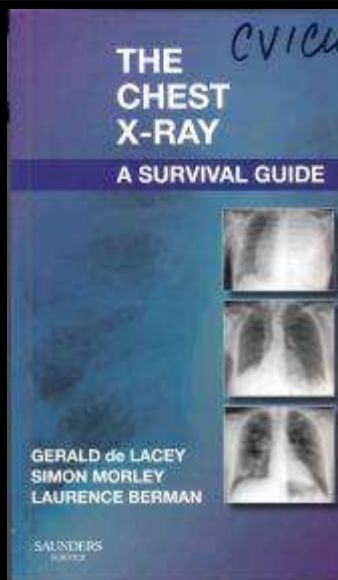


# *As Easy as Black & White: CXR Interpretation*

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Power Point Handout available at  
[www.cherylherrmann.com](http://www.cherylherrmann.com)

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- Connolly M A. Black, white, and shades of gray: Common Abnormalities in chest radiographs. *AACN Clinical Issues*. 2001;12(2):259-289.
- **Lacey G, Morley S , et Berman L. *The Chest X-ray: A Survival Guide*. Philadelphia: Saunders/Elsevier.2008**
- **Siela D. Chest radiograph evaluation and interpretation. *Advanced Critical Care*. 2008;19(4):444-475.**
- Siela D. Advanced Chest Imaging Interpretation of Acute Pulmonary Disorders. *AACN Advanced Critical Care*. 2015;25(4):365-386
- Huseby JS, Ledoux D. Radiologic Examination of the Chest. In: Woods SL, Froelicher S, Motzer SA, Bridges, E J,ed. *Cardiac Nursing*, 5th ed. Philadelphia: Lippincott Williams & Wilkens. 2005: 296-306.
- <http://radiologymasterclass.co.uk/tutorials/tutorials.html>
- [www.medmastery.com](http://www.medmastery.com)

# Basics of Xrays

- Photograph negative principle
- White color indicates lack of exposure
- Black color indicates intense exposure
- Dense substances absorb all the rays and appear white on the film
- Soft tissues and air absorb part of the beam and appear gray or black

# Whitest

- Bone: Ribs, Sternum, Spine, Clavicle
- Barium
- Calcium Deposits
- Prosthetic valves
- Surgical wires, clips

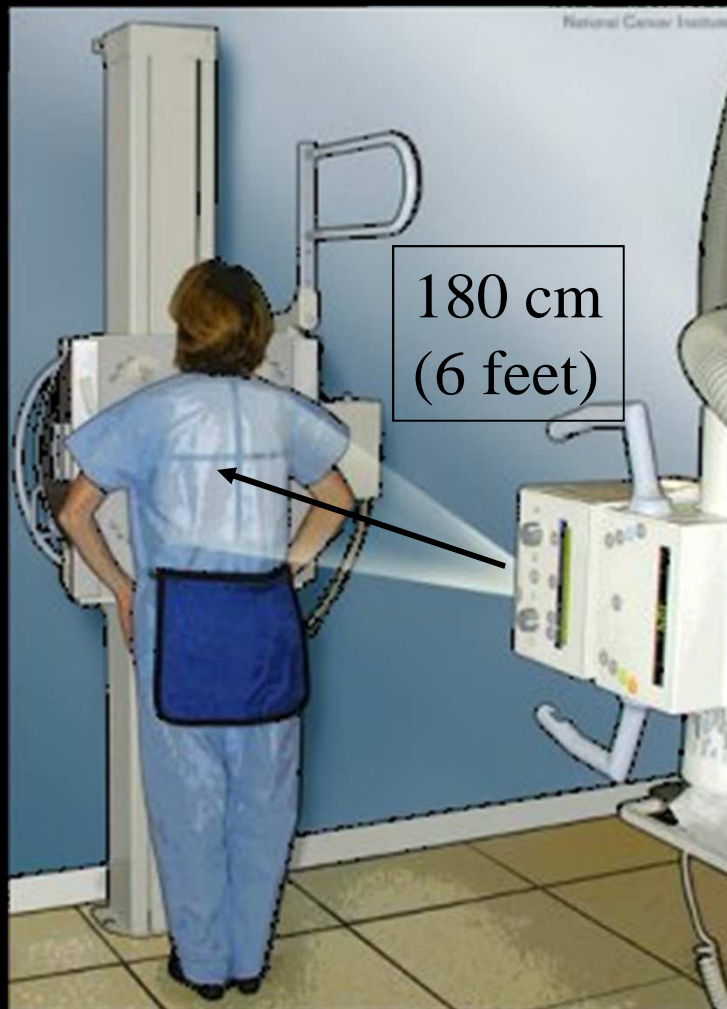
## Off White -- Gray

- Fluid
- Blood
- Heart
- Veins/arteries
- Aorta
- Skin/fat

# Blackest

- Air
- Lungs
- Trachea
- Stomach
- Bowel

PA = Posterior to Anterior



AP = Anterior to Posterior

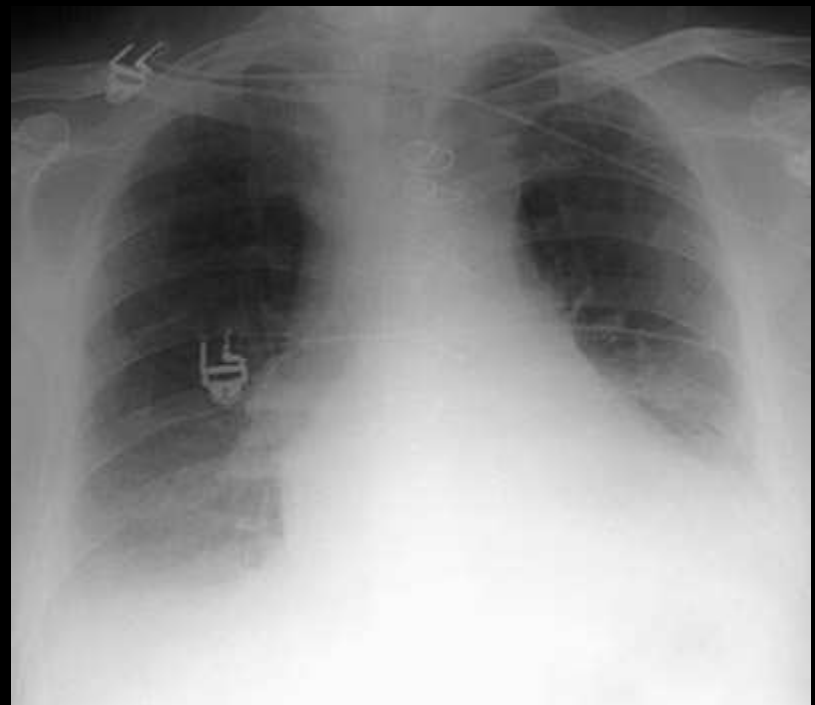


40 inches



# Projections

- PA – 6 feet
- AP -- Heart and mediastinum are magnified at 40 inches compared to PA at 6 feet



Lateral:

Named for the part of the anatomy closest to the film



# Right Lateral Decubitus position



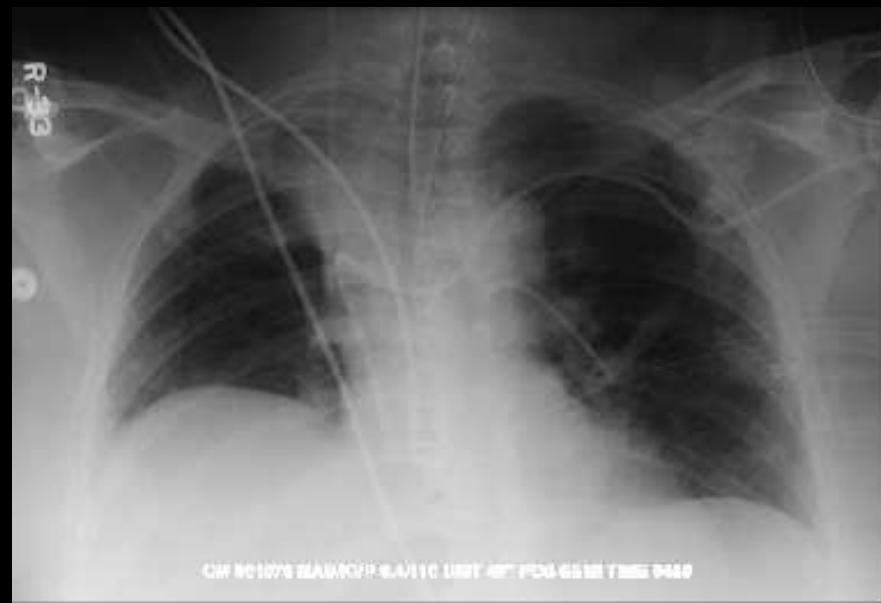
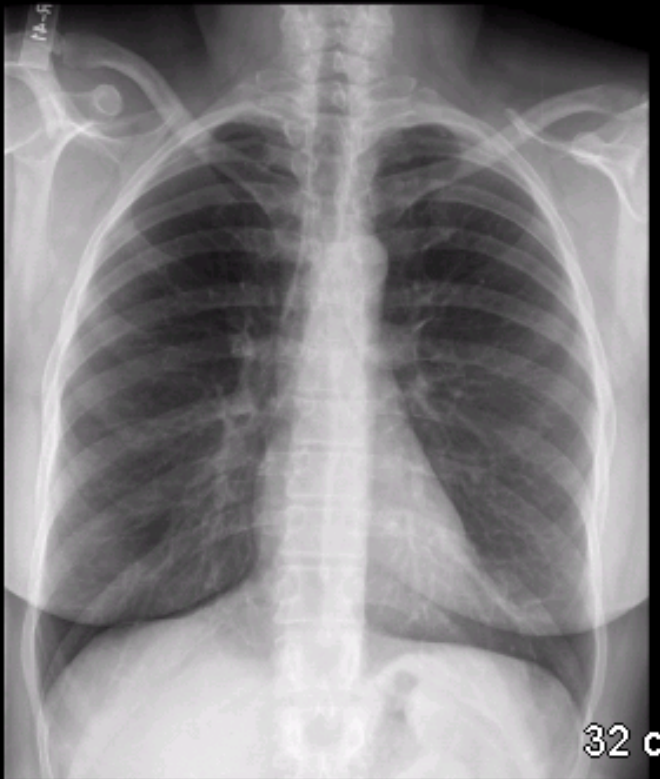
- Lateral: Named for the part of the anatomy closest to the film
- Decubitus: Side lying

# Good technique is essential

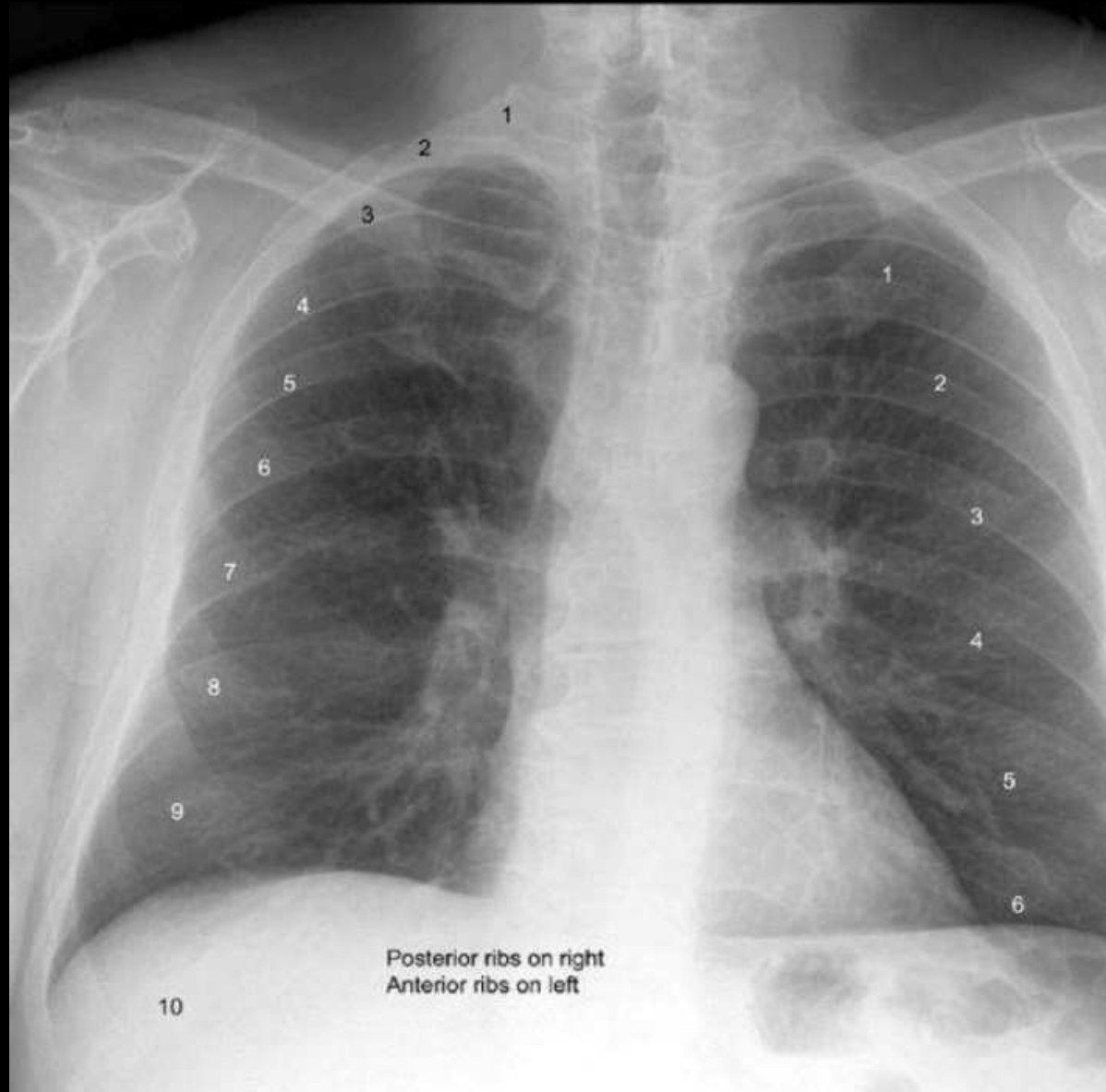
- Take in an upright position
  - Fluid will go to the bases and form a line
  - Air rises
- Remove unnecessary lines and wires to prevent obscuring the underlying structures
- Ensure all structures including bases of the lungs are visible

# Full Inspiration 9 – 10 ribs should be visible

- Good Inspiration
- Poor inspiration



# Ribs



# Systematic Approach of Reading Chest Xray

1. Technique & rotation
2. Bony structures
3. Soft tissues
4. Lungs/trachea/pulmonary vasculature
5. Diaphragm and pleura
6. Mediastinum
7. Heart and great vessels
8. Non-physiological structures

# The obvious abnormality

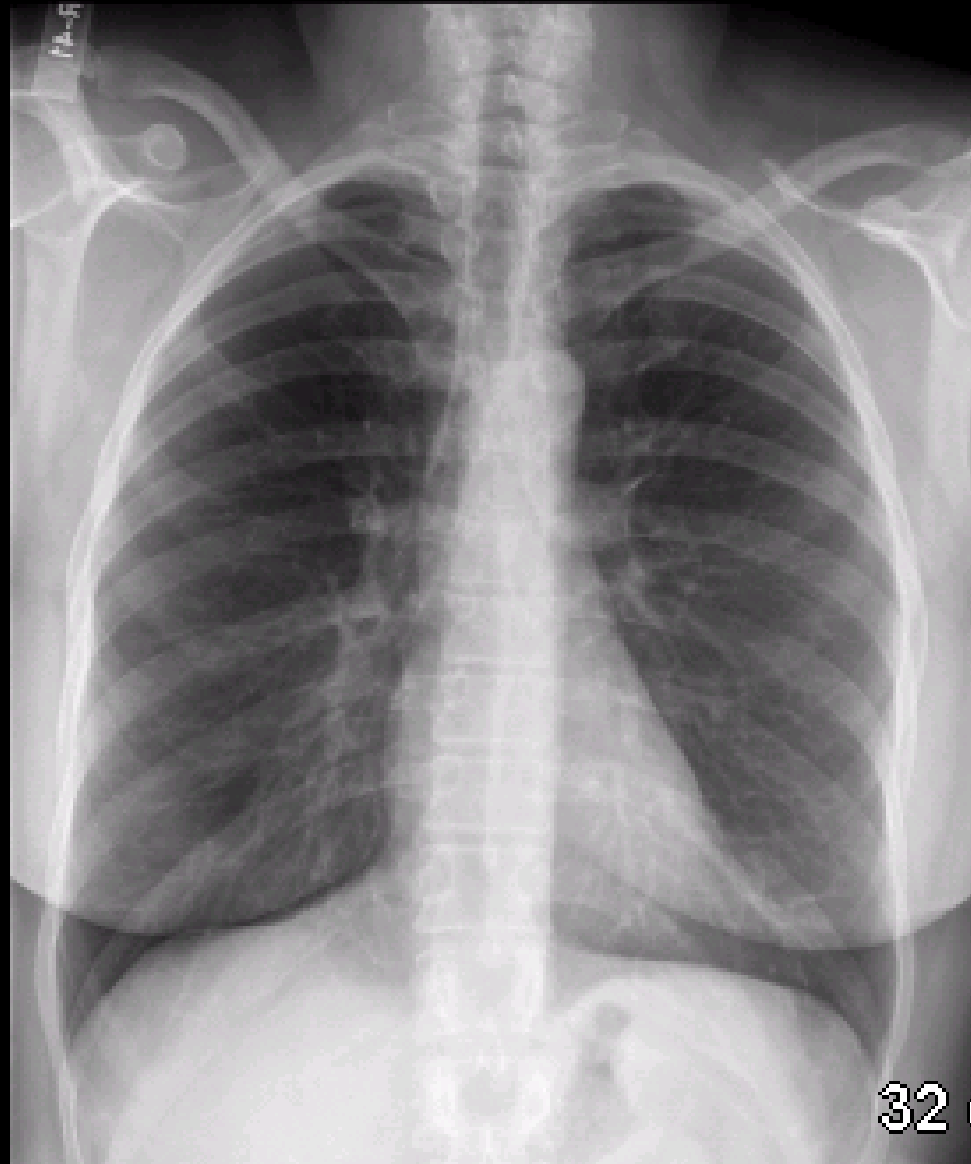
- The rule is - don't ignore the 'elephant' on the image - describe its long trunk, its big ears, its tusks, and its rough, grey skin.
- Once you've done this you stand a better chance of diagnosing the 'animal' you are dealing with, but you should then continue by using a systematic approach to look at the rest of the image.



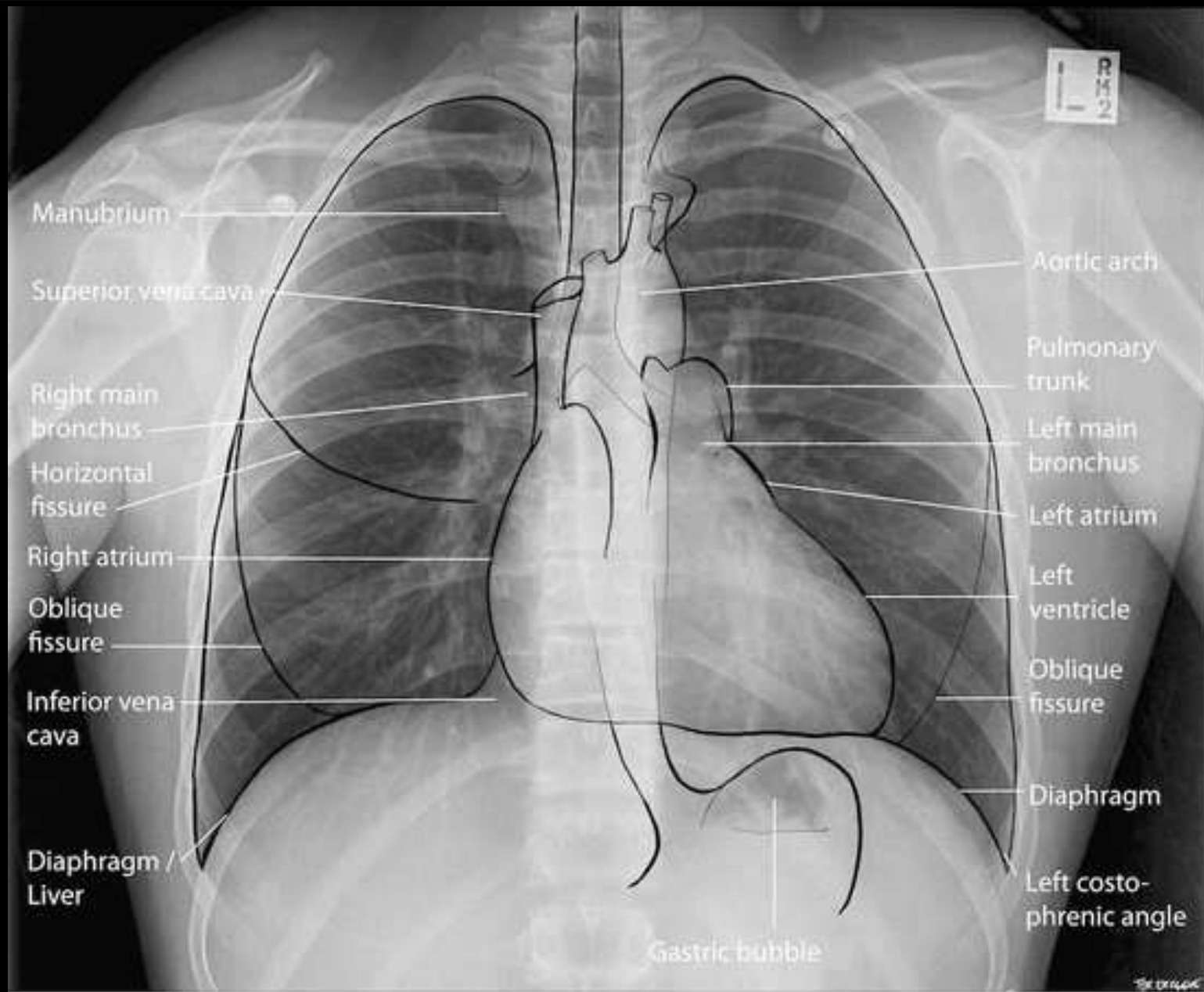
[http://radiologymasterclass.co.uk/tutorials/chest/chest\\_system/chest\\_system\\_03.html](http://radiologymasterclass.co.uk/tutorials/chest/chest_system/chest_system_03.html)



