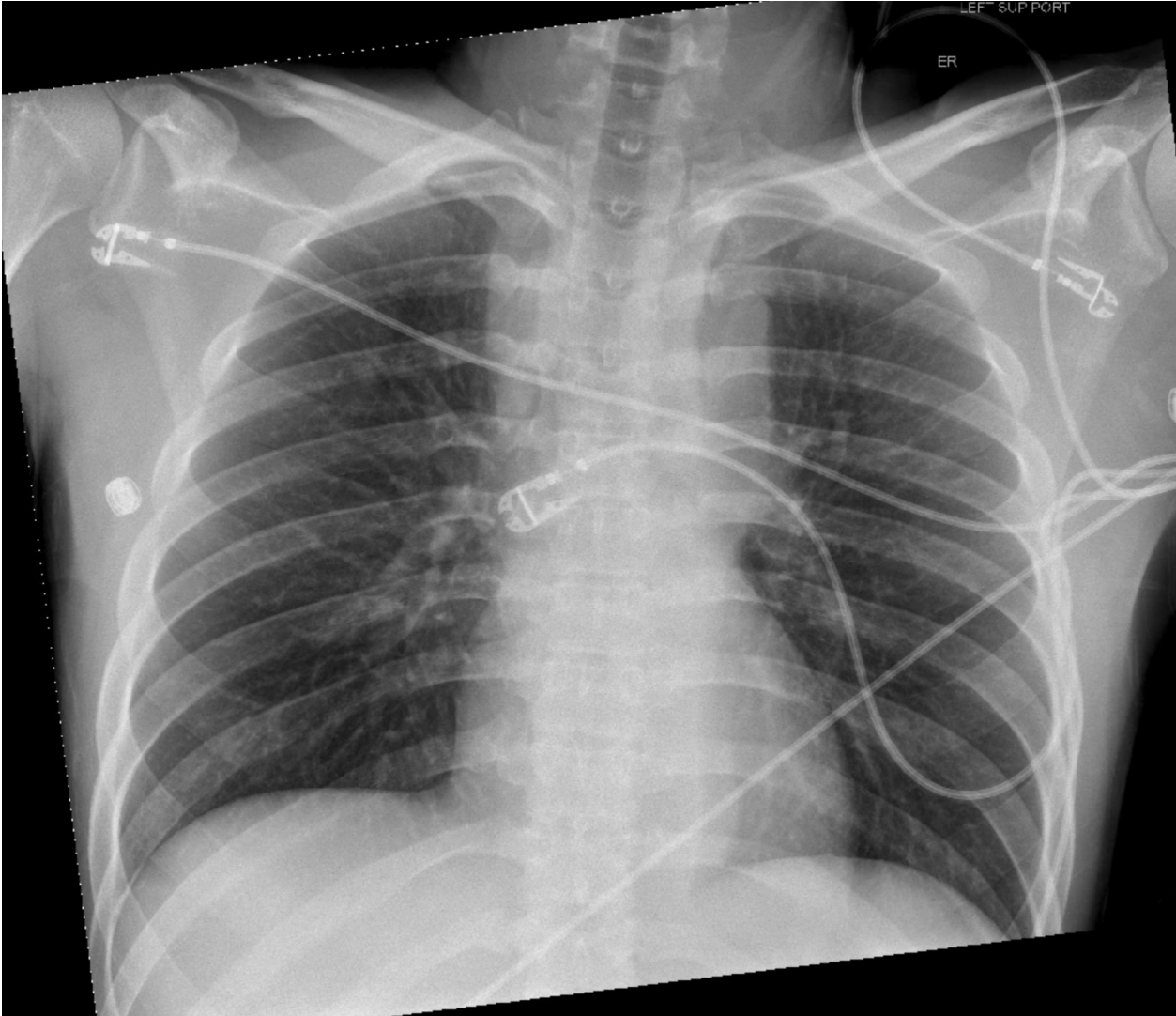


Bilateral hilar adenopathy

- Sarcoidosis (stage 1)
- Berylliosis
- Lymphoma
- Granulomatous disease (TB, NTM)
- Metastatic cancer



Mediastinal and Hilar Pathology



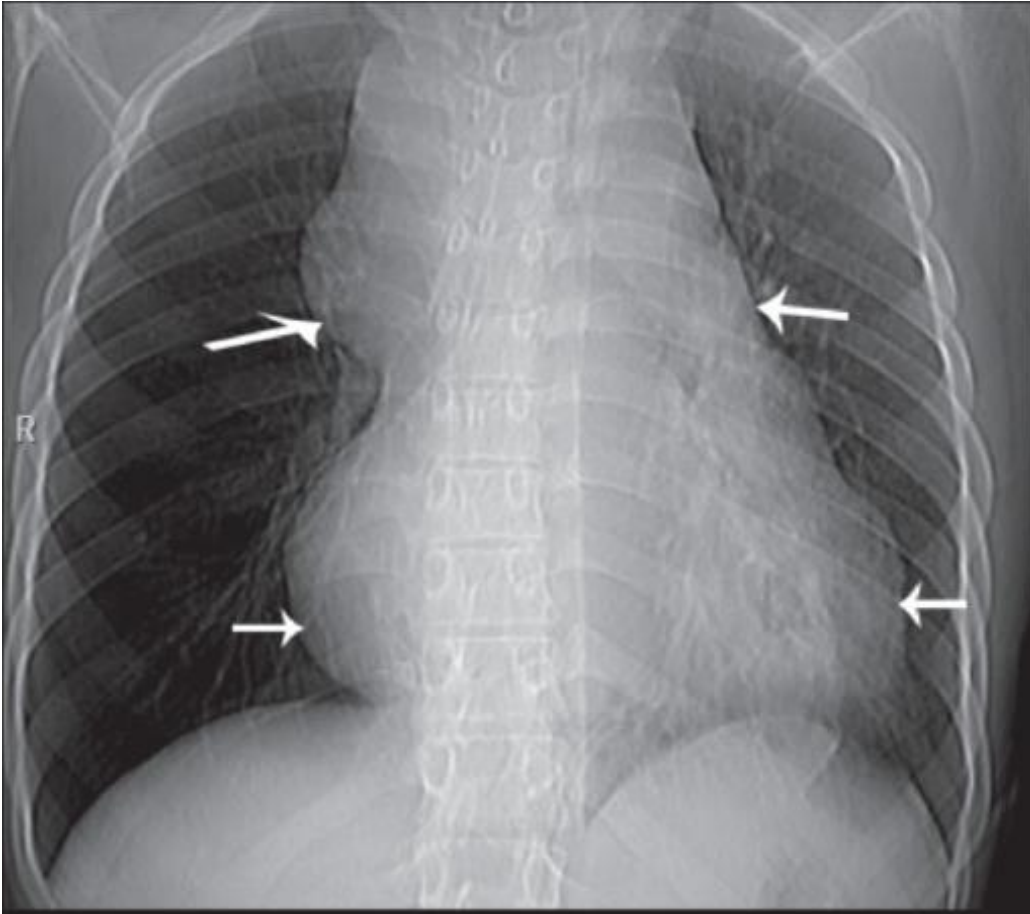
Widened mediastinum

Emergent association:

Aortic dissection

- Loss of normal contour of aortic arch

Mediastinal and Hilar Pathology



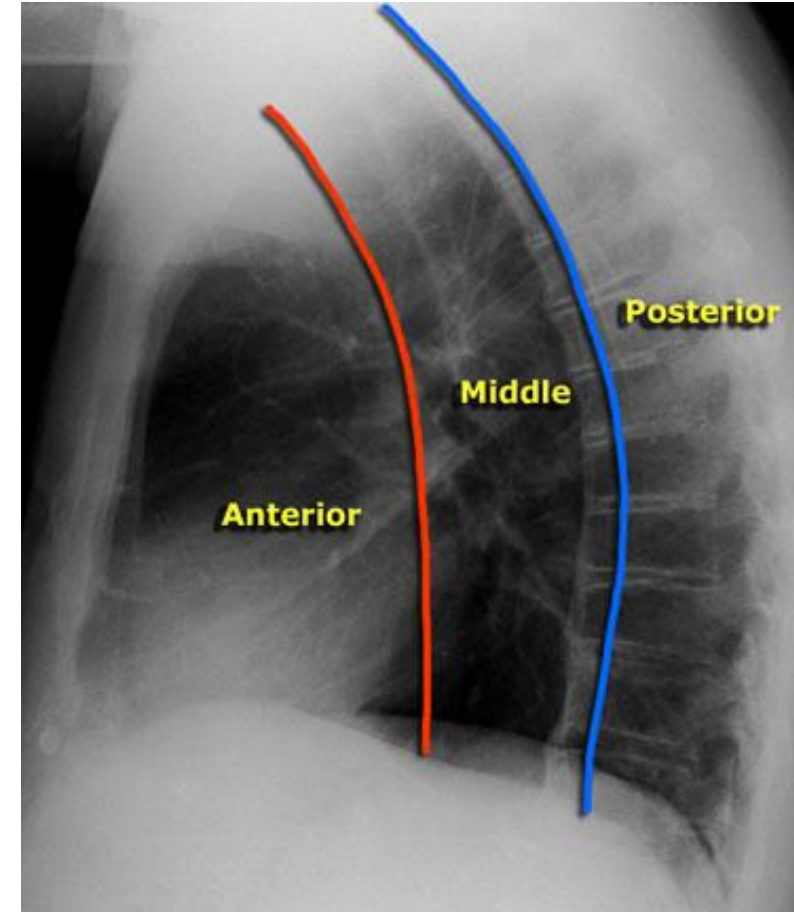
Widened mediastinum

- Mediastinal mass

Anterior mediastinal mass

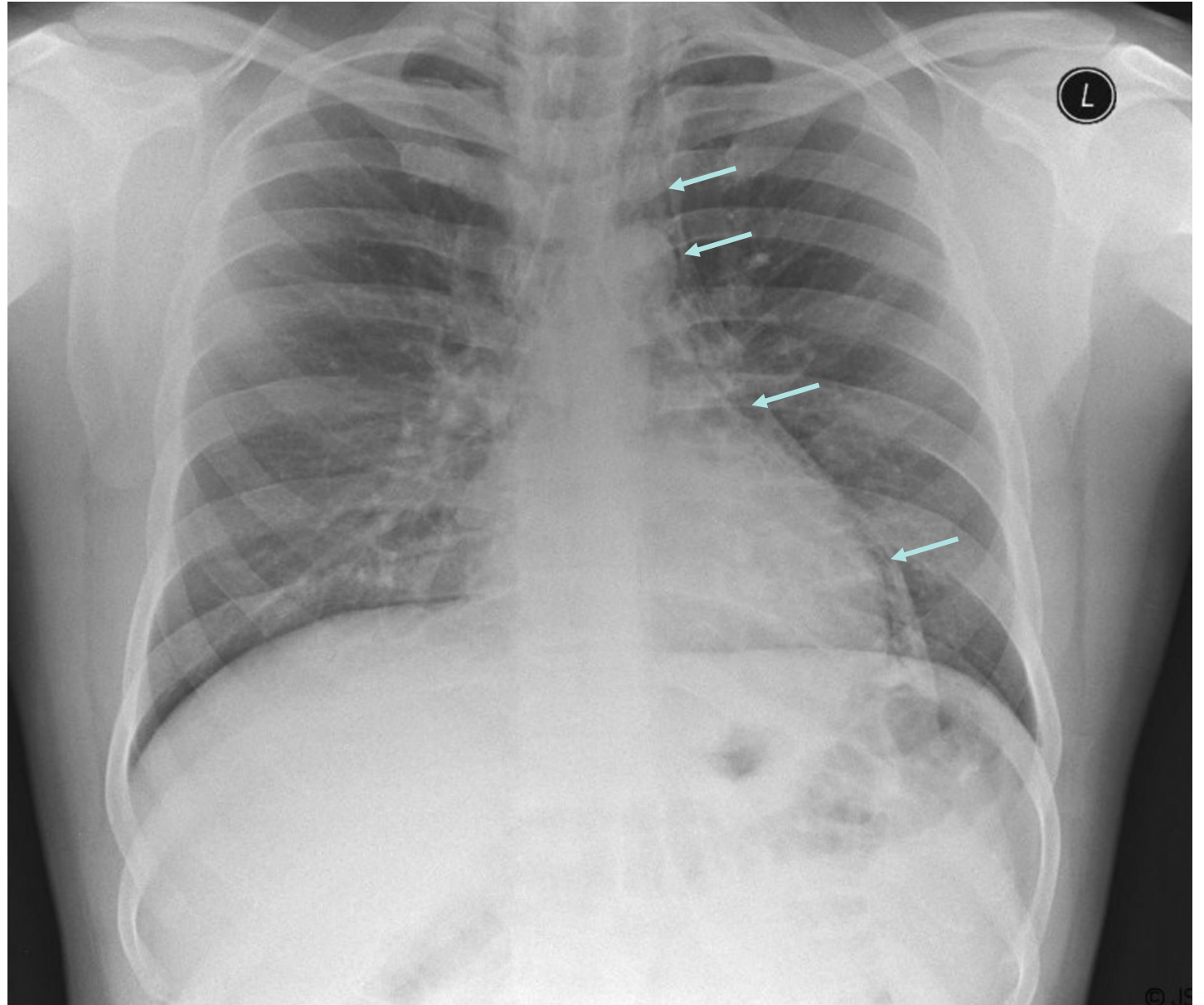
Classic “4 Ts”:

- Thymoma
- Teratoma
- Thyroid
- Terrible lymphoma

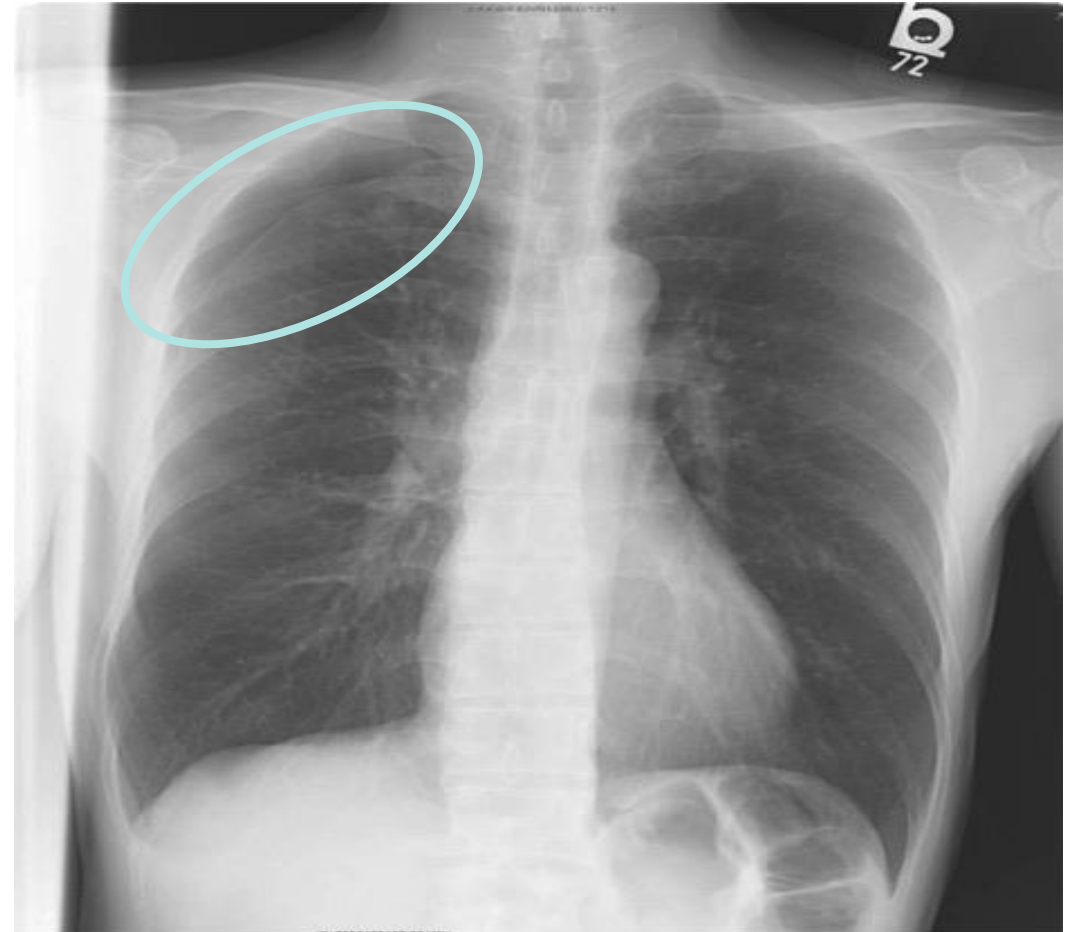
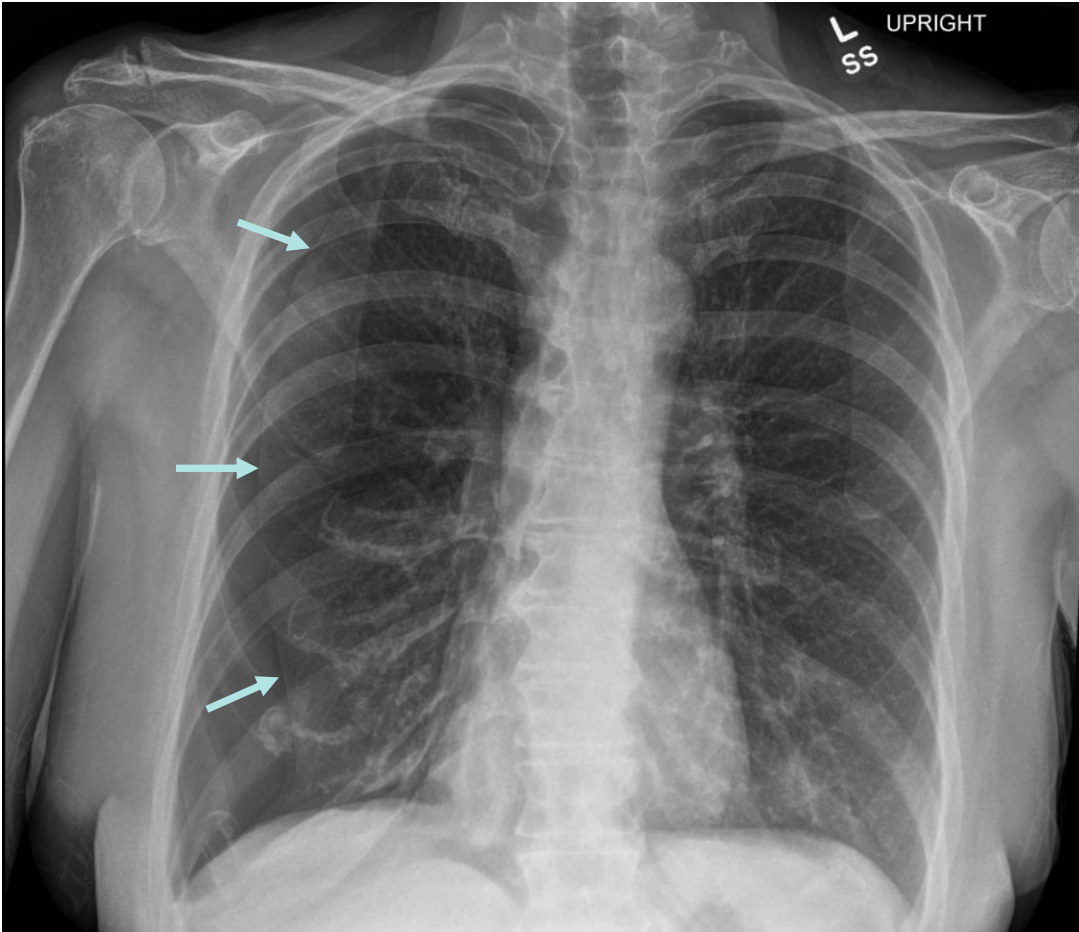


Pneumomediastinum

- Underlying lung disease (CF, IPF, asthma) – often after coughing
- Boerhaave syndrome (esophageal rupture after prolonged vomiting)
- Inhaled substances
- Altitude / pressure changes (i.e. scuba diving)
- Trauma
- Iatrogenic



