



RADY Resident Symposium: CXR #1 in the World

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Module objectives

By the end of this activity, participants will be able to:

1. Describe the utility of chest radiography
2. State chest radiography anatomy
3. Describe a suggested approach to reviewing CXR
4. Understand the CXR basics of pneumonia, pulmonary edema, CHF, cardiomegaly, atelectasis, aortic aneurysm, lymphadenopathy

(NB: in our Critical Values and Radiographic Aunt Minnie sim labs, we will discuss 'don't miss' and iatrogenic CXR findings)

Module outline

- I. Chest radiography facts and figures
- II. Anatomy on CXR
- III. Approach to chest film interpretation
- IV. Cardiopulmonary diseases

Chest Radiography Facts

- Chest film is the most commonly performed radiographic examination in the world, but it is also very difficult to interpret expertly
- Low radiation dose (PA film = 0.01-0.02 mSv) inexpensive examination
- First line imaging for cardiopulmonary diseases
 - PA and lateral series always preferred over single AP/portable
- Limitations do exist
 - Not for nodules < 1 cm, subtle rib fxs, lung CA screening. Chest radiography is not recommended for rib fx in uncomplicated setting, or for asymptomatic preop patient

Chest Radiography Facts

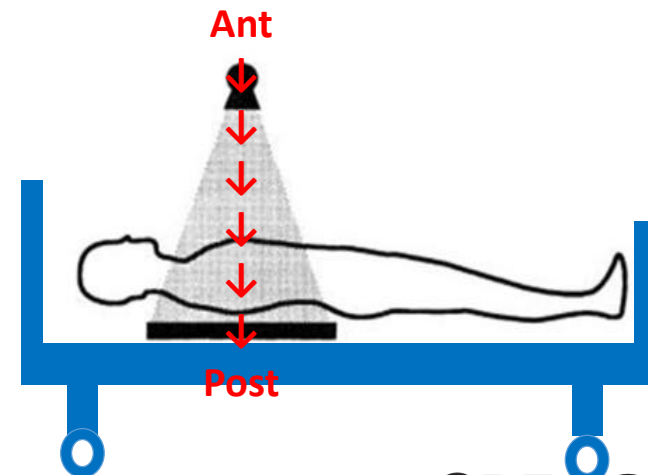
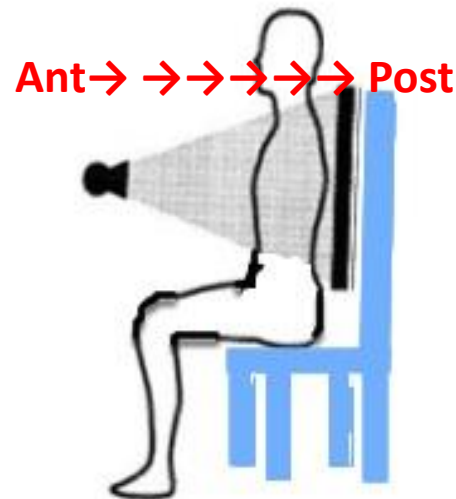
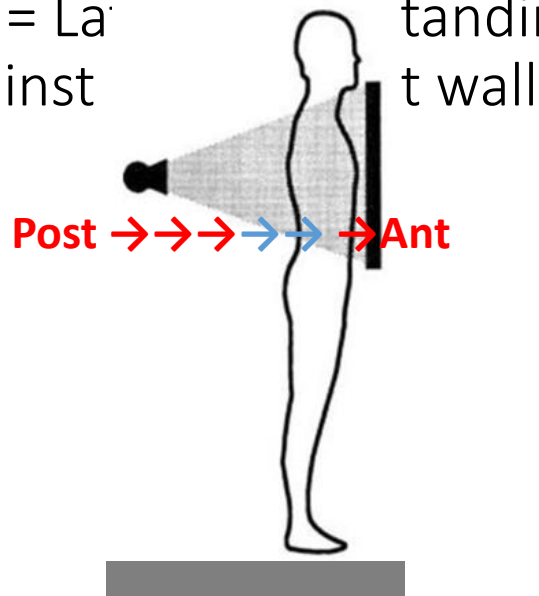
- Routine and emergent diagnoses in critical settings around the world
 - WHO recommendations for CXR make it the primary means of diagnosis, triage, as well as screening of TB in resource-poor settings
 - In patients receiving mechanical ventilation in the ICU, utilized by about 3/5ths of patients on a daily basis
- In 2019, ongoing research in JAMA about recommendations for CXR utilization in different clinical settings
- Prudent use is important as routine CXR can lead to delays of care, incidental findings, unnecessary radiation, and increased healthcare costs

Chest Radiography Technique

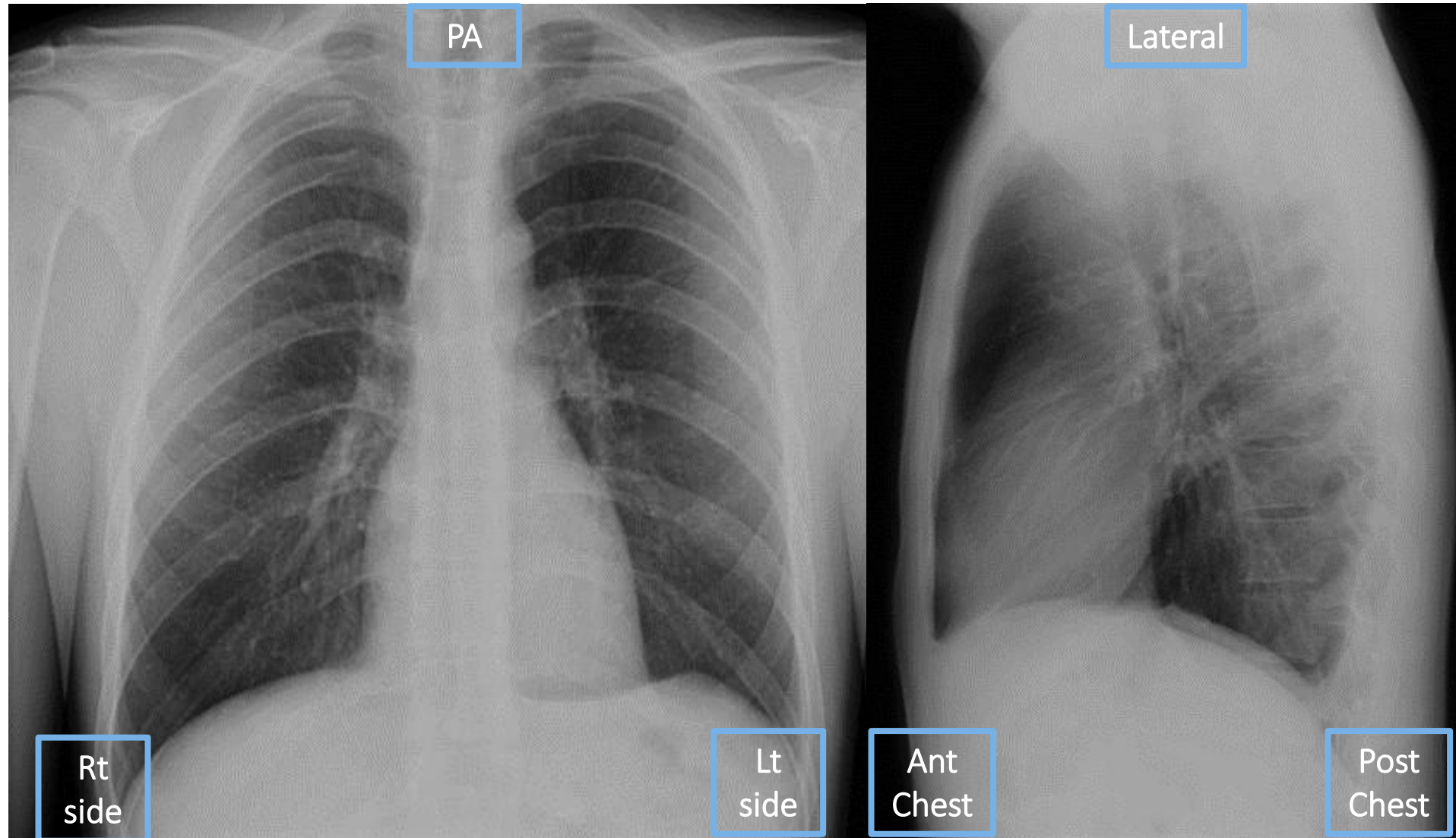
- PA = Posterior to anterior, pt is standing, xray beam comes from back and pt chest is against the film
- AP = Anterior to posterior, pt is supine or seated, xray beam comes from front and pt back is against the film
- Lat = Lateral, pt is standing or seated, beam comes from right and film is on left against lateral chest wall

Chest Radiography Technique

- PA = Posterior to anterior, pt is standing, xray beam comes from back and pt chest is against the film
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- Lat = Lateral, pt is standing or seated. beam comes from right and film is on left against chest wall

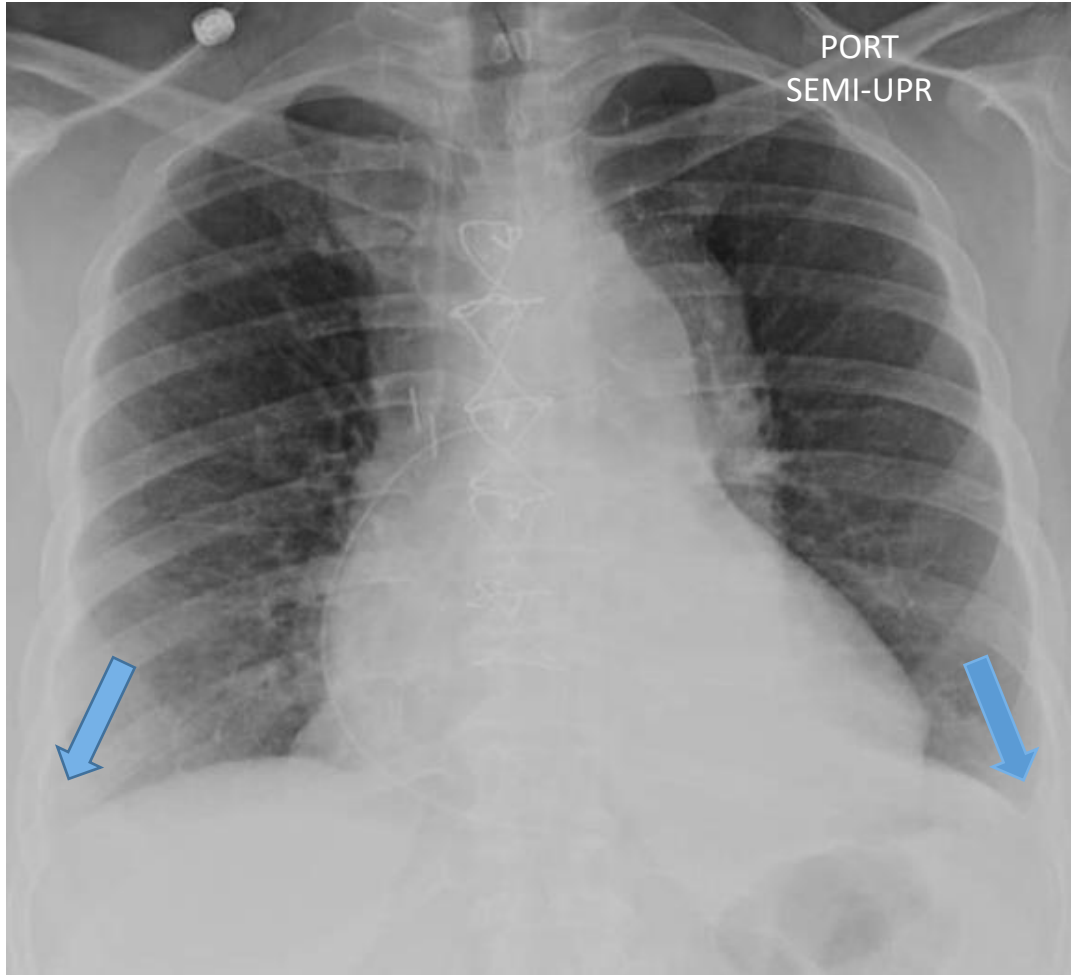


Always view films as if looking at patient !

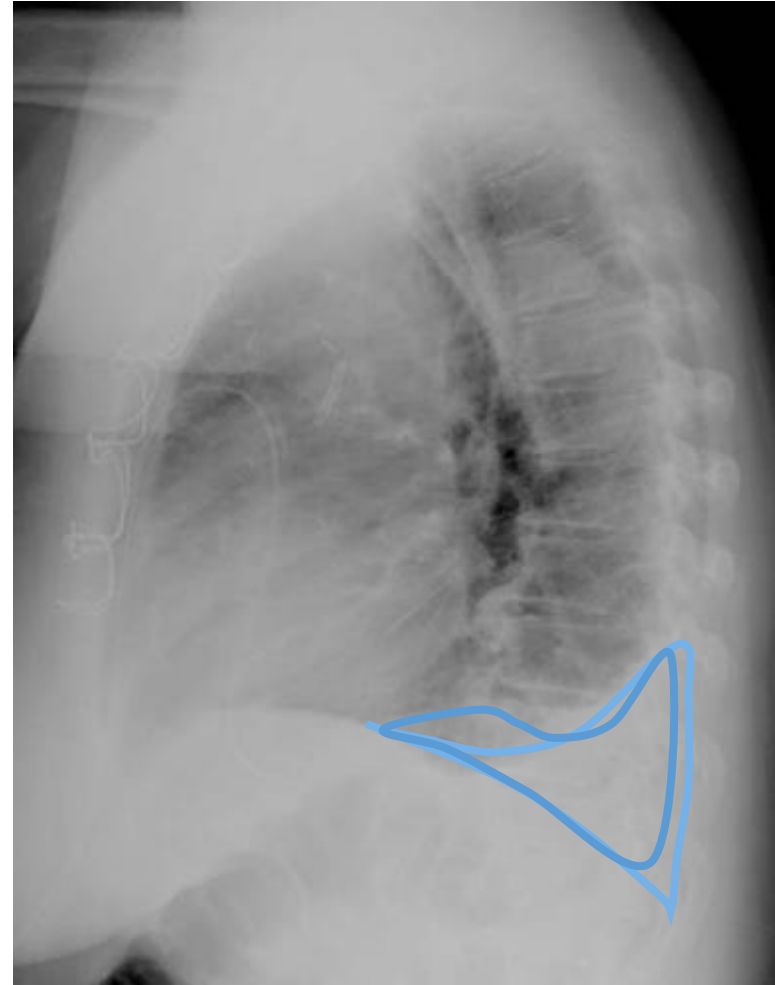


Portable versus Lateral Erect CXR

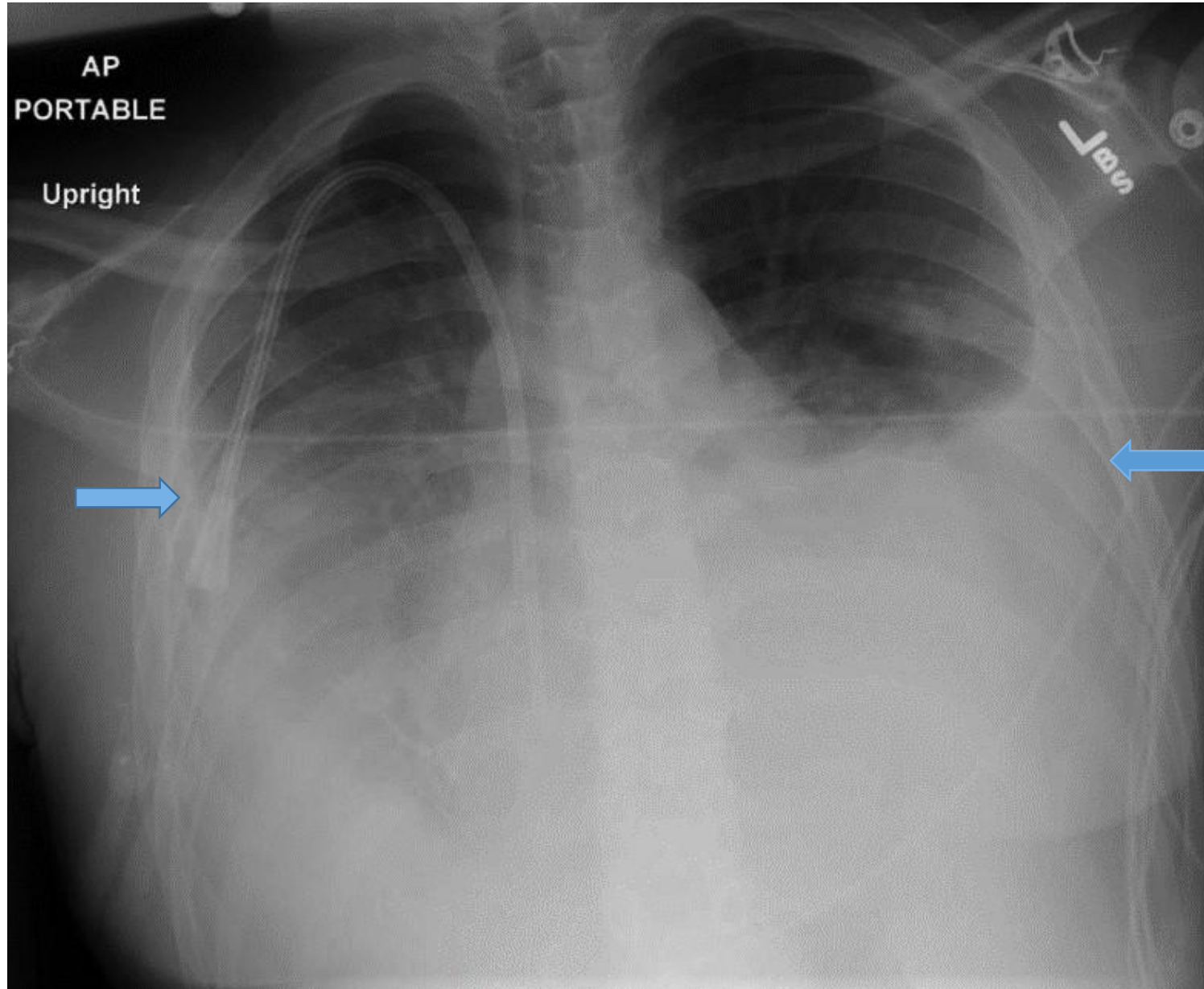
Portable film post-op aortic dissection repair