# Normal AP

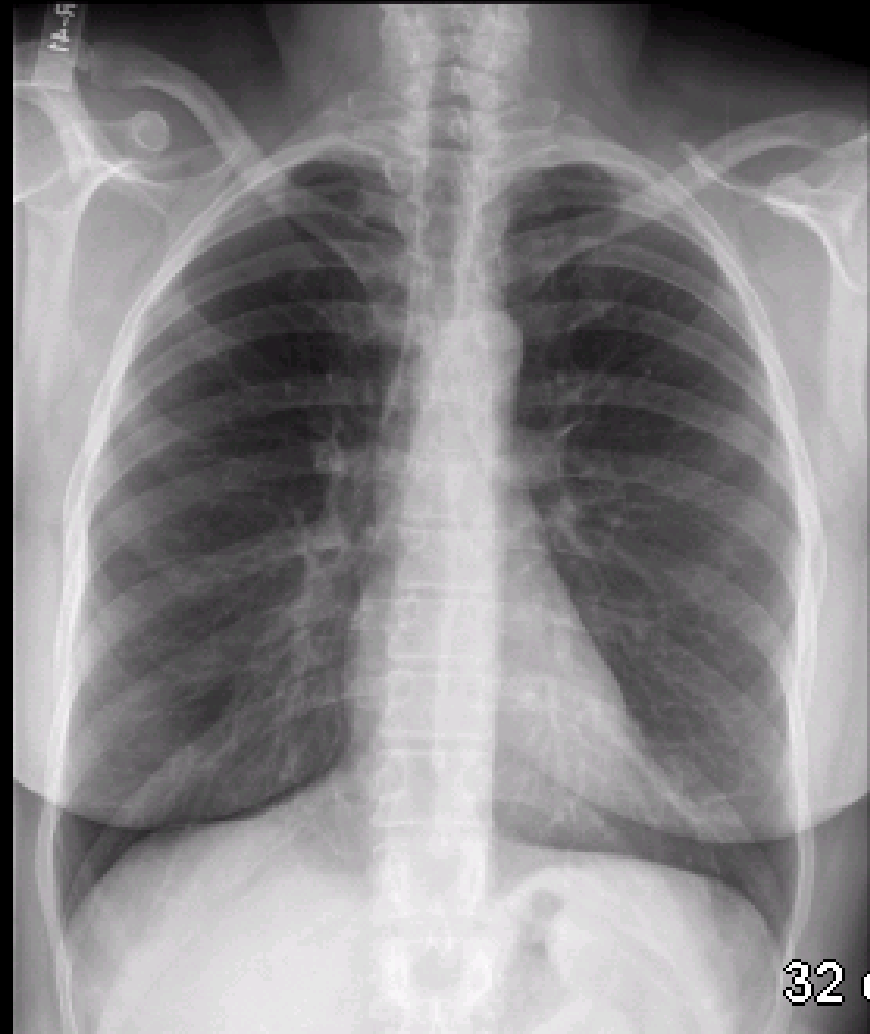


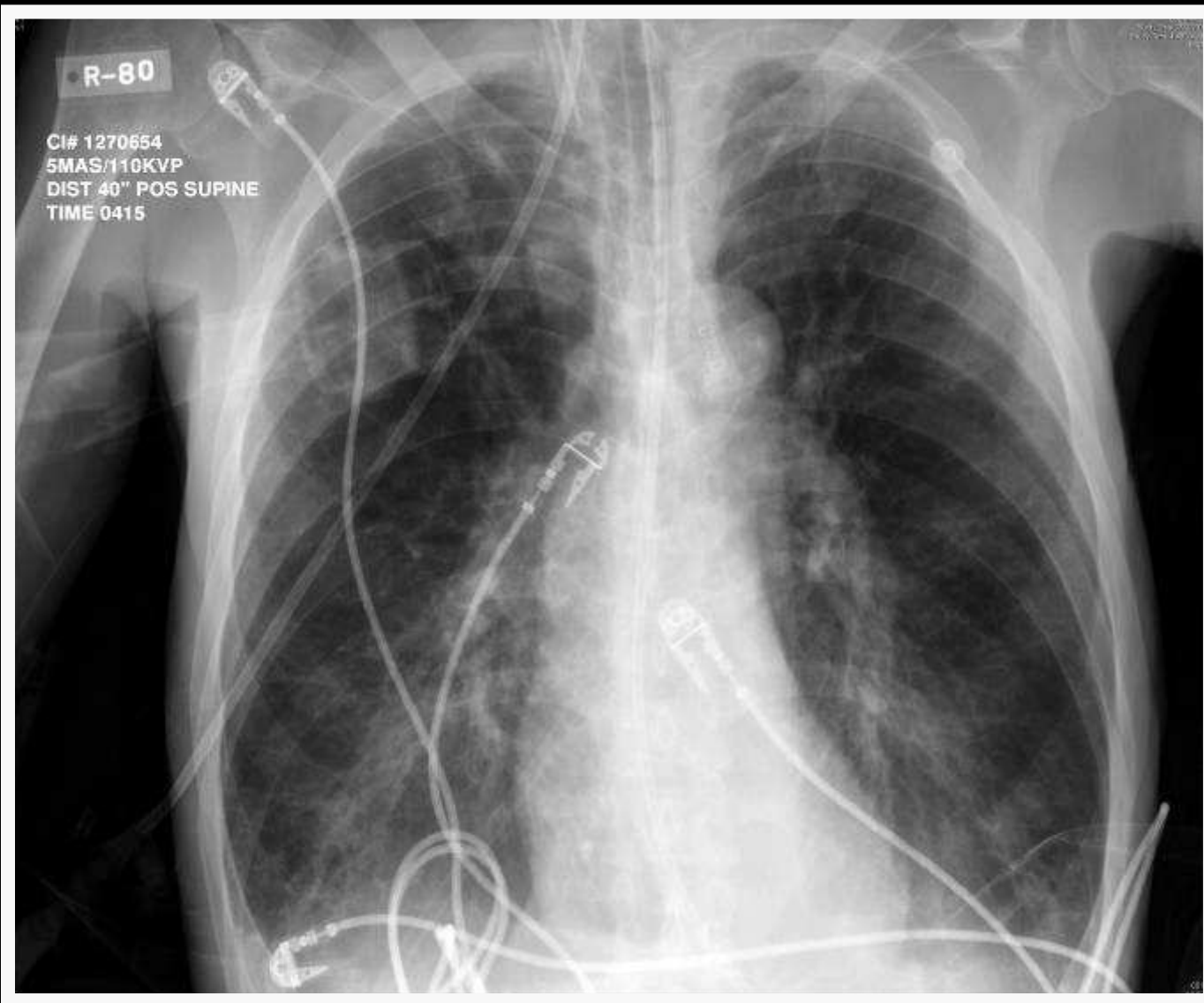
32 c



# Boney Structures

- Is the entire thorax visible?
- Shape of the thorax – emphysema, polio, scoliosis?
- Any rib fractures?