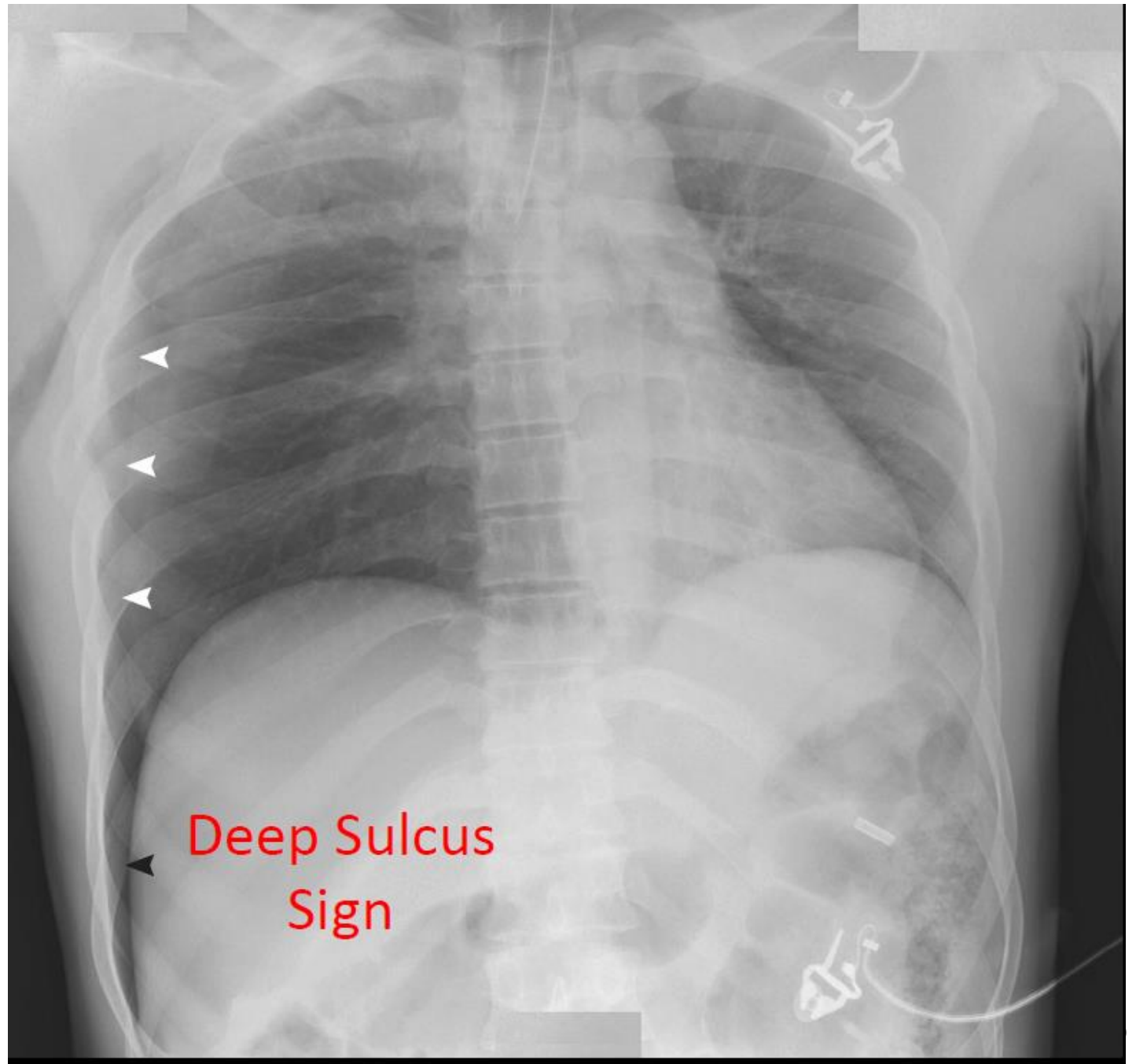
Pneumothorax



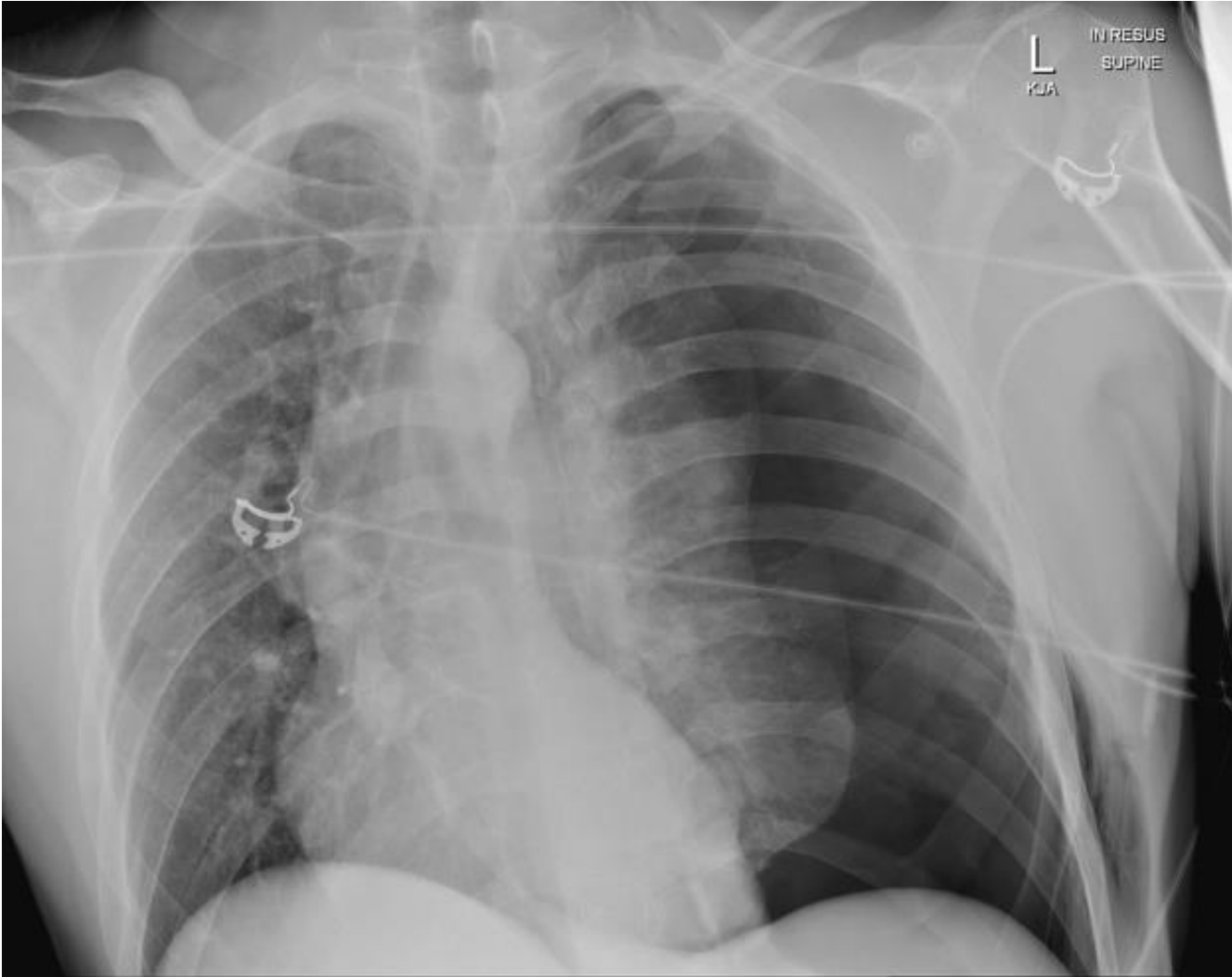
Recognize:

- Visible pleural line
- Absence of lung markings peripheral to line

Pneumothorax



Tension Pneumothorax



Tension pneumothorax findings:

Mediastinal shift

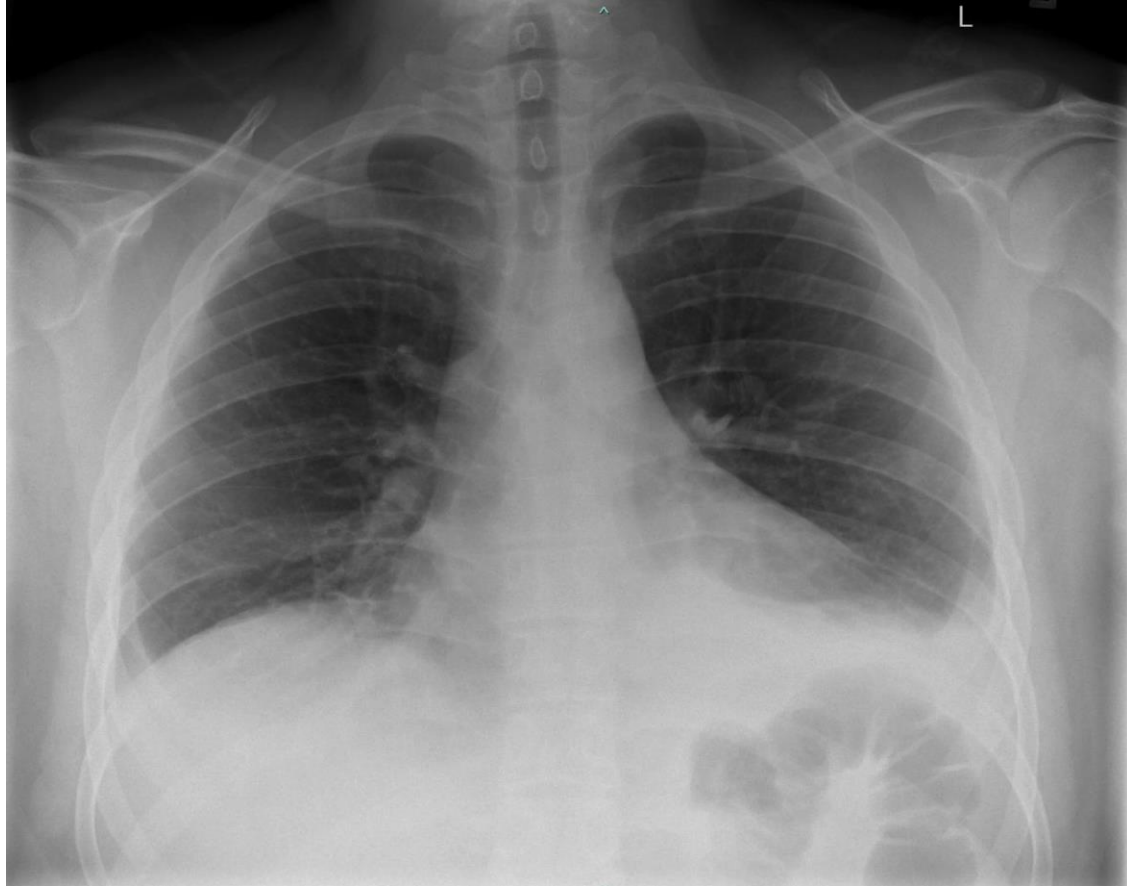
Lung collapse

Clinically:

- Hypotension
- Distended neck veins
- Respiratory failure

Often due to trauma, rupture of pulmonary bleb (young healthy male playing sports)

Pleural Disease – Pleural effusion



Know how to recognize:

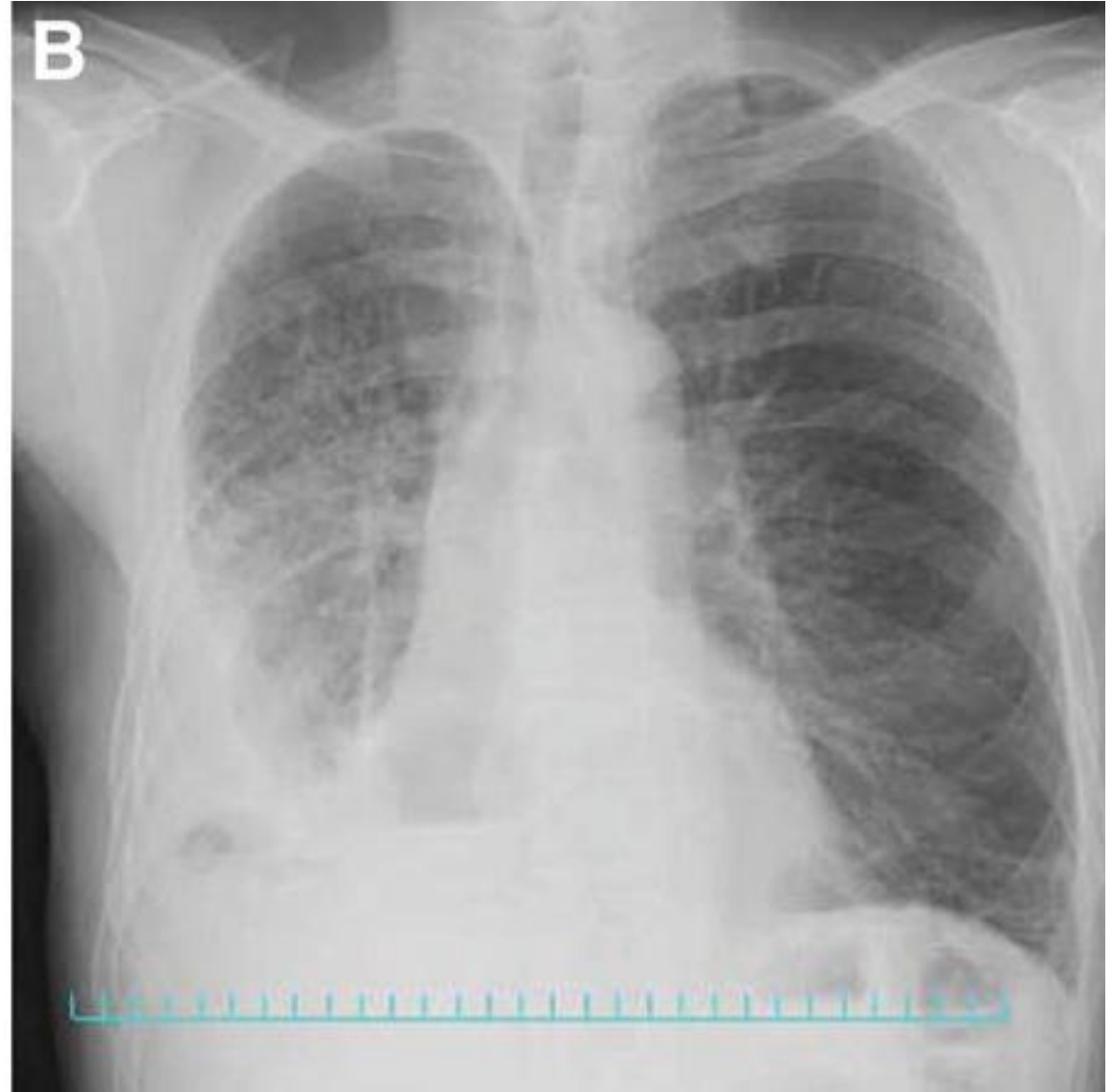
- Blunting of the costophrenic angle
- Meniscus sign
- Unilateral vs bilateral effusions