Lateral film same patient



Portable CXR with large bilateral effusions



Chest Radiography: Two vs One

- PA and Lateral series ALWAYS preferred

Two views provide more information

Cardiac size is more accurate, pleural effusions are more readily seen, and lesion location can be triangulated

- Portable AP films are more limited but are the only option for critically ill patients


Single view

Magnified cardiac silhouette

Unable to triangulate lesions

Pleural effusions may not be detected if small

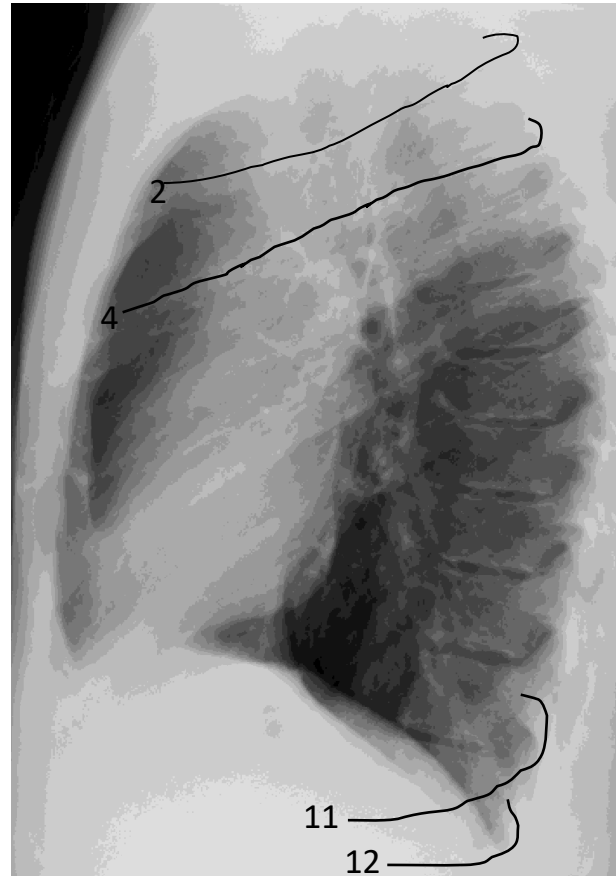
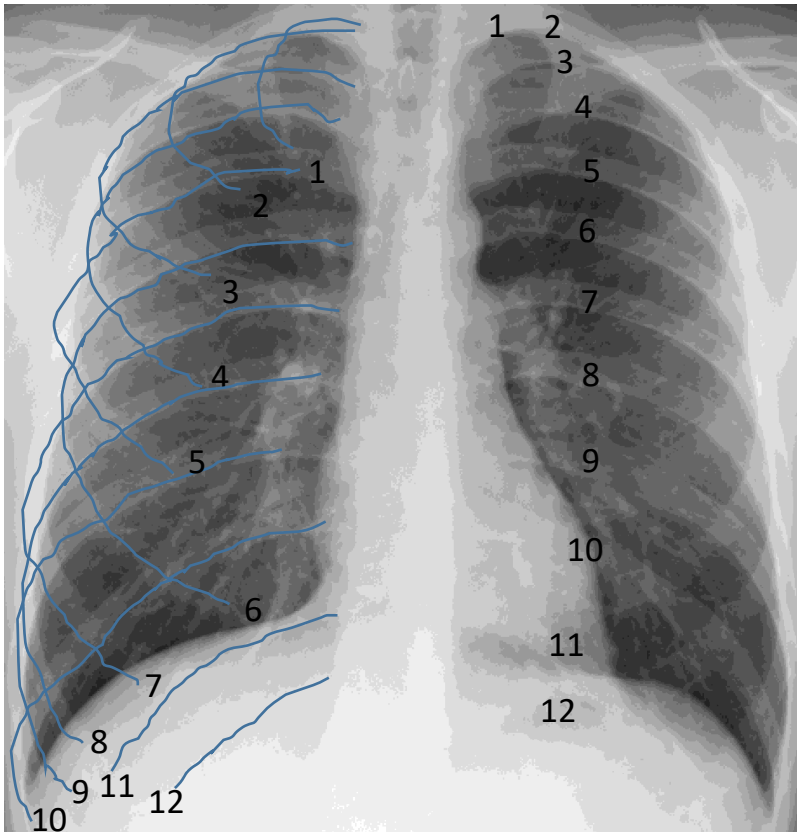
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Normal Anatomy CXR

- Bones
- Lungs
- Pleural space
- Diaphragm
- Heart
- Mediastinum

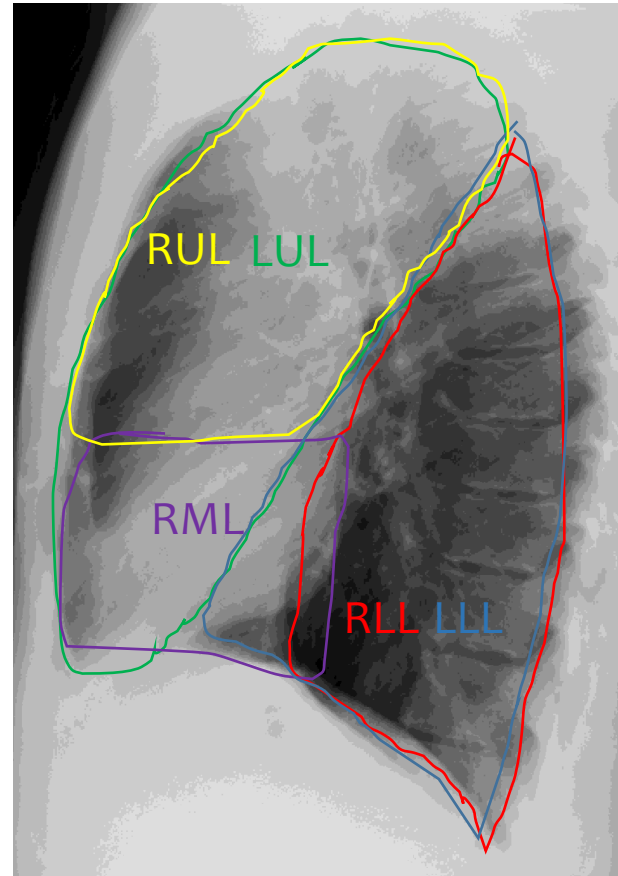
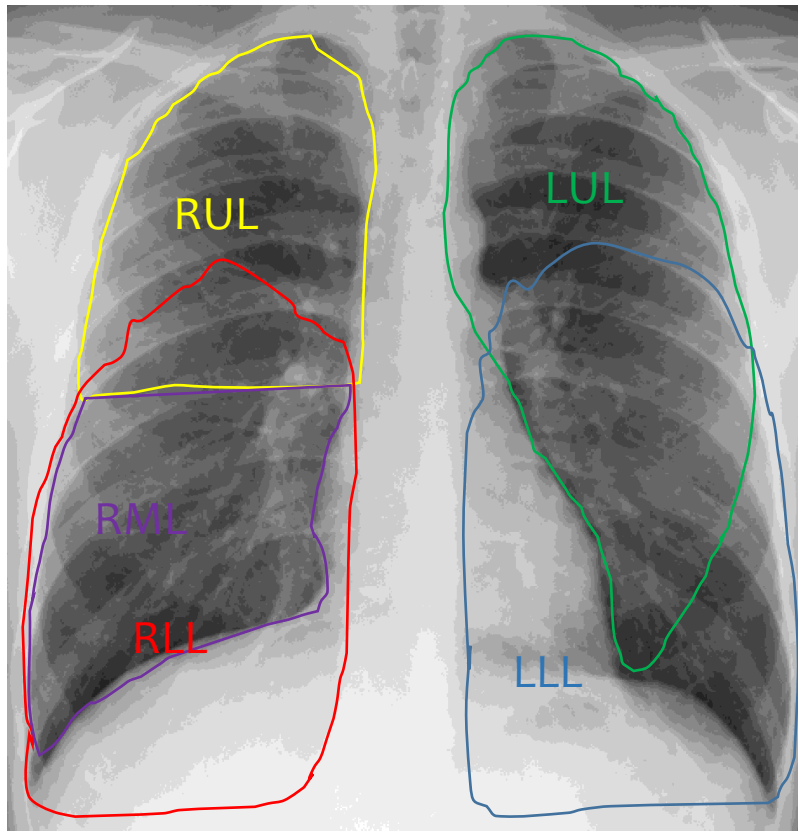
Normal Anatomy CXR: RIBS



Q: How do you judge lung volumes, and what is normal?

A: Count POSTERIOR ribs:
9-10 posterior ribs seen above hemidiaphragm on frontal film is normal

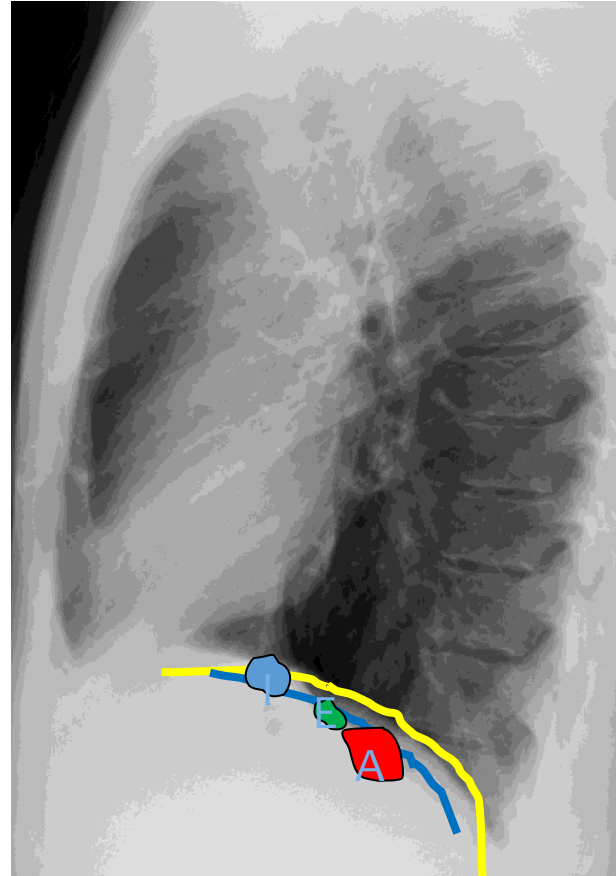
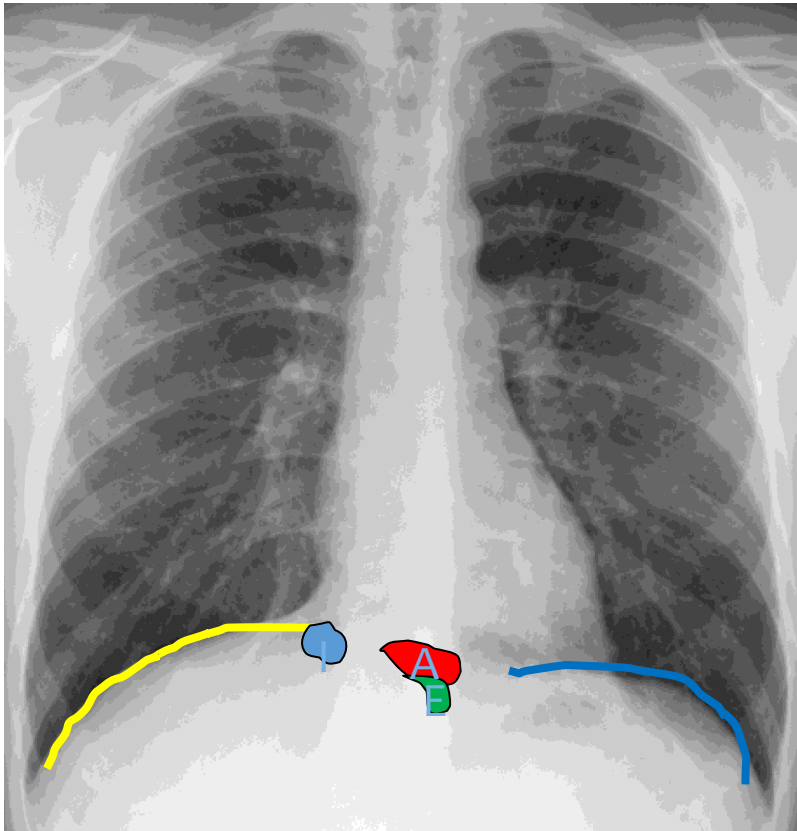
Normal Anatomy CXR: LUNG LOBES



RIGHT:
Upper lobe
Lower lobe
Middle lobe

LEFT:
Upper lobe
Lower lobe

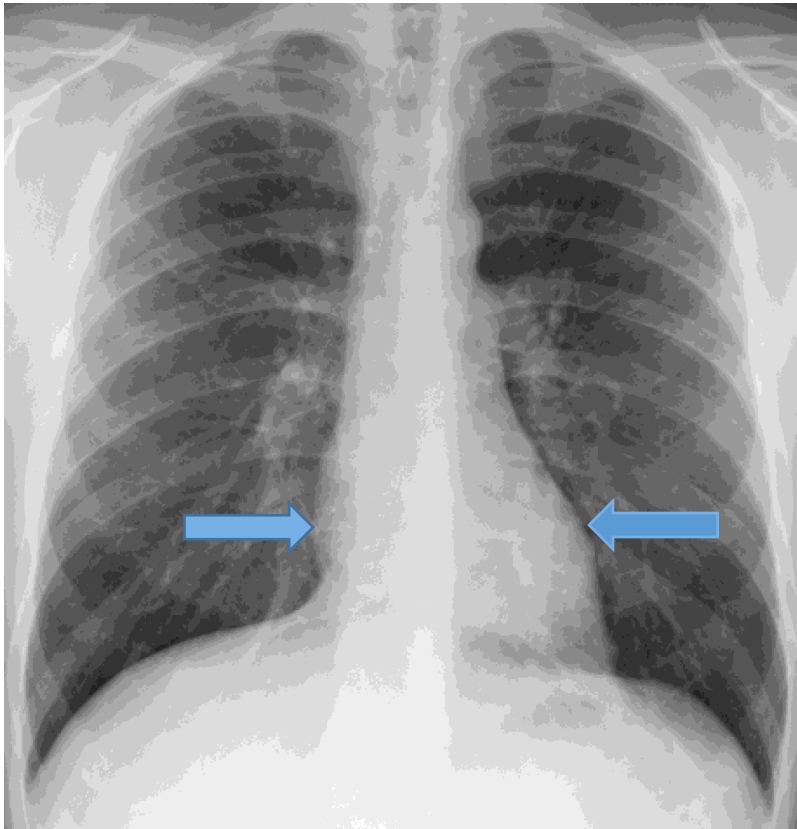
Normal Anatomy CXR: DIAPHRAGMS



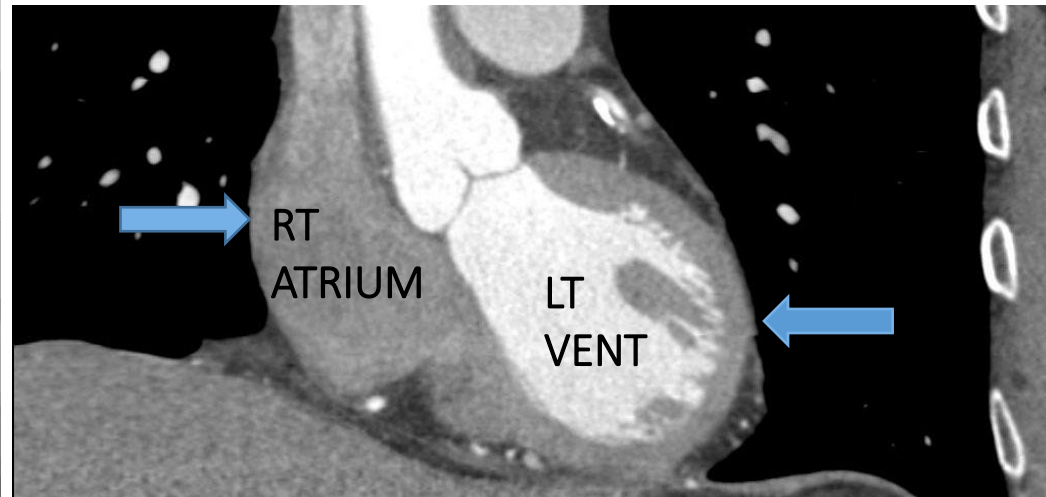
DIAPHRAGMATIC
HIATUS:
IVC
Aorta
Esophagus