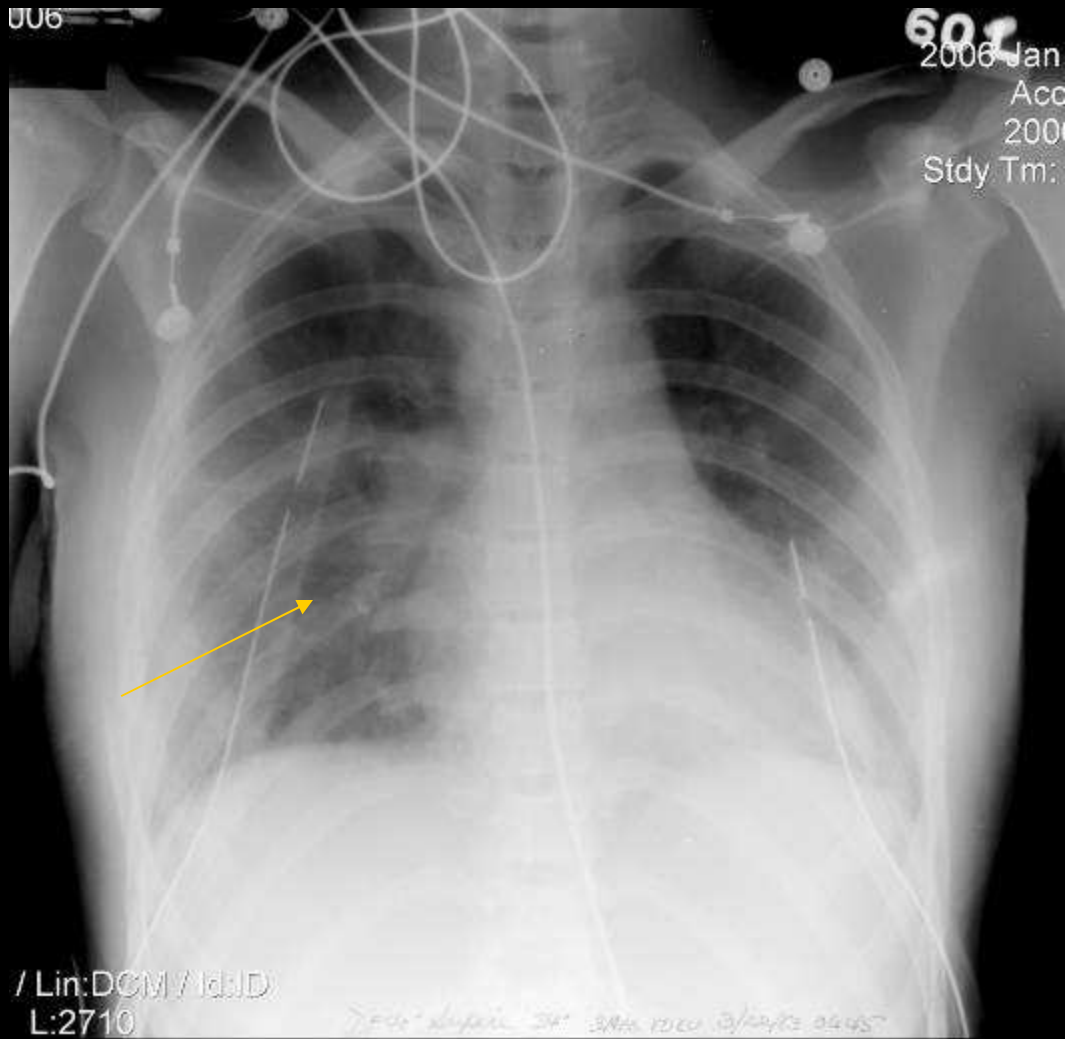


Hyperexpanded lungs consistend with emphysematous change, Bibasilar fibrosis

## Severe dextro-convex curvature of midthoracic spine



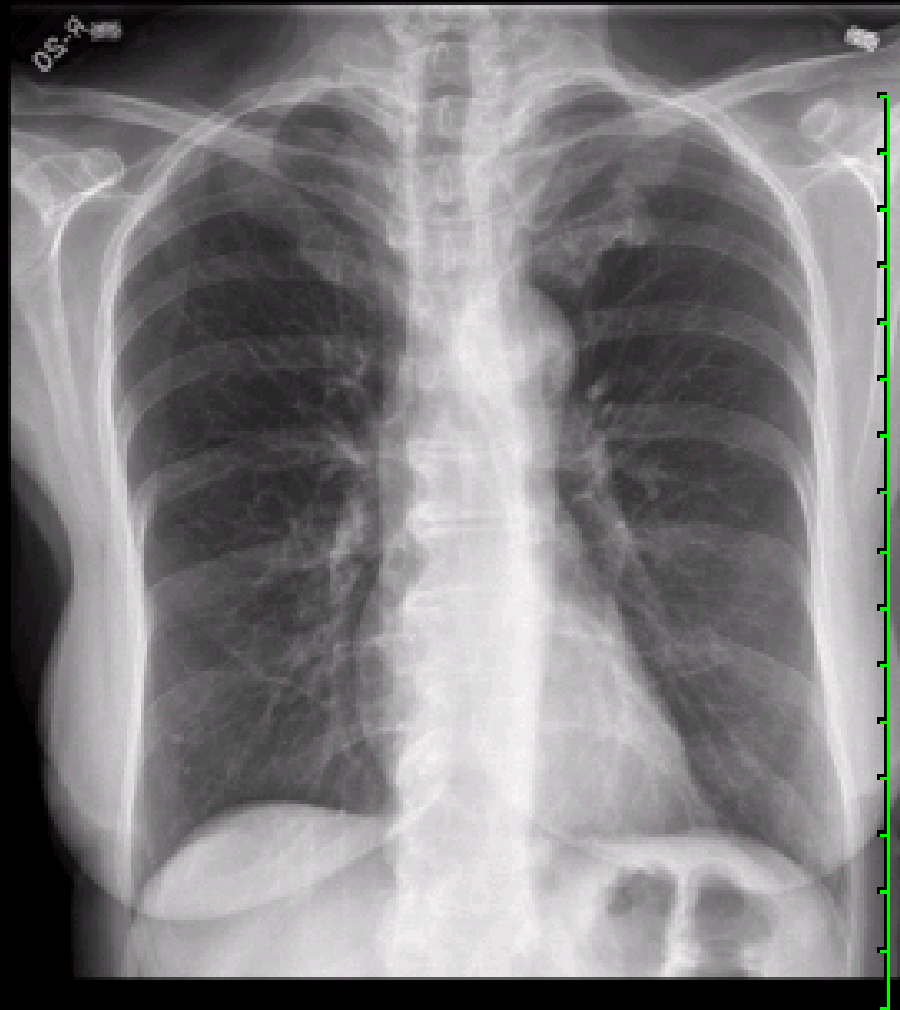
# Right rib fractures



- Old healed Fx Left Clavicle and left ribs

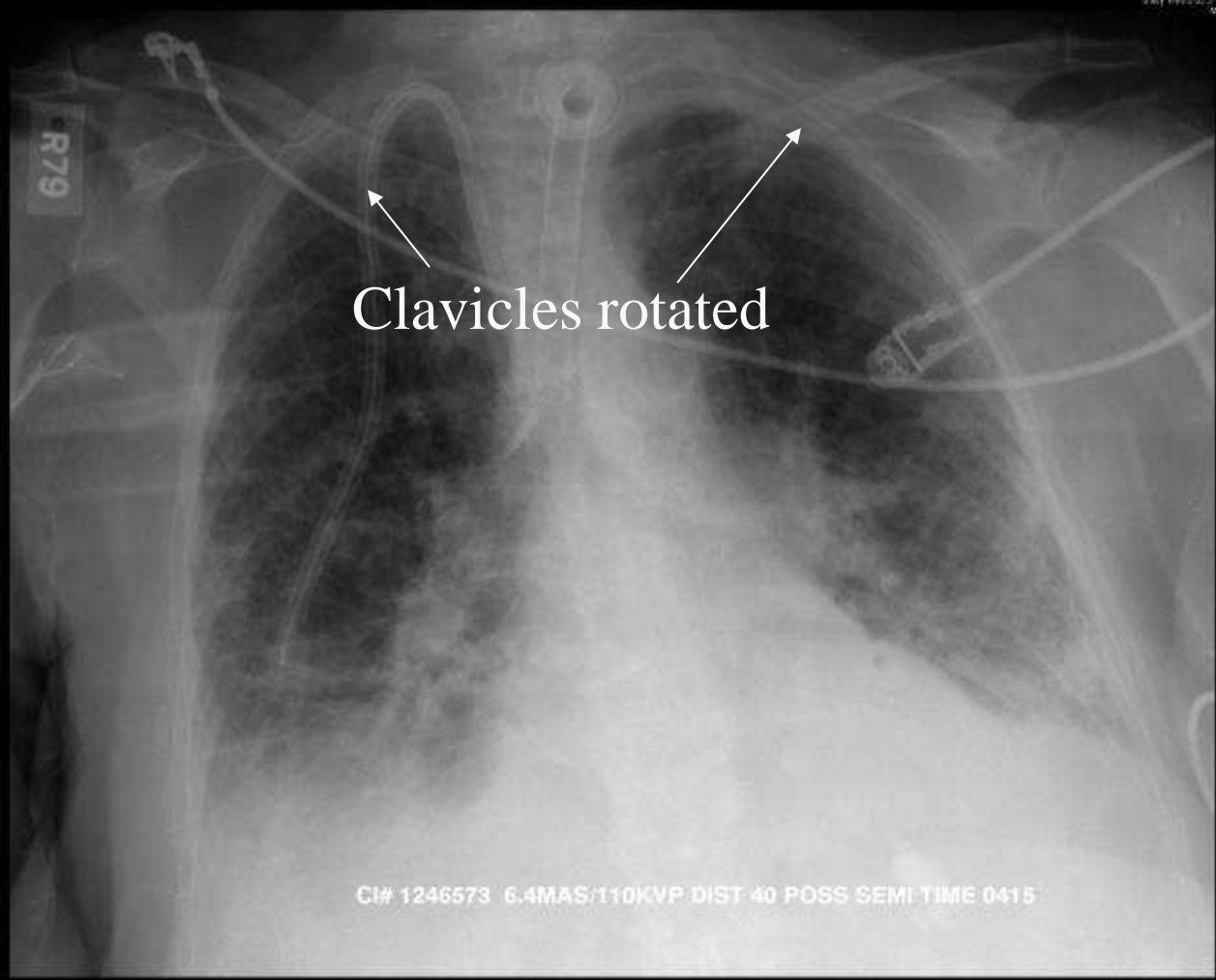


- Clavicles help identify patient rotation
- Should be symmetrical

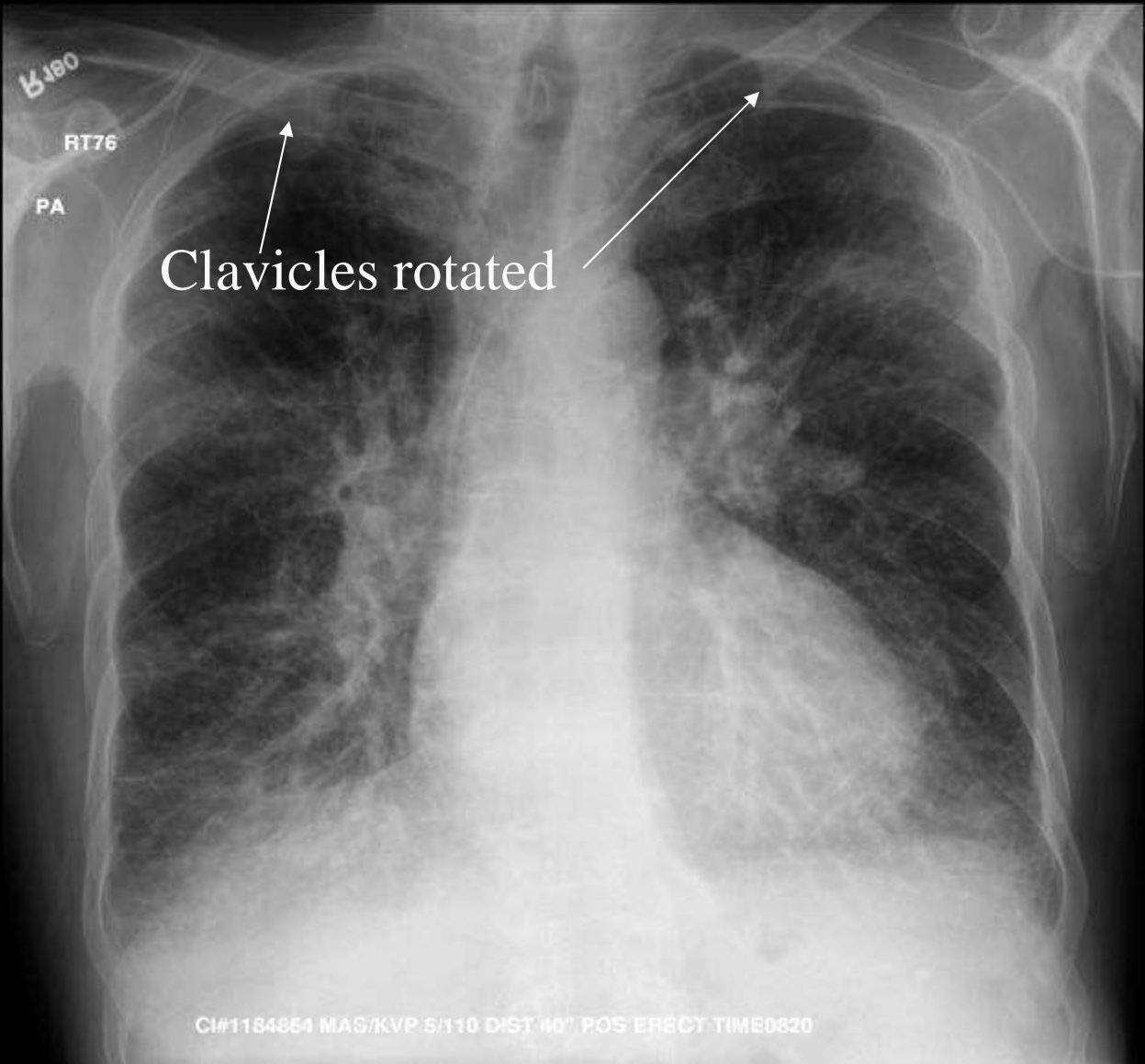




# Rotation



5-1  
RT7



G. ROBERT D  
2745  
Date: 9/20/2010  
Time: 10:13:10 AM  
MSK

B 180

RT76

PA

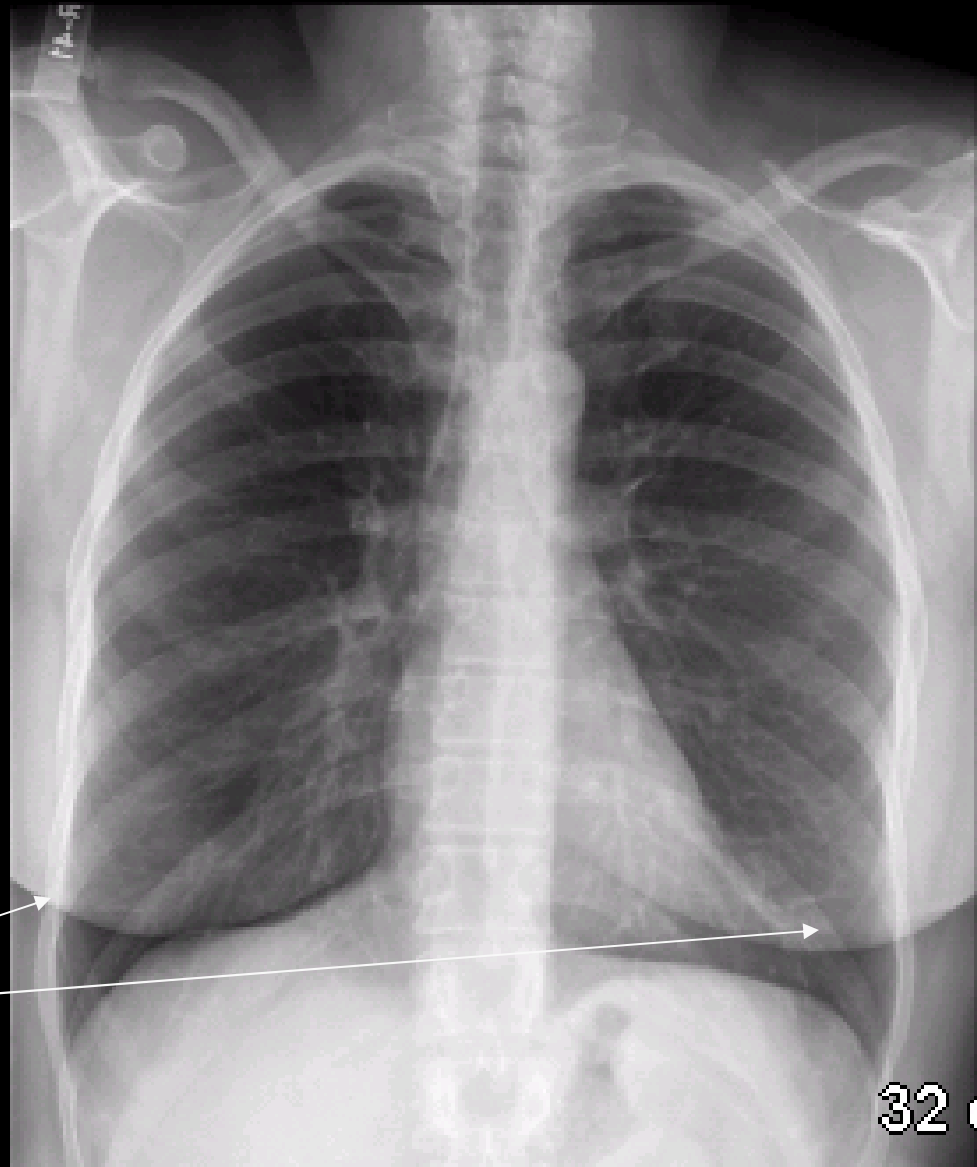
Clavicles rotated

CI#1184864 MAG/KVP 5/110 DIST 40" POS ERECT TIME0820

RT1  
MSK

## Soft Tissues

- Check neck and axilla for SQ emphysema, hematomas, tumors
- Large breast tissue may obscure lung field to some extent



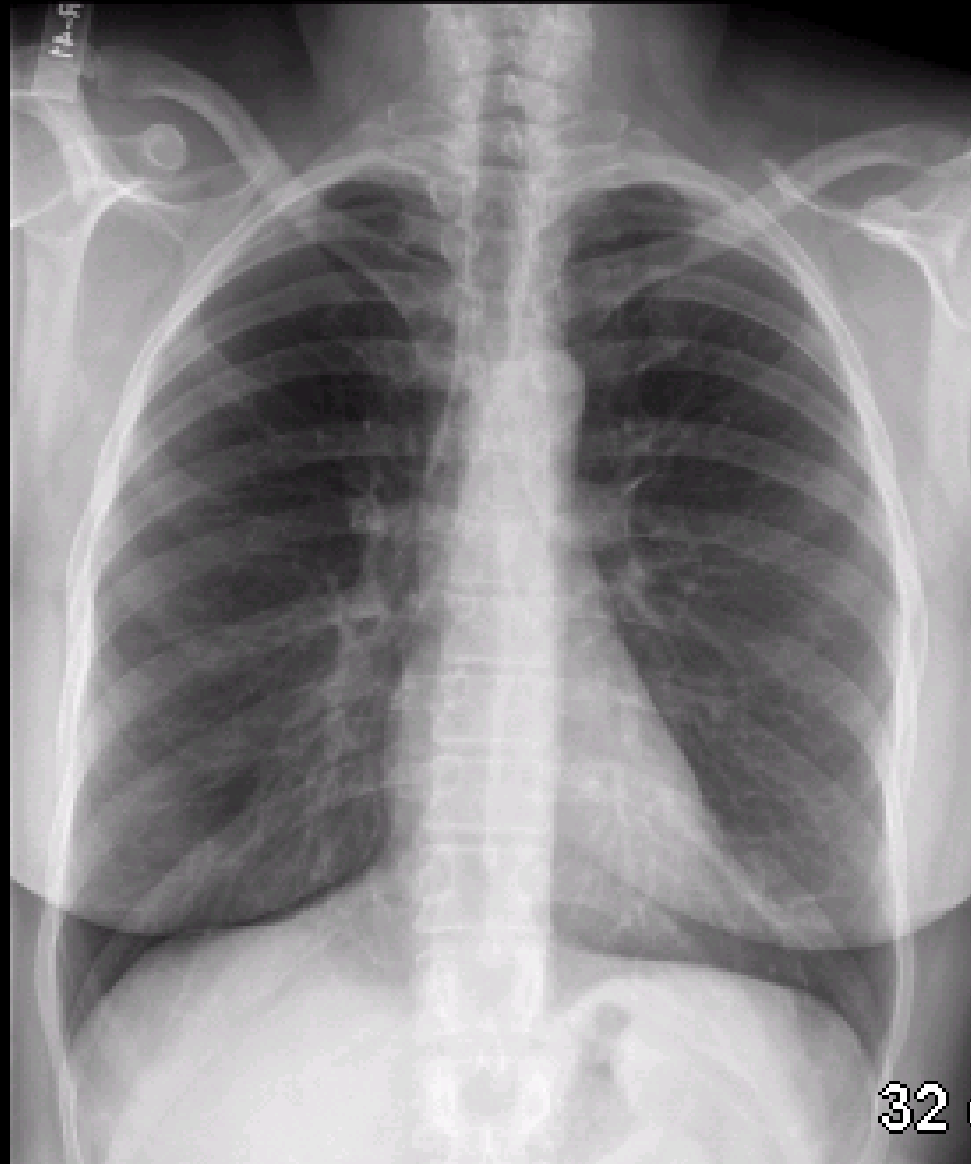
Breast Tissue

32 c

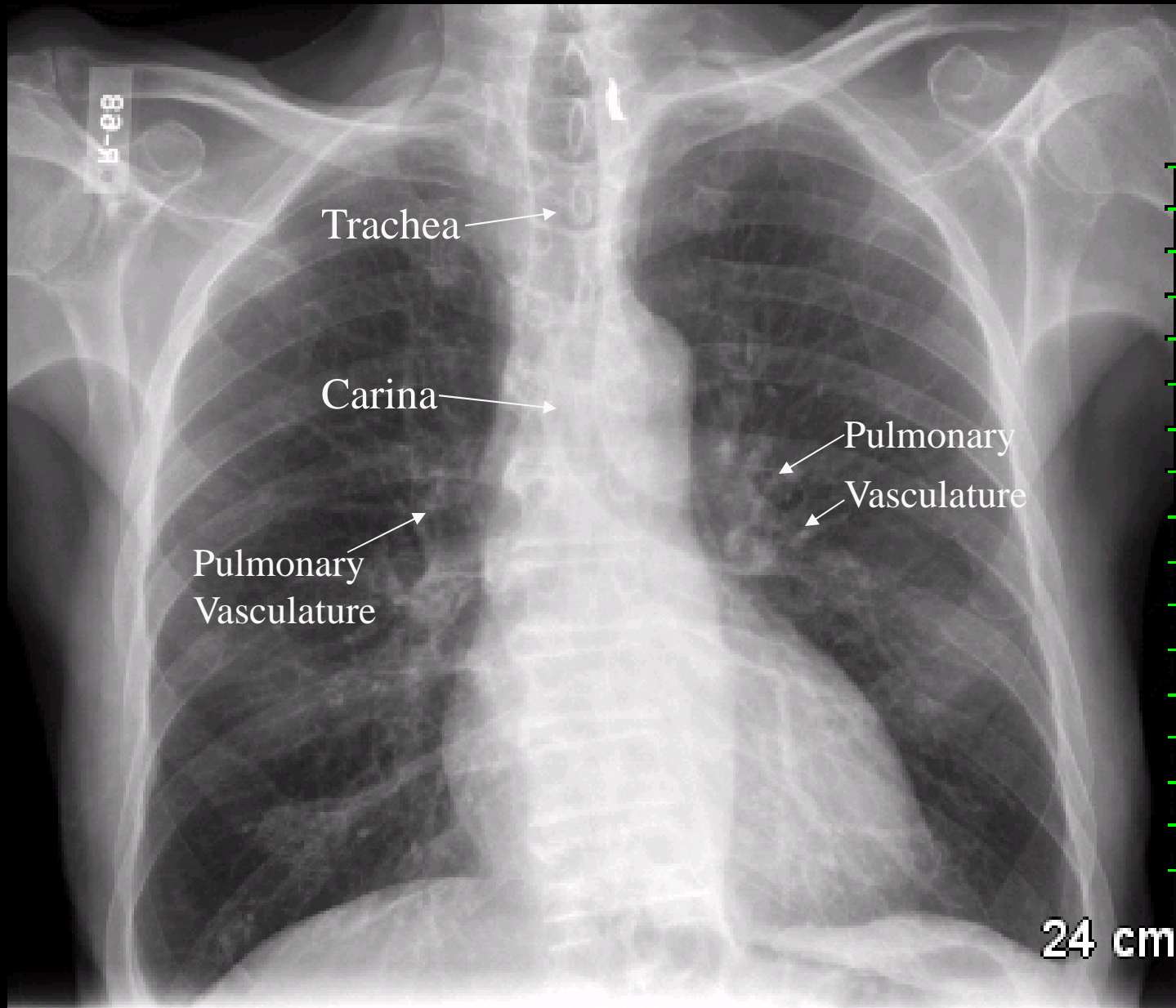
# Lungs/Trachea/pulmonary vasculature

- Check expansion of lungs
- Is the entire thorax visible?
- The lungs are radiolucent with traces of gray linear marking which are blood vessels
- Carina (where trachea divides into right and left bronchus) should be visible with slightly blacker outline over the lung fields themselves. May need to slightly elevate the film to visualize the carina.

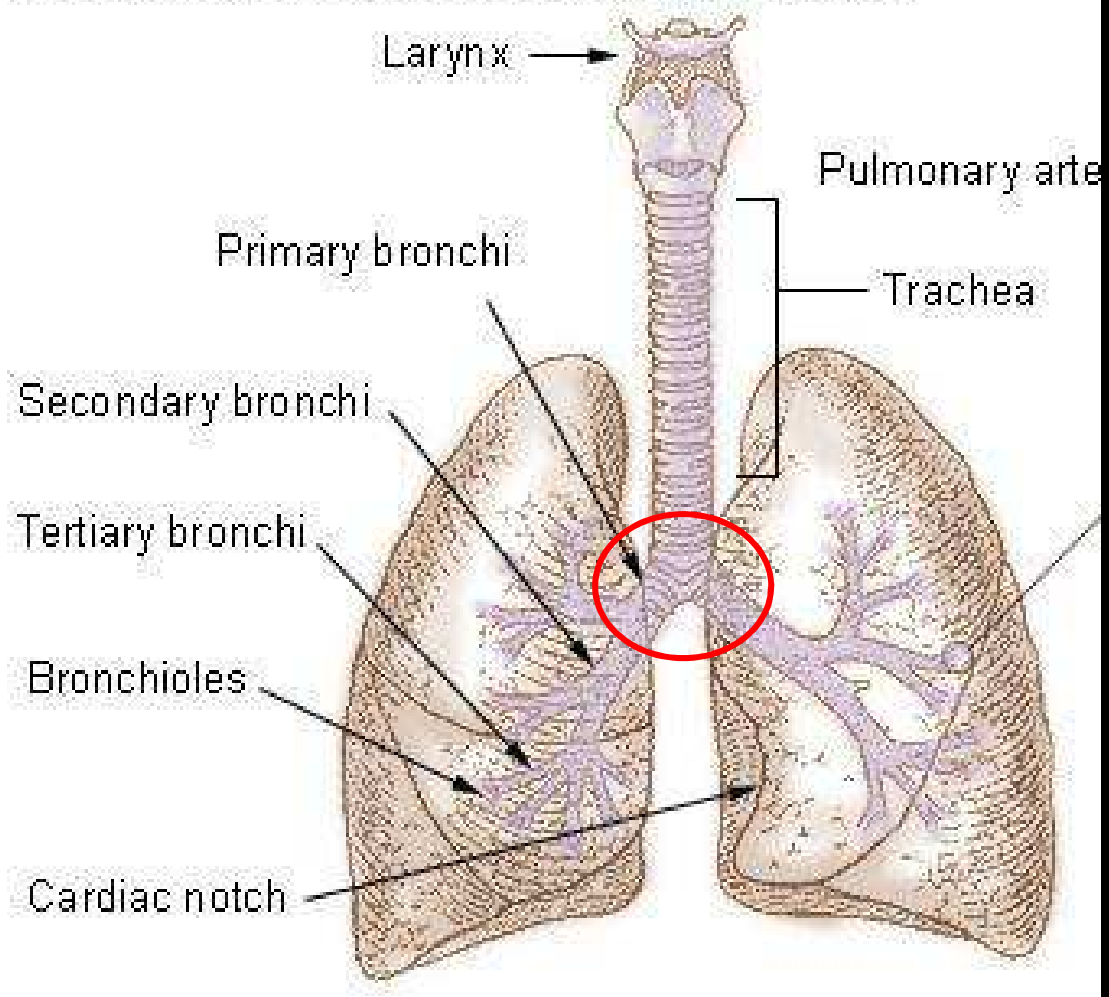
# Normal AP



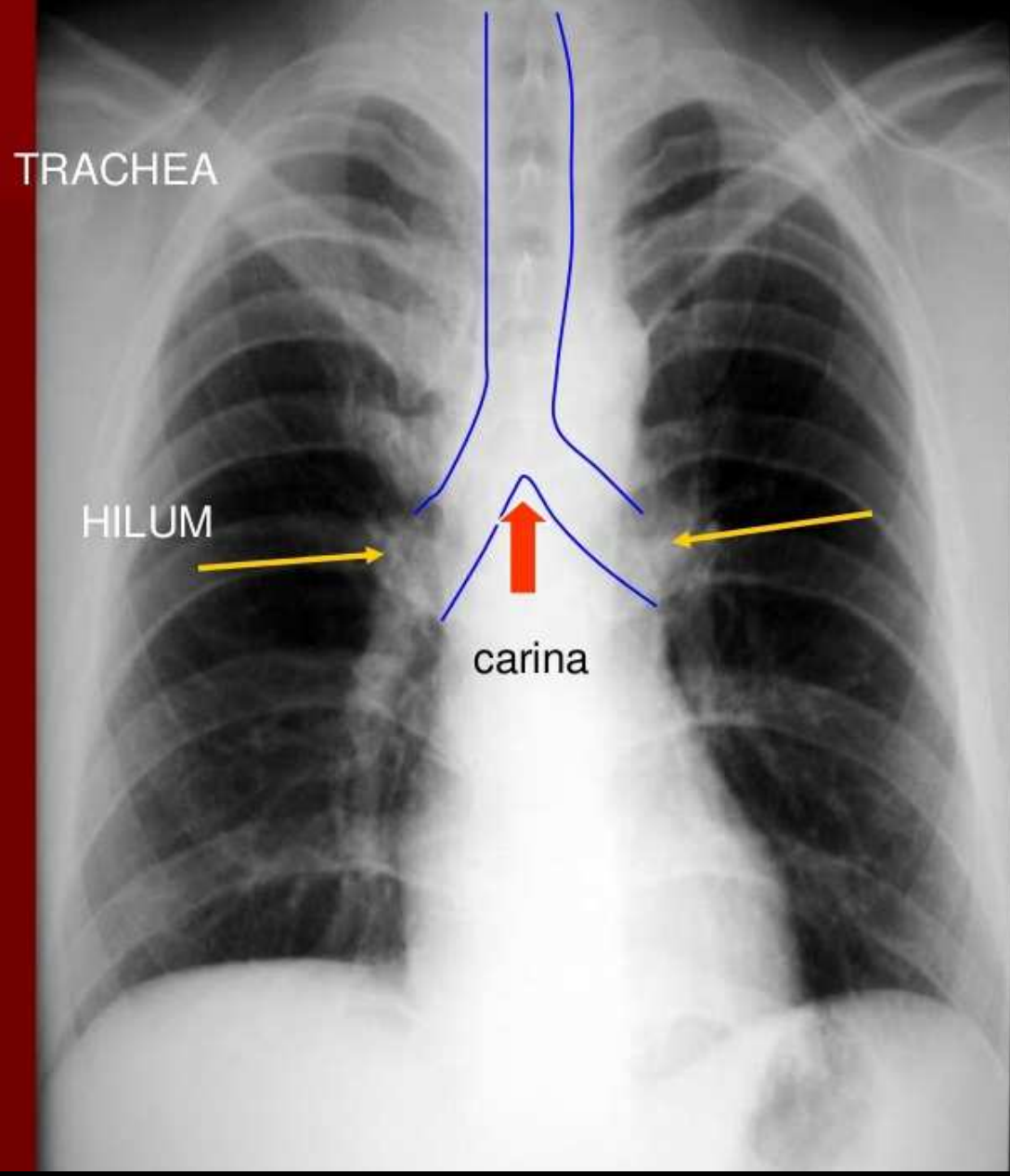
32 c

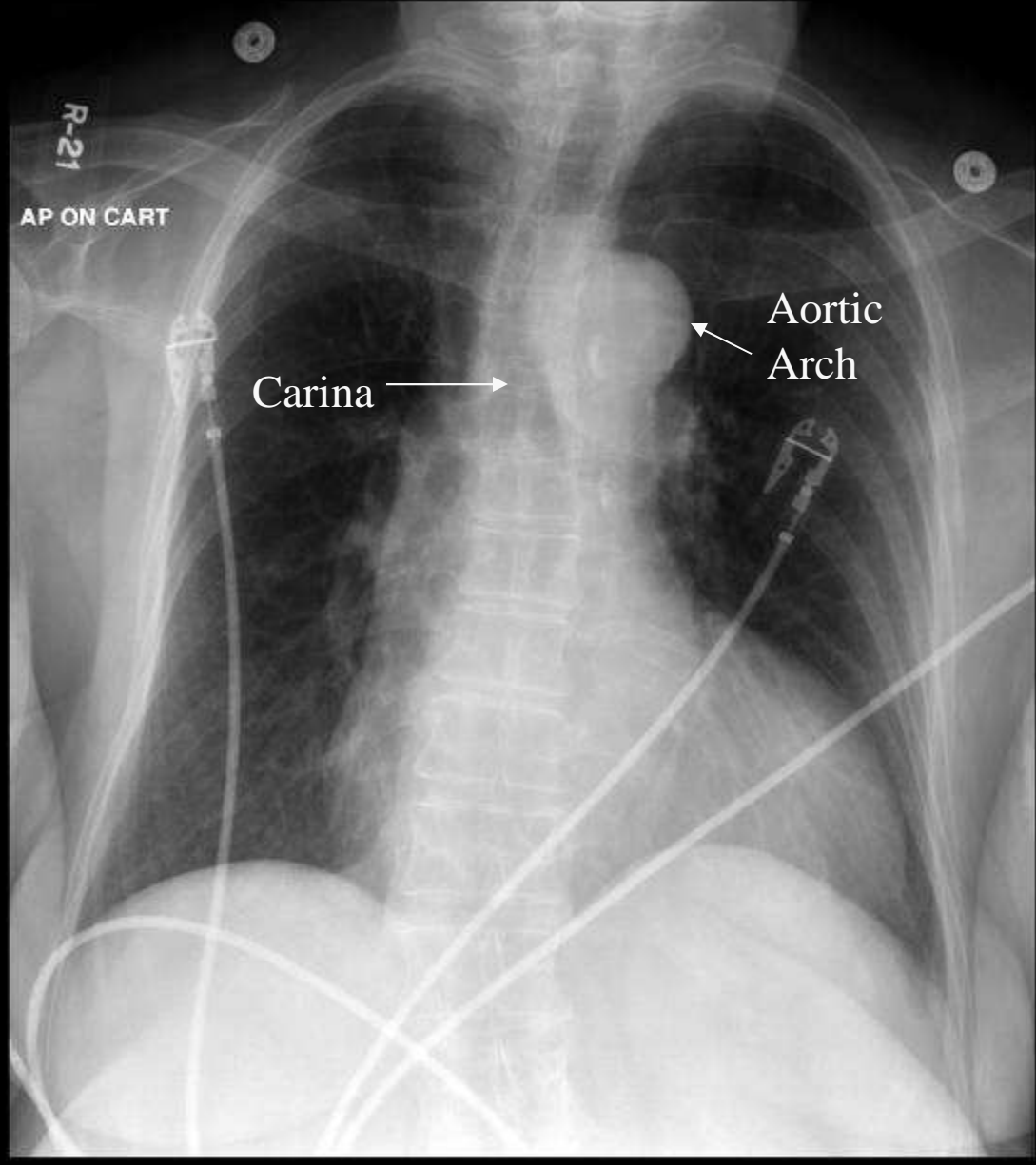


## Bronchi, Bronchial Tree, and Lungs









309MCRAD086

Ex: 000001

Se: 1/1

Im: 2/23

CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

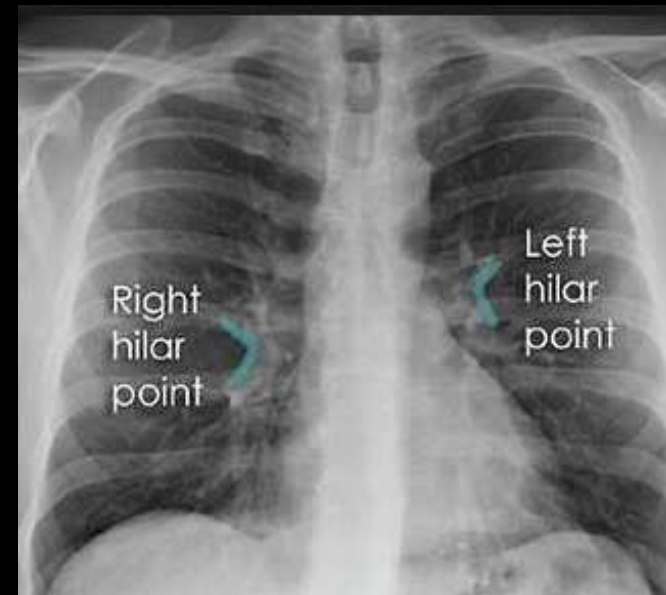
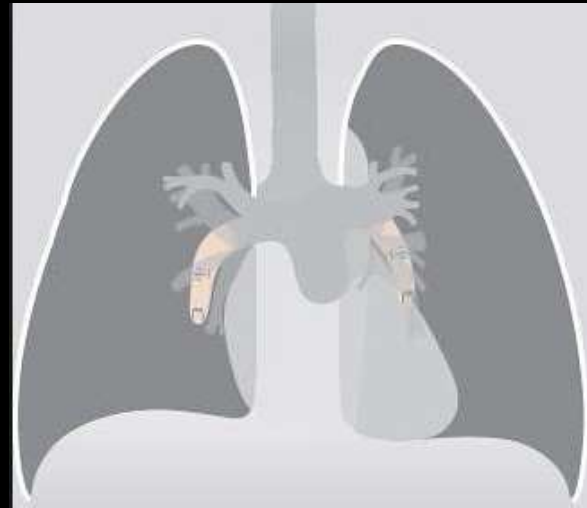
Study Tm: 10:00:25