Pleural Disease – Bilateral effusions (CHF)



Pleural Disease - Empyema

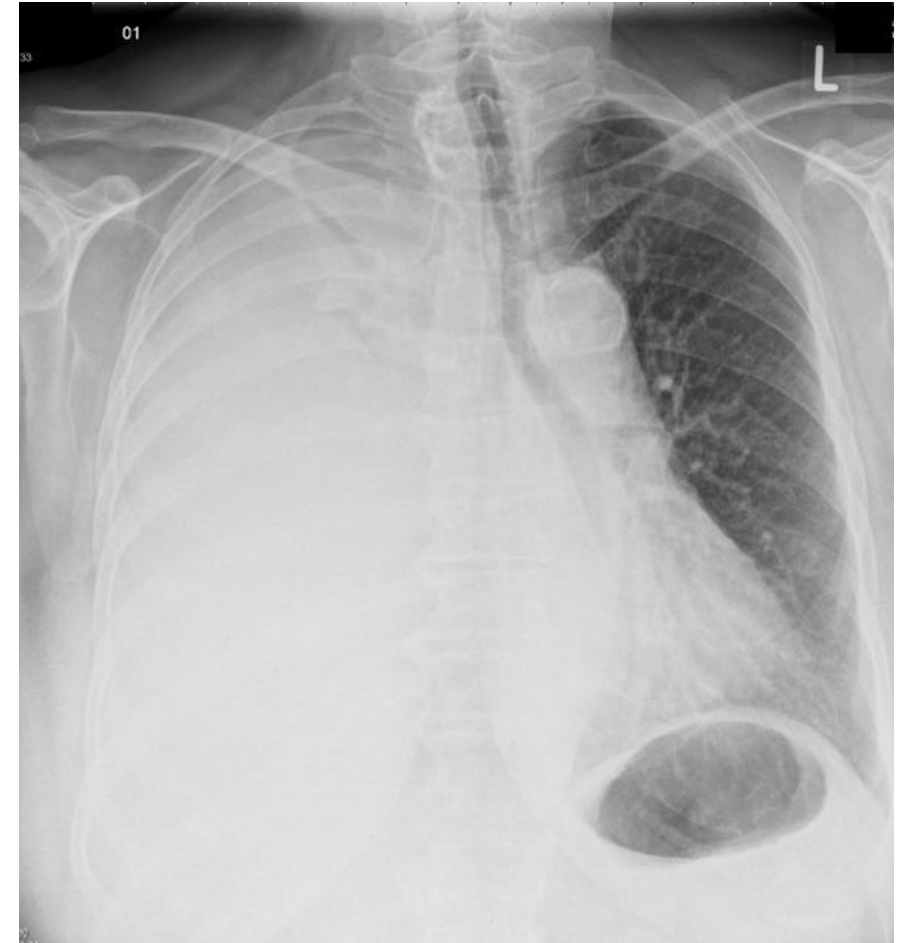
- Often associated with infiltrate
- May not follow gravity, no meniscus sign
- Possible air within fluid component



Pleural Disease – R Hemithorax Whiteout



Airway obstruction with complete atelectasis
– think mucous plugging, tumor, foreign body



Large pleural effusion – trauma, malignancy, hepatic hydrothorax



Pulmonary Edema – Cardiogenic



Classic findings:

- Cephalization
- Kerley B lines
- **Bat-wing** perihilar opacities
- Cardiomegaly
- Pleural effusions
- Fluid in the fissures



Pulmonary Edema – Non-Cardiogenic (ARDS, TRALI, TACO)



ARDS

B/l symmetric opacities

Not explained by heart failure

Often will have an endotracheal tube

Question stem will highlight acute onset

Common causes of ARDS

Sepsis

Pneumonia

Pancreatitis

Trauma

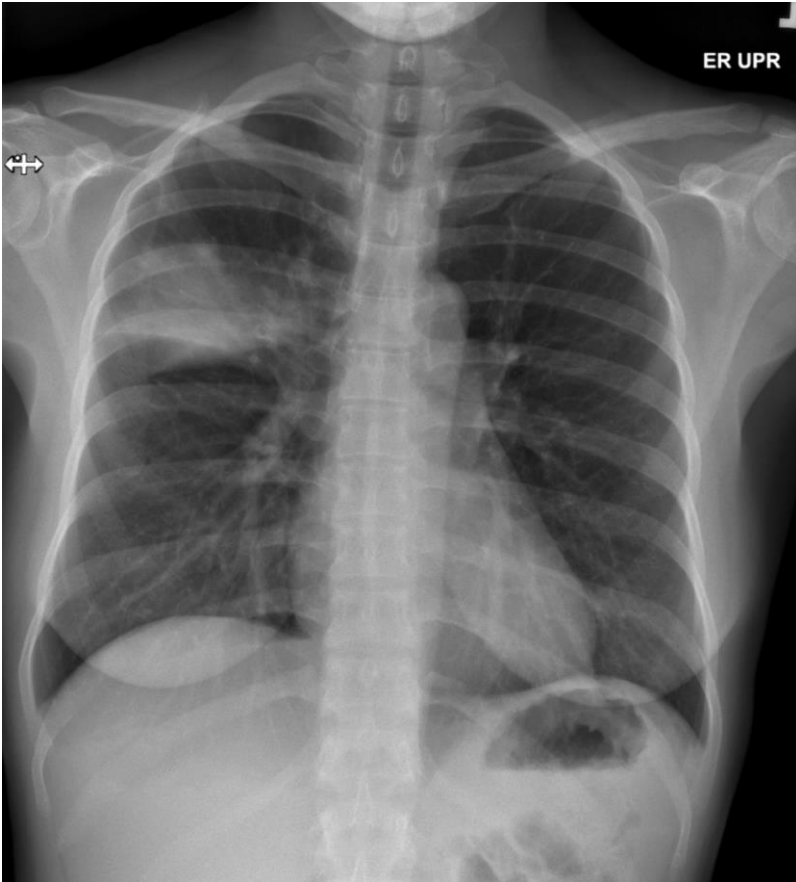
Aspiration

Inhalational Injury

Pulmonary Edema – Non-Cardiogenic - TRALI



Pneumonia – Lobar Pneumonia



Pneumonia Patterns

Lobar pneumonia

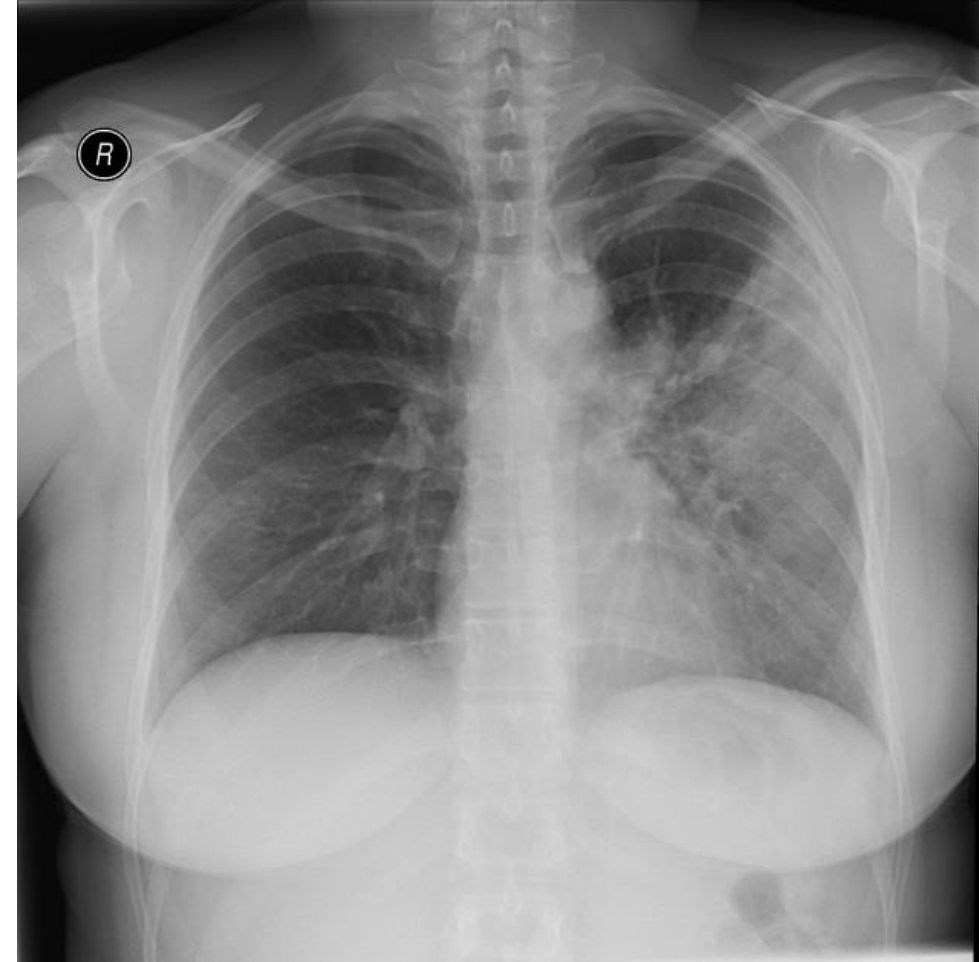
- Dense focal consolidation
- Can have air bronchograms.

Classic organisms:

- Streptococcus pneumoniae (most common)
- Klebsiella
- Legionella
- Staph aureus

Also think about **aspiration**:

- Dependent infiltrates
- RLL most common upright, can be posterior upper lobes if supine (i.e. after surgery)



Pneumonia – Atypical / Interstitial Pneumonia



Diffuse reticular or patchy infiltrates.