Normal Anatomy CXR: CARDIAC BORDERS

PA CXR



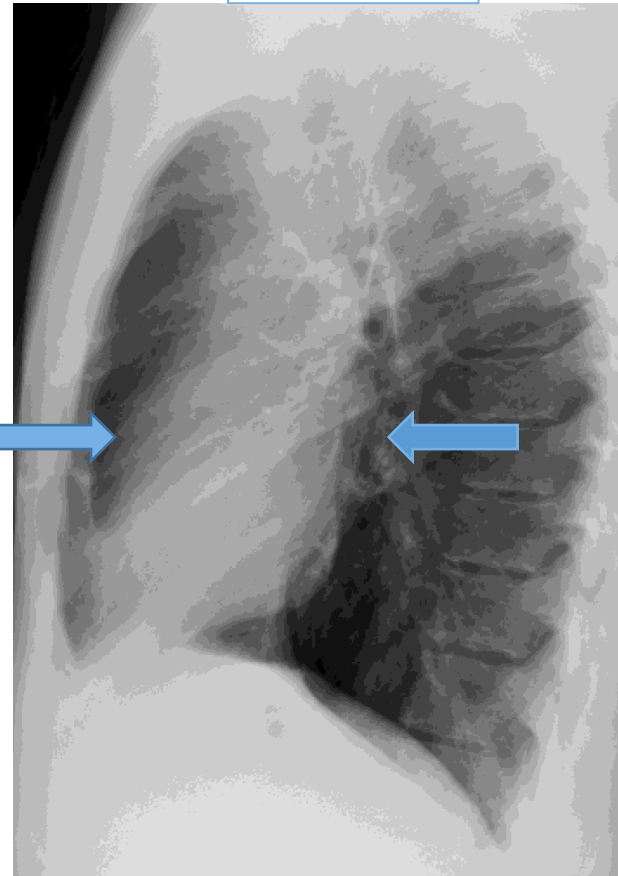
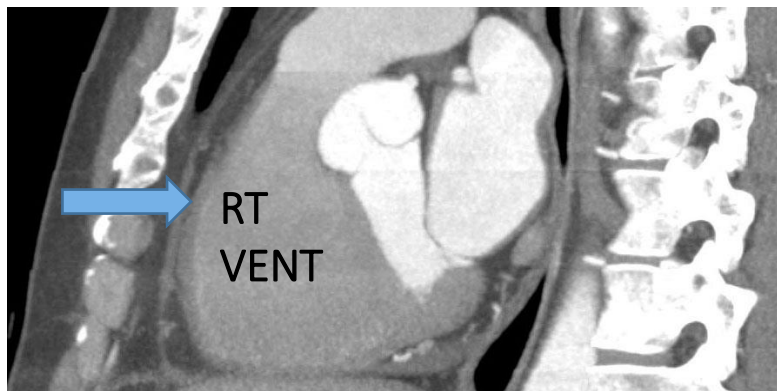
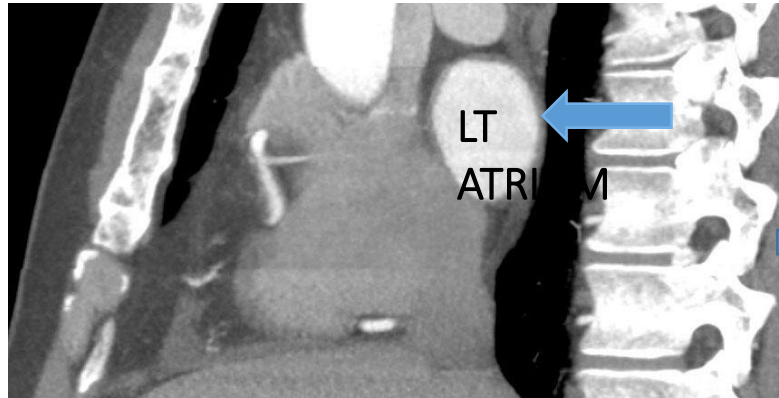
CARDIAC CT



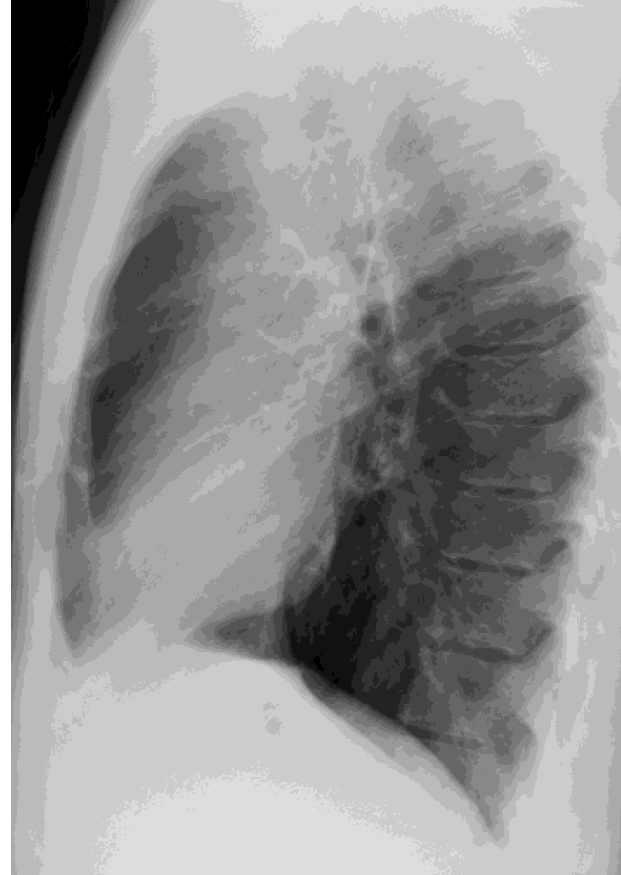
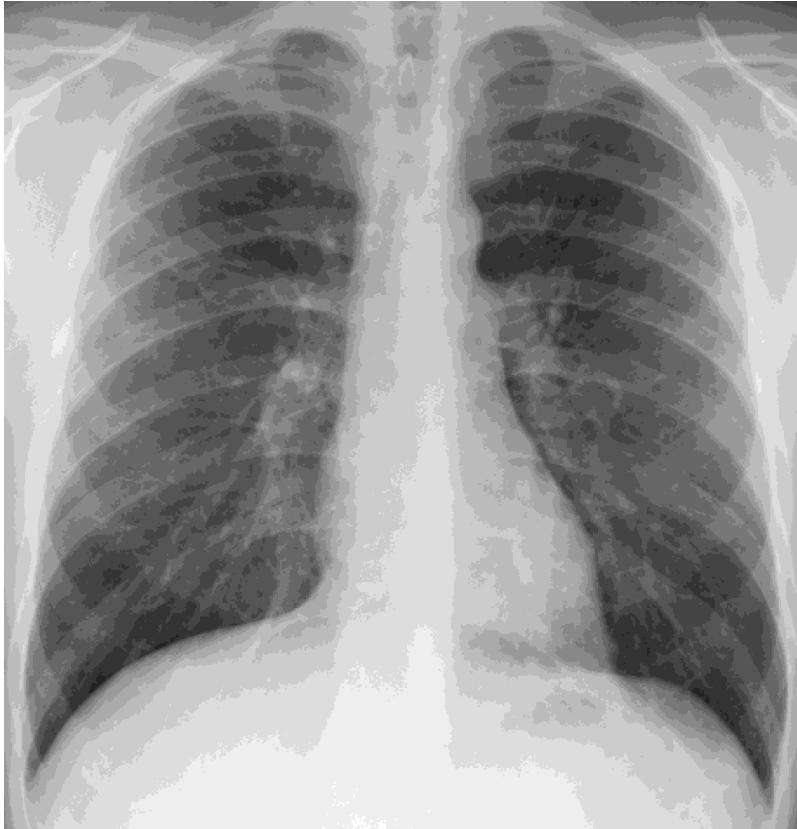
Normal Anatomy CXR: CARDIAC BORDERS

CARDIAC CT

LAT CXR



Normal Anatomy CXR: MEDIASTINAL LINES



FRONTAL PA or AP

CHECKLIST:

Trachea

Carina, RMB, LMB

Hila/hilar vessels

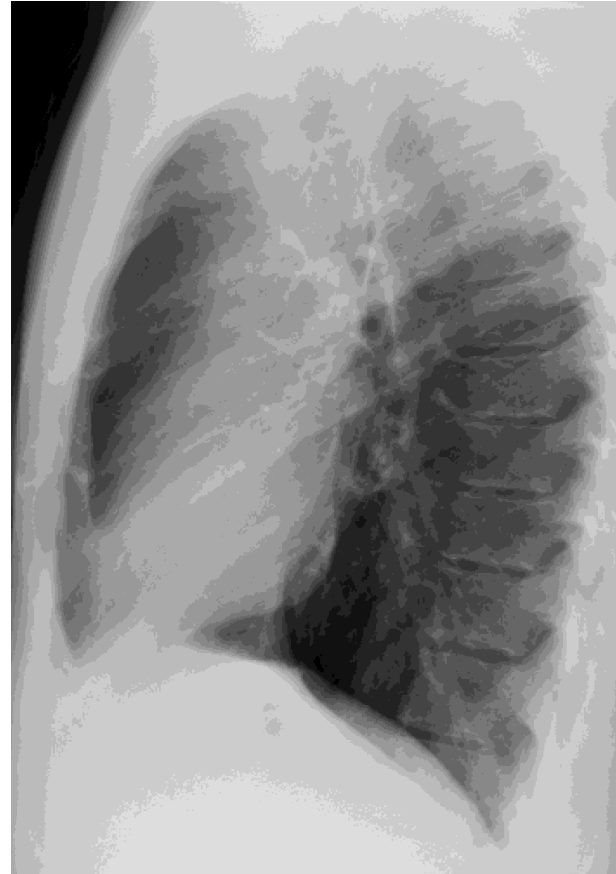
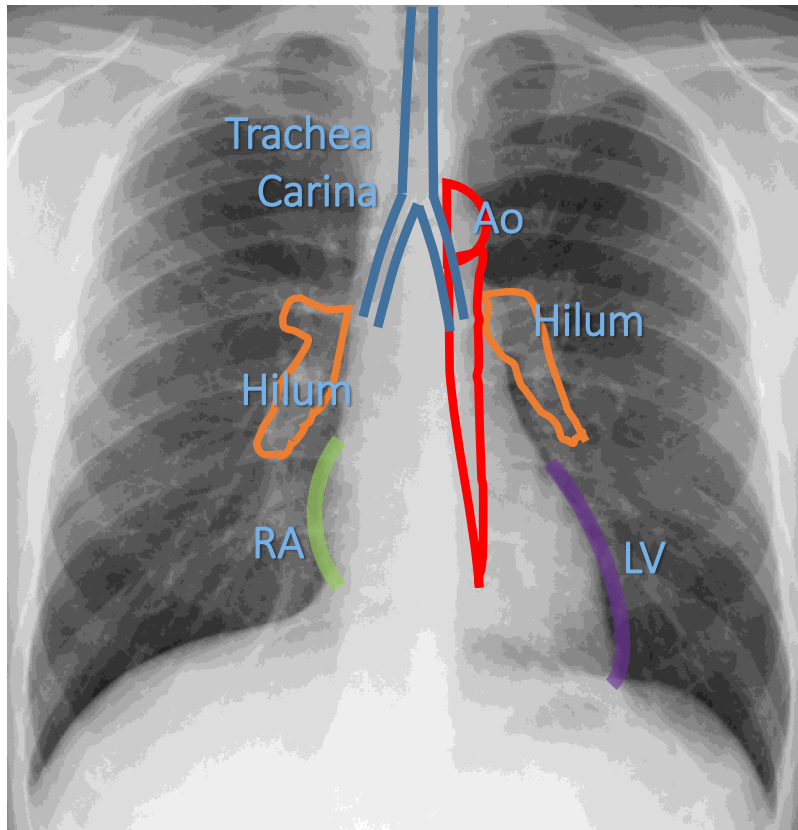
(right hilum lower than
than left, hila = density
and size)

RA border

LV border

Aortic arch & desc
aorta

Normal Anatomy: MEDIASTINAL LINES



FRONTAL PA or AP

CHECKLIST:

Trachea

Carina, RMB, LMB

Hila/hilar vessels

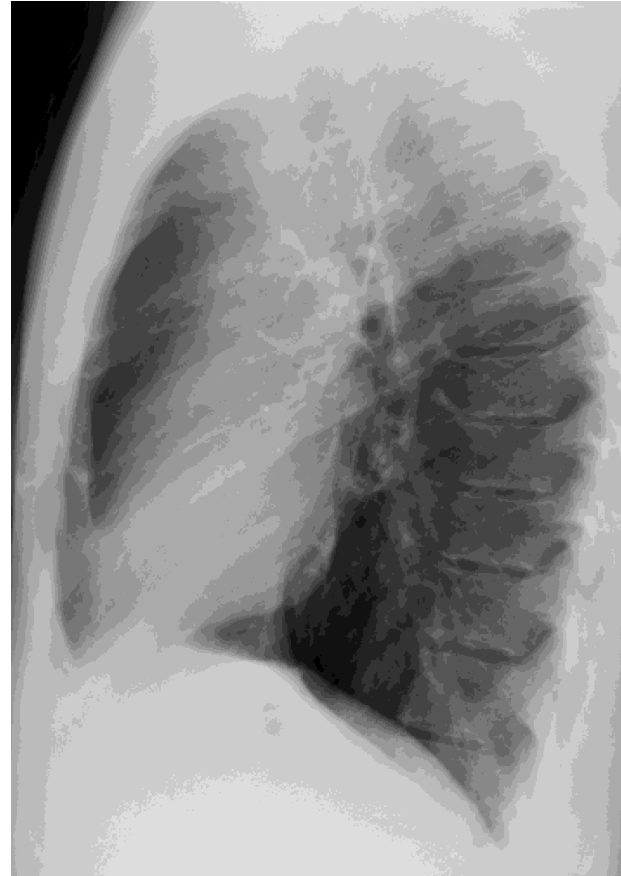
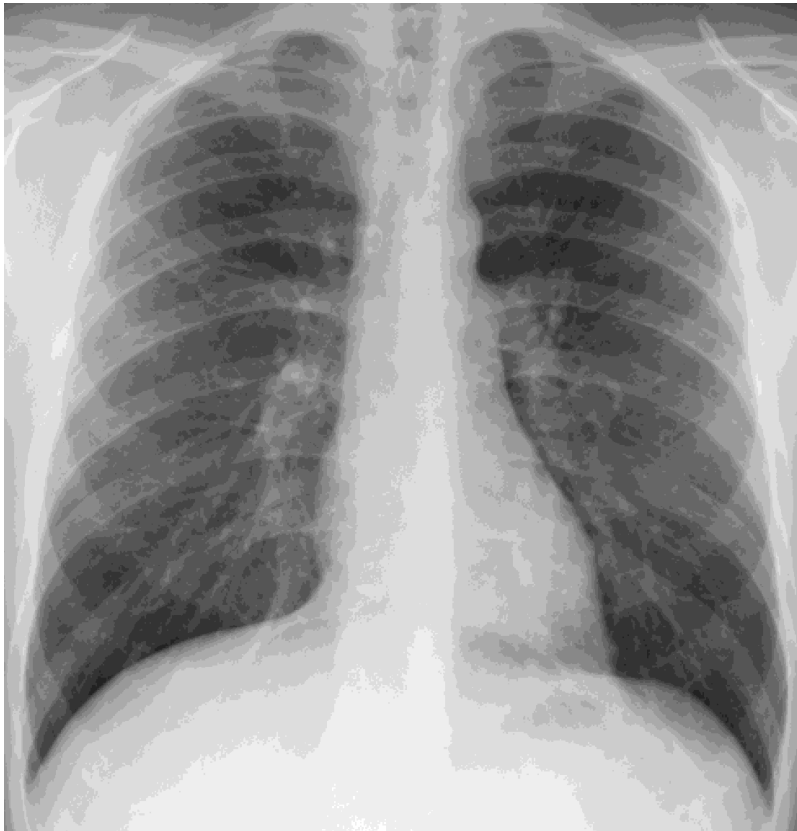
(right hilum lower than
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Aortic arch & desc
aorta

RA border

LV border

Normal Anatomy CXR: MEDIASTINAL LINES



LATERAL
CHECKLIST:

Trachea

RV and RVOT

Hila/hilar vessels

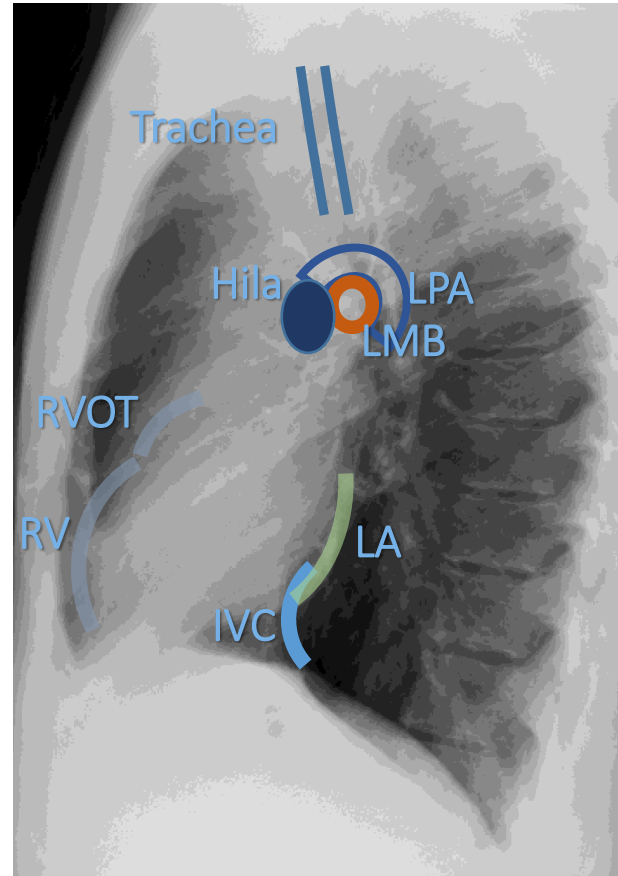
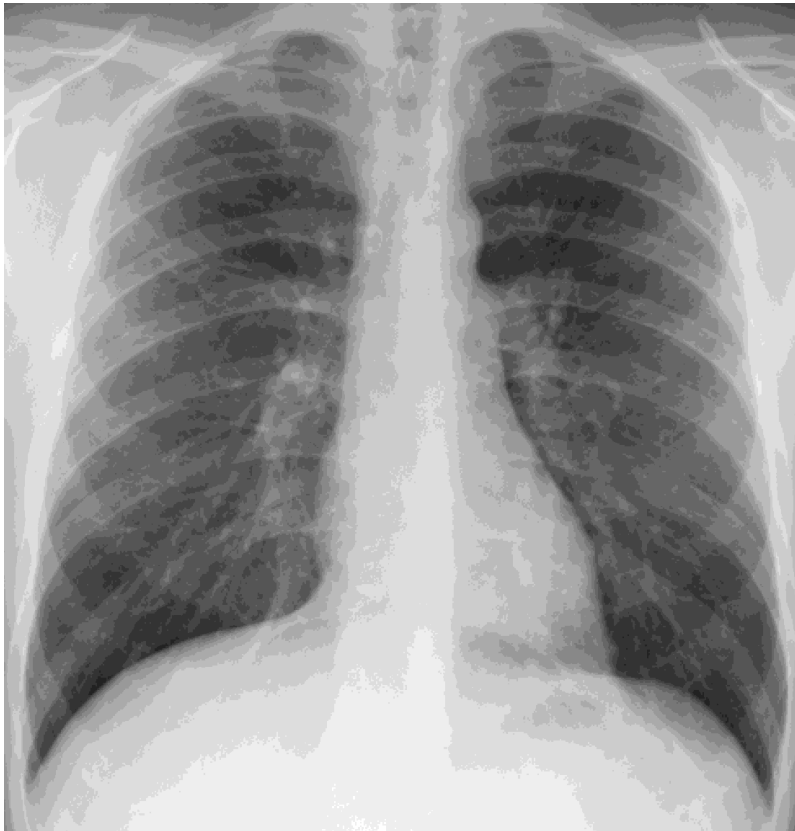
(LMB and LPA