Id:DCM / Lin:DCM / Id:ID

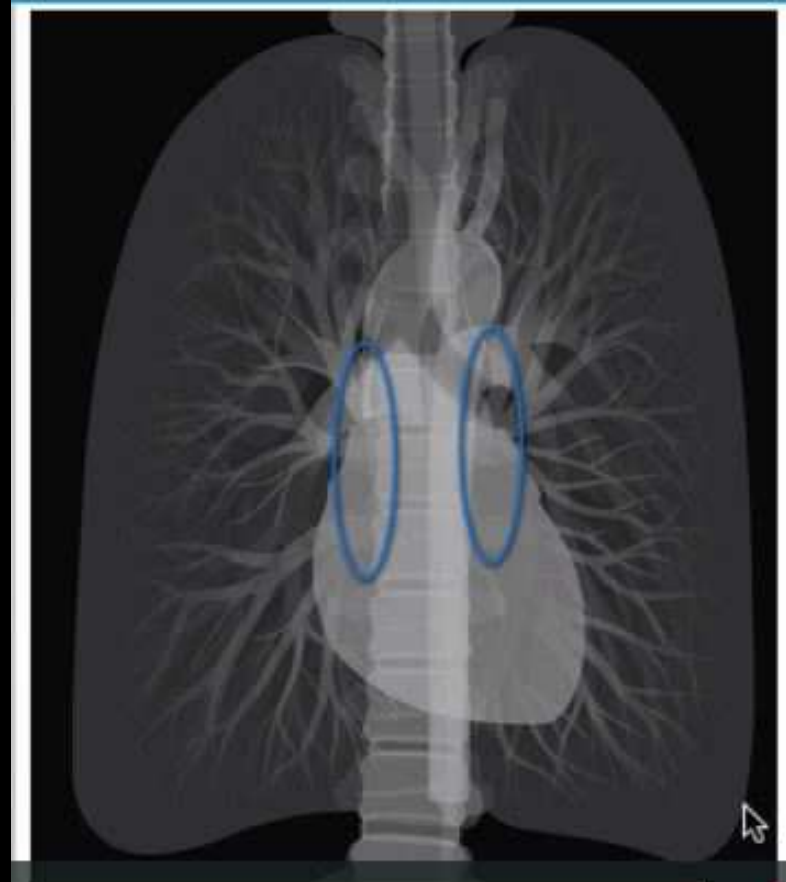
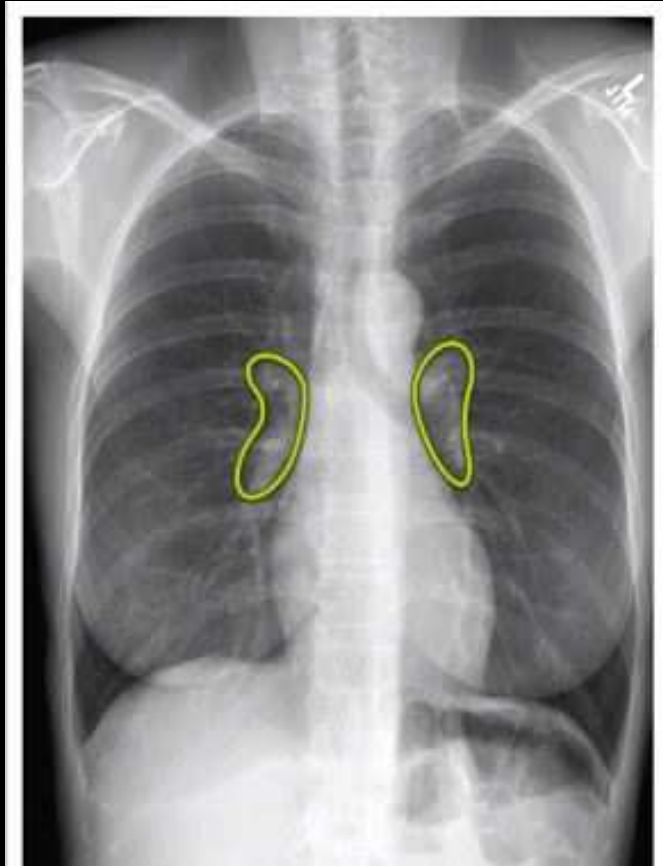
W:3036 L:2476

# Hila – Lung roots

- Consists of
  - Major bronchi
  - Pulmonary veins
  - Pulmonary arteries
- The above structures pass through the narrow hila & then widen and branch out into the lungs
- Left hilum is typically higher than right



# Normal Hila

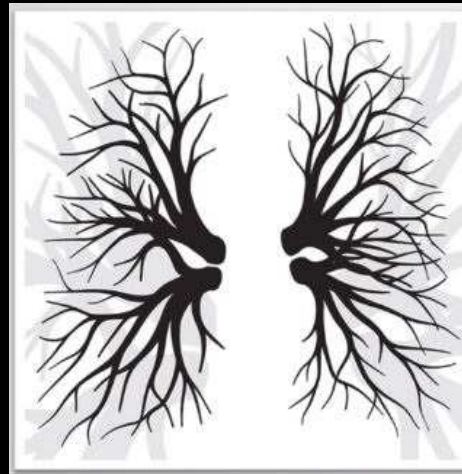
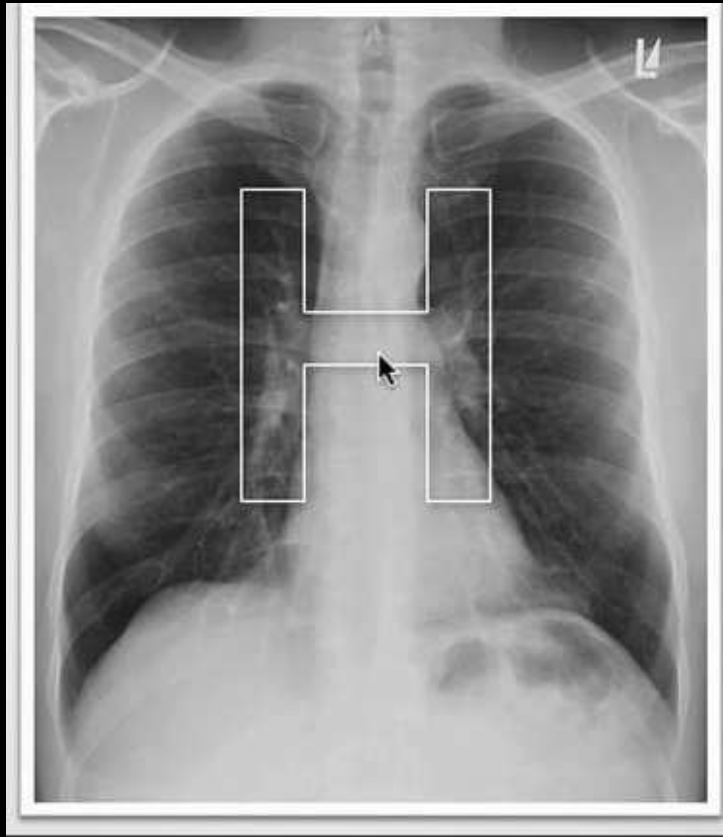


Source: [www.medmastery.com](http://www.medmastery.com)

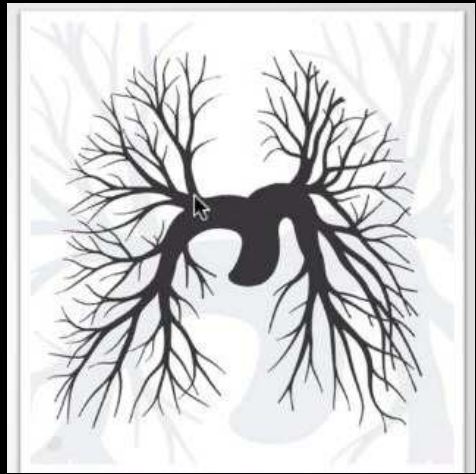
# Normal Hila



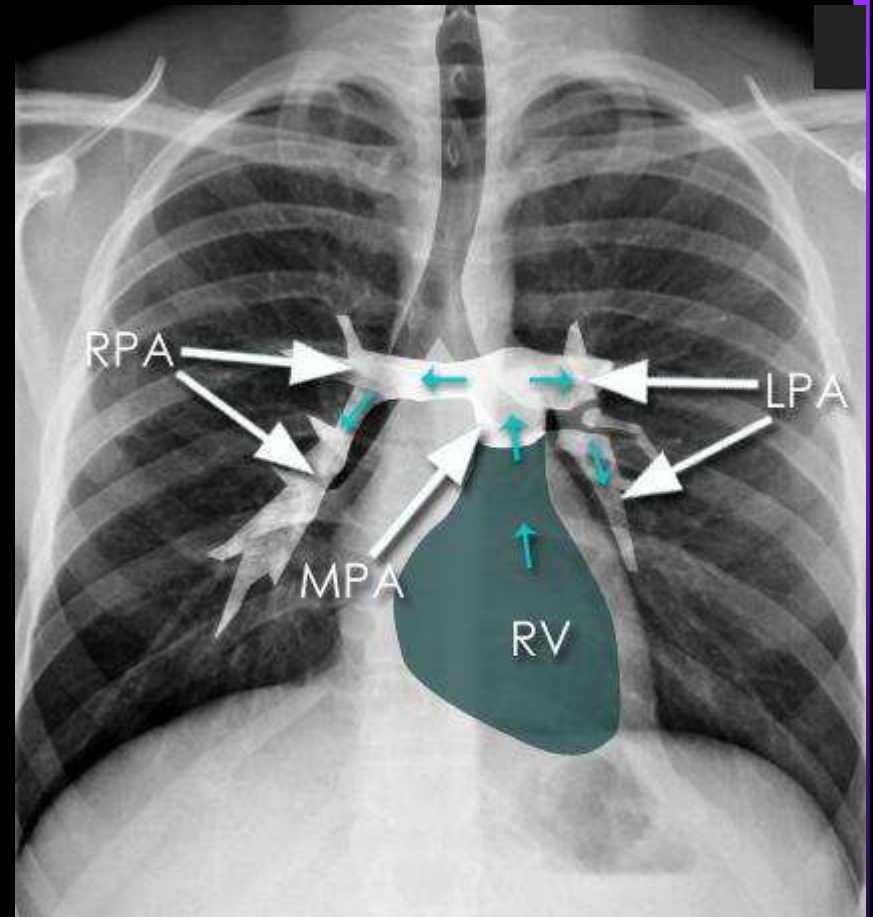
# Proximal Pulmonary Arteries Form H-Shape on Frontal CXR



Pulmonary Veins



Pulmonary Arteries

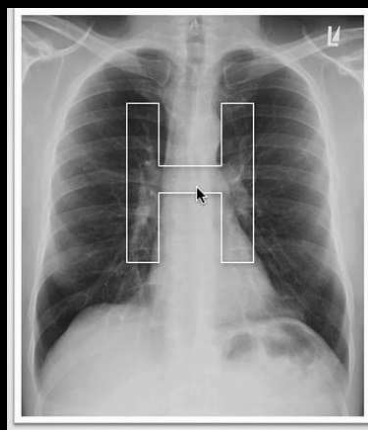
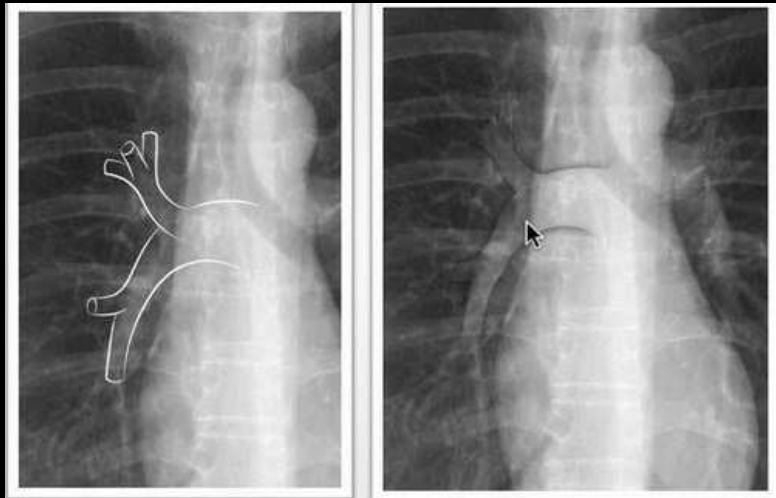




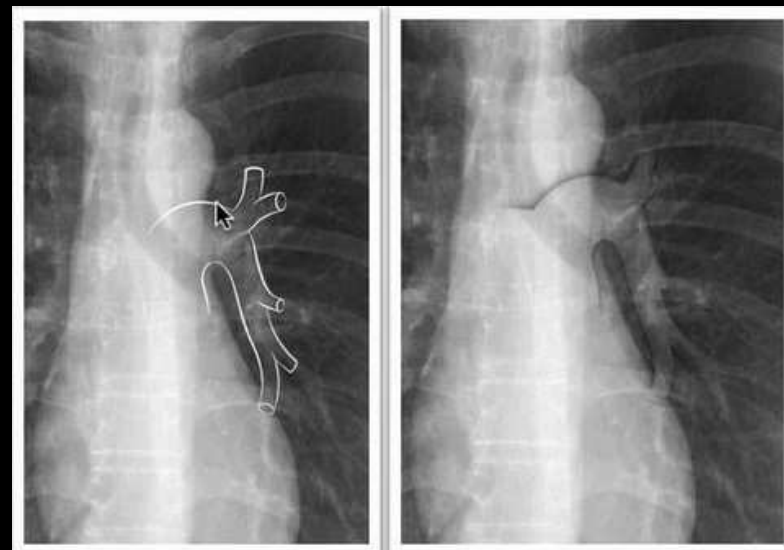


HILAR REGION  
ON  
CHEST X-RAY

## Right Pulmonary Artery



## Left Pulmonary Artery



# Normal Hila



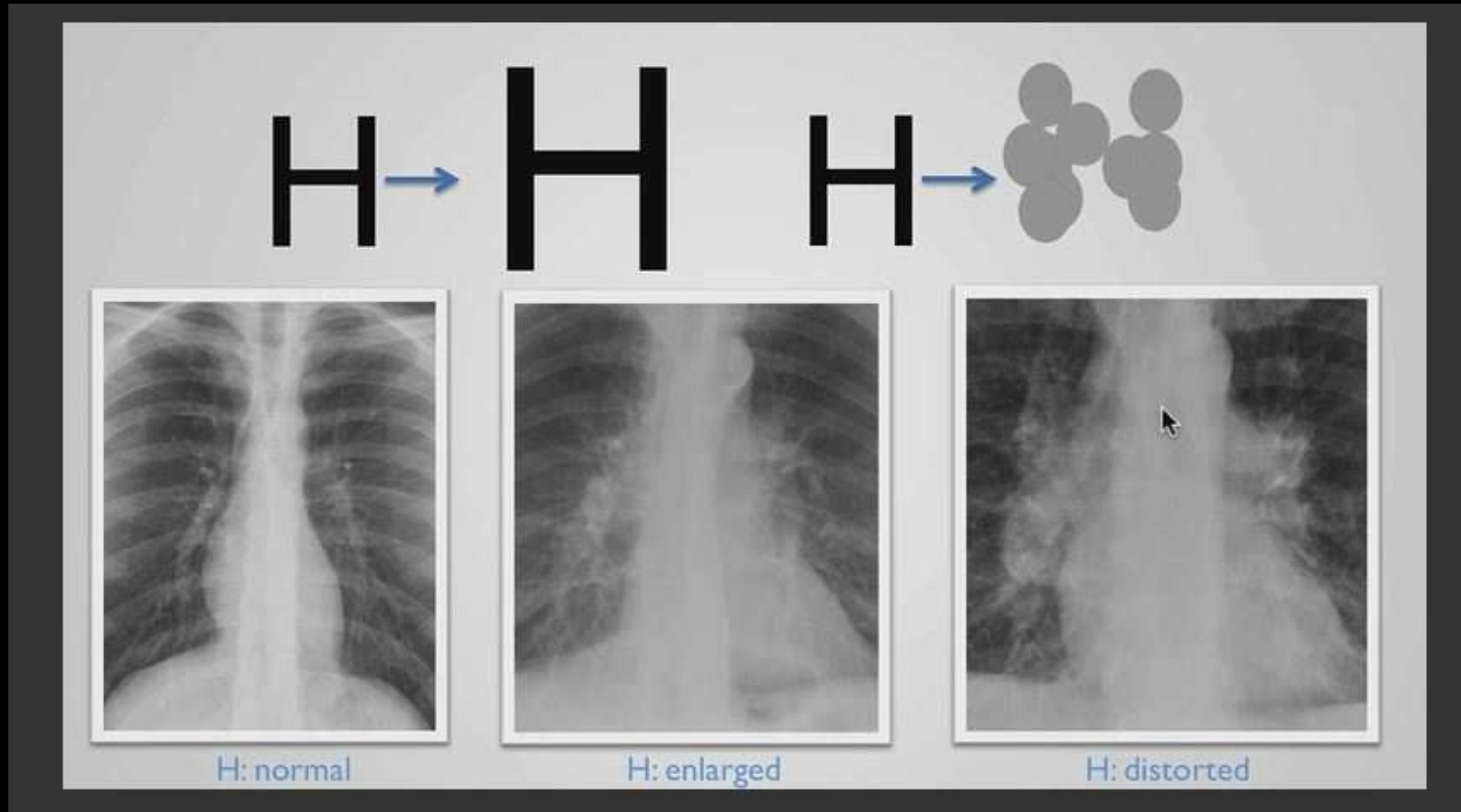
# Normal Hila



# Abnormal Hila

- Increase in density
  - Is it too white?
- Change in size
- Abnormal Position
- Abnormal Shape

# Abnormal Hila



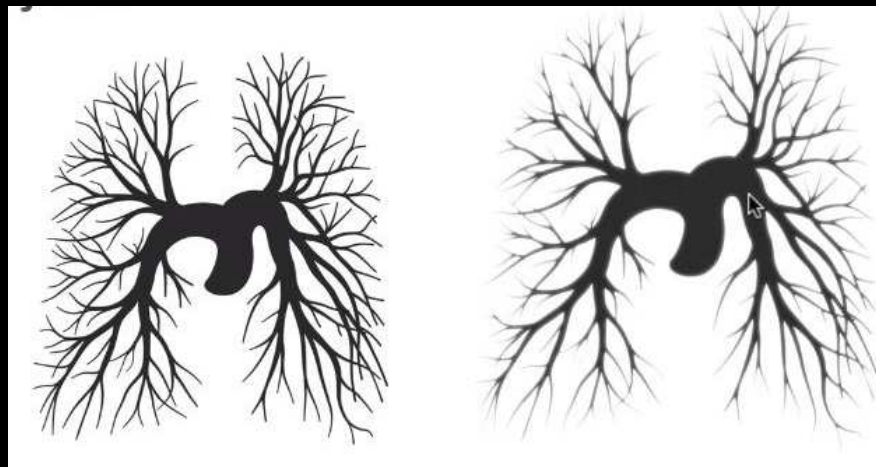
Normal

Enlarged

Distorted

# Hazy Hila

Pulmonary Edema



Normal

Hazy



# Hilar Enlargement

## Unilateral Hilar Enlargement

- Tumor
  - Lung Cancer -- Lymphoma
  - Metastasis
- Enlarged nodes
- Infection
  - TB-viral-infection
- Pulmonary arterial aneurysm/stenosis