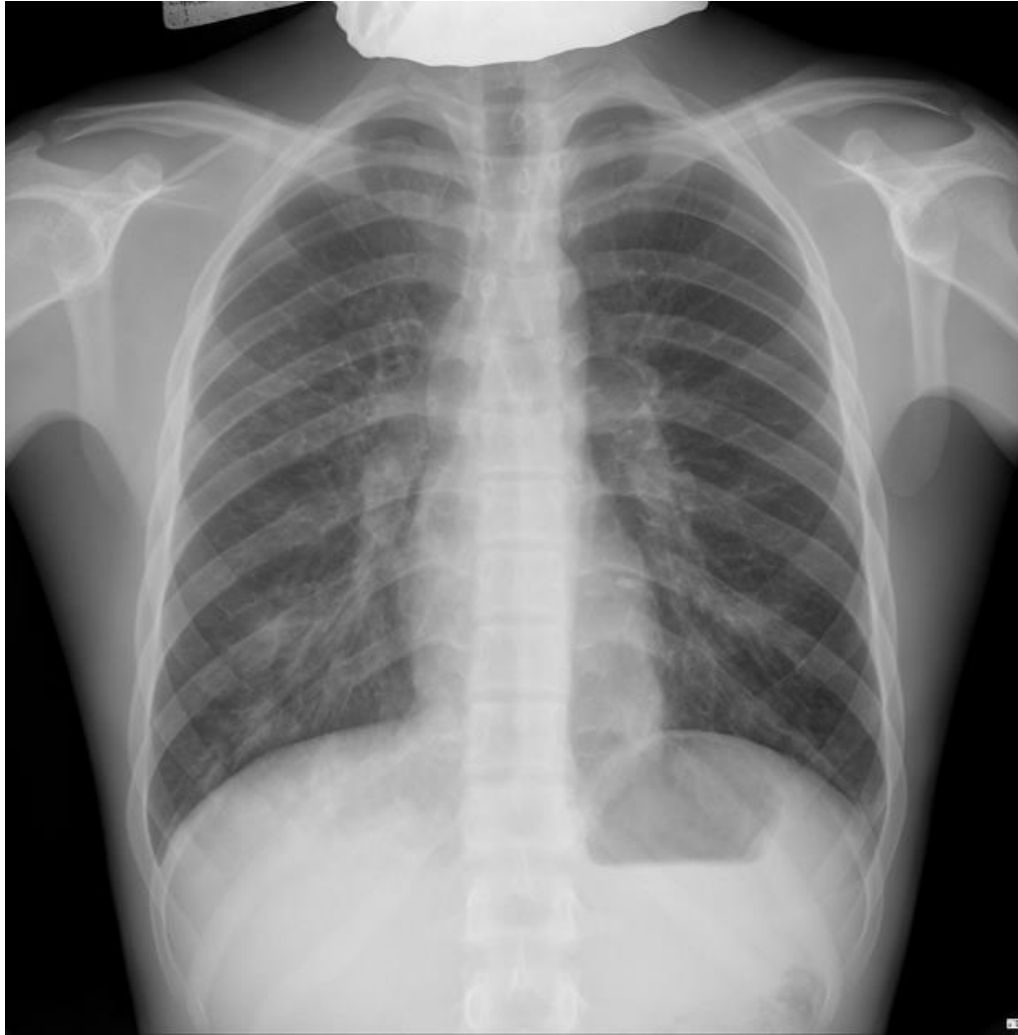
Think:

- Viral (Flu, COVID, others in the right host)
- Mycoplasma
- Pneumocystis (PJP)

Influenza A Pneumonia



Pneumonia – Atypical / Interstitial Pneumonia



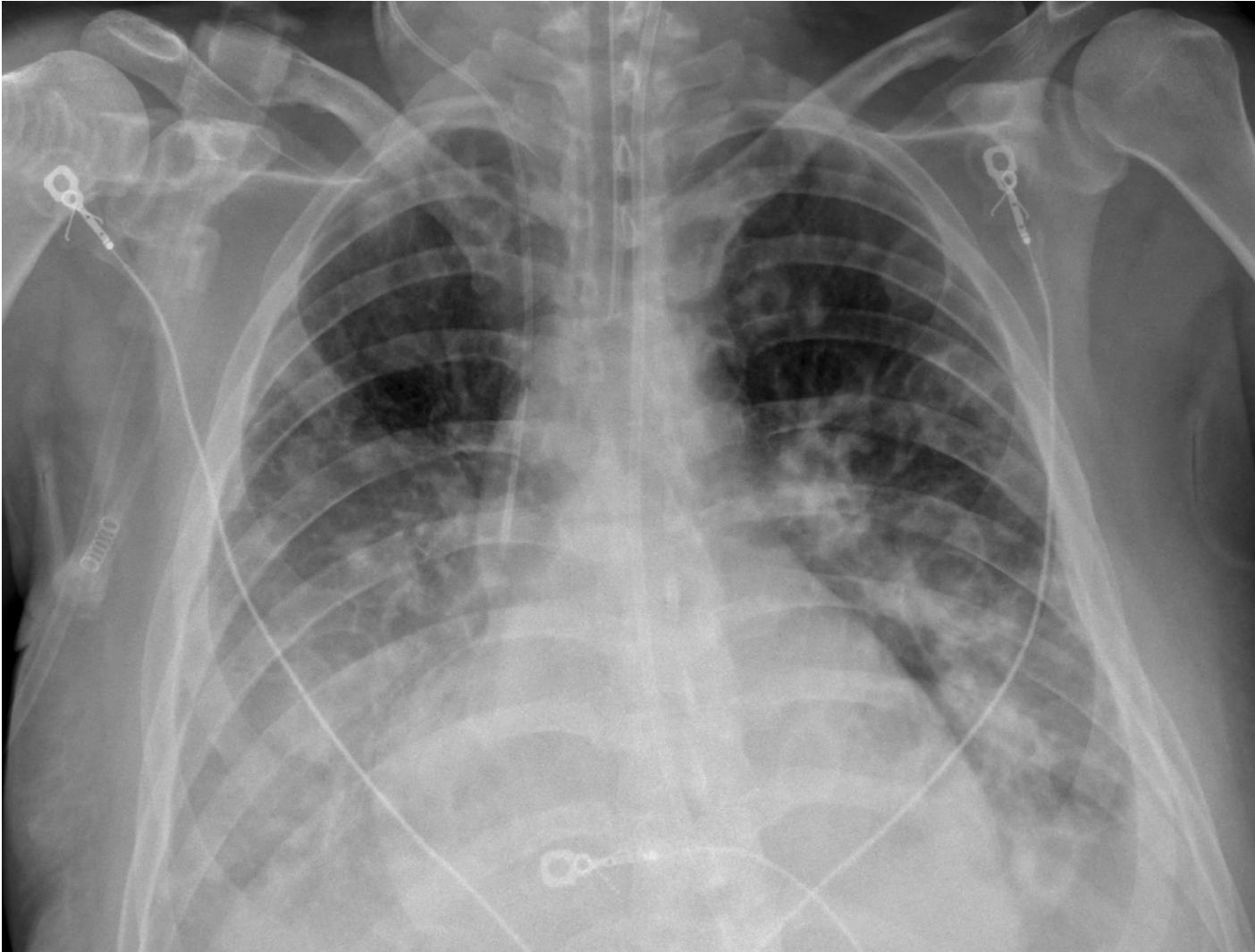
Diffuse reticular or patchy infiltrates.

Fever, cough for > 10 days



Mycoplasma Pneumonia

Pneumonia – Cavitory Lesions



Cavitory lesions

Very important differential:

TB

Lung abscess

Necrotizing pneumonia

Fungal disease (in the right host)