RPA confluence)

LA contour


IVC

Normal Anatomy CXR: MEDIASTINAL LINES

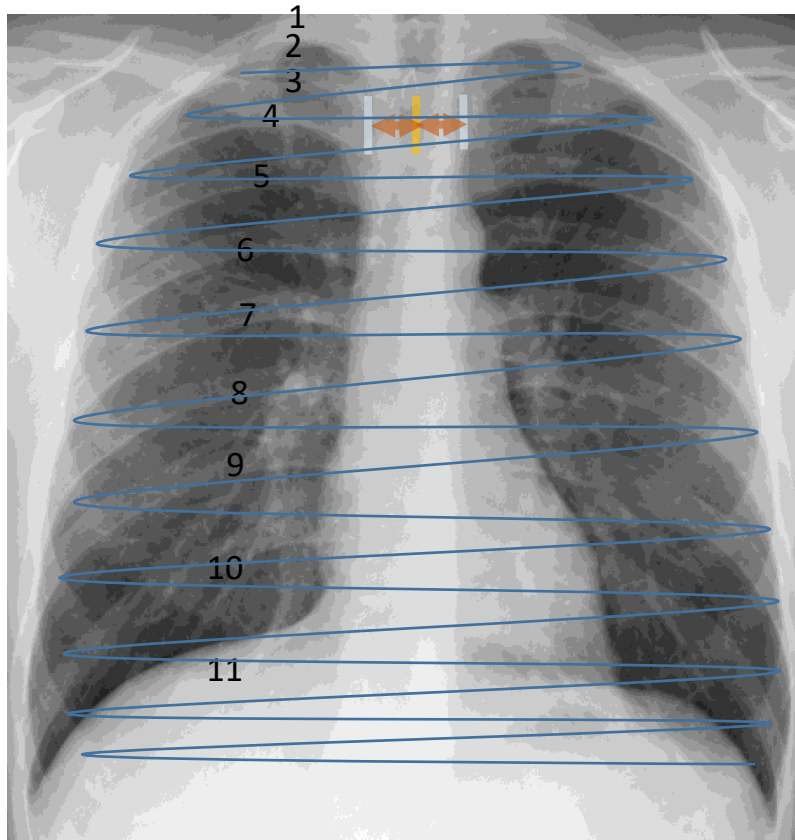


- LATERAL
CHECKLIST:
- Trachea
 - RV and RVOT
 - Hila/hilar vessels
(LMB and LPA
RPA confluence)
 - LA contour
 - IVC

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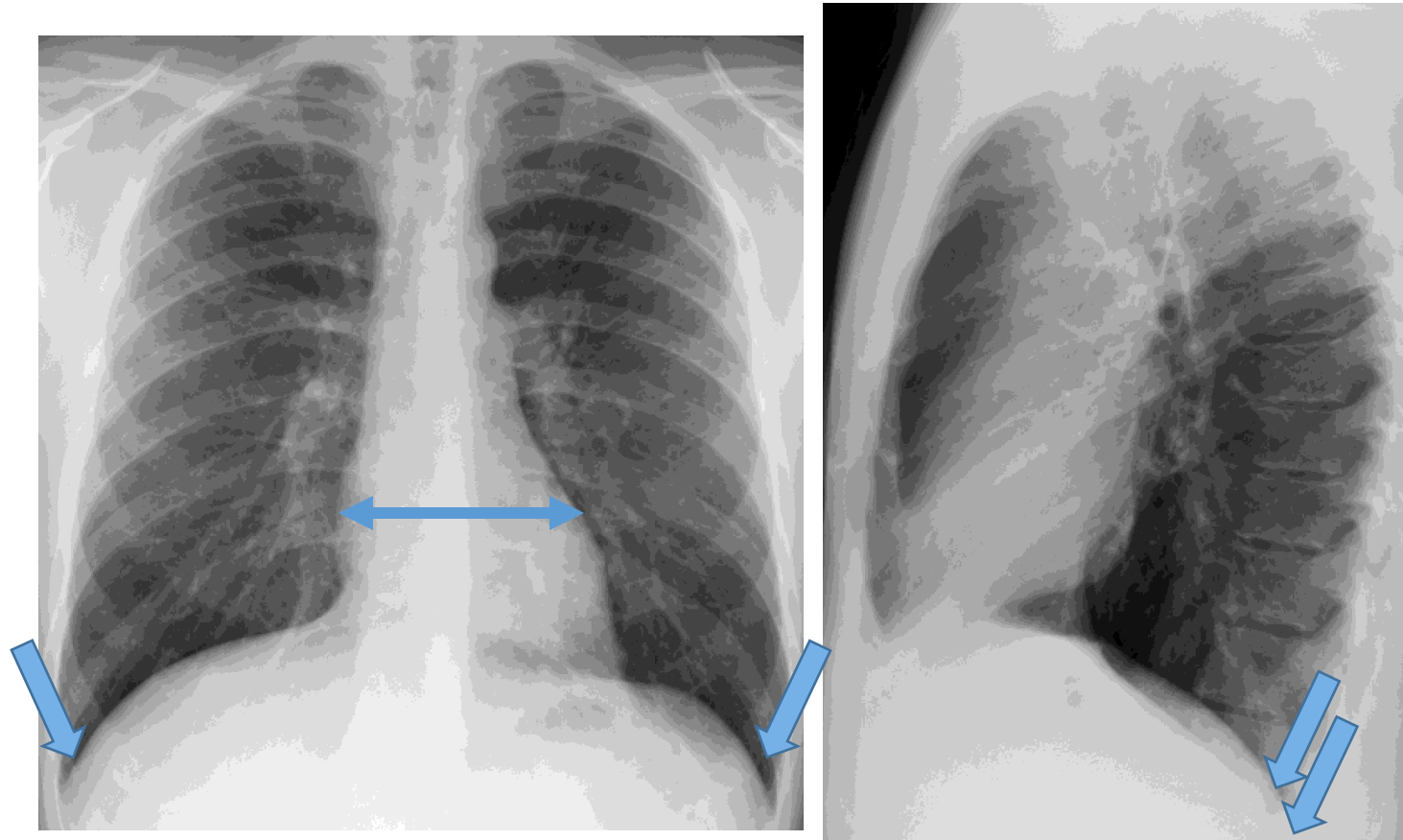
APPROACH TO CHEST FILM INTERPRETATION



CHECKLIST:

- 1 Technique
- 2 Rotation
- 3 Lung Volumes
- 4 Lung Parenchyma
- 5 CP Angles
- 6 Heart Size
- 7 Bones & Soft Tissues


APPROACH TO CHEST FILM INTERPRETATION



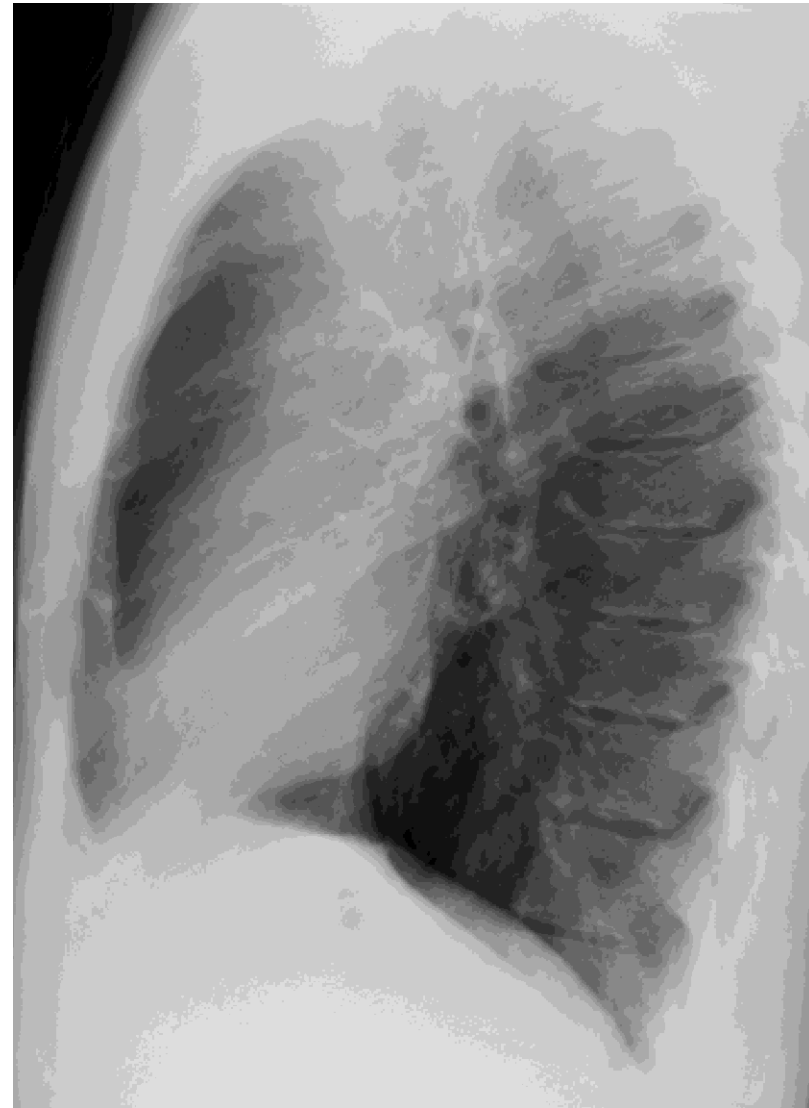
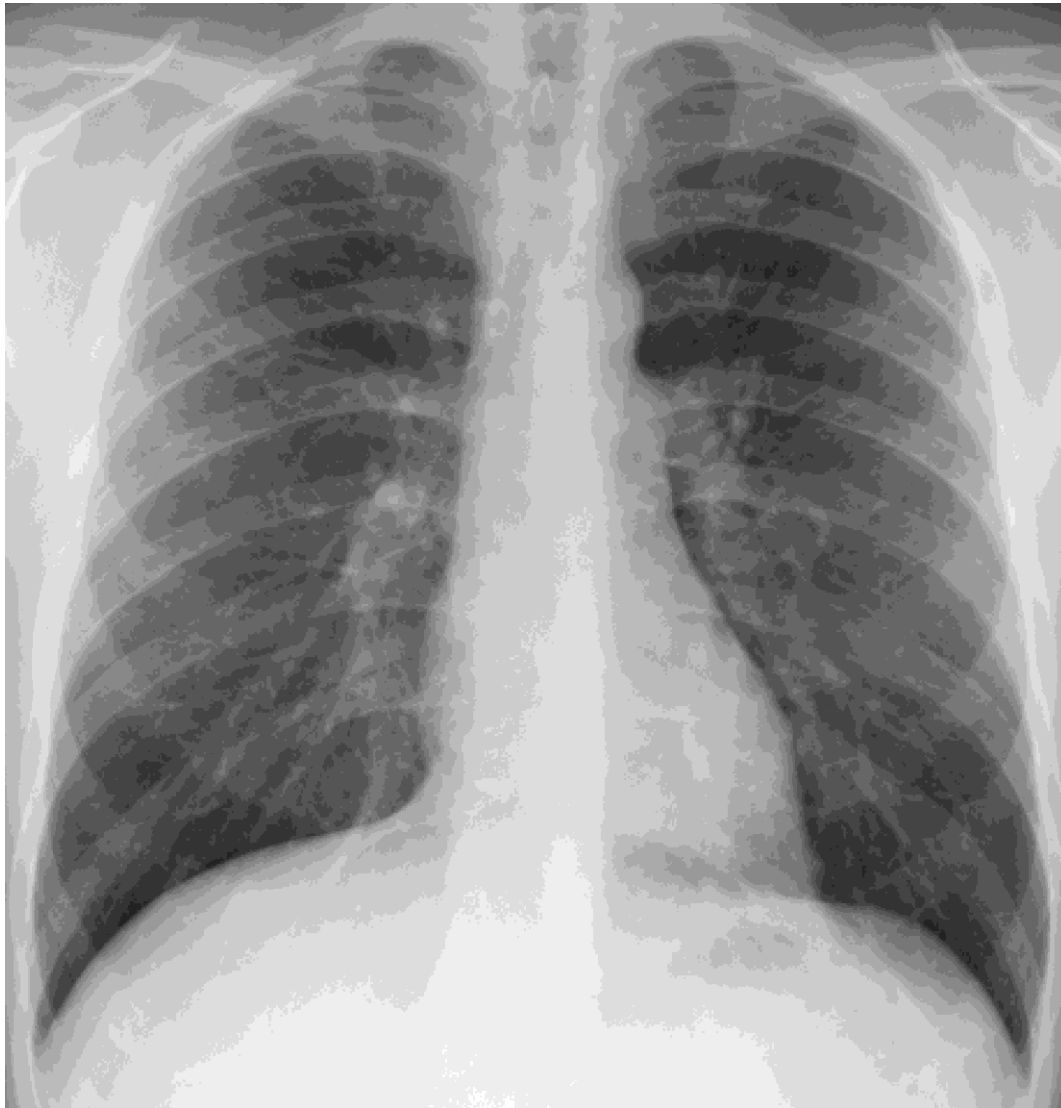
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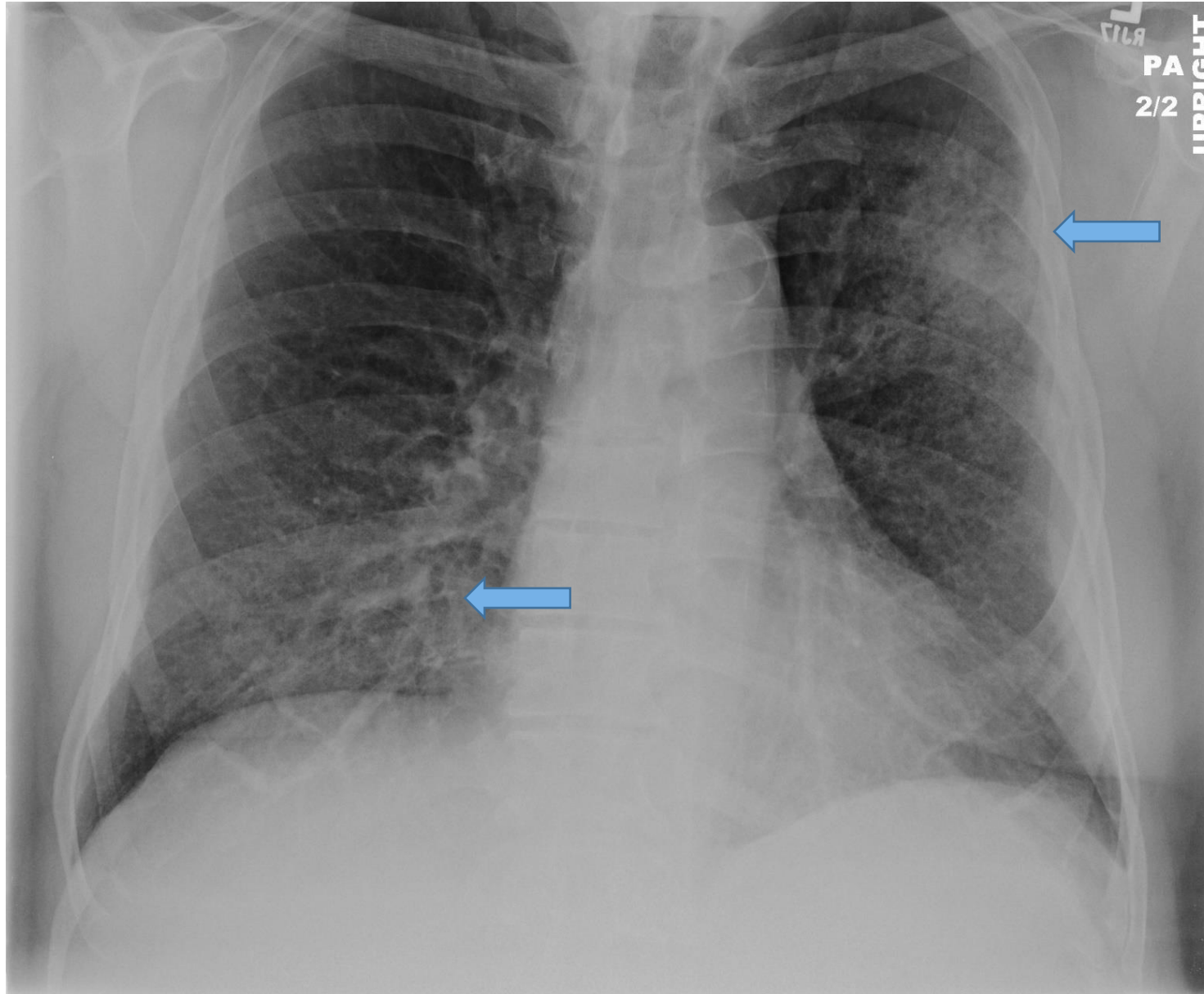
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RECALL: Normal CXR Appearance



Case 1: Pneumonia



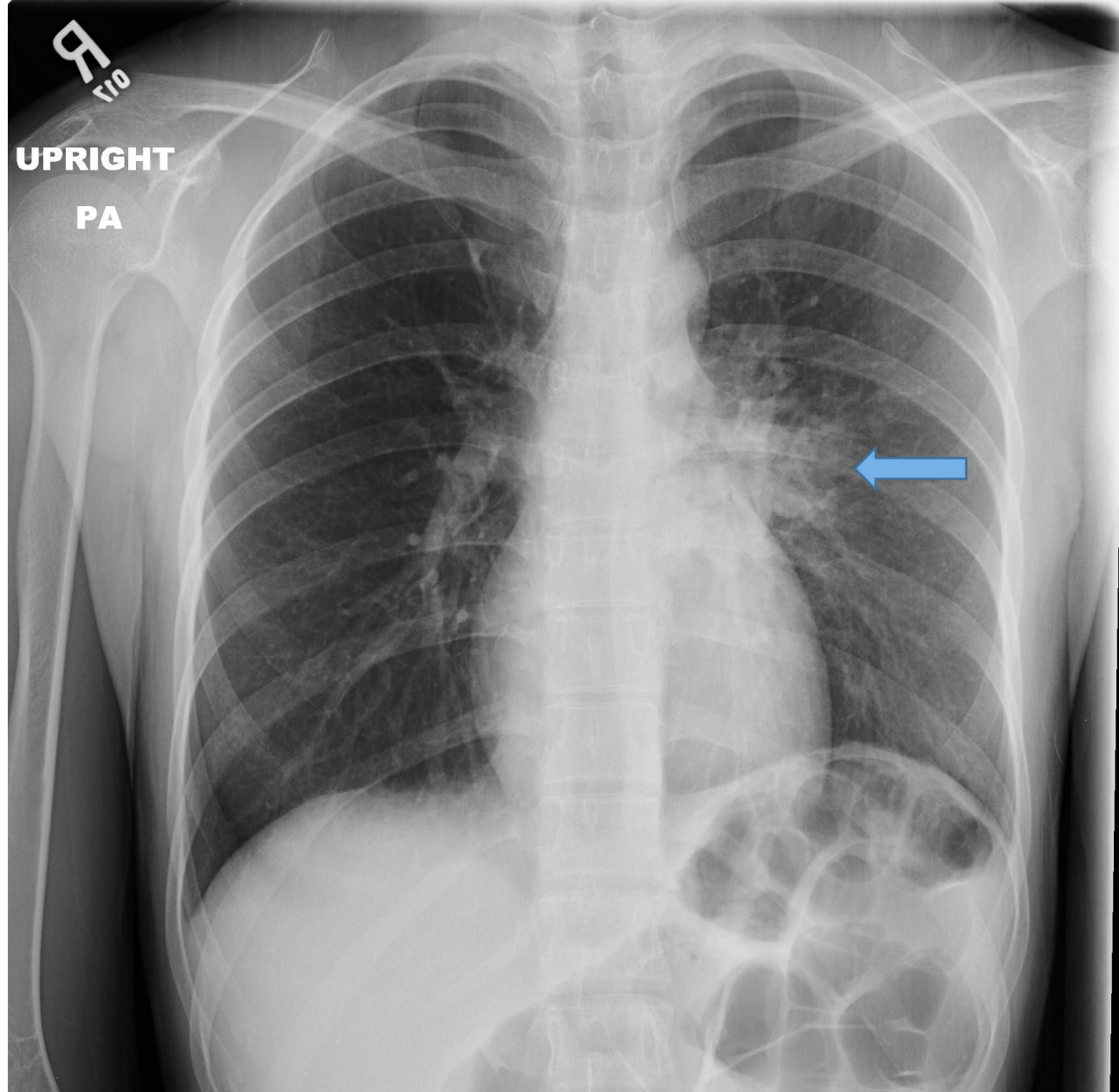
Pneumonia very common disease and one of the most common causes of death worldwide.