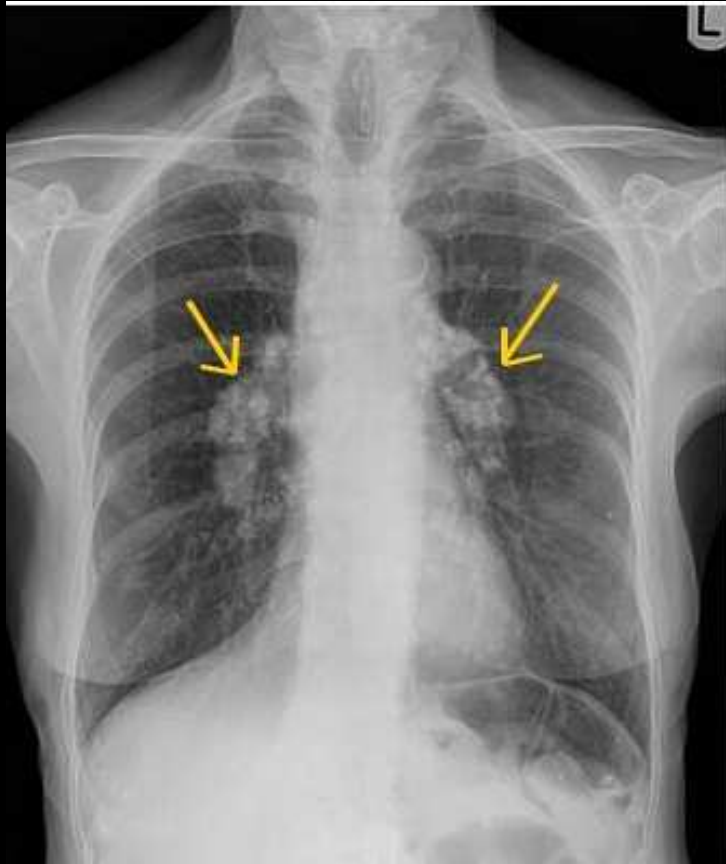
## Bilateral Hilar Enlargement

- Pulmonary Hypertension
- Adenopathy
  - Sarcoidosis
  - Lymphoma
  - Metastasis
  - Infection
    - TB-viral-bacterial



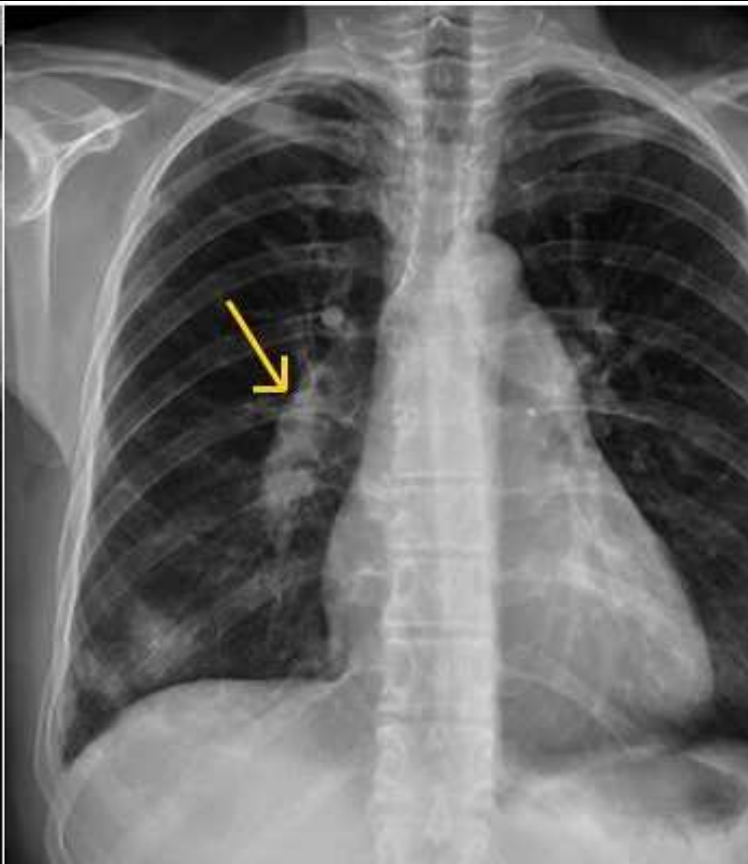
## Calcified Bilateral Hilar Lymphadenopathy

Sarcoidosis



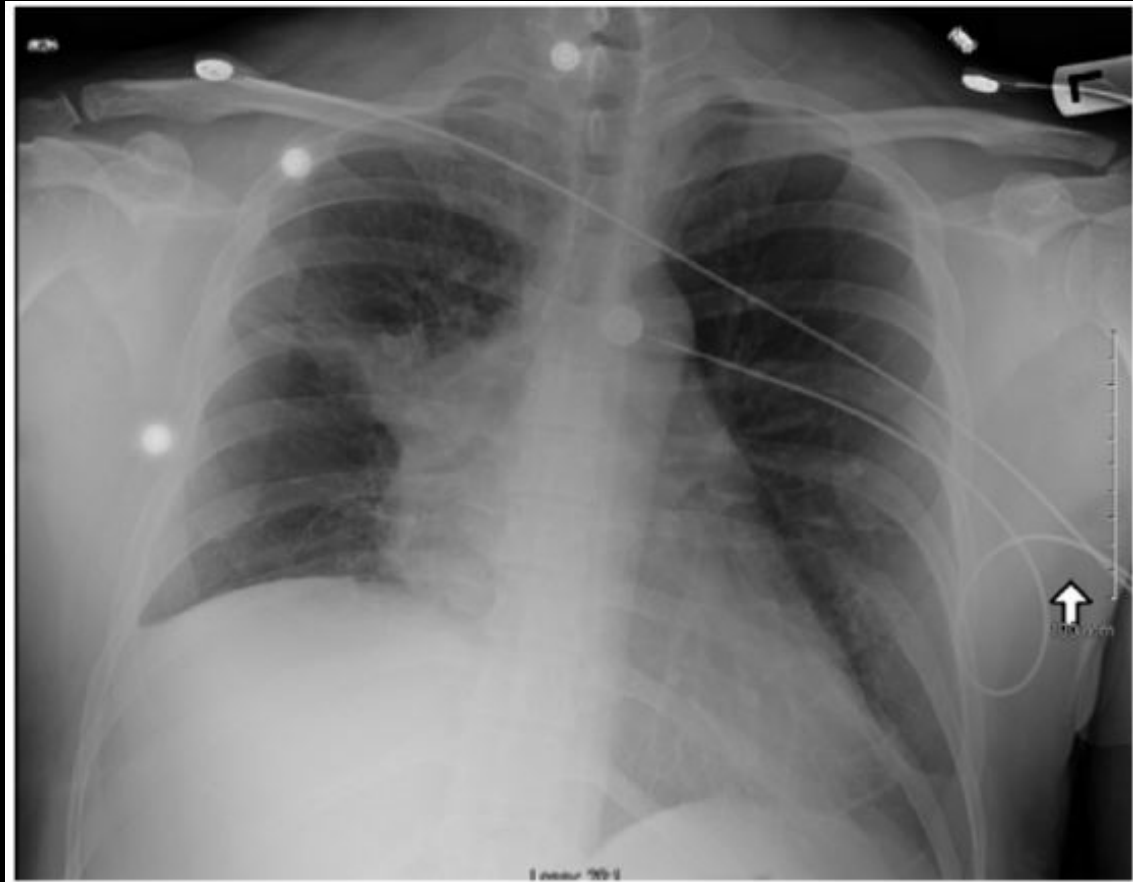
## Unilateral Enlargement

Pulmonary Artery Hypertension



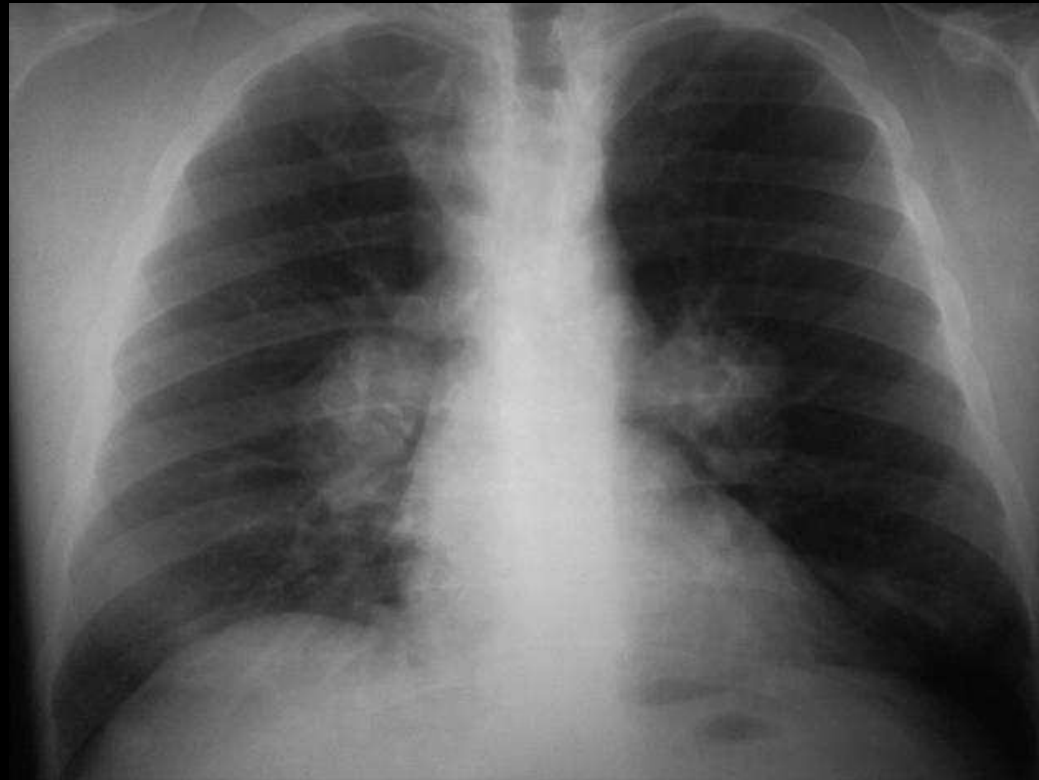
# Unilateral Hilar Enlargement

- Large right hilar mass extending to the right upper lobe
- Right pleural effusion



# Bilateral Hilar Lymph Node Enlargement

## Sarcoidosis



# Pulmonary Hypertension & Cardiomegaly



# Diaphragm

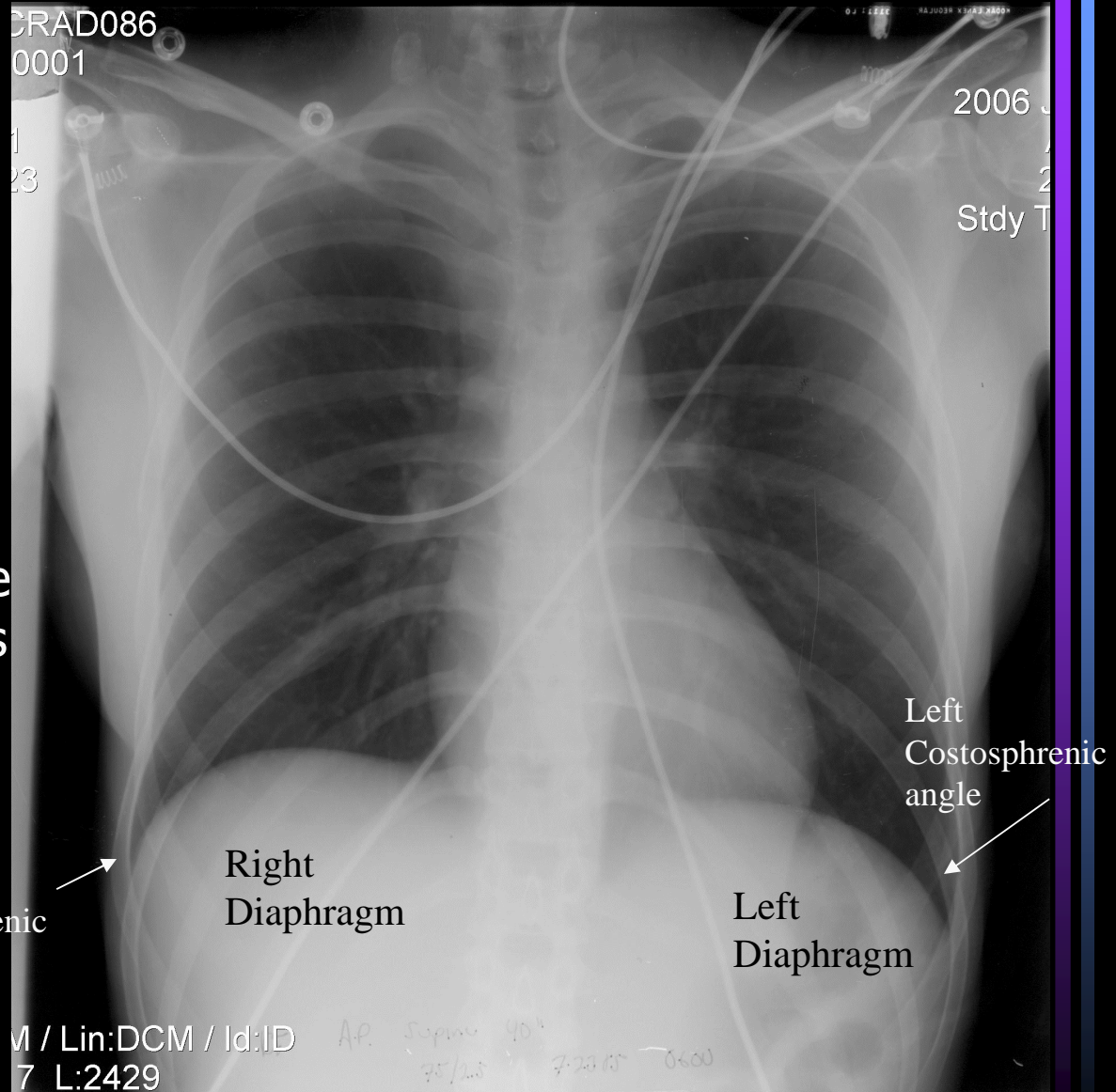
- Diaphragm is normally rounded and concave (domeshaped)
- The right hemidiaphragm is usually higher than the left due to the liver.
- Costophrenic angles are very sharp acute angles formed by the water density of the diaphragm and chest wall

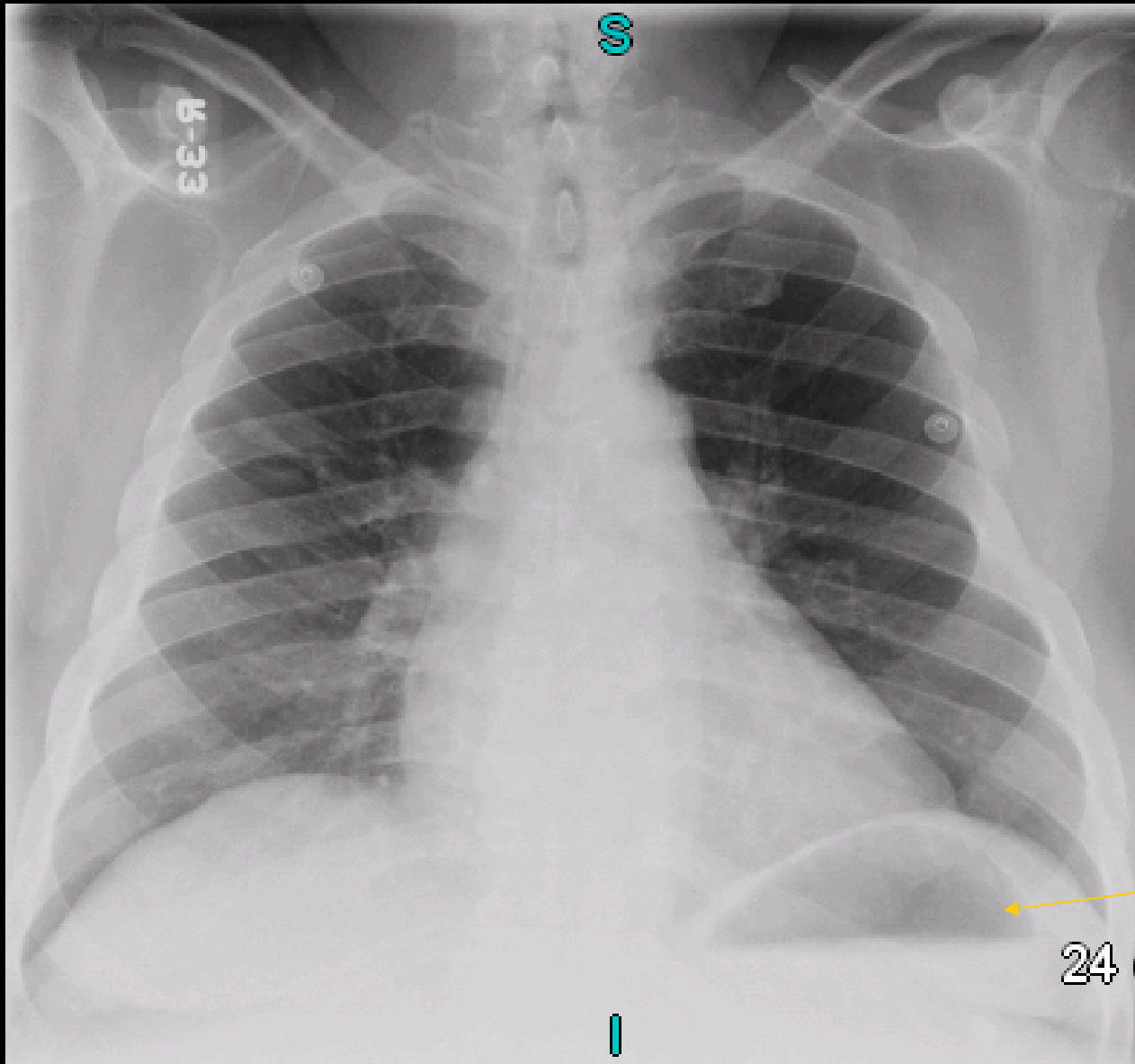
Right Costophrenic angle

Right Diaphragm

Left Diaphragm

Left Costophrenic angle





Air under  
diaphragm

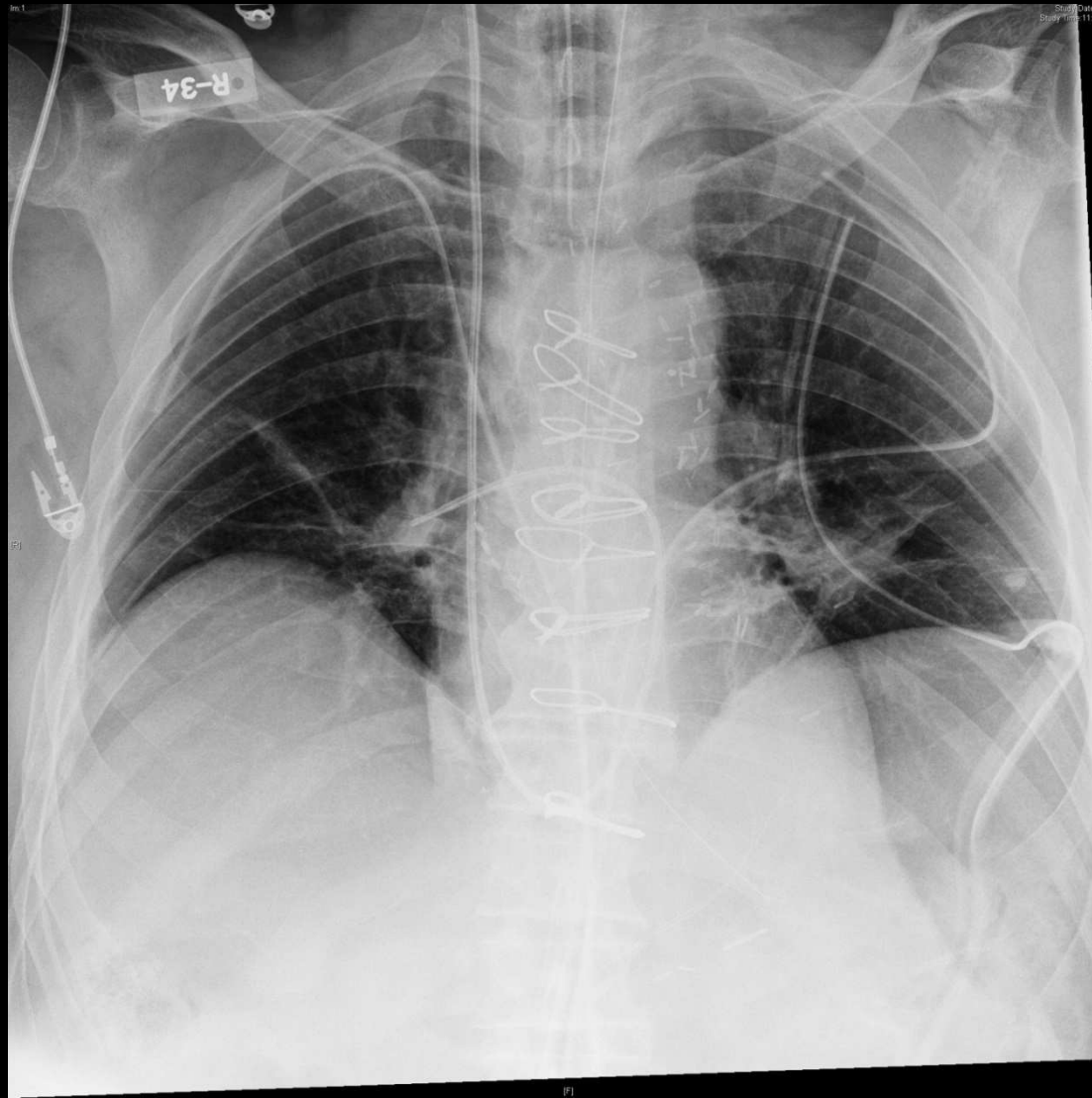
# Diaphragm Variations

- Normal diaphragm elevations occur with
  - obesity
  - pregnancy
  - pain
  - bowel obstruction
- Flatten diaphragms
  - emphysema
- Unilateral diaphragm changes
  - abdominal organ distention or paralysis



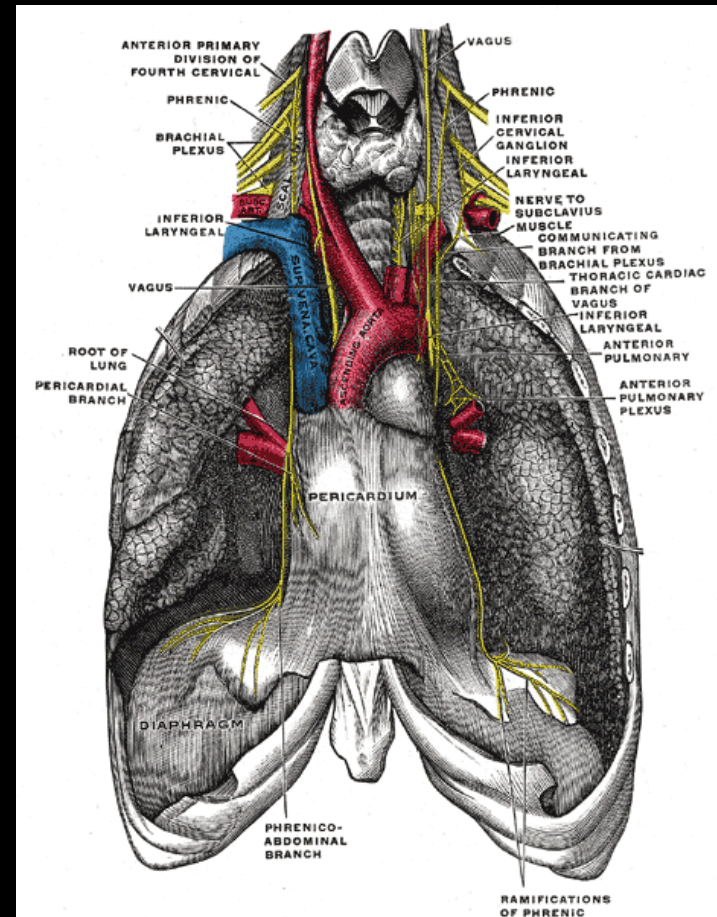


Elevated right diaphragm....  
Maybe phrenic nerve cut during surgery.