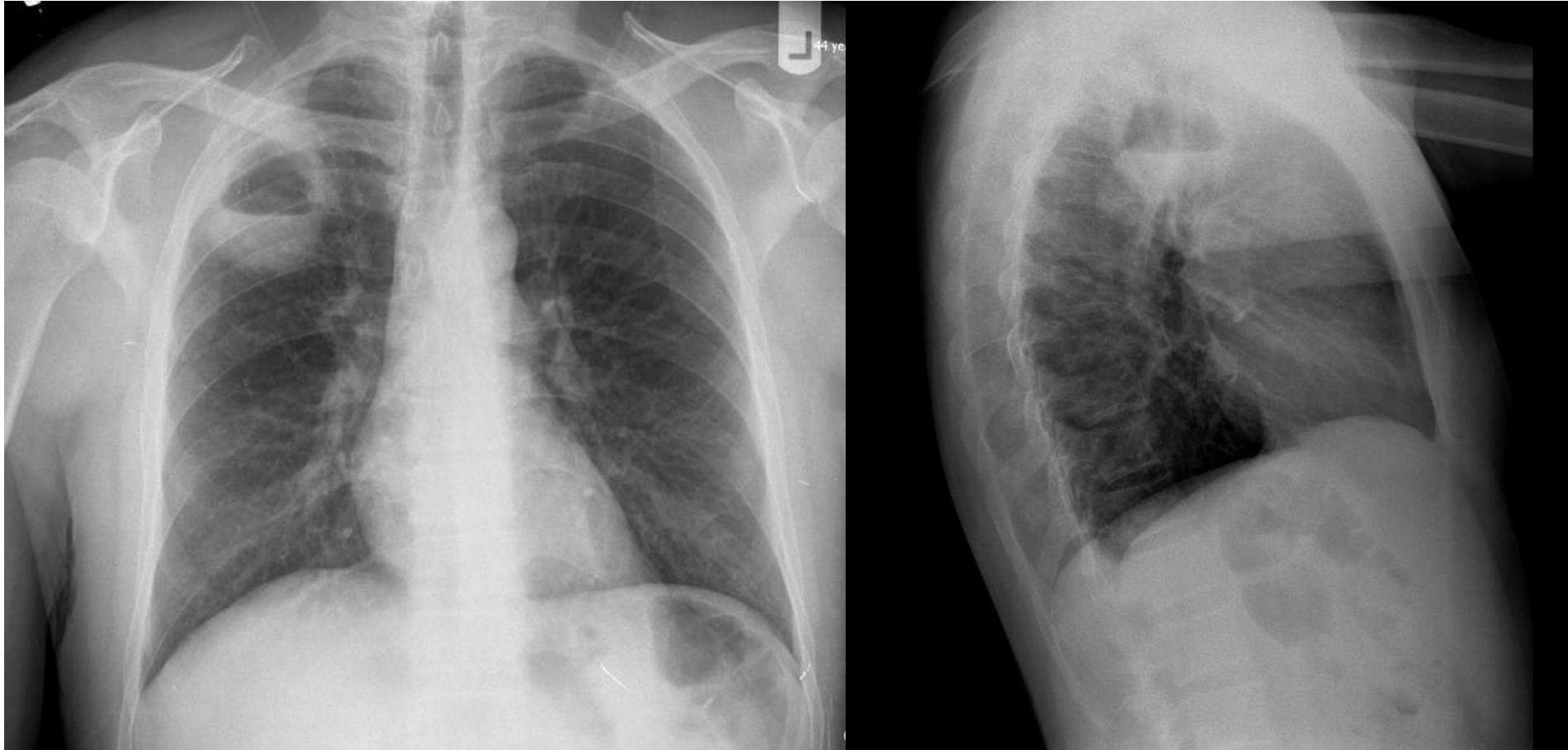
Septic emboli

Squamous cell carcinoma



Multiple septic emboli

Pneumonia – Cavitory Lesions – Lung Abscess



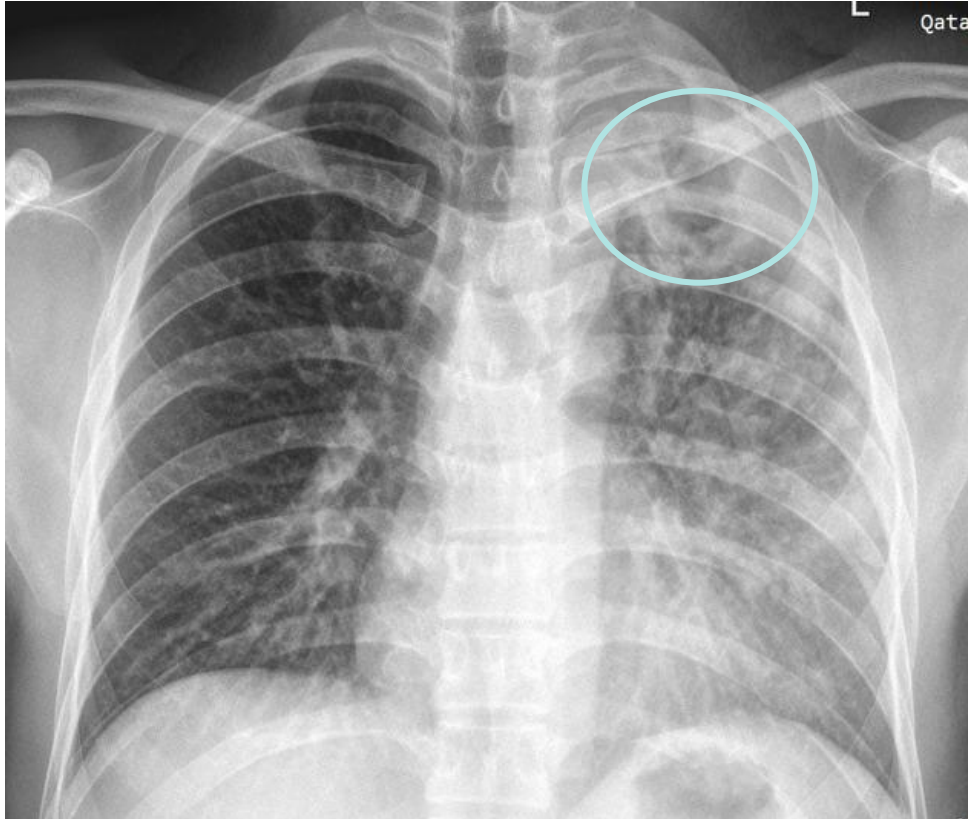
Common bacteria causing necrotizing pneumonia / abscess:

- *Staph aureus*
- *Klebsiella pneumonia*
- *Pseudomonas aeruginosa*
- Oral anaerobes (esp in alcoholics, aspiration)

Important DDx:

- Squamous cell carcinoma

Pneumonia – Cavitory Lesions - TB



Active TB infection



Active TB:

- Symptomatic
- Can be infectious
- *usually* TST and IGRA positive
- Sputum / BAL may be culture positive
- **CXR with infiltrate, cavity, pleural effusion, lymphadenopathy - usually abnormal**
- **CT can show miliary pattern**

Latent TB:

- Asymptomatic
- Not infectious
- usually TST and IGRA positive
- Sputum / BAL culture negative
- CXR may show old upper lobe predominant fibrocavitary disease

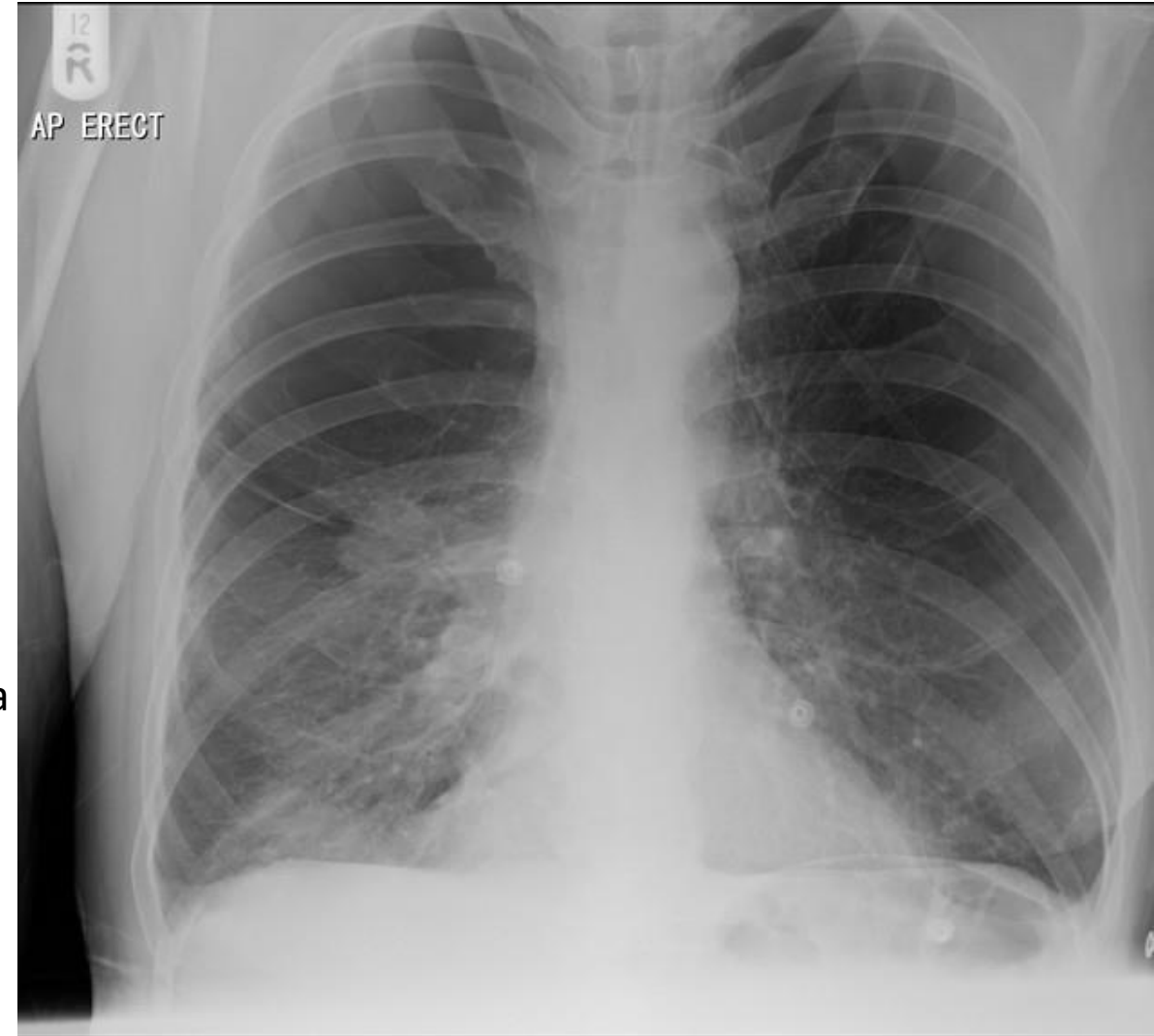
Chronic Lung Disease – COPD



COPD/emphysema

Recognize:

- Hyperinflation
- Flattened diaphragms
- Narrow cardiac silhouette
- Loss of soft tissue / pulmonary cachexia



Chronic Lung Disease – IPF



Recognize:

- Reticular opacities
- Volume loss
- Basilar predominance
- Need chest CT to determine UIP pattern characteristic of IPF

Clinically:

- Age >50
- Insidious onset (>3 mos)
- Dyspnea, cough
- Dry, “velcro” crackles on exam

Chronic Lung Disease - Cystic Fibrosis



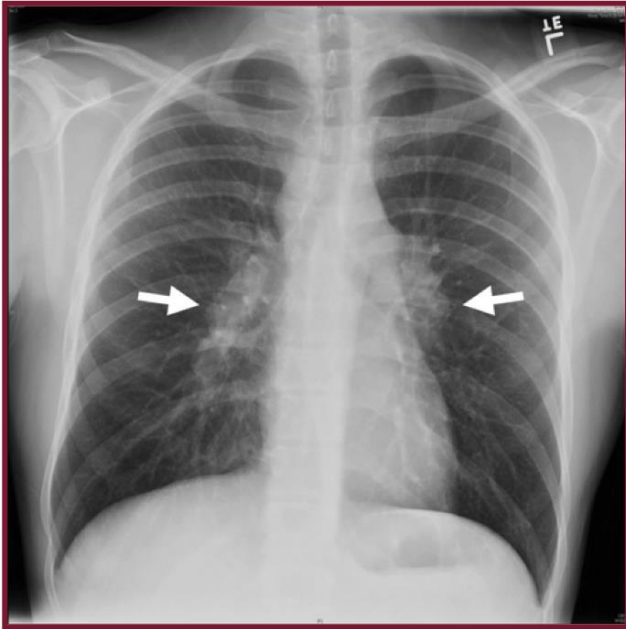
Recognize:

- Upper lobe predominant bronchiectasis
- Can have spontaneous pneumothorax

Clinically:

- Classically younger patients (this is changing!)
- Recurrent pulmonary exacerbations
- Colonization with *Pseudomonas*, *Staph aureus*, *Burkholderia*, *Stenotrophomonas*, among others
- Can present with hemoptysis

Chronic Lung Disease – Sarcoidosis



Stage 1:
Hilar Lymphadenopathy



Stage 2:
Lymphadenopathy and
infiltrates (usually nodular)