Causative organisms may be bacterial, viral, or fungal. In pneumonia (particularly bacterial), alveolar spaces are filled with organisms, inflammatory cells, and pus.

Lobar pattern of consolidation containing air bronchograms.

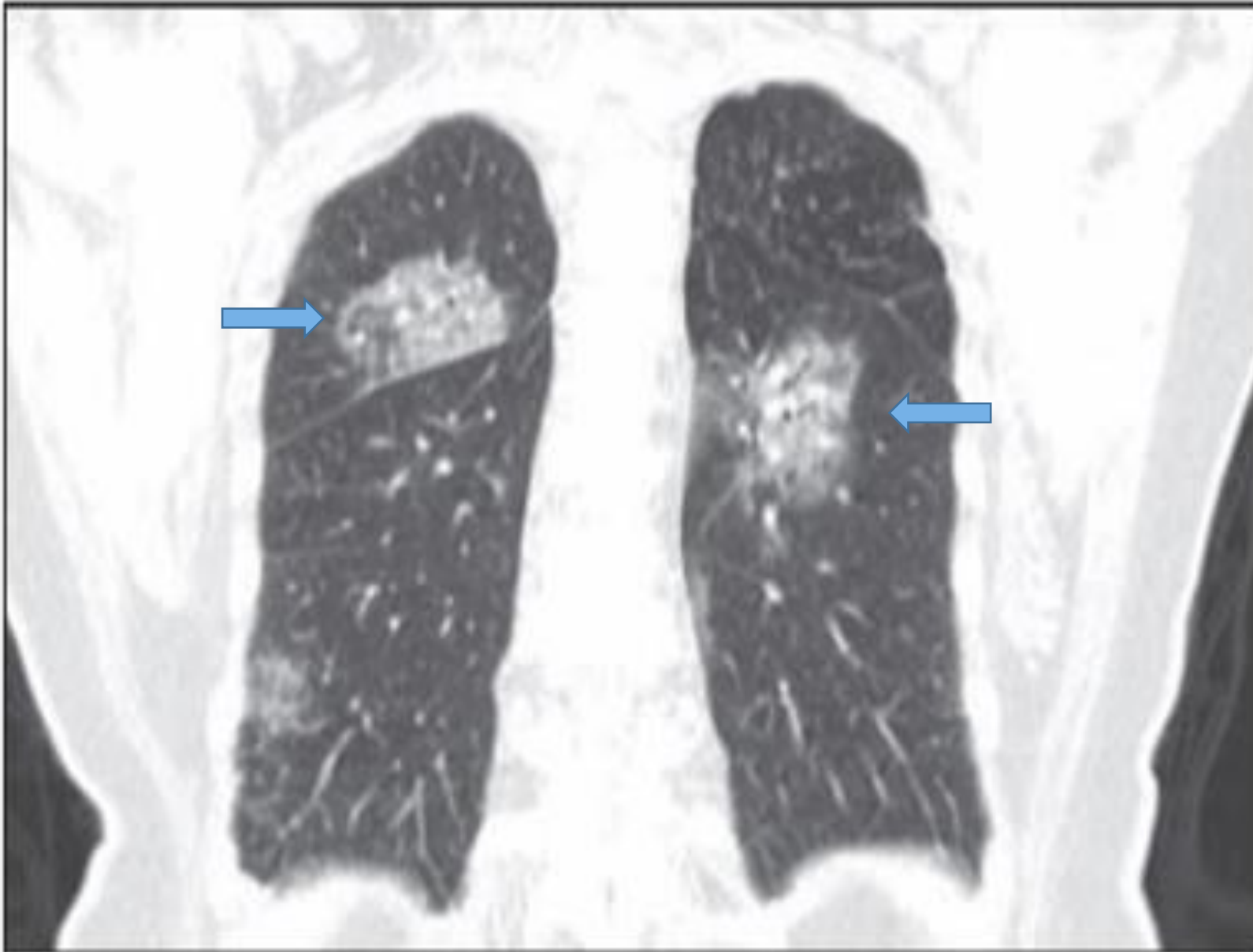
Peripheral ground-glass opacities are present.

Case 2: Pneumonia



Lobar consolidation containing air bronchograms is the classic appearance seen in bacterial pneumonia. Interstitial disease seen as reticular (mesh-like or netlike), nodular (small round opacities), or reticulonodular (mixed reticular and nodular patterns) with infecting organisms 'atypical'. These patterns may be found in viral, mycoplasma, or fungal pneumonias.

Case 3: COVID19 Pneumonia

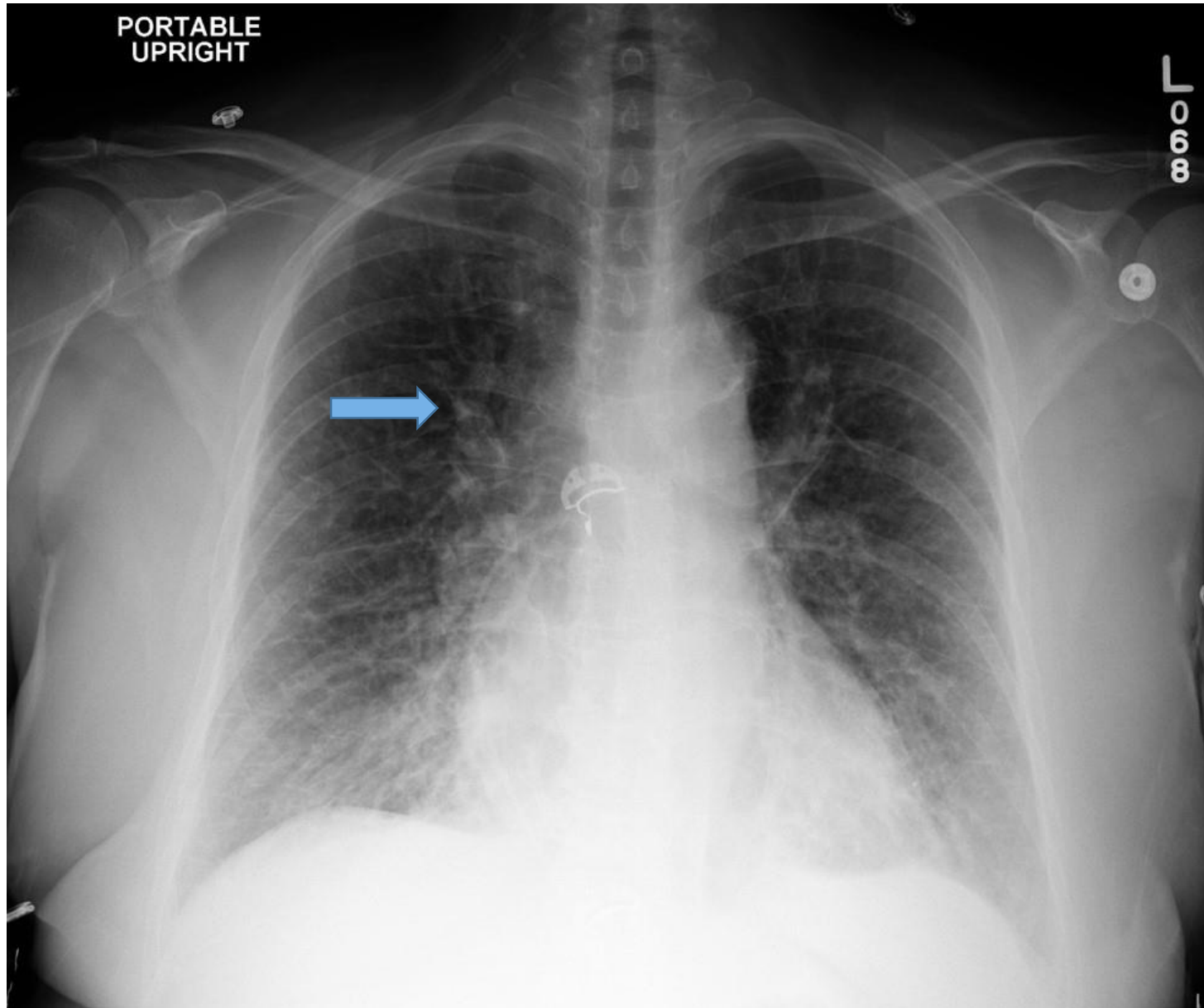


Corona virus disease 19
(SARS, MERS also
coronavirus)

Fever, chills, dyspnea,
malaise, myalgia, dry cough

Acute: Normal imaging 15%,
CXR underestimates
disease. On CT: bilateral
multifocal lower lobe vs
diffuse peripheral airspace
(ground glass) opacities and
consolidation

Case 4: Interstitial Pulmonary Edema

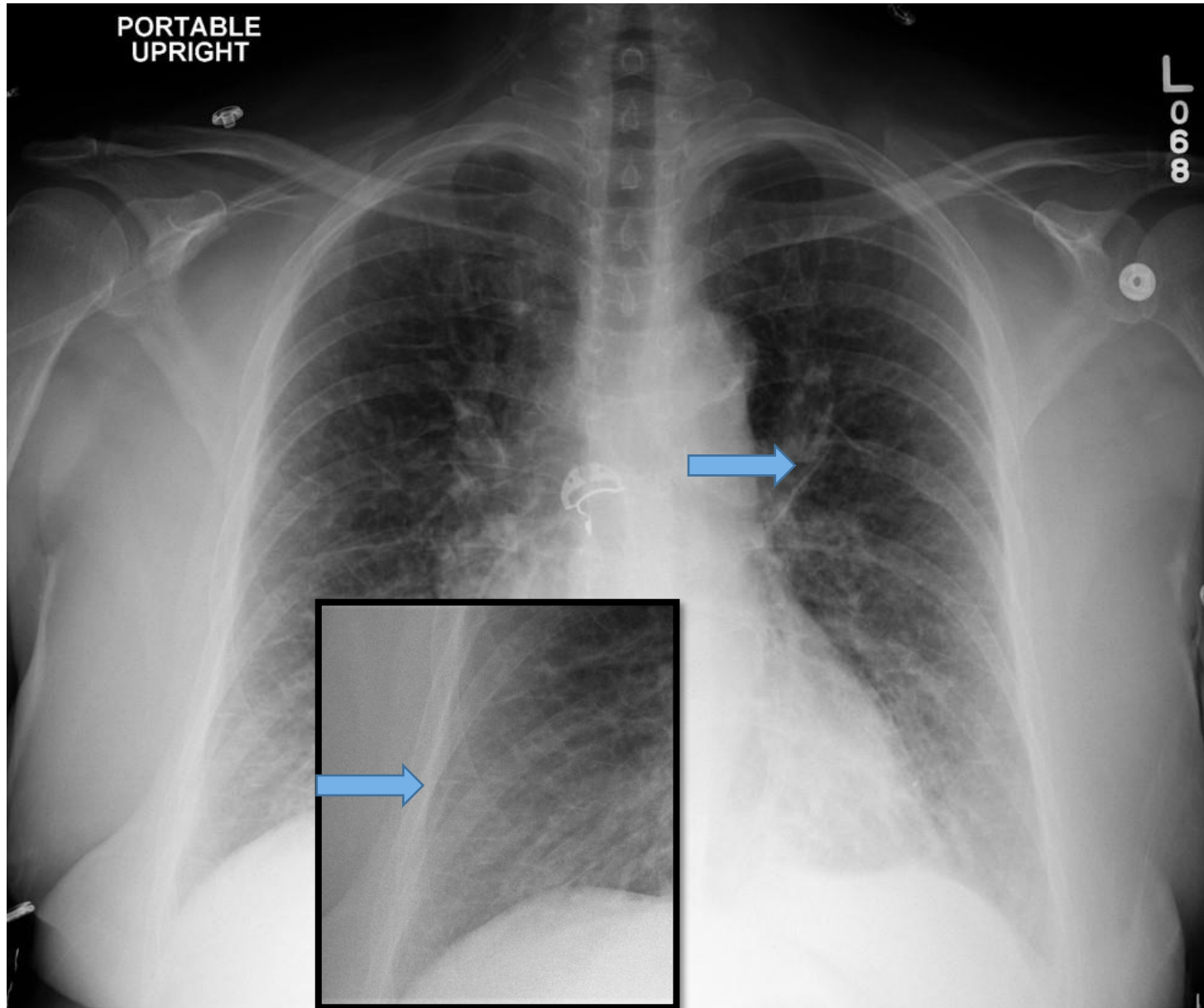


Increased pulmonary venous pressure causes early dilation of superior zone veins.

Increased prominence of the vasculature superiorly is cephalization.