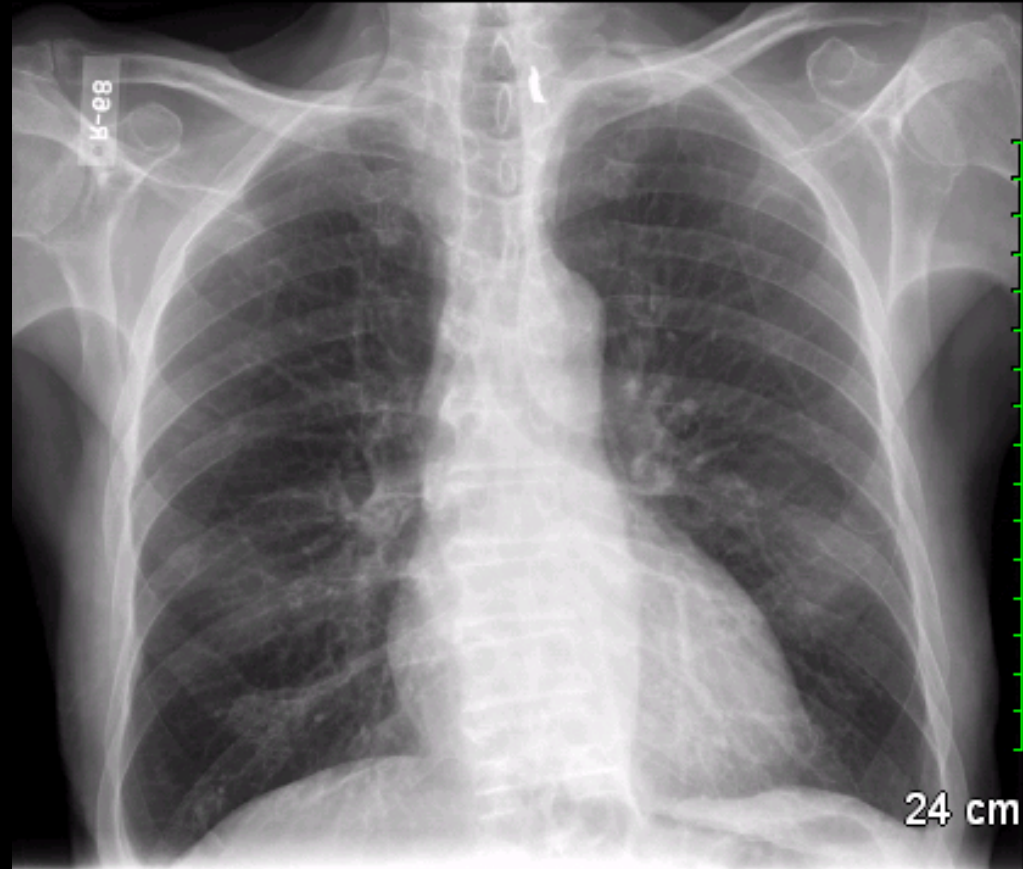
# Phrenic Nerve Injury Causes

- Cold injury to nerve from cardioplegia solution
- Surgical trauma during takedown of IMA



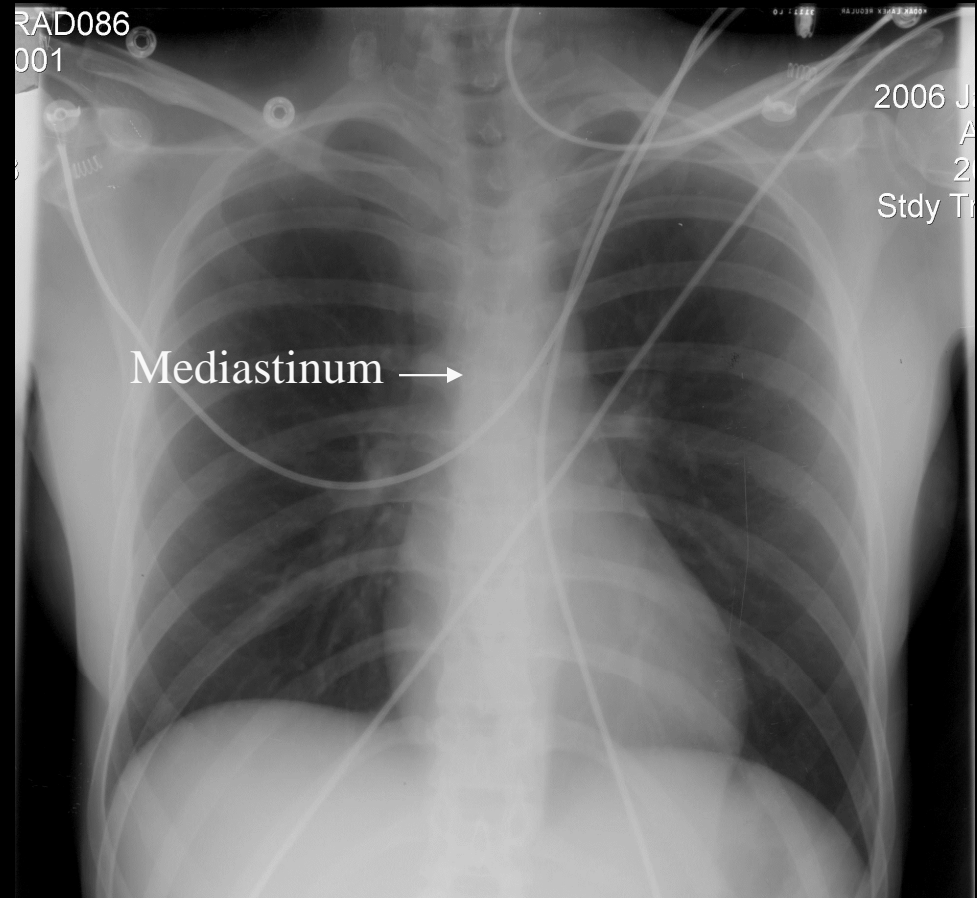
# Pleura

- Pleural is only able to be identified if separated from the thoracic lining by fluid or air



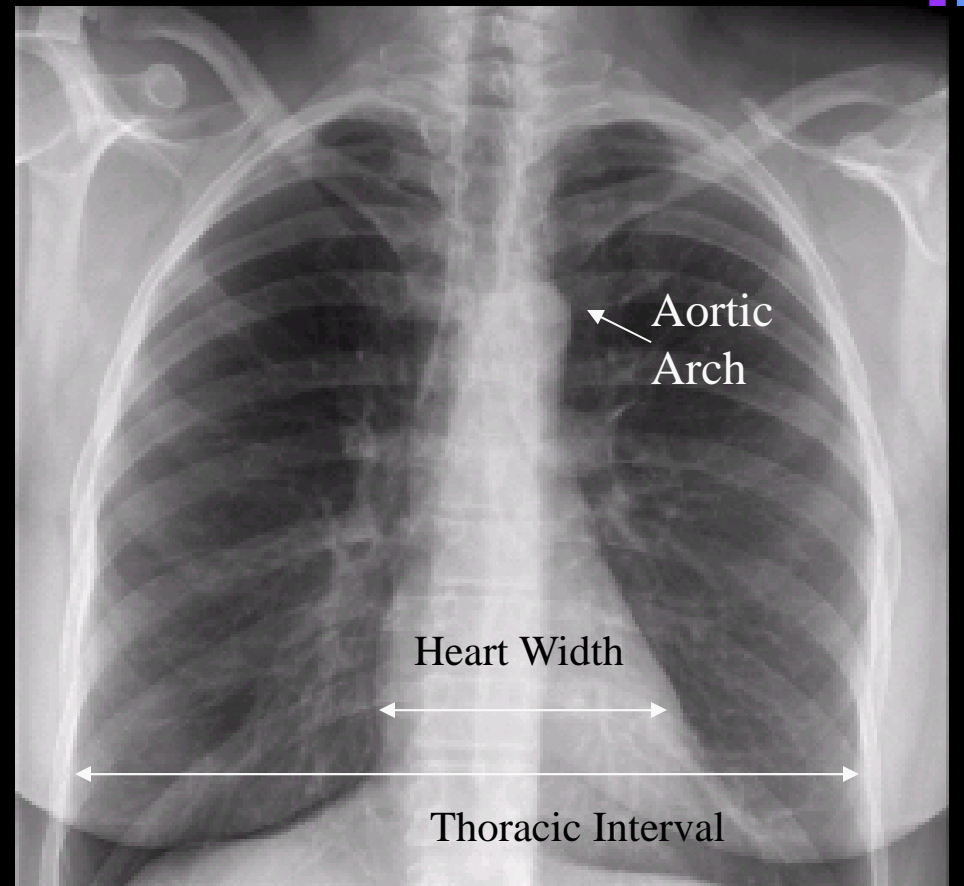
# Mediastinum

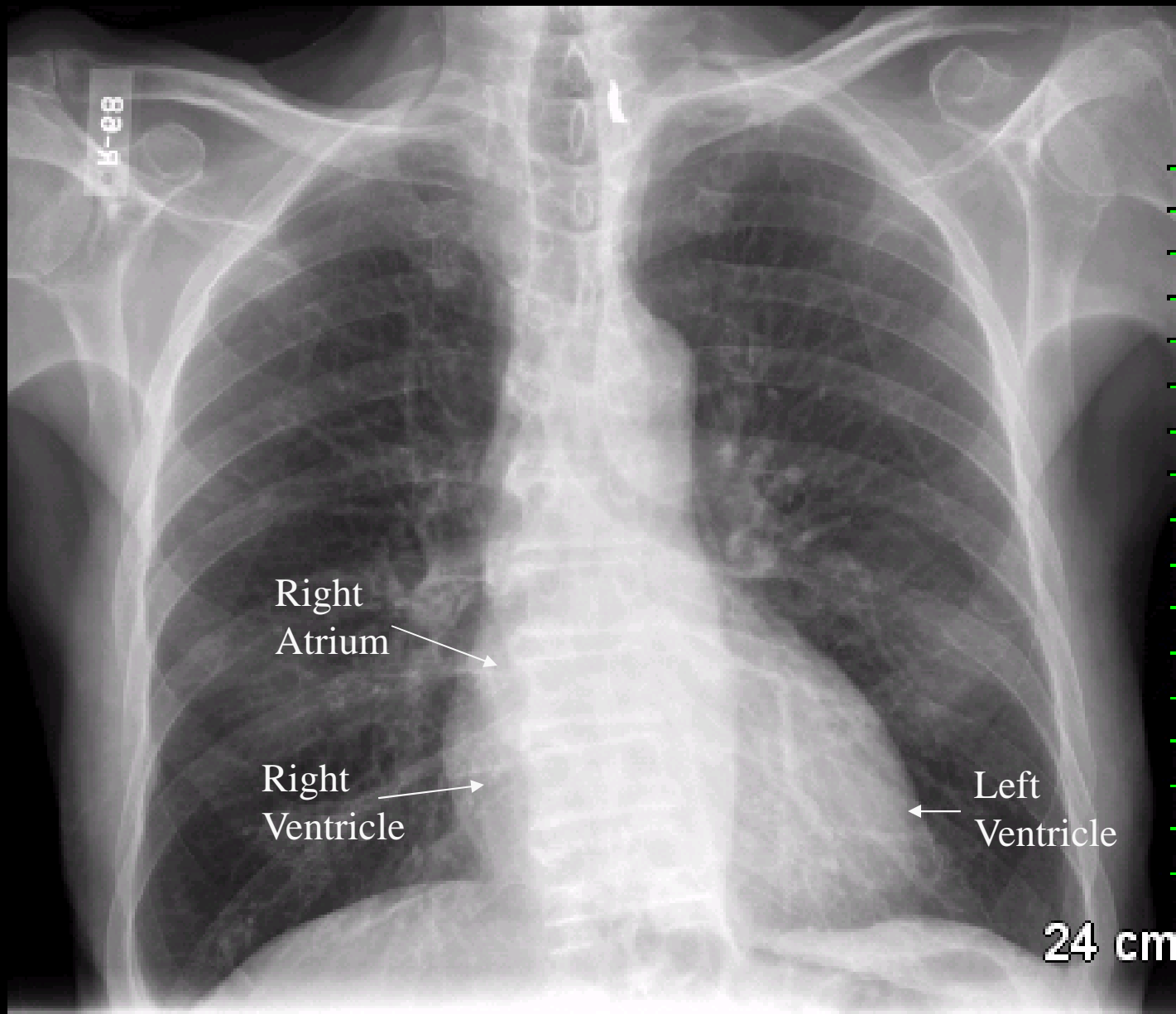
- Check for mediastinal shifts
- Check for increasing shadows from tamponade, aneurysms, tumors



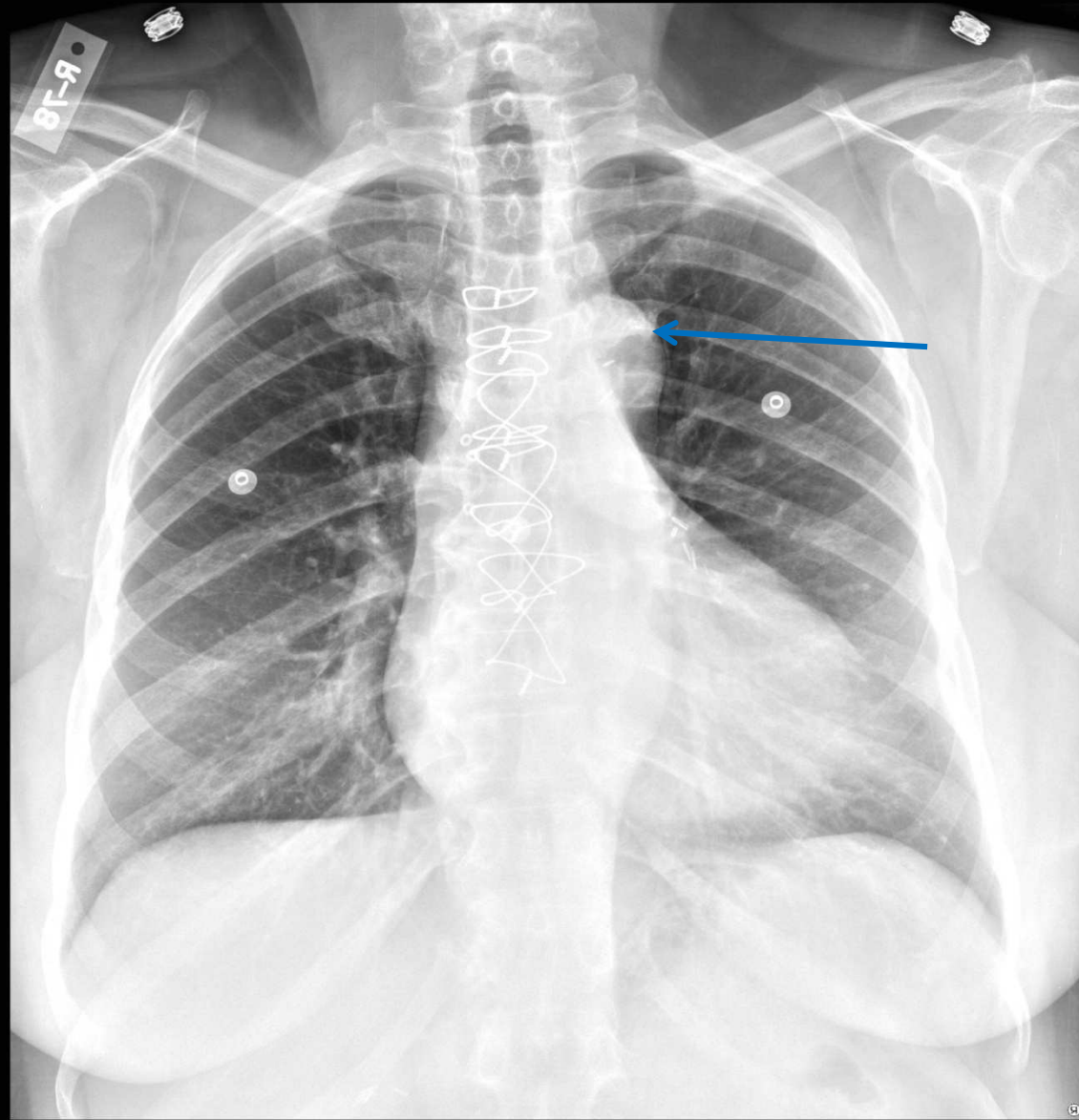
# Heart and great vessels

- Check size
  - Should be  $< 50\%$  of the Cardiothoracic ratio (CTR)
  - $\text{CTR} = \frac{\text{Horizontal width of the heart}}{\text{widest thoracic interval}}$
- Check aortic arch for aneurysm
- Check for prosthetic valves

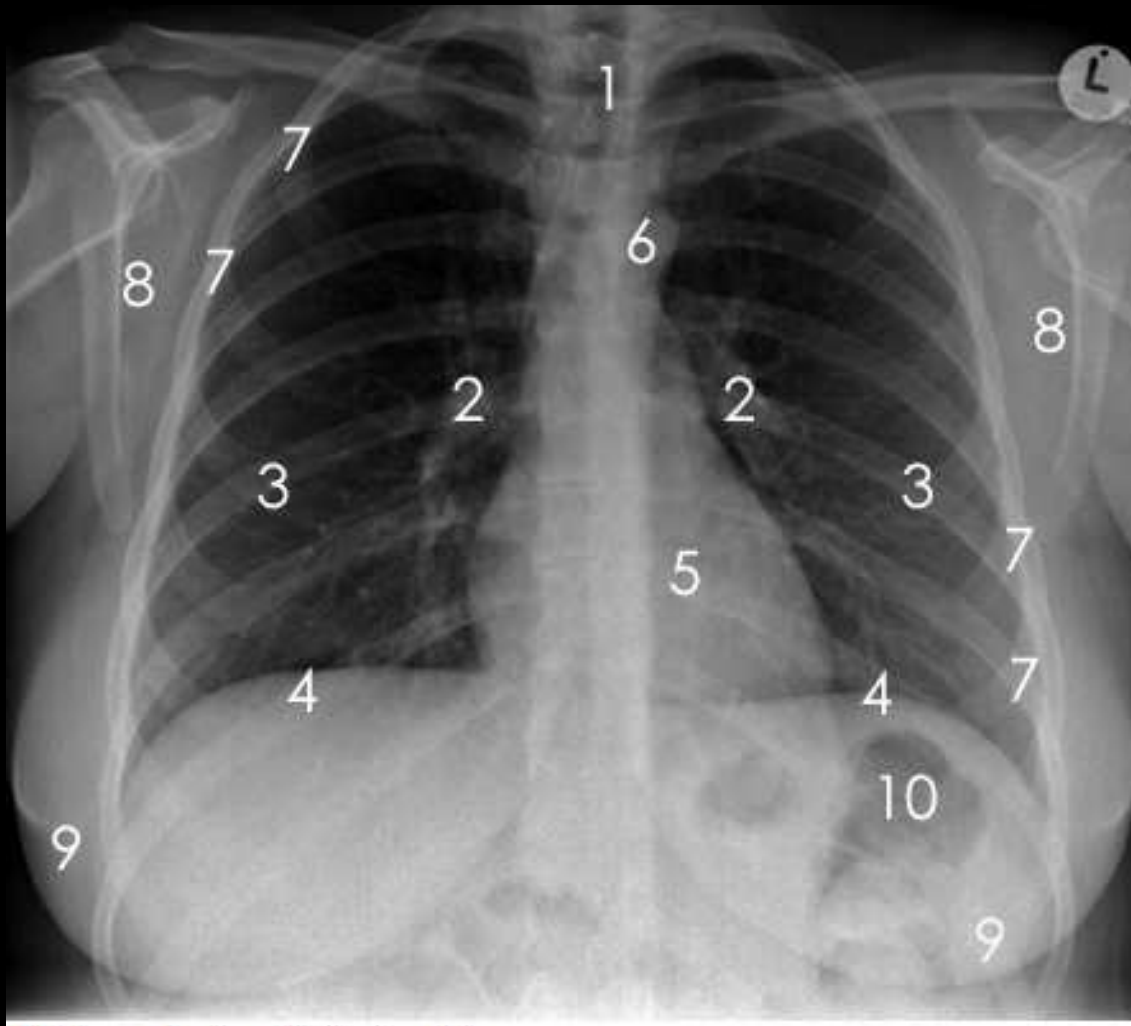




# Prominent Aorta



# Chest x-ray anatomy



- 1 - Trachea
- 2 - Hila
- 3 - Lungs
- 4 - Diaphragm
- 5 - Heart
- 6 - Aortic knuckle
- 7 - Ribs
- 8 - Scapulae
- 9 - Breasts
- 10 - Bowel gas