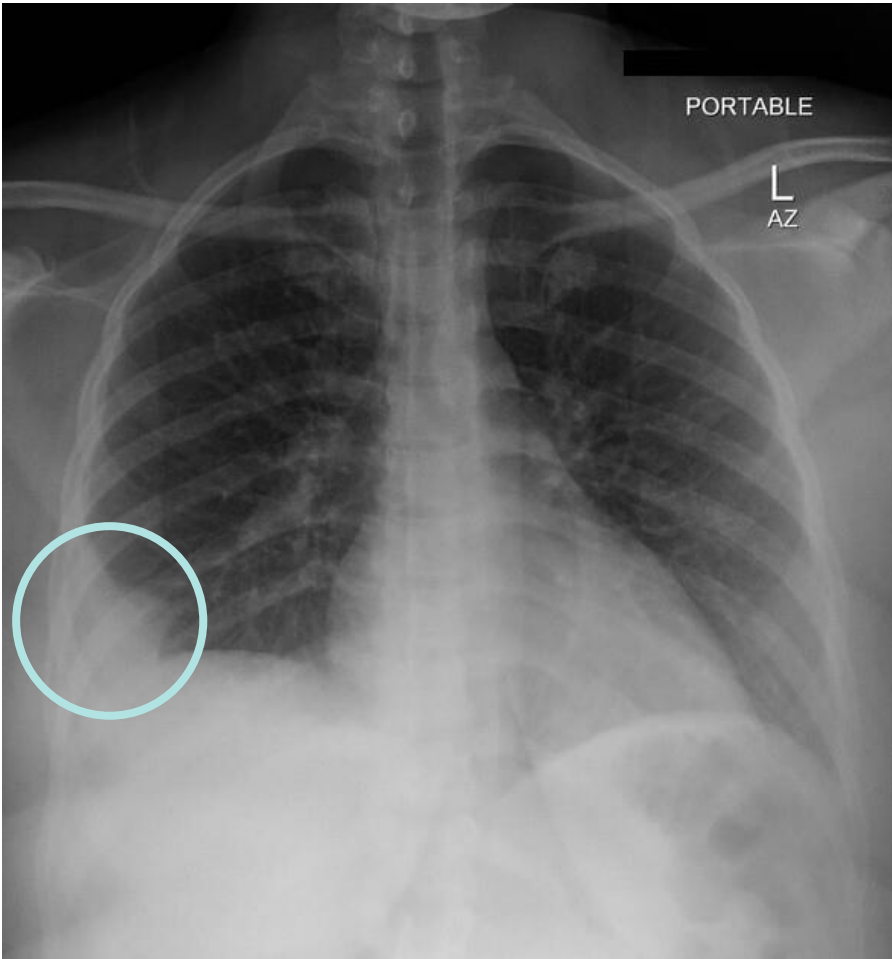


Stage 3:
Parenchymal Infiltrates
without Lymphadenopathy



Stage 4:
Fibrotic Interstitial Lung
Disease

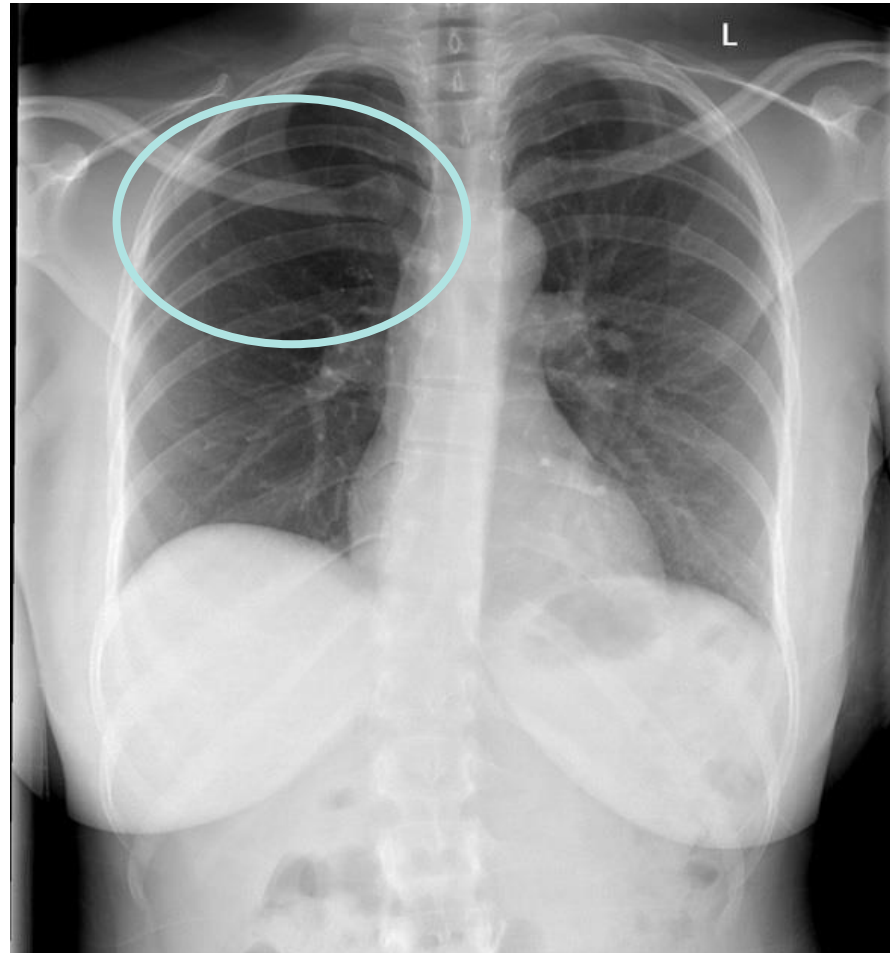
Pulmonary Embolism



Hampton hump



- wedge shaped, peripheral infiltrate



Westermark sign (here, RUL)

- decreased vascular markings (oligemia)

Chest x-ray is usually normal!

But classic findings:

- Hampton hump
- Westermark sign

Boards test the idea:
hypoxemia out of proportion to
relatively unimpressive CXR

Occupational Lung Disease

The key to getting these questions right will be in the history:

Silicosis:

- Sandblasting, mining, quarry work, stone cutting, tunneling, ceramics, foundry work.
- Often associated with increased risk of tuberculosis
- **“eggshell” calcification** of hilar lymph nodes, upper lobe nodules and fibrosis, can lead to progressive massive fibrosis

Berylliosis:

- Aerospace, electronics, fluorescent light manufacturing, nuclear industry exposure.
- Resembles sarcoid radiographically and pathologically.
- Diagnostic test is positive beryllium lymphocyte proliferation test.

Coal workers pneumoconiosis:

- Coal miner with years underground
- Black sputum may be mentioned
- Progressive massive fibrosis in severe disease
- Anthracotic pigment on pathology



Occupational Lung Disease – Silicosis



Upper lobe predominant mass-like scarring with calcification and volume loss. Hilar and mediastinal lymph node calcification better seen on CT.



Occupational Lung Disease

Asbestos-related lung disease

- Classic history: Shipyard worker, insulation worker, construction/demolition, pipefitter
- Long latency period (often decades)
- Smoking synergistically increases lung cancer risk

Key clue for the boards:

- Exposure during construction/insulation work many years earlier

Asbestos-related lung disease can include:

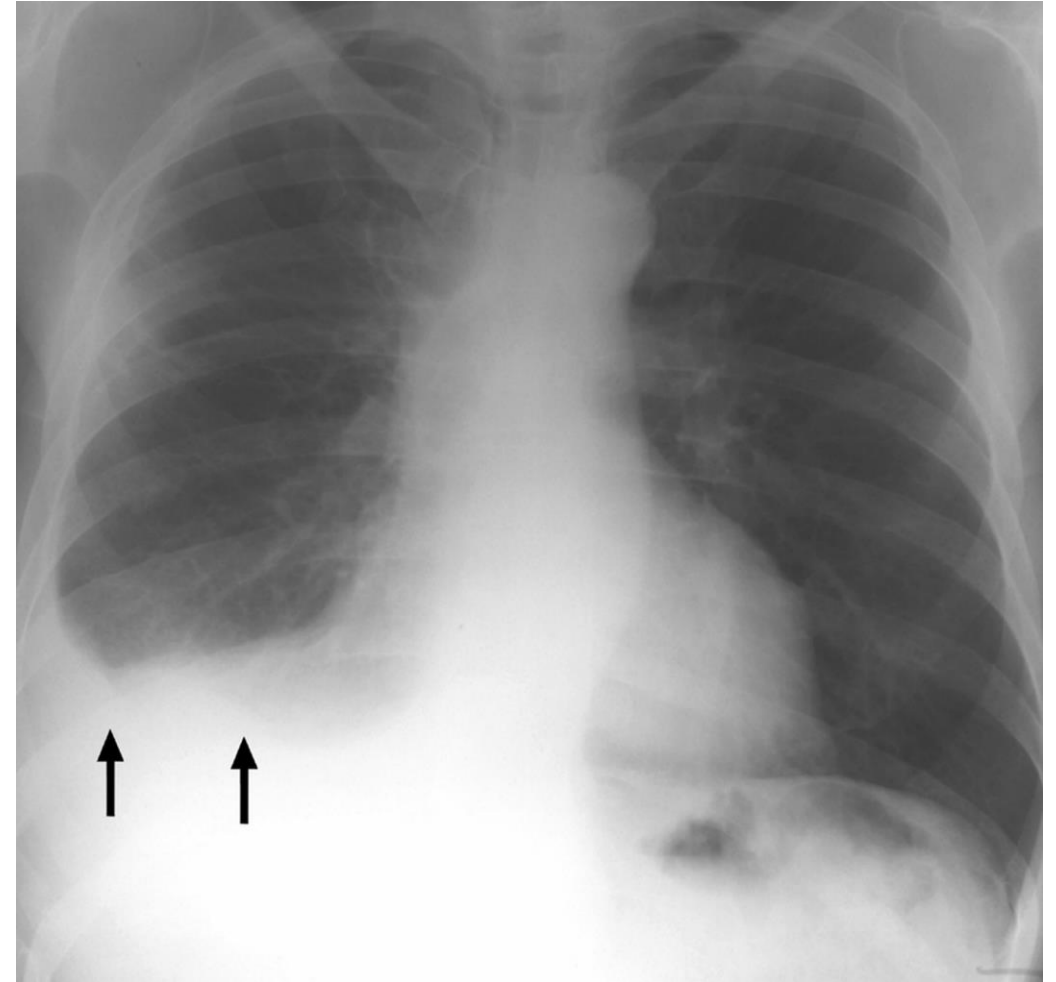
1. Pleural plaques
2. Interstitial Fibrosis (Asbestosis)
3. Mesothelioma (but also increased risk of lung adenocarcinoma which is more common)
4. Benign Asbestos Pleural Effusion (BAPE)