Typical for early CHF with approx 15-25 mm HG

Case 4: Interstitial Pulmonary Edema

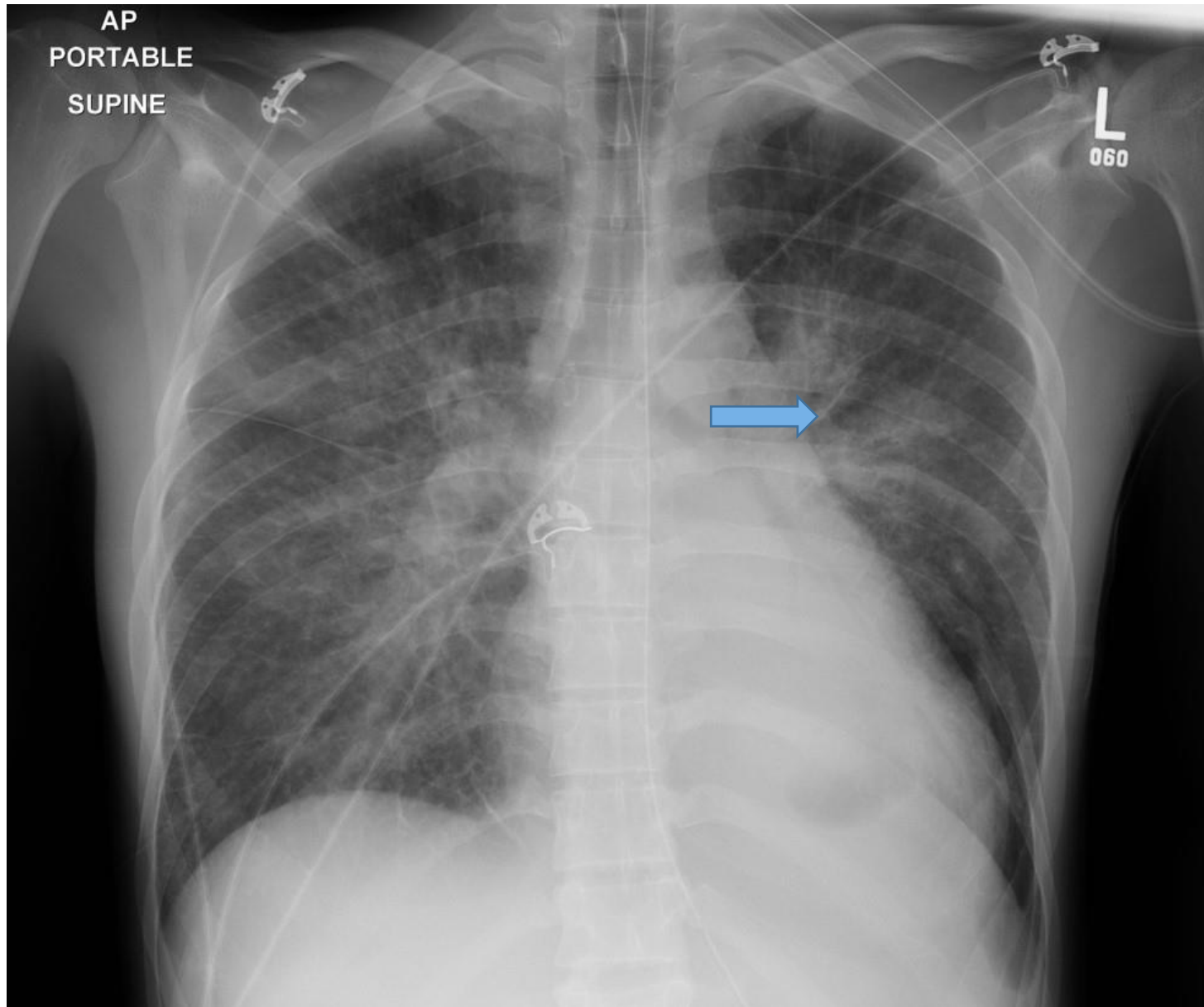


Kerley lines are present, consistent with a wedge pressure of approx 25-30 mmHg

Due to thickened interlobular septa

Horizontal lines typically found in periphery

Case 5: Alveolar Pulmonary Edema

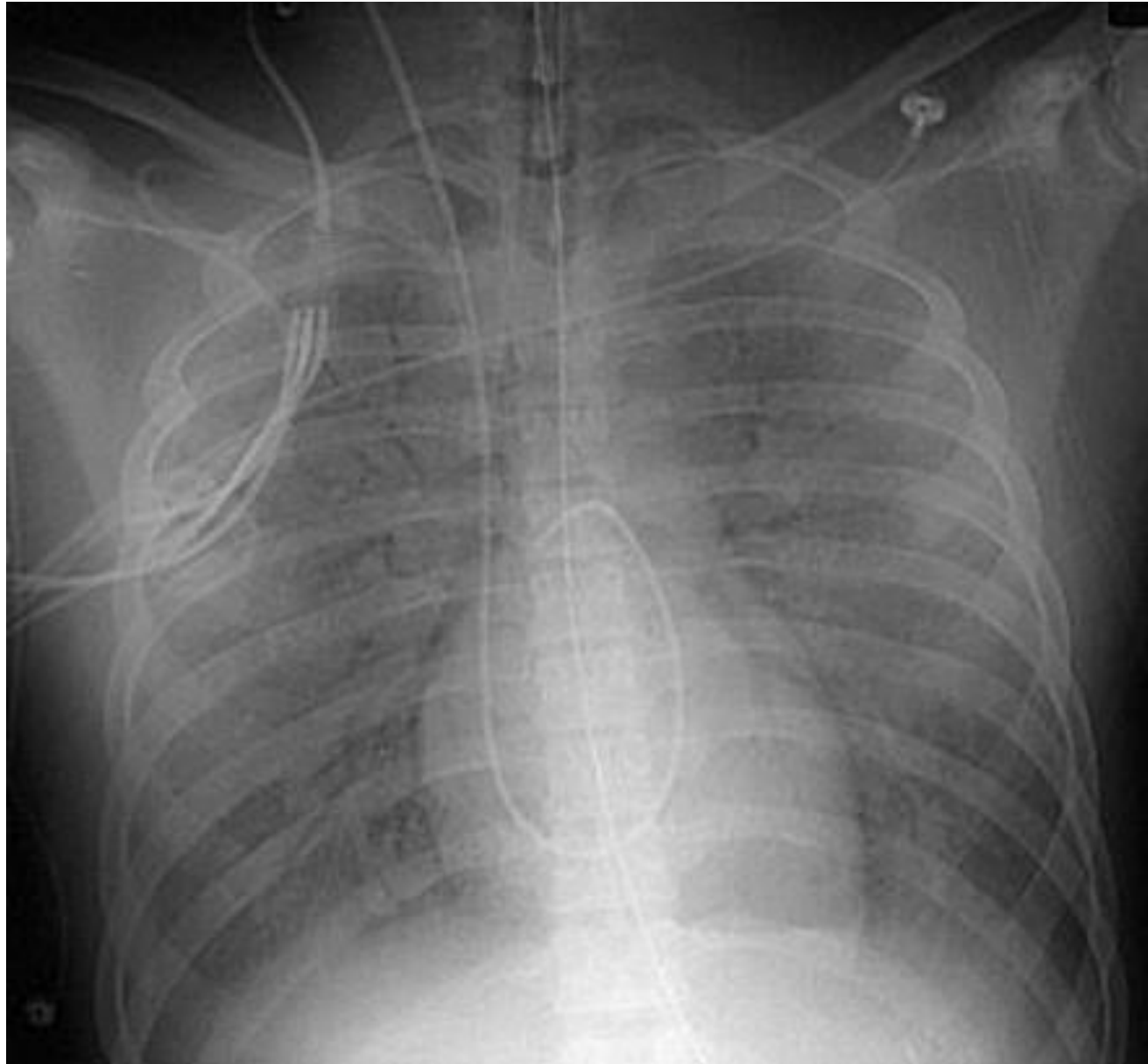


As pulmonary pressure progresses above 30 mm Hg or higher 'Batwing' edema appears.

Perihilar opacities

With a high enough wedge pressure, the fluid spills into the alveoli yielding air bronchograms and air alveolograms.

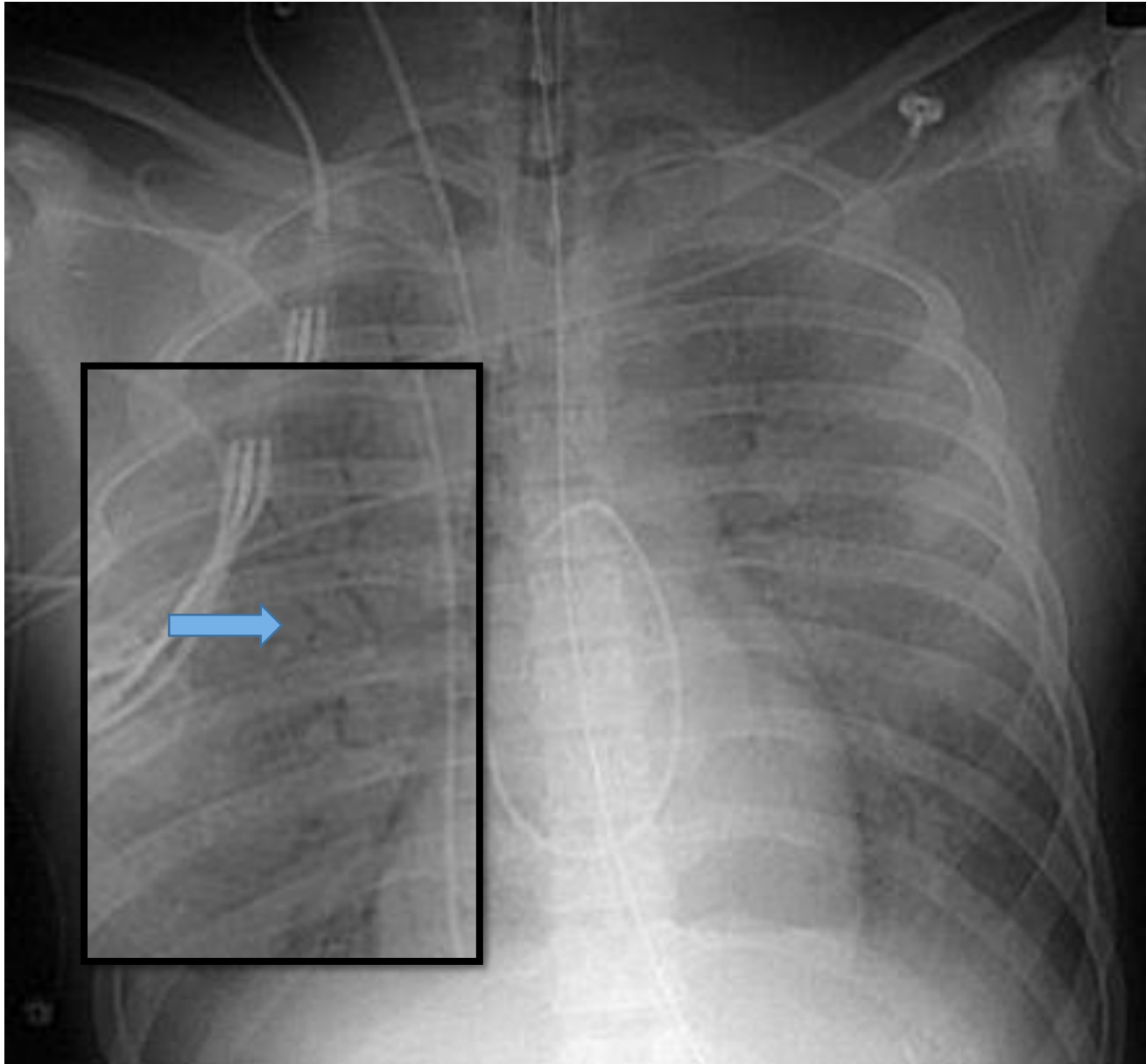
Case 6: Alveolar Pulmonary Edema



As pulmonary pressure progresses above 30 mm Hg or higher 'Batwing' edema appears.

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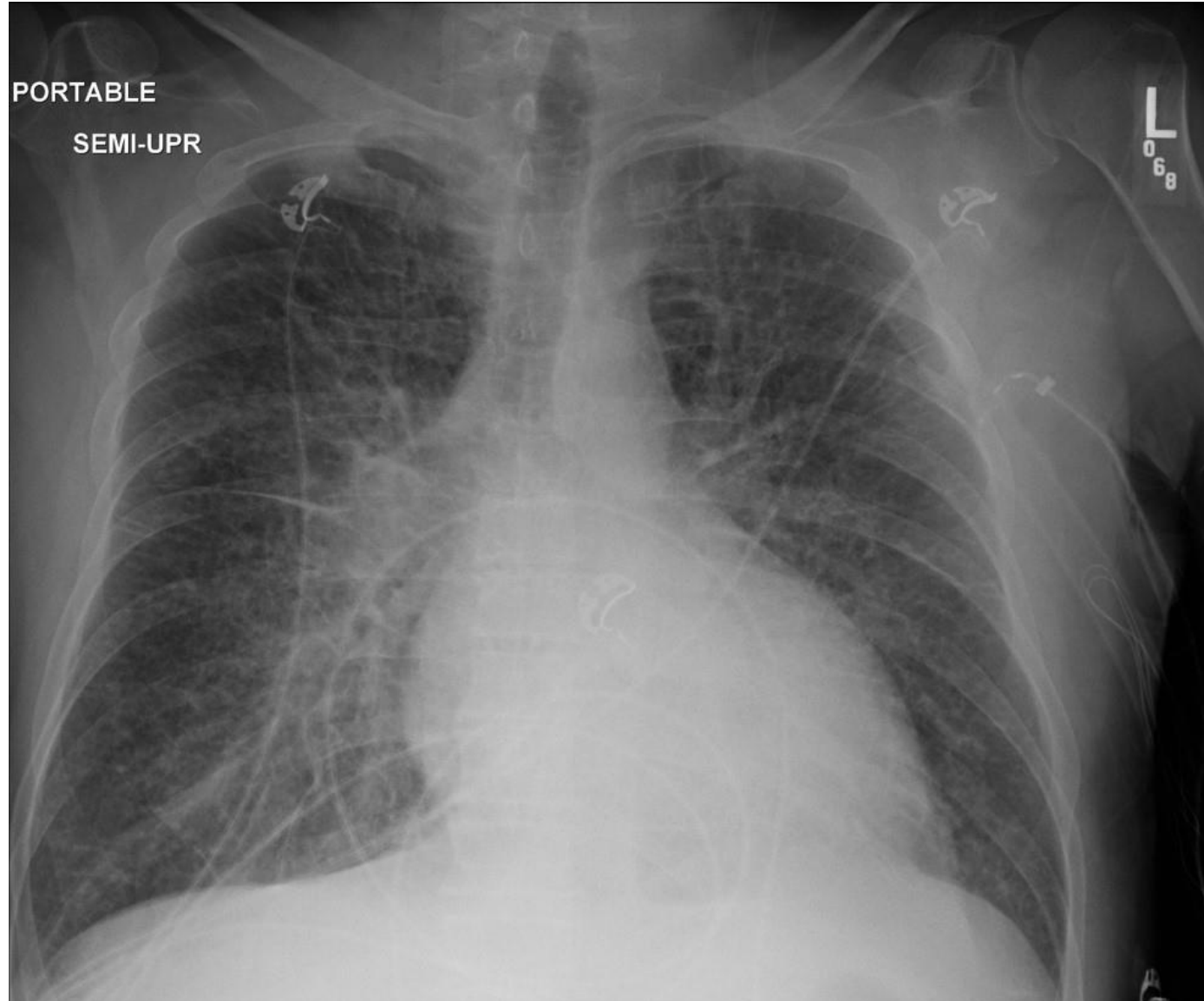
Case 6: Alveolar Pulmonary Edema



As pulmonary pressure progresses above 30 mm Hg or higher 'Batwing' edema appears.

With a high enough wedge pressure, the fluid spills into the alveoli yielding air bronchograms and air alveolograms.

Case 7: Congestive Heart Failure



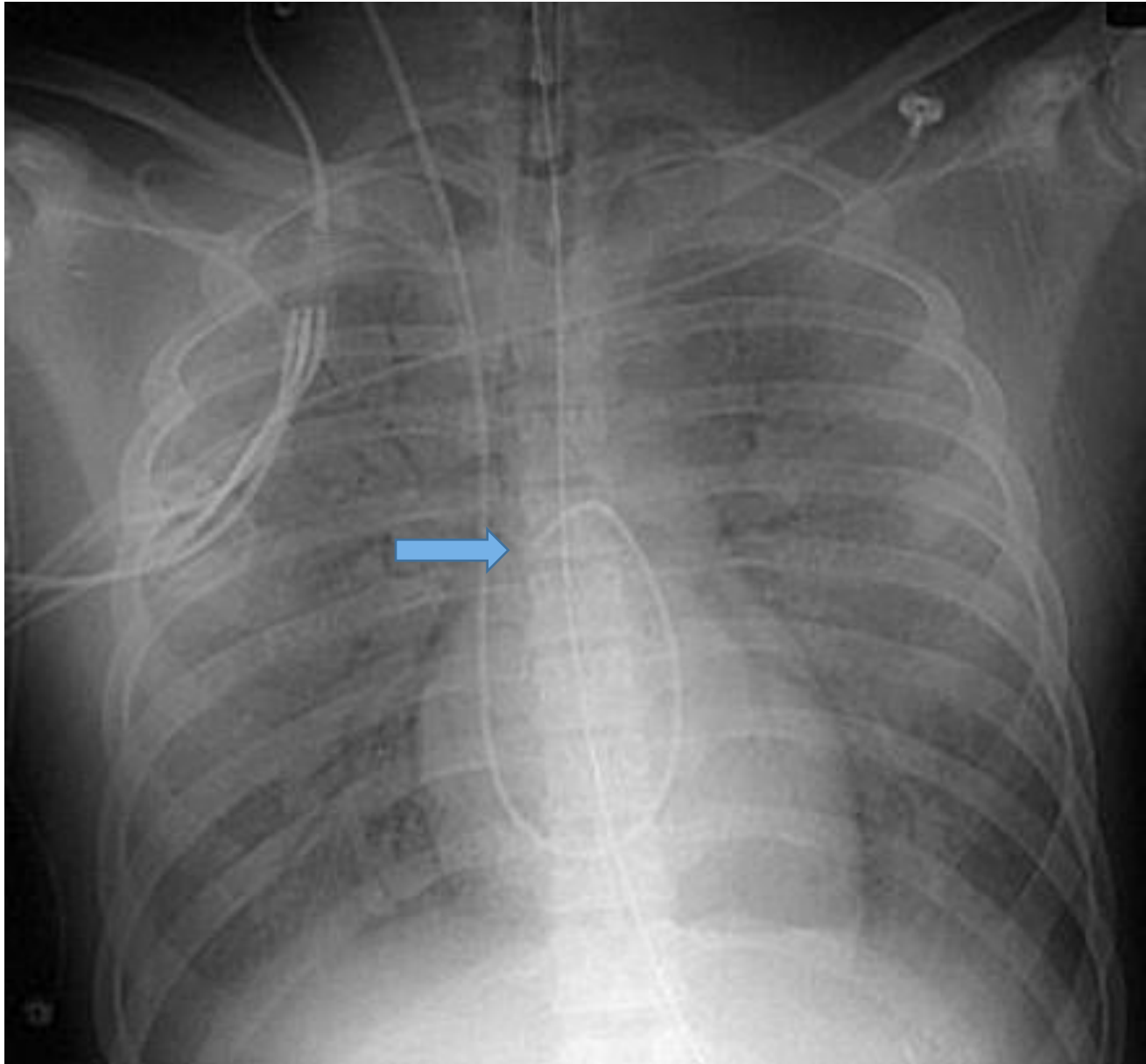
CHF

Cardiomegaly

Pulmonary edema

Pleural effusions are also
common

Case 8: Pulmonary Artery Catheter



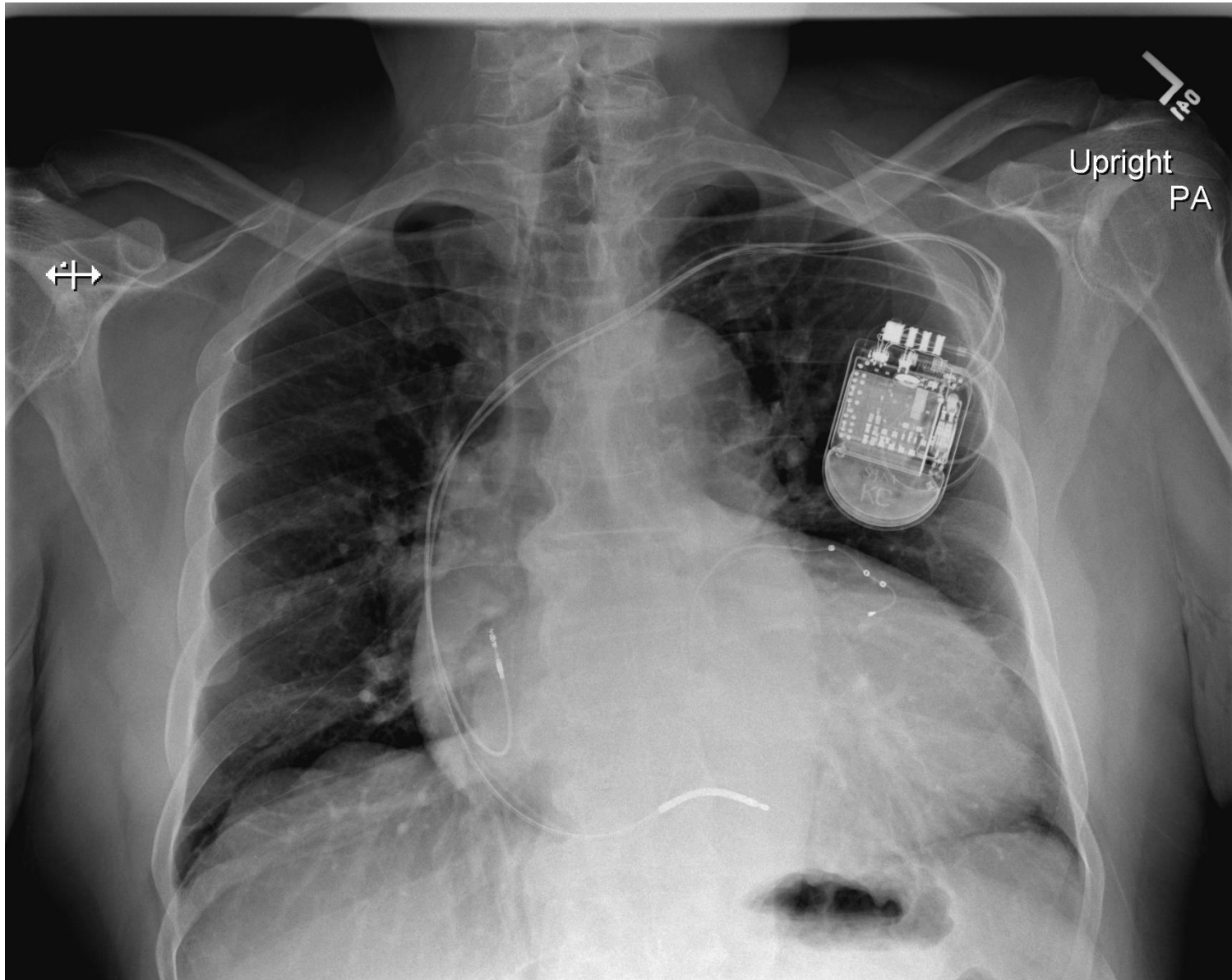
SG catheter monitors hemodynamic status

Aids in differentiating cardiogenic from noncardiogenic edema via use of a pressure balloon