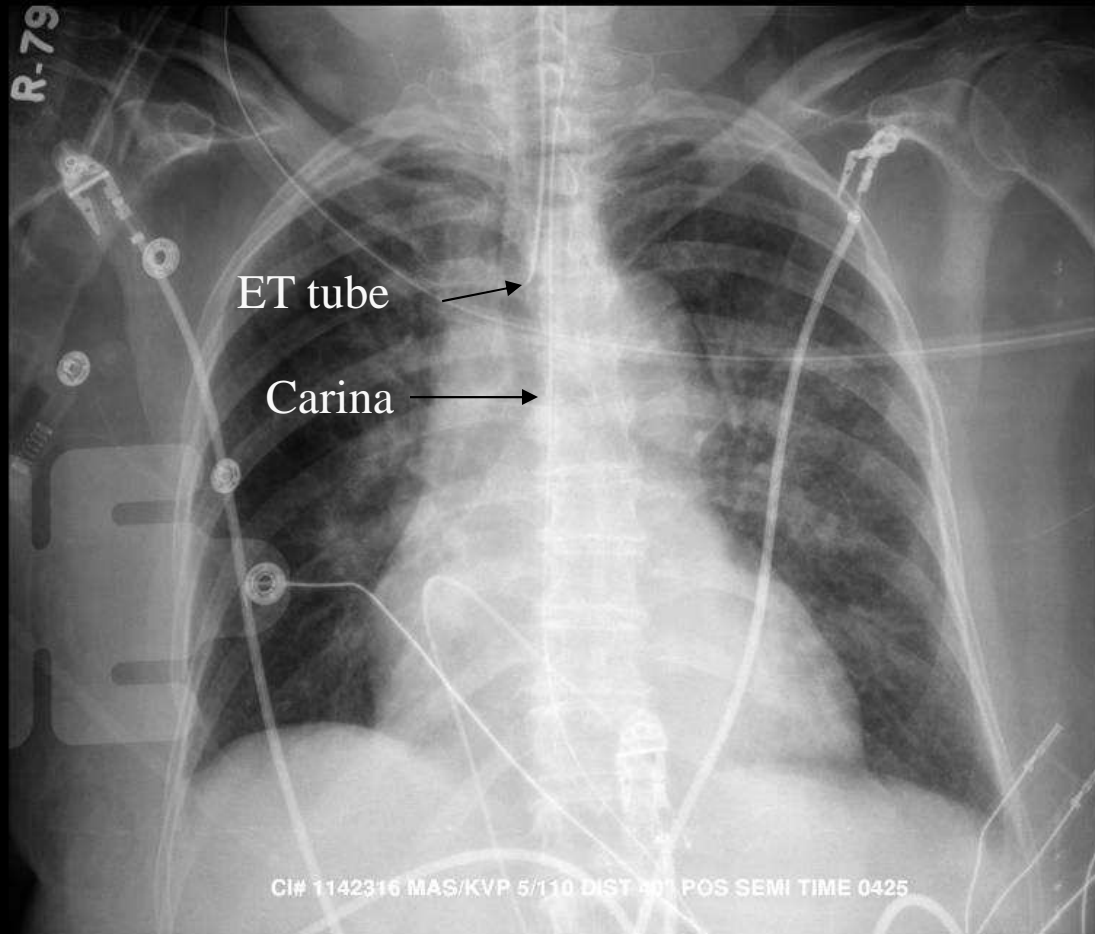
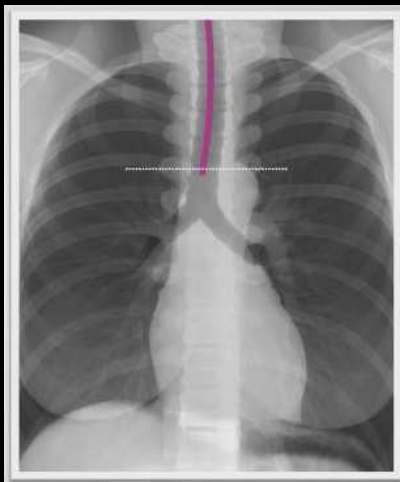


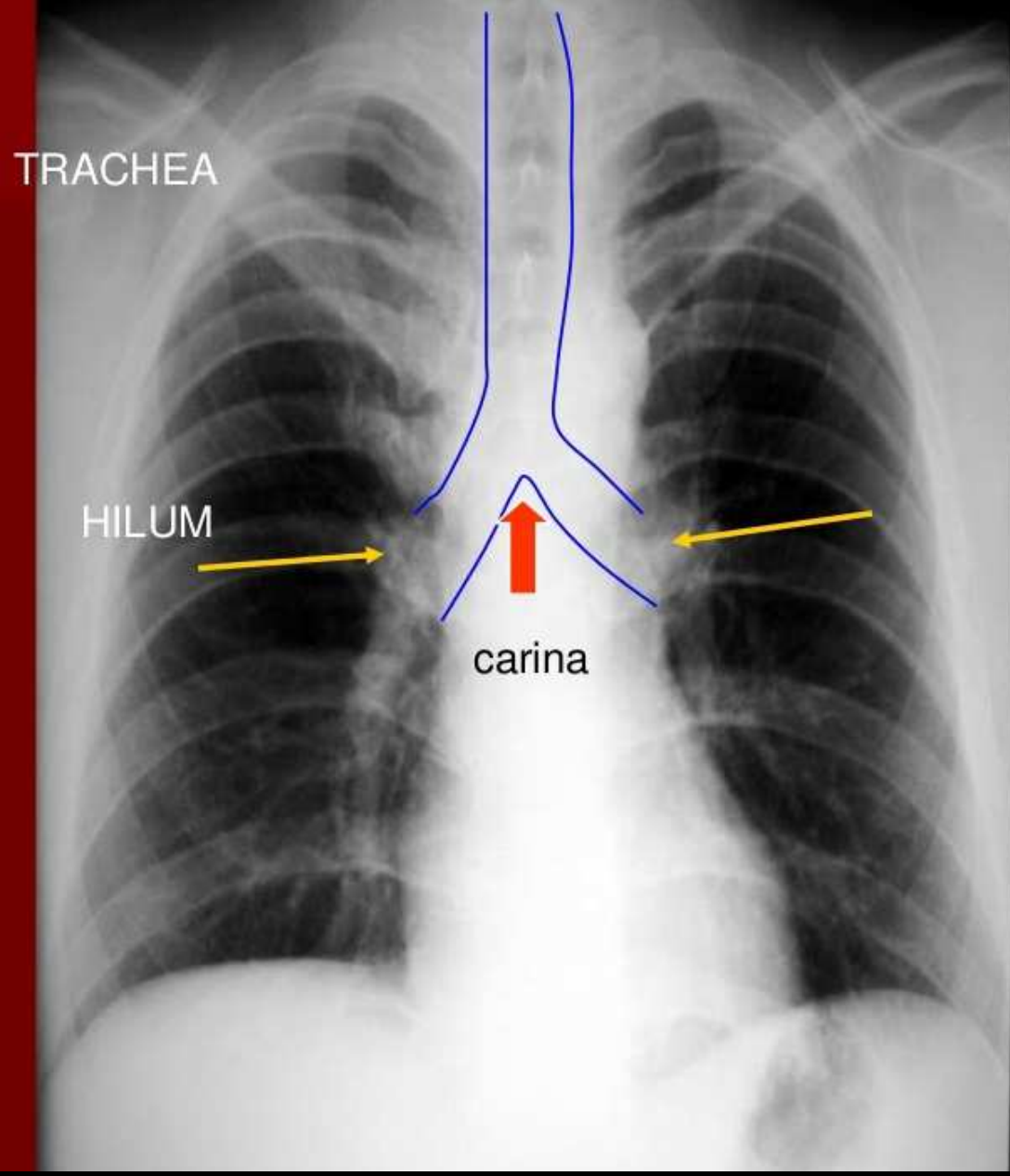
# Nonphysiological structures -- lines, etc

- ET tube: Correct placement is usually 5 cm above the carina but can be 2 – 8cm above carina
- Trach tubes: Position
- Nasogastric tubes: Thin radiopaque line down in the esophagus to the stomach
- Central venous line: Tip should be in right atrium
- Swan ganz catheter: Tip should be in pulmonary artery
- Pacemaker: Look for point of origin, location of wires – transvenous, epicardial, or permanent , generator
- Prosthesis: Valves, bone pinnings,
- Sutures: Clips, metal rings, wire sutures
- Chest tubes: Location – inserted high in apex for pneumothorax, low in bases for effusions or hemothorax.
- Intraaortic Balloon Catheter: Tip should be in the aorta – 2 cm below the aortic arch
- Foreign bodies --- bullets, inhaled objects, swallowed objects, safety pins, hemostats

# ET tube

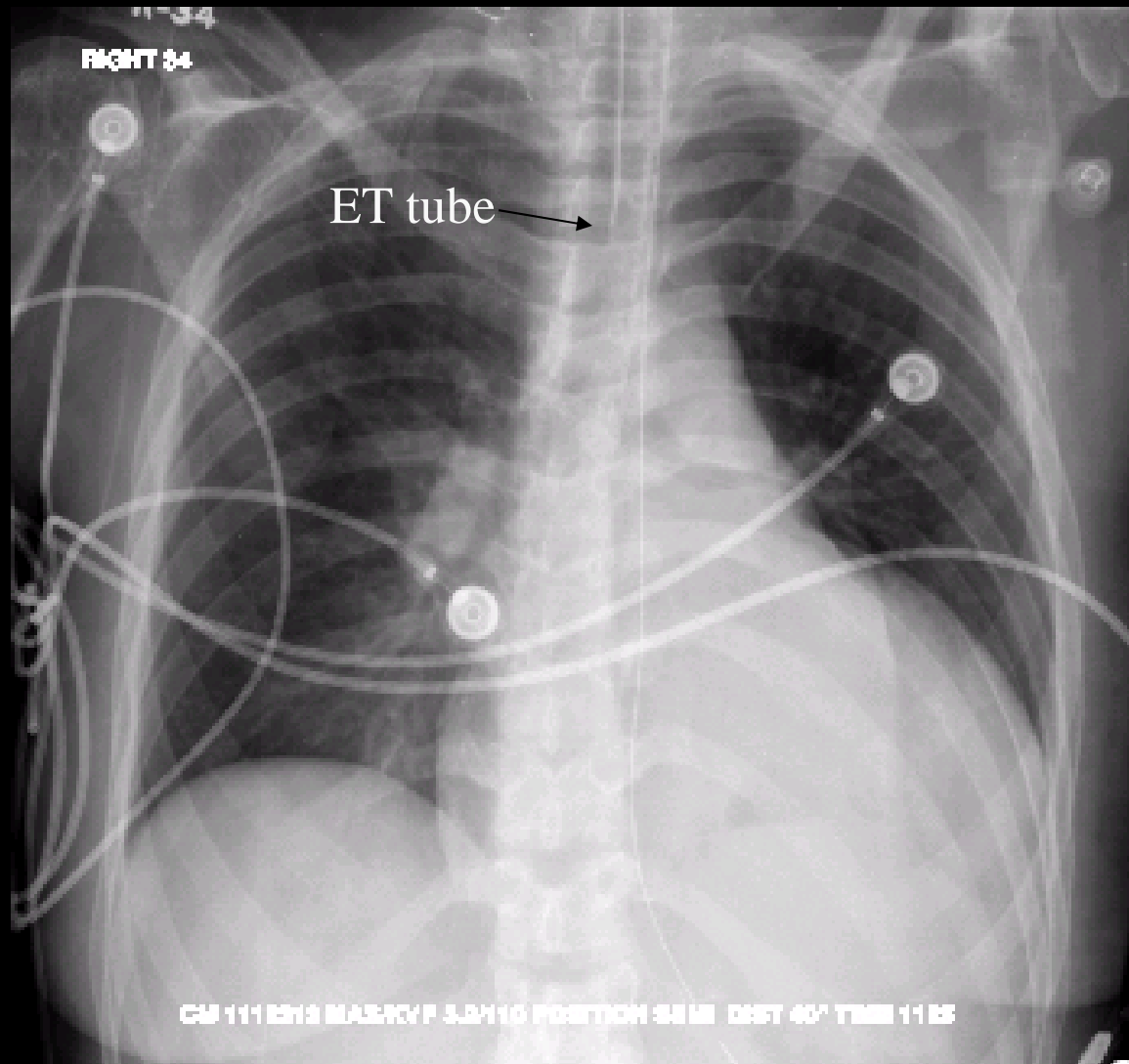
- Correct placement 4 - 5 cm above the carina
- Can be 2 – 8 cm above carina

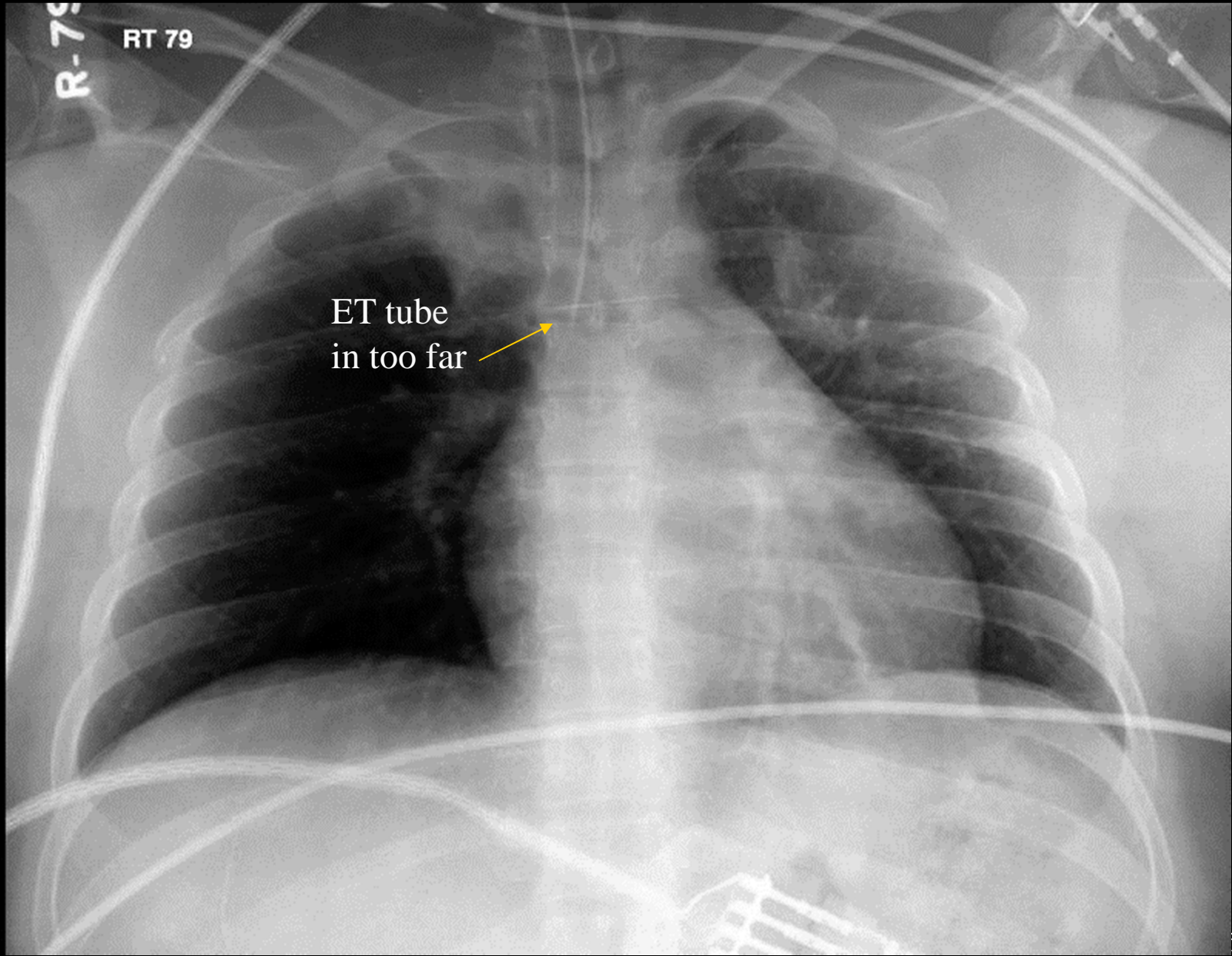




# ET tube correct position

## Cardiomegaly





R-56

Right mainstem  
intubation



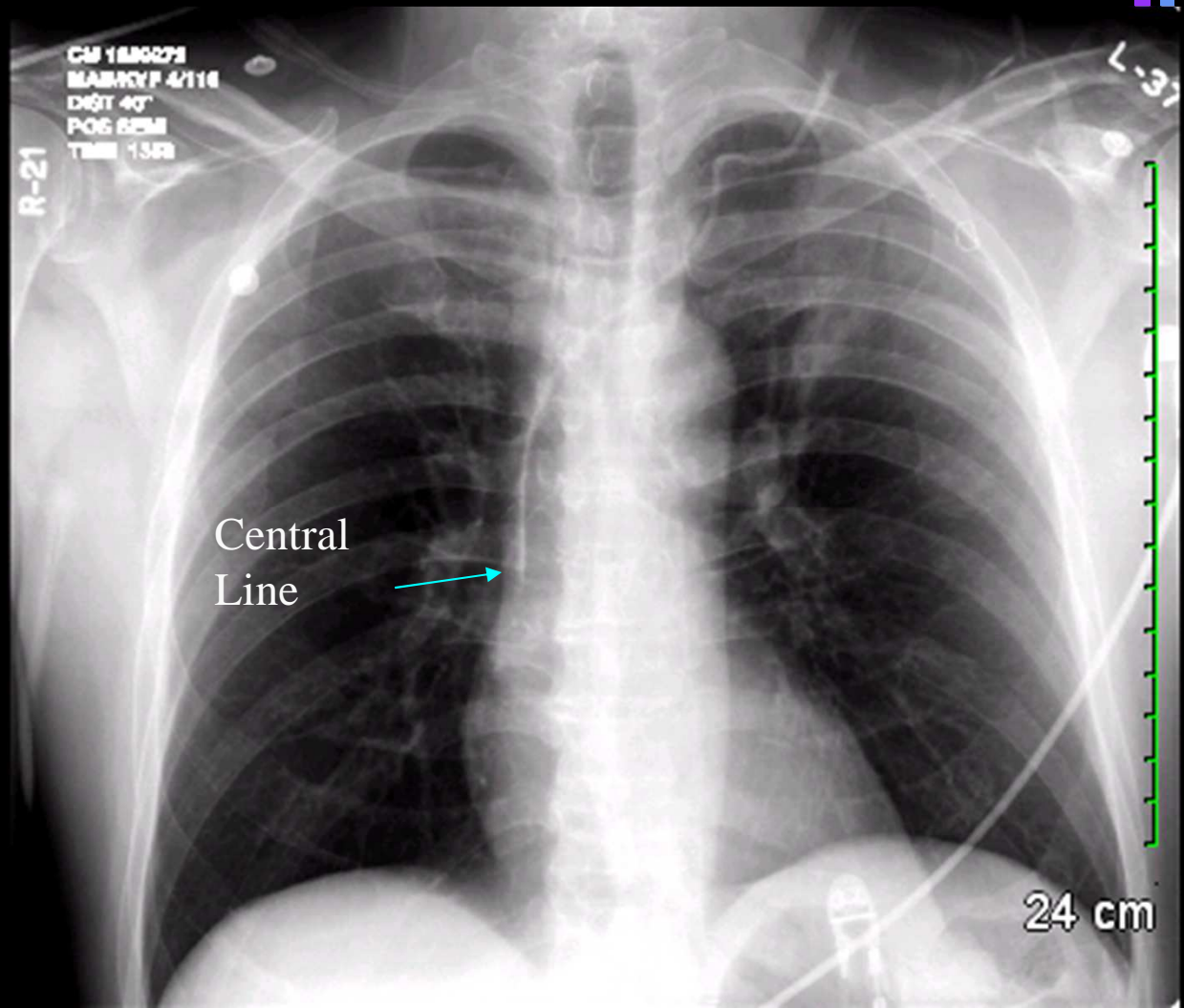
CM 00007 MAS-RVP 100110  
DIBT 40" POB SUPINE TIME 2009