Asbestos-related Lung Disease – Pleural Plaques, BAPE

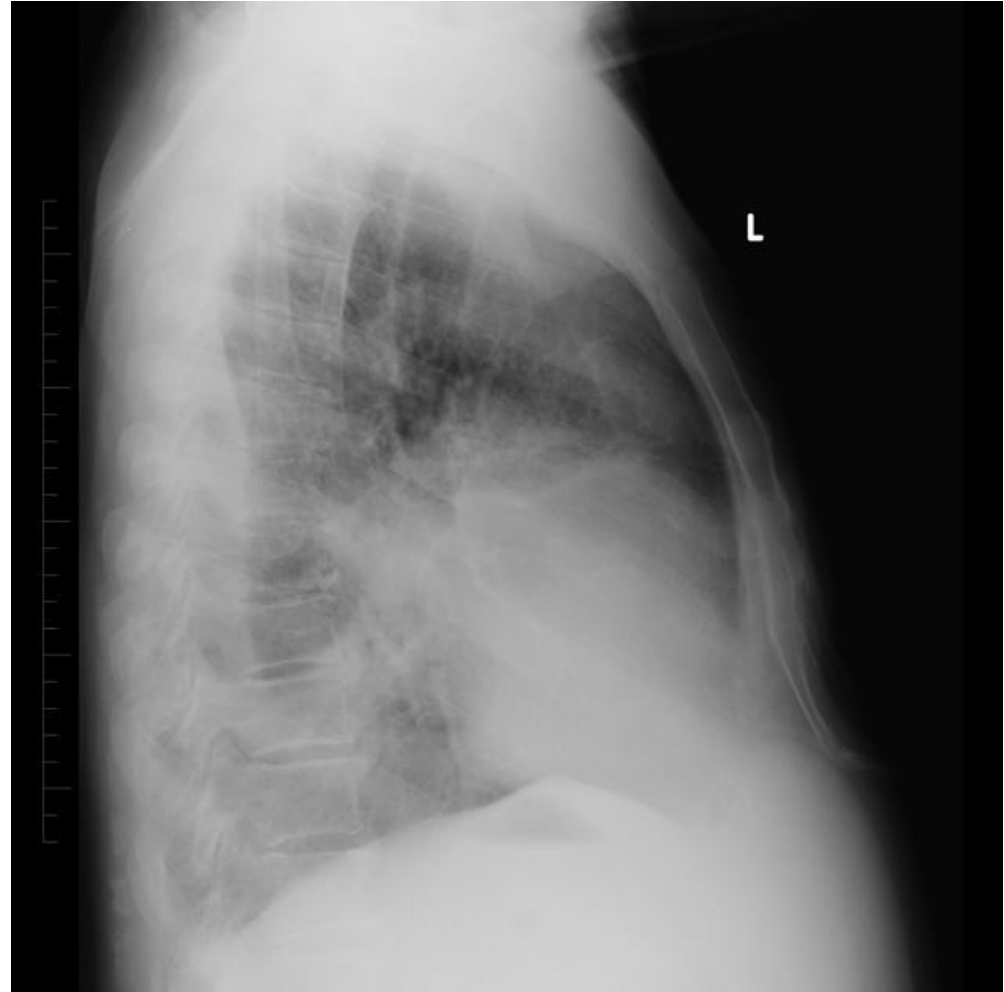
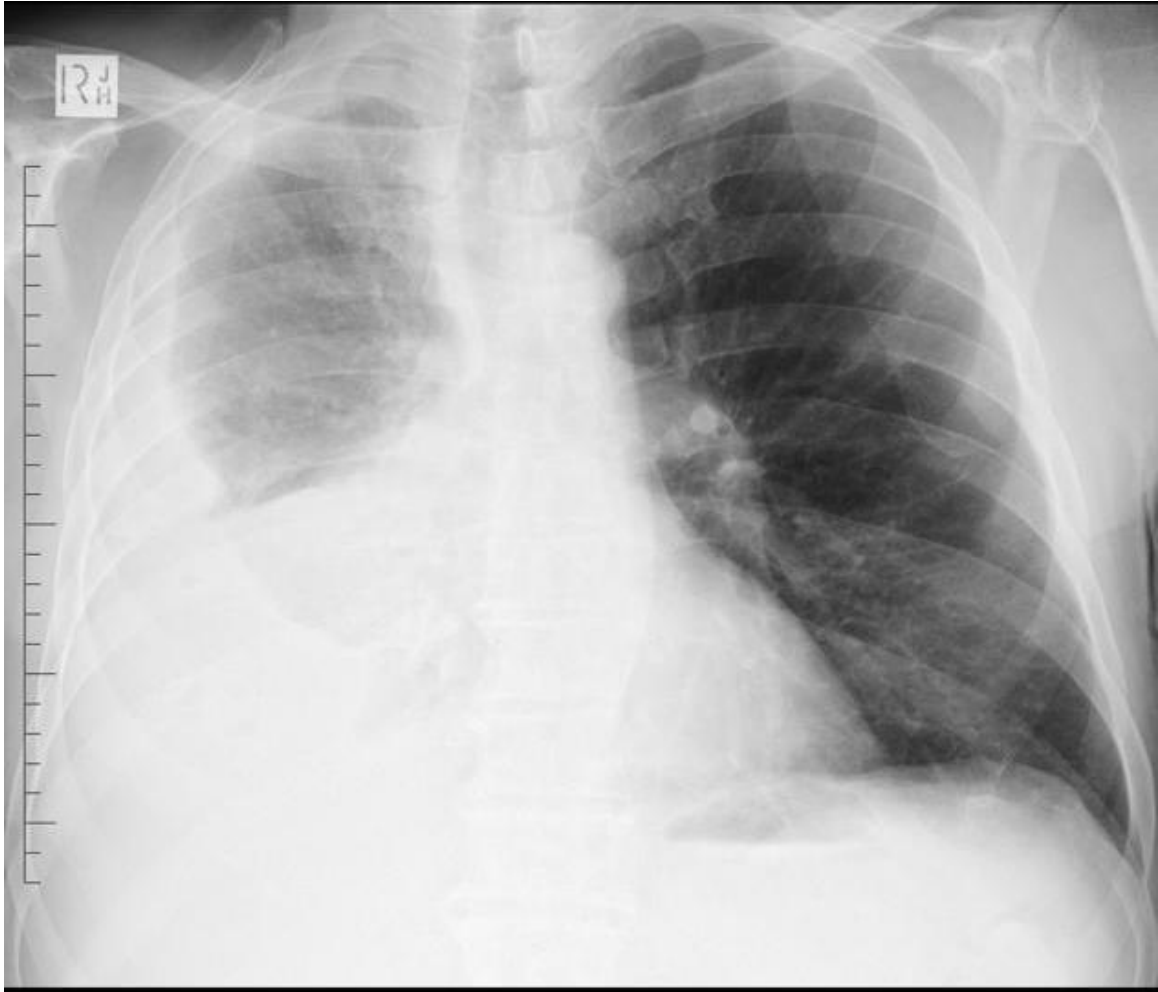


Pleural plaques



BAPE

Asbestos-related Lung Disease – Mesothelioma



CXR Buzzwords for the Boards

Imaging finding

Bat-wing edema

Bilateral hilar adenopathy

Hyperinflation + flat diaphragms

Cavitary upper lobe lesion

Wedge-shaped opacity

White-out hemithorax + tracheal shift away

White-out hemithorax + shift toward

Air-fluid level cavity

Pneumomediastinum after vomiting

Classic diagnosis

CHF

Sarcoid

Emphysema

TB

PE

Massive effusion

Atelectasis

Lung abscess

Boerhaave syndrome



MOC REFLECTIVE STATEMENT (BRIEF TAKE HOME NOTES FOR REFERENCE)

- Using a consistent, systematic approach to every CXR reduces the chance of missed findings.
- The boards do not usually ask for CXR interpretation – rather **“what is the next step, complication, or disease process?”**
- **Focus on:** clinical context integration and management implications
- Recognize classic chest radiograph patterns commonly tested on the exam including **CHF, COPD, pneumonia, cavitory lesions, pleural disease, and occupational lung diseases.**
- Many abnormalities discussed here require CT imaging to clarify in the real world



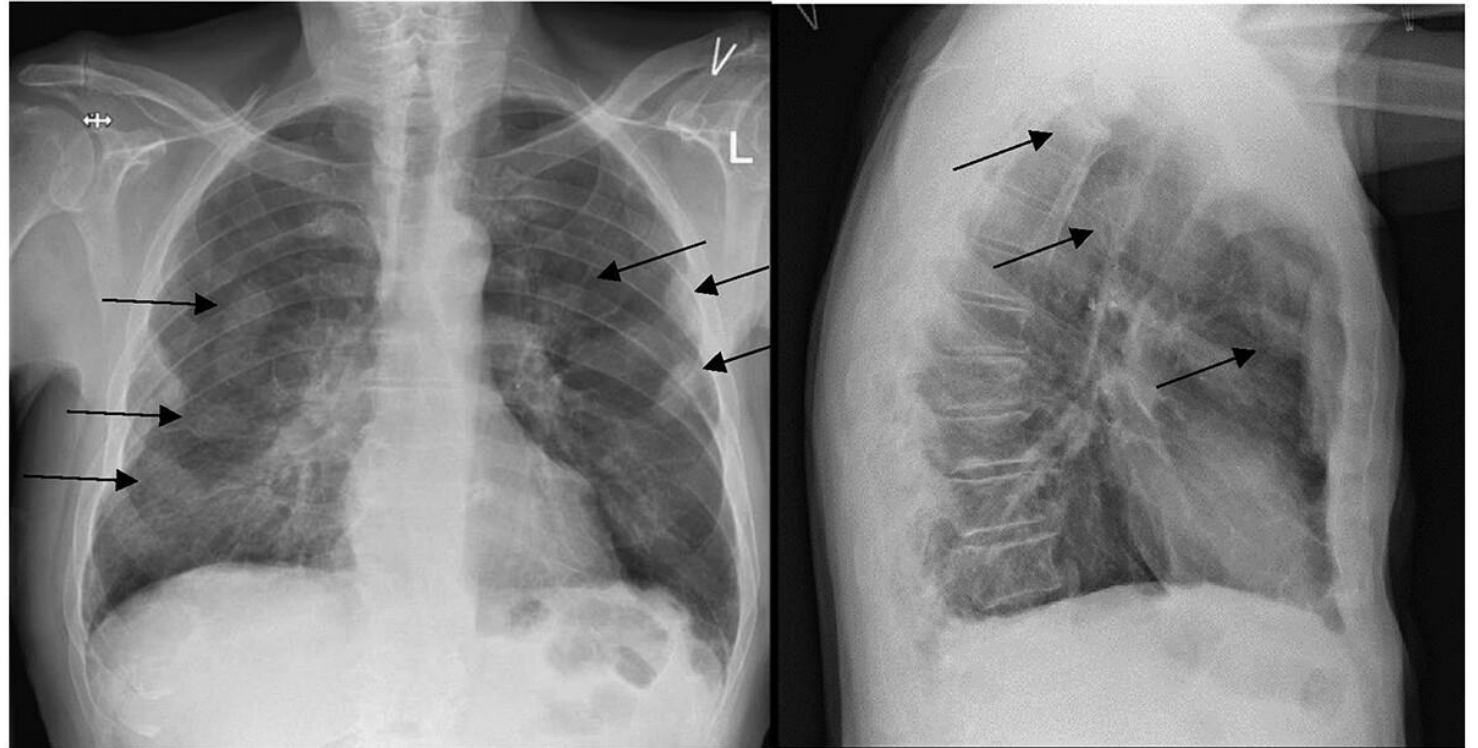
Question 1

A 67-year-old man is evaluated for progressive shortness of breath and dry cough over 8 months. He worked for 35 years installing insulation in shipyards. He quit smoking 20 years ago after a 25-pack-year history. Temperature is 36.8 °C (98.2 °F), blood pressure is 128/74 mm Hg, pulse rate is 82/min, and oxygen saturation is 93% on room air. Bibasilar inspiratory crackles are present.

CXR shown here.

Which of the following is the most likely?

- A. Chronic beryllium disease
- B. Coal workers' pneumoconiosis
- C. Hypersensitivity pneumonitis
- D. Prior asbestos exposure**
- E. Silicosis



Question 2

A 33 yo woman presents with intermittent fever, night sweats, migratory joint pain, and red, painful nodules on her shins. She has no pulmonary symptoms. Shown is her CXR.



Which of the following is true about her disease?

1. Next step in management would be treatment with prednisone 1mg/kg daily.
2. Next step in management would be bronchoscopy with transbronchial biopsy for diagnosis.
3. Spontaneous resolution is likely.
4. Fevers are an unusual manifestation of this disease.

Löfgren Syndrome

- An acute, self-limiting variant of sarcoidosis.
- Typically affects younger adults
- Characterized by classic symptoms:
 - Erythema nodosum (painful red nodules on the shin)
 - Bilateral hilar lymphadenopathy
 - Polyarthrititis, particularly in the ankles
 - Often accompanied by fever
- Biopsy generally not necessary with classic presentation
- It typically carries a very favorable prognosis, with most cases resolving spontaneously
- Treatment is generally supportive (NSAIDs) but can use prednisone for severe symptoms



References

1. Radiopeadia.org
2. Chestdb.org
3. Radiologyassistant.nl
4. Openi.nlm.nih.gov
5. Sharma N, Sharma A, Bajaj M. Case report: Epidermoid cyst misdiagnosed as a loculated pericardial effusion. *Indian J Radiol Imaging*. 2008 Nov;18(4):319-21.
6. Chudasama K, Seenath M, Gourevitch D. Pneumomediastinum after cocaine use: an unusual aetiology. *J Surg Case Rep*. 2010 Mar 1;2010(1):3. doi: 10.1093/jscr/2010.1.3.
7. Sakuraba M, Umezawa H, Miyamoto S, Fujiki M, Higashino T, Oshima A, Tsuboi M. Reconstructive Surgery for Bronchopleural Fistula and Empyema: New Application of Free Fascial Patch Graft Combined with Free Flap. *Plast Reconstr Surg Glob Open*. 2017 Jan 17;5(1):e1199.
8. Roach HD, Davies GJ, Attanoos R, Crane M, Adams H, Phillips S. Asbestos: when the dust settles an imaging review of asbestos-related disease. *Radiographics*. 2002 Oct;22 Spec No:S167-84.
9. O'Regan A, Berman JS. Sarcoidosis. *Ann Intern Med*. 2012 May 1;156(9)
10. Panou, V., Bhatnagar, R., Rahman, N., Christensen, T. D., Pietersen, P. I., Arshad, A., & Laursen, C. B. (2024). Advances in the diagnosis and follow-up of pleural lesions: a scoping review. *Expert Review of Respiratory Medicine*, 18(6), 423–434.