Position 2 cm distal to hilum in proximal R or L pulm art

SG risks pulm hemorrhage & infarct if overdressed

Case 9: Cardiomegaly



Cardiomegaly defined as widest transverse heart diameter greater than half the transverse thoracic diameter on PA film in full inspiration

False positives

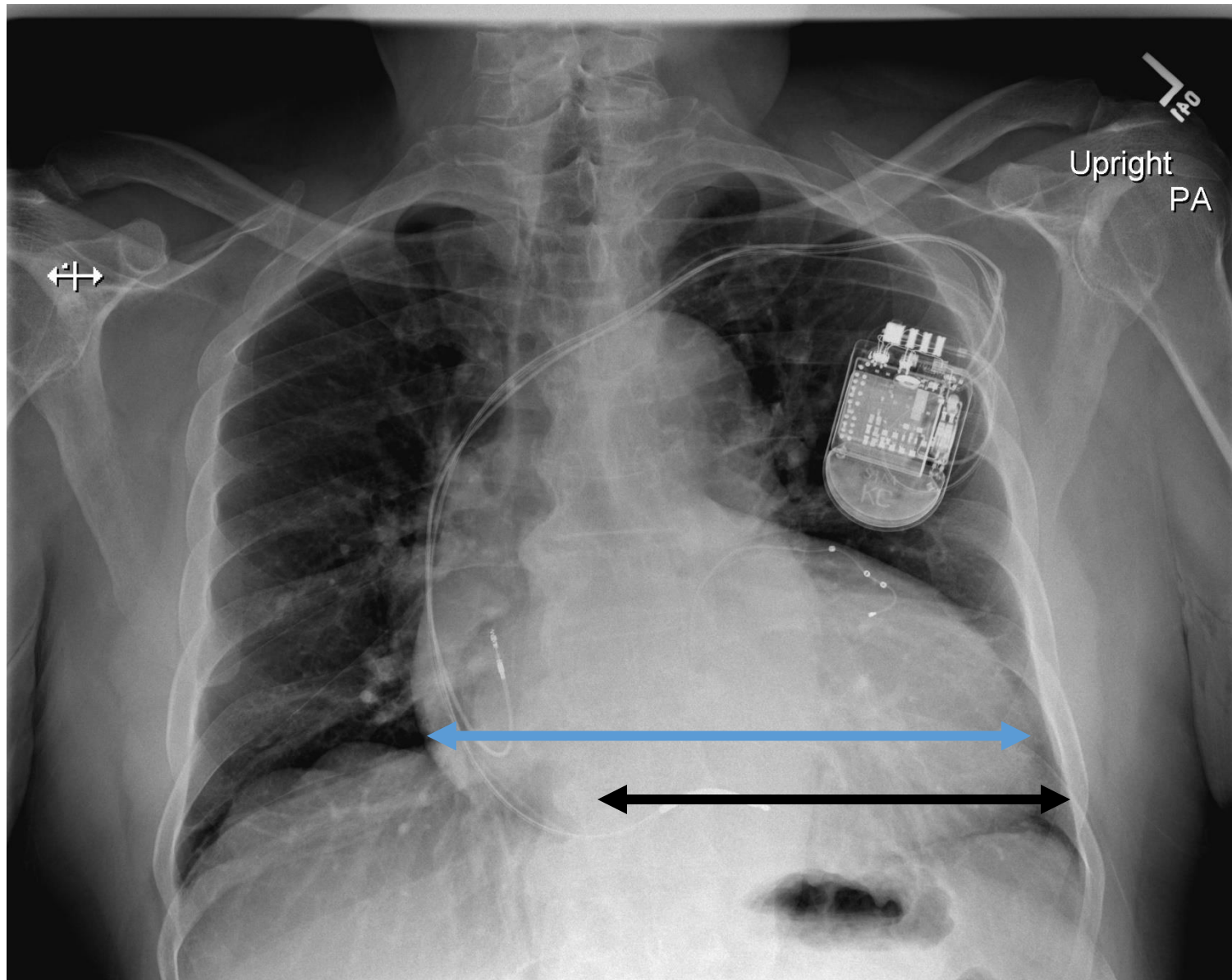
- Low lung vol

- Chest wall abnl

- Pericardial effusion

- AP view

Case 9: Cardiomegaly



Cardiomegaly defined as widest transverse heart diameter greater than half the transverse thoracic diameter on PA film in full inspiration

False positives

Low lung vol

Chest wall abnl

Pericardial effusion

Case 10: Atelectasis



Increased lung opacity with evidence of volume loss

Direct signs: Vascular crowding, displacement of fissures

Indirect signs: Elevation of the hemi diaphragm of the affected lung, mediastinal shift to side of volume loss, rib crowding, obscuration of heart or diaphragm border.

Silhouette sign: RUL (mediastinum), RML (rt heart), RLL LLL (hemidiaphragms), LUL (mediastinum)

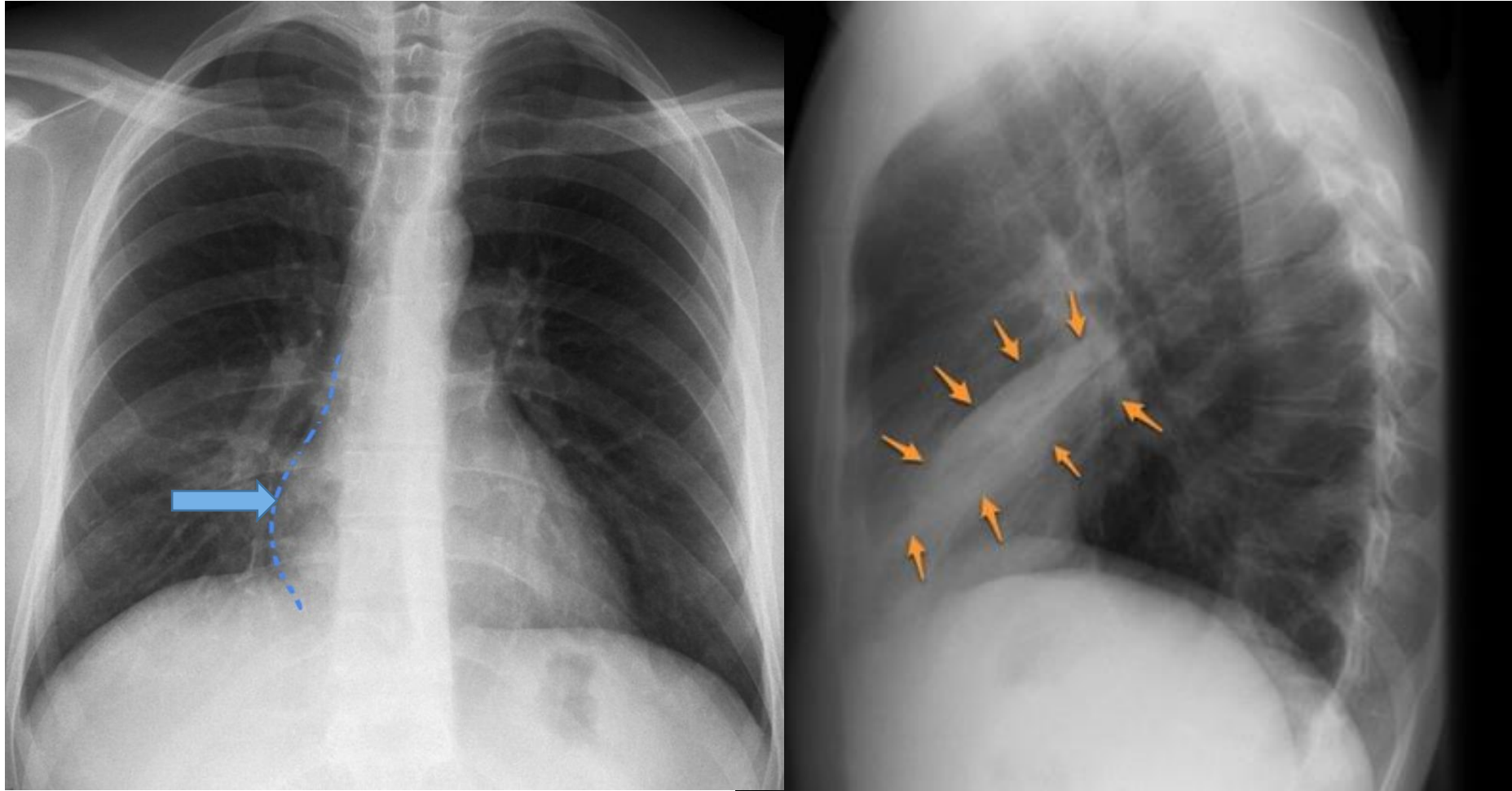
Case 11 (Schematic): Atelectasis



Patterns of collapse

**Directly from Core Radiology textbook

Case 12: Atelectasis RML



Can be difficult to detect on frontal radiograph
Silhouetting of R heart border by collapsed lobar segment
Lateral radiograph demonstrates wedge-shaped opacity

Case 13: Atelectasis LUL

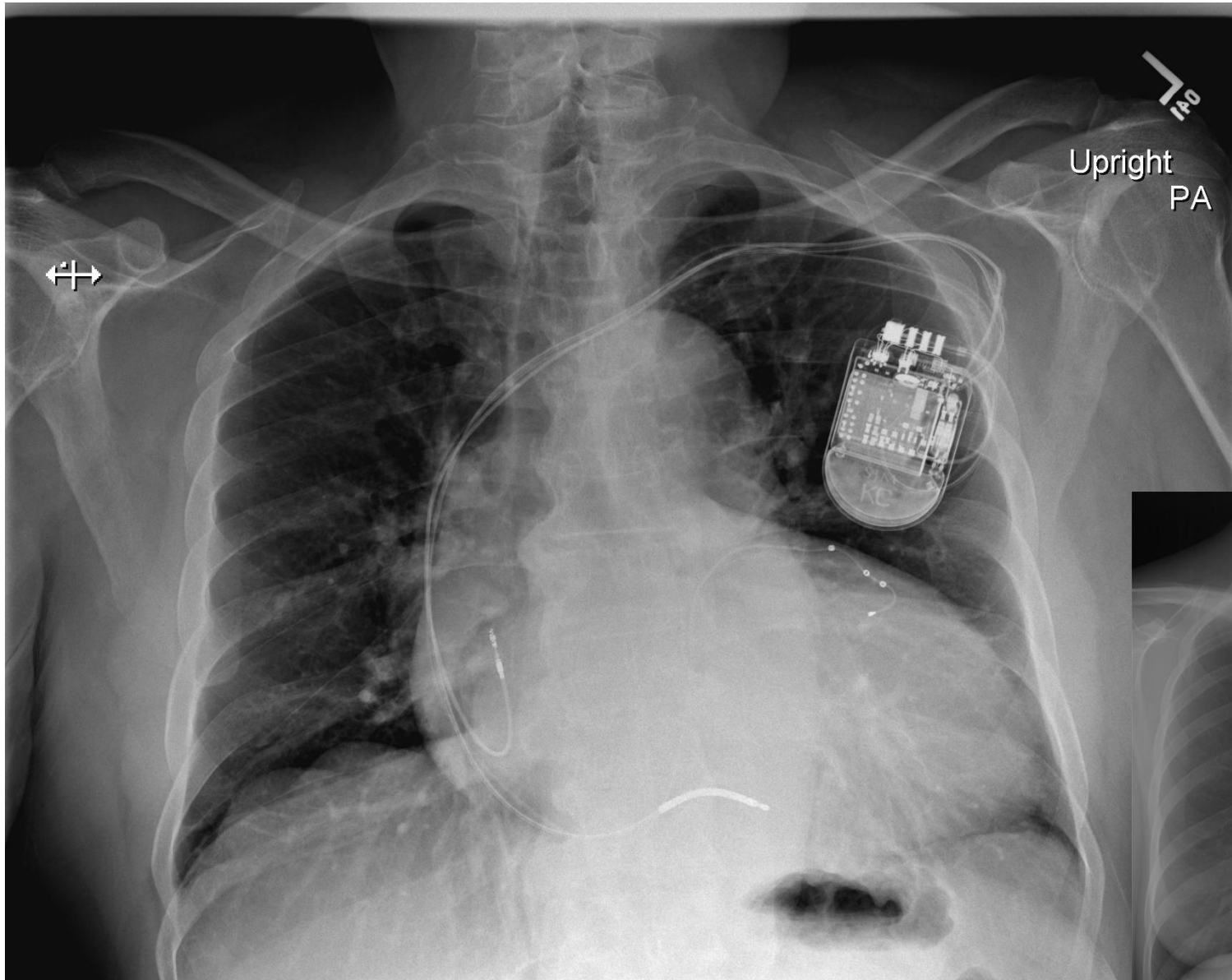


Left upper lobe atelectasis demonstrates the 'luftsichel' or 'air sickle' sign

Abnormal air crescent present when aorta is illuminated against the backdrop of hyperexpanded superior segment of left lower lobe



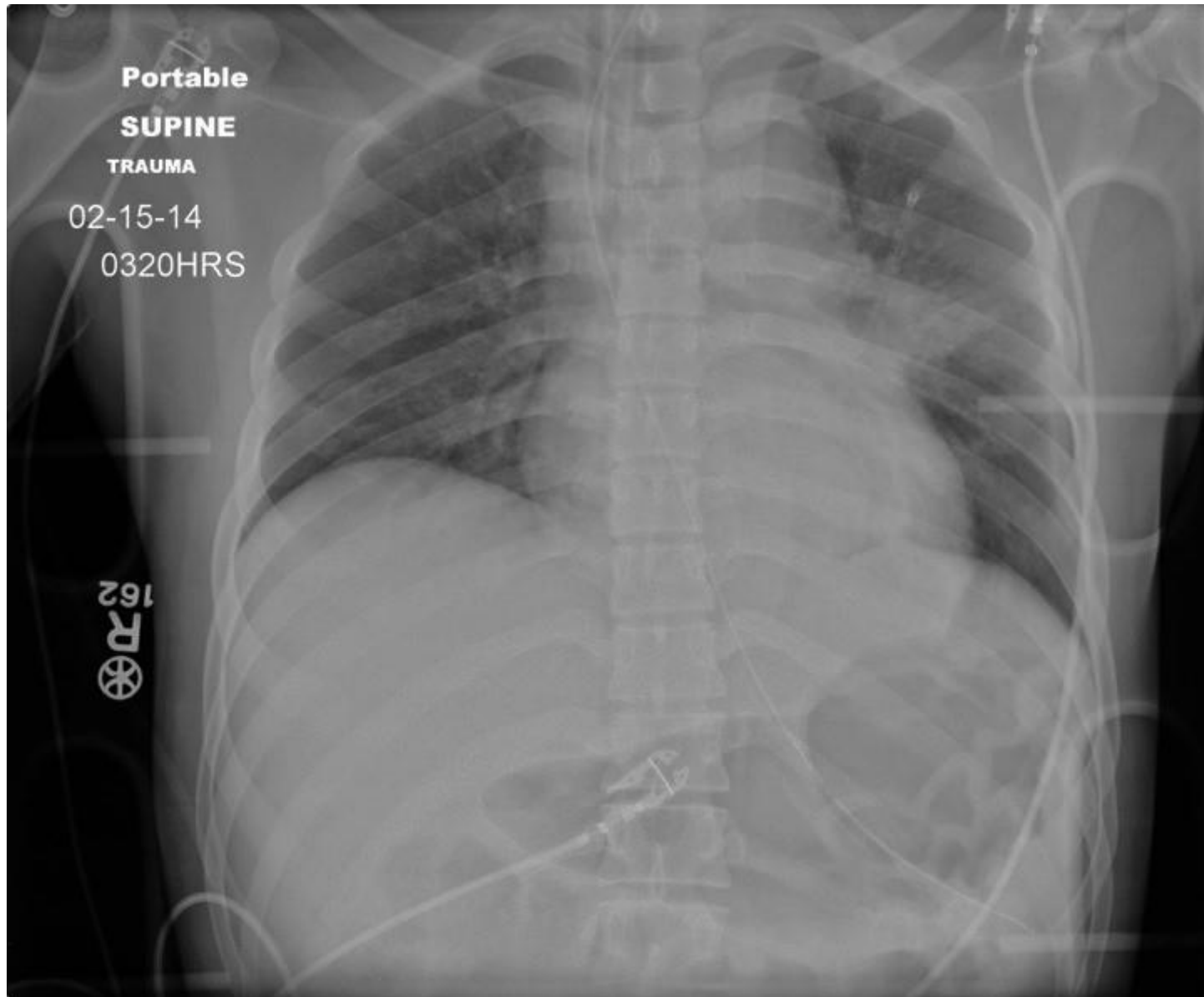
Case 14: Aortic Aneurysm



Thoracic aorta can be dilated tortuous (ectatic) or aneurysmal. Aneurysm defined as maximal transverse diameter $> 50\%$ larger than normal vessel. Upper limit normal ascending aorta = 40 mm, and descending aorta = 30

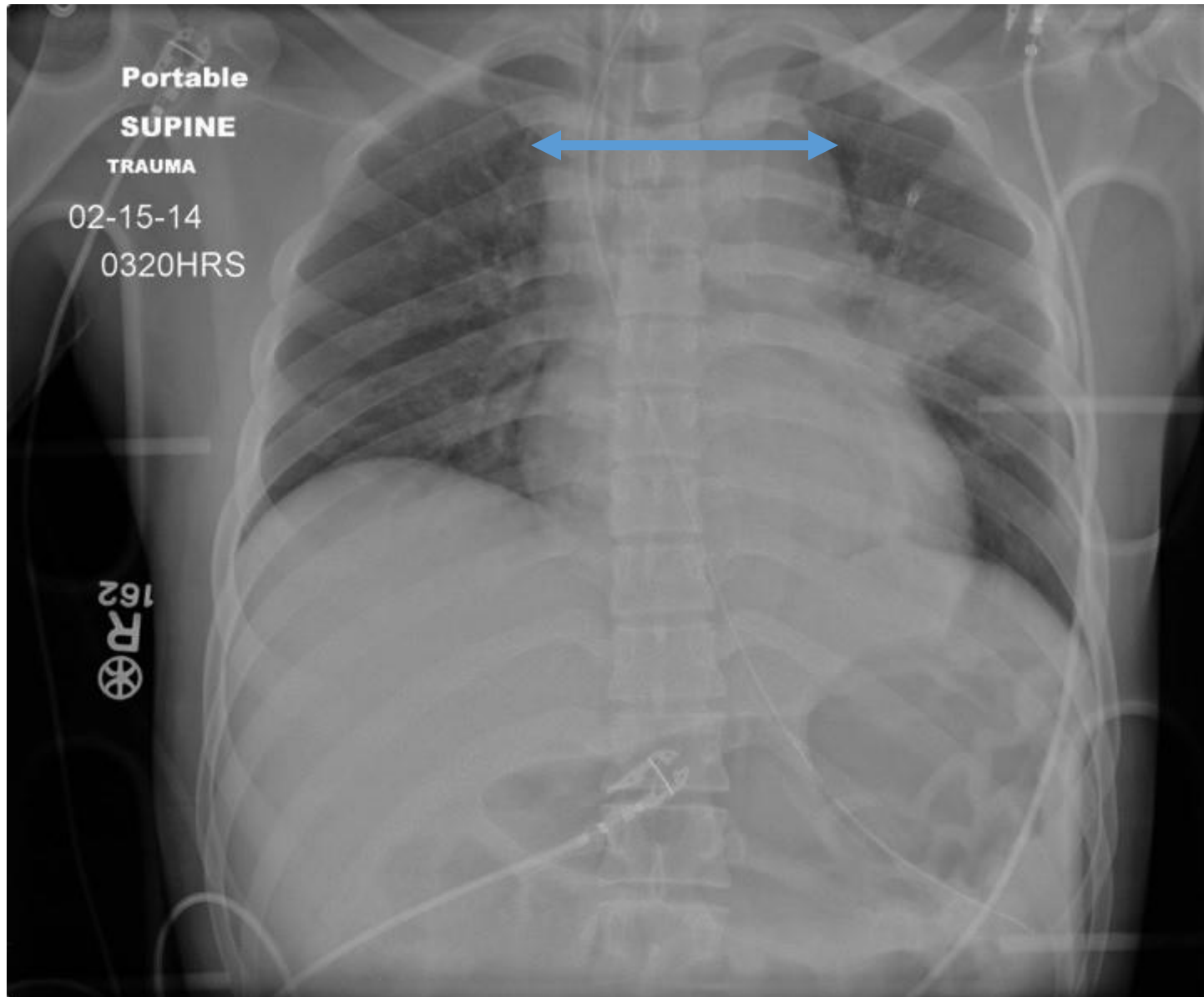


Case 15: Aortic Injury



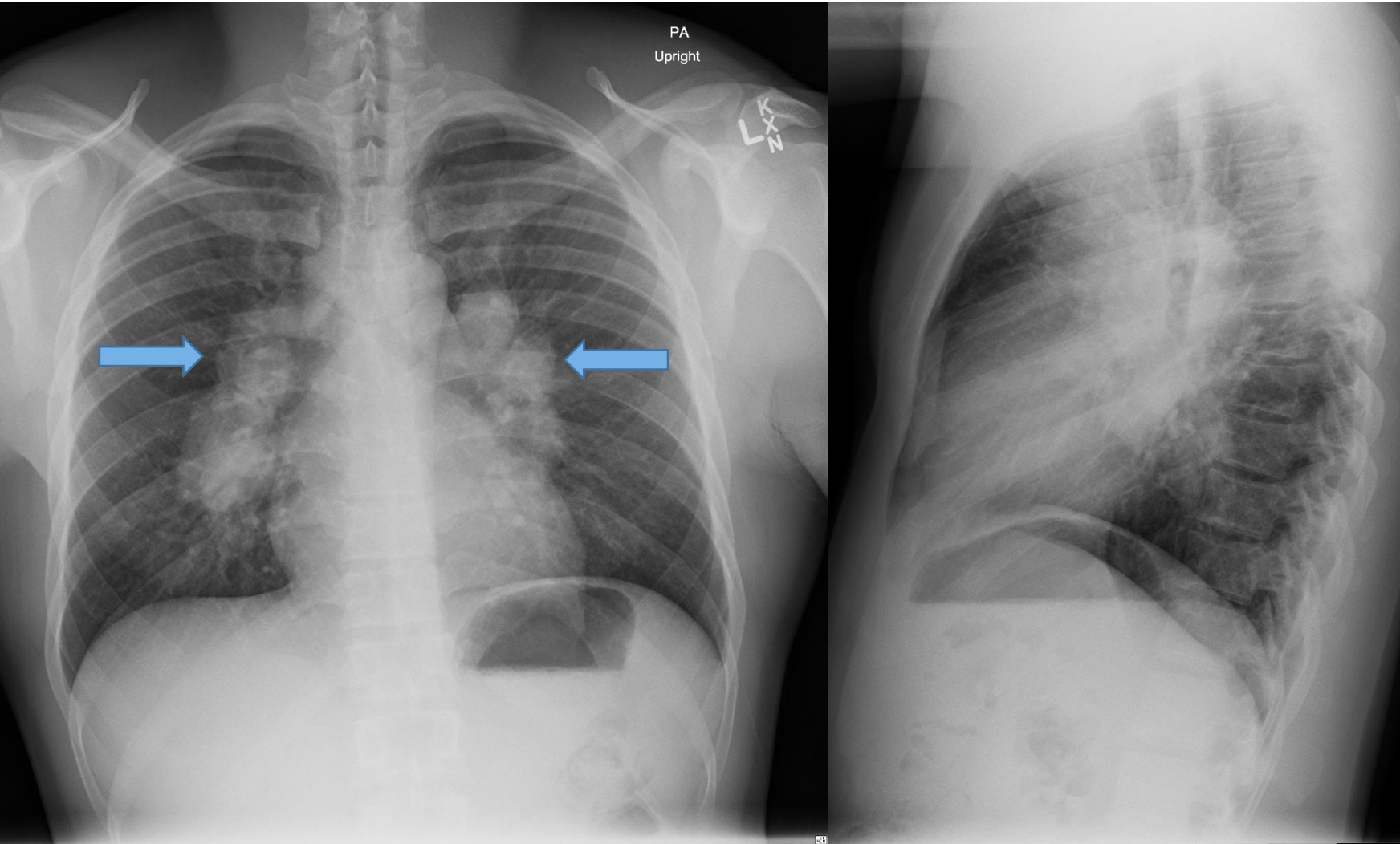
Deceleration injury of thoracic aorta aka aortic transection
High mortality
Widened mediastinum, >8cm level arch), obscured or irregular aortic arch, deviation of the trachea to the right of T4 spinous process, deviation of NGT to right of T4 spinous process, left apical cap

Case 15: Aortic Injury



Deceleration injury of thoracic aorta aka aortic transection
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Widened mediastinum, >8cm level arch), obscured or irregular aortic arch, deviation of the trachea to the right of T4 spinous process, deviation of NGT to right of T4 spinous process, left apical cap

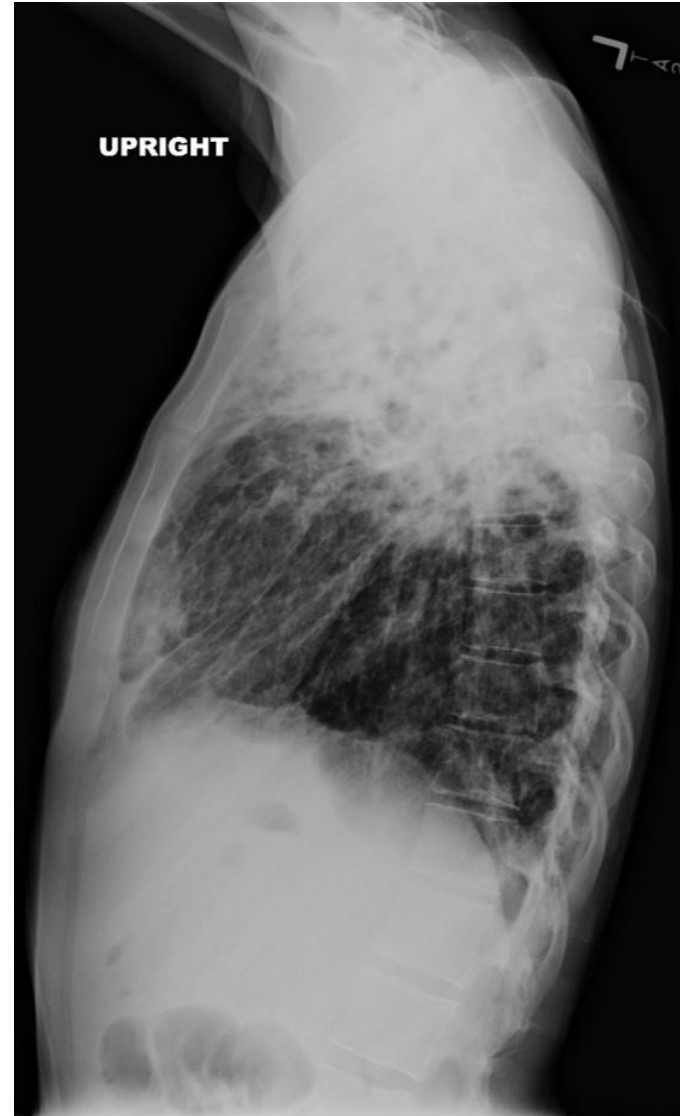
Case 16: Lymphadenopathy



Bilateral hilar LAN:
manifested as enlarged
lobular hila
Mediastinal LAN:
thickening of the right
paratracheal stripe and the
left paratracheal stripe.
DDx of thoracic
lymphadenopathy includes
granulomatous disease,
HIV, other infection,
metastatic disease.

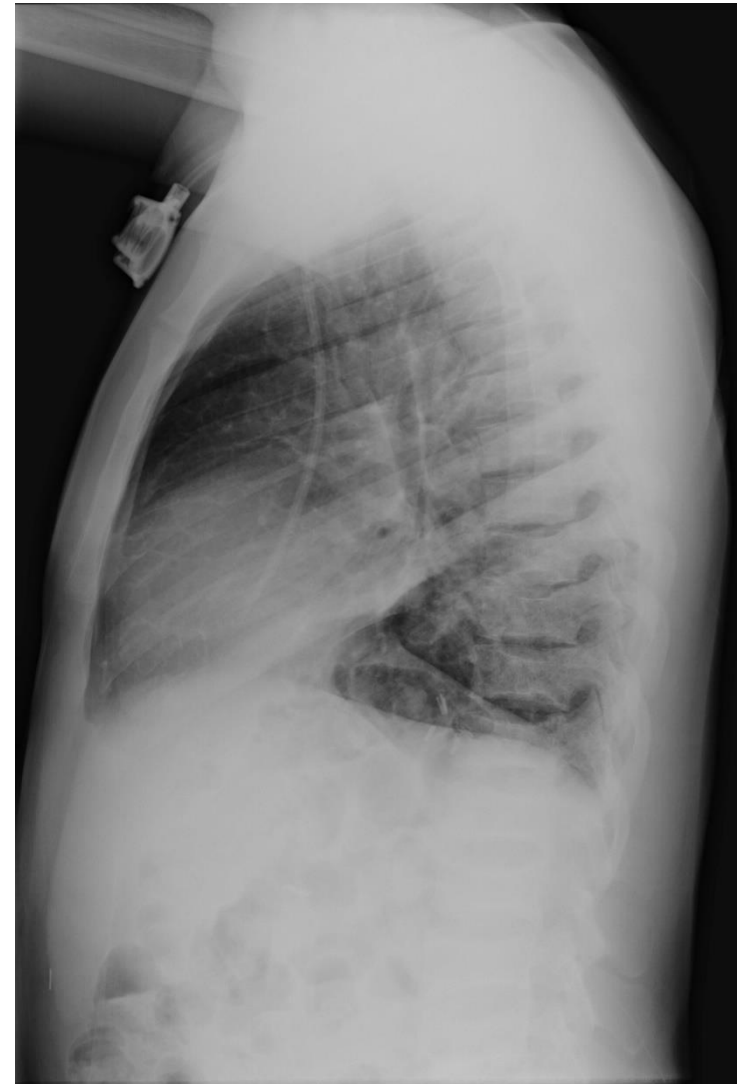
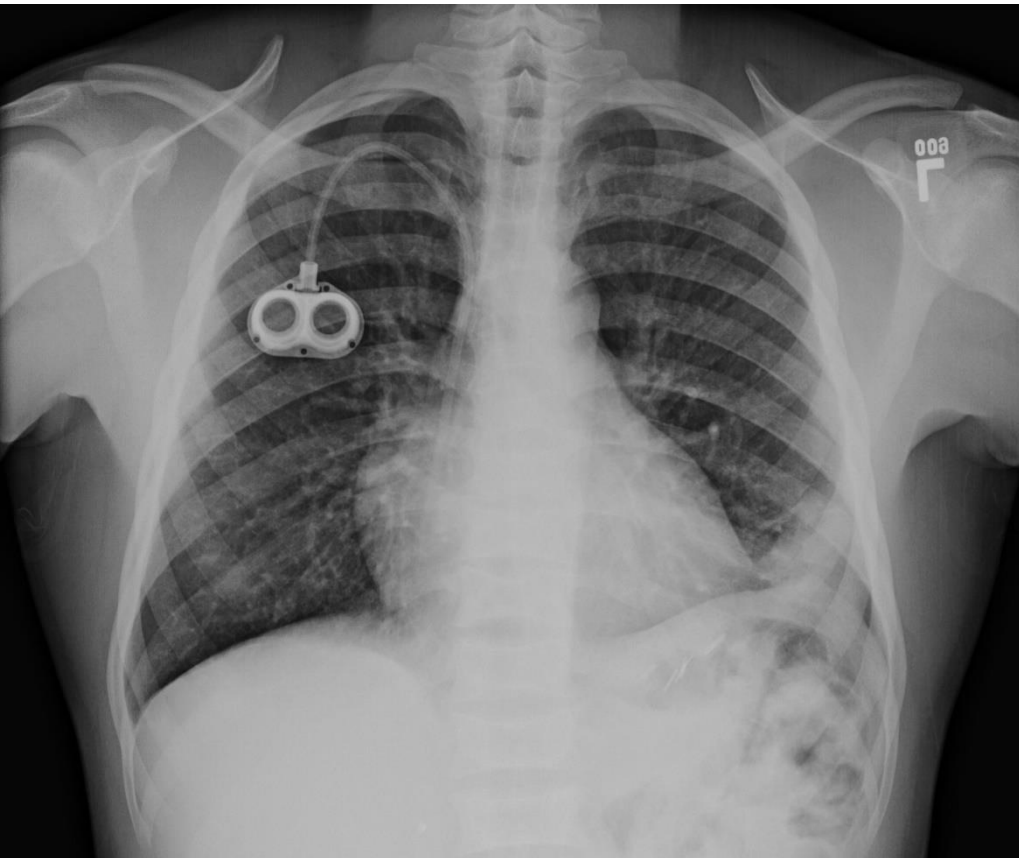
Sarcoidosis

Case 17: Cystic Fibrosis



CXR findings are bronchial thickening, bronchiectasis, atelectasis, focal consolidation, hilar lymphadenopathy, enlarged pulmonary arteries, hyperinflation due to chronic airway obstruction. Severe disease can lead to mucus plugging, pneumothorax, pneumomediastinum, hemoptysis, and pulmonary hypertension.

Case 18: Sickle Cell Disease



SC Disease
cardiopulmonary and bone changes namely CM, pulm opacities, atelectasis and peripheral pulmonary infarcts, pleural effusion, bone infarcts in humeral heads and spine (H shaped vertebra), upper abdominal findings (RUQ cholecystectomy clips and auto-splenectomy)

CXR RECAP

- Relatively cheap and widely used
- May demonstrate very subtle findings in a variety of settings and diseases
- May be better than cross sectional imaging depending on indication
- Adopt an organized approach to chest radiograph interpretation and stick with it!

References

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- Gershengorn HB, Wunsch H, Scales DC, Rubenfeld GD. Trends in Use of Daily Chest Radiographs Among US Adults Receiving Mechanical Ventilation. *JAMA Netw Open*. 2018;1(4):e181119.
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