24 cm



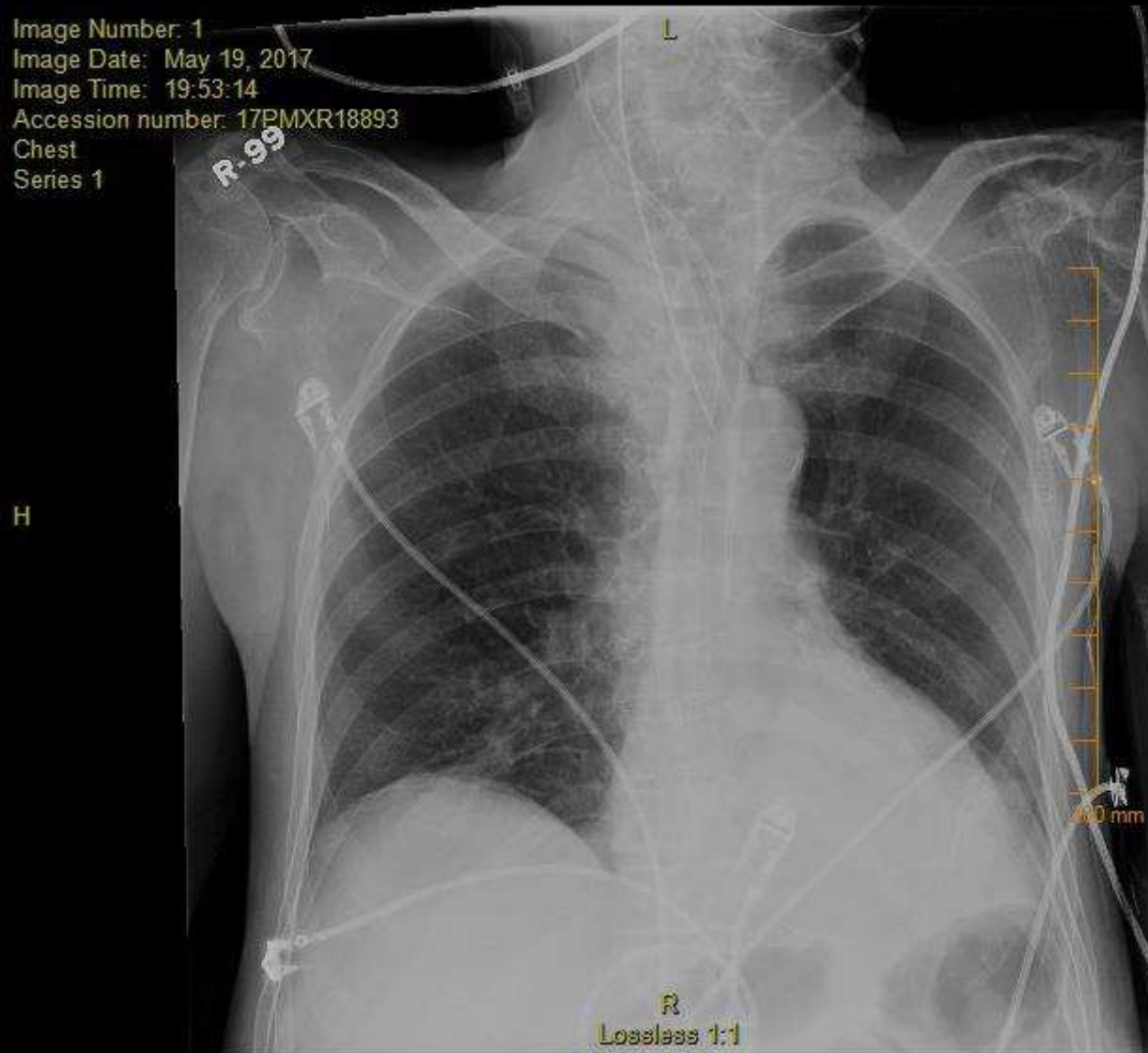
## Central venous line:

- Tip should be in right atrium



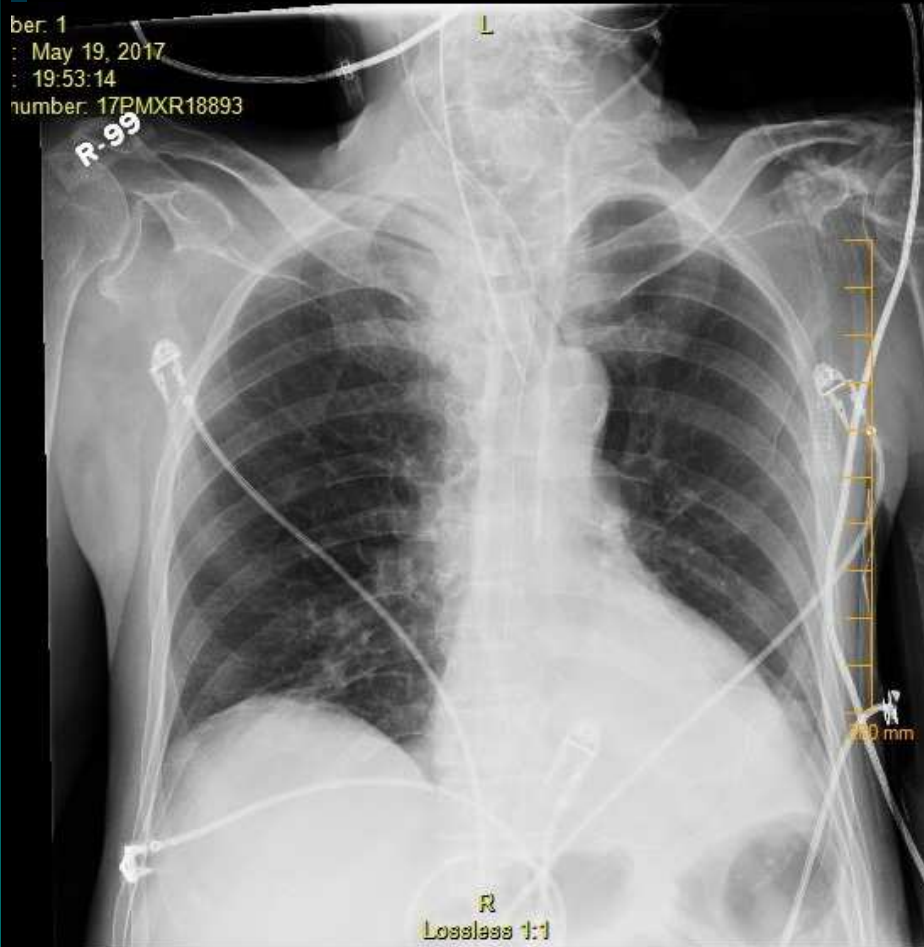
# CXR for ET tube and central line insertion

Image Number: 1  
Image Date: May 19, 2017  
Image Time: 19:53:14  
Accession number: 17PMXR18893  
Chest  
Series 1





If CL is inserted in the left, it should cross over to the right to get to the inferior vena cava

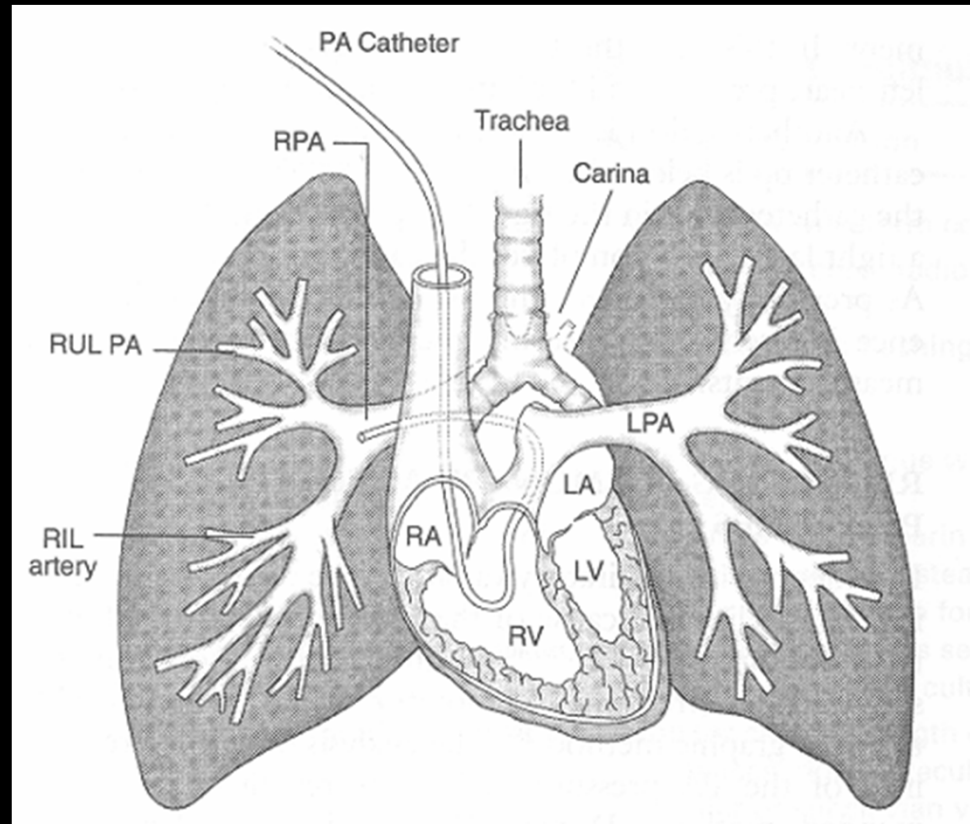


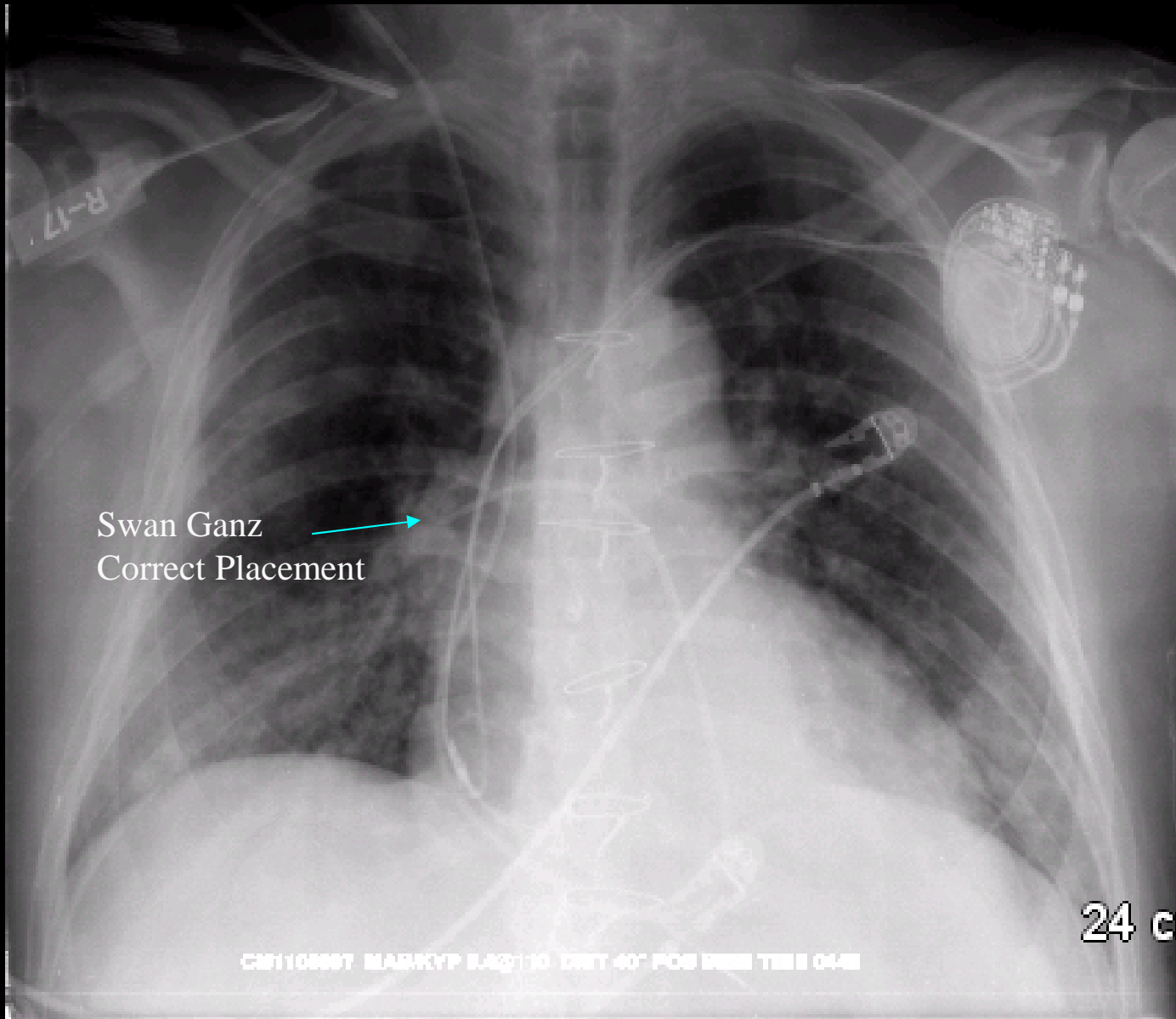
# Mediport



# Pulmonary Artery Catheter Swan Ganz Catheter

- Tip should be in the proximal right or left pulmonary artery
- Tip should be about 2 cm from the hilum or no more than 2 – 4 cm beyond the vertebral midline

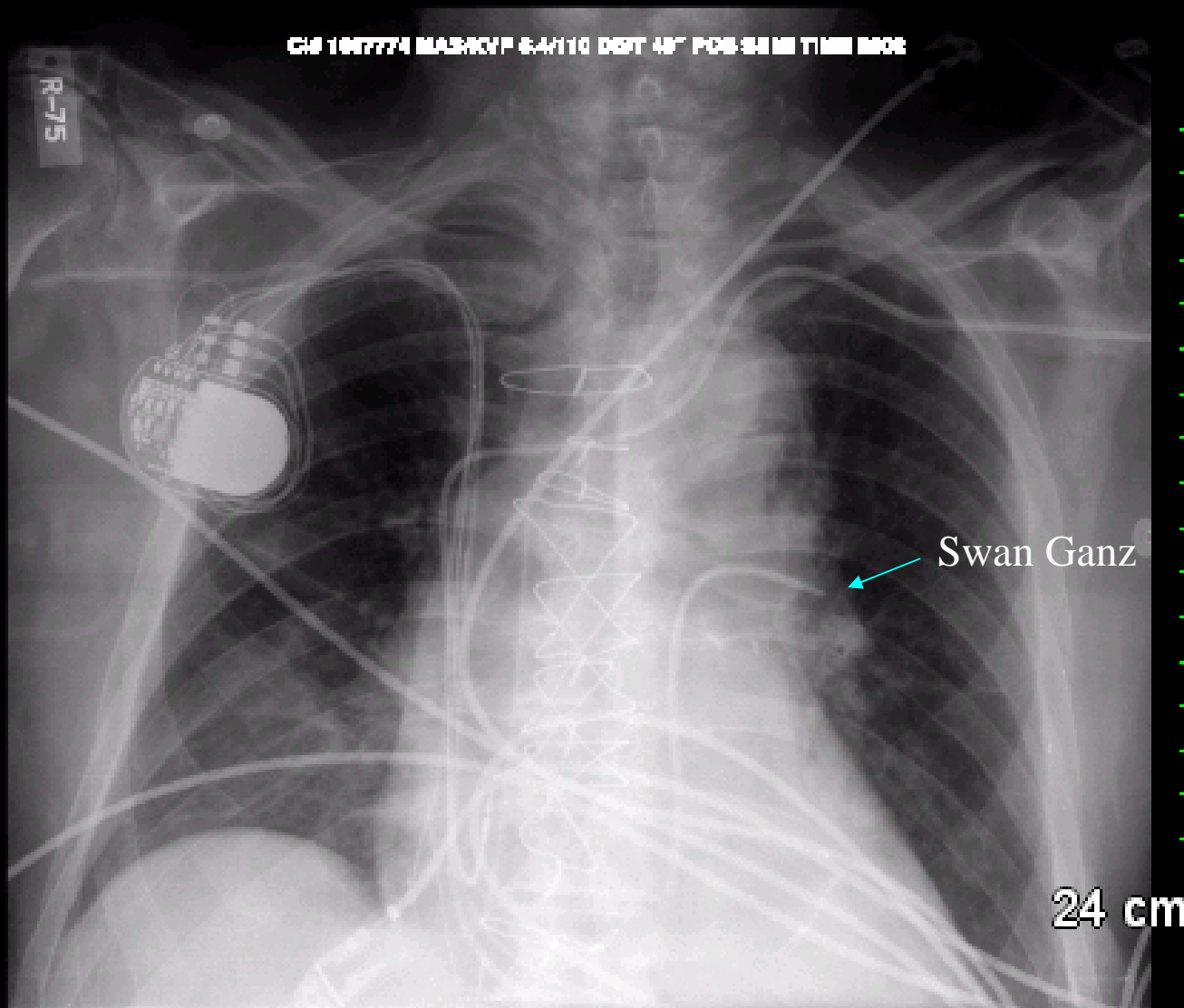


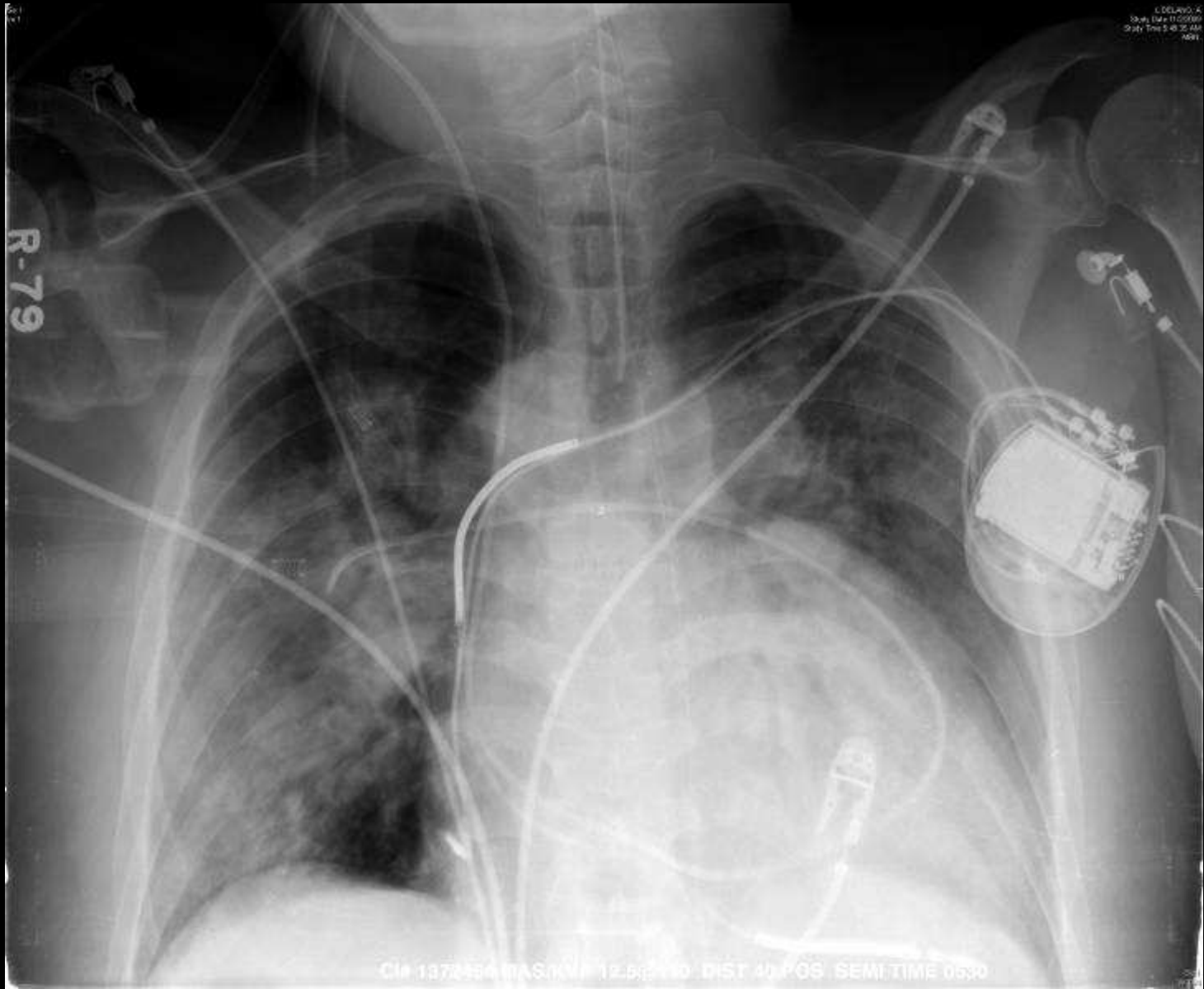


Swan Ganz  
Correct Placement

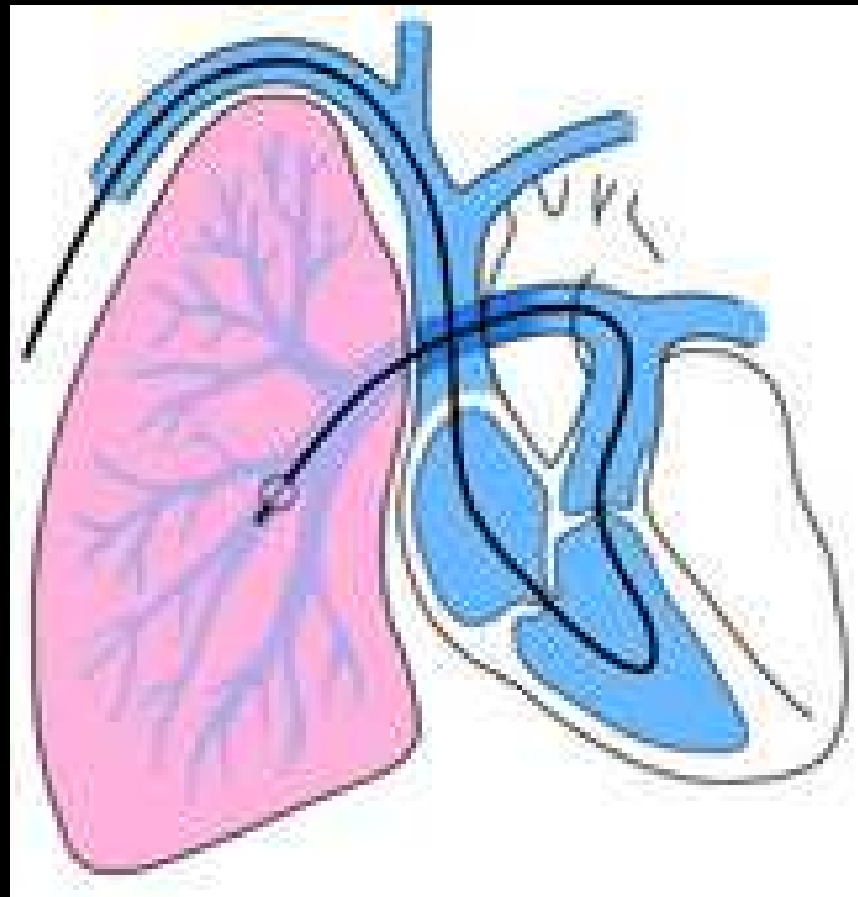
24 cm

CMI100007 MARKYP B.A. 130 DWT 40" FOR BURET TUBE 0448





- Tip should not be in the peripheral or distal pulmonary artery
- May cause pulmonary infarction or pulmonary artery rupture



309MCRAD086

Ex: 000001

Se: 1/1

Im: 13/23

54 LVCICU

2006 Jan 01 test

Acc: 000001

2006 May 31

Stdy Tm: 10:00:25

Swan Ganz  
In too far



Id:DCM / Lin:DCM / Id:ID

W:3064 L:2724



309MCRAD086

Ex: 000001

Se: 1/1

Im: 14/23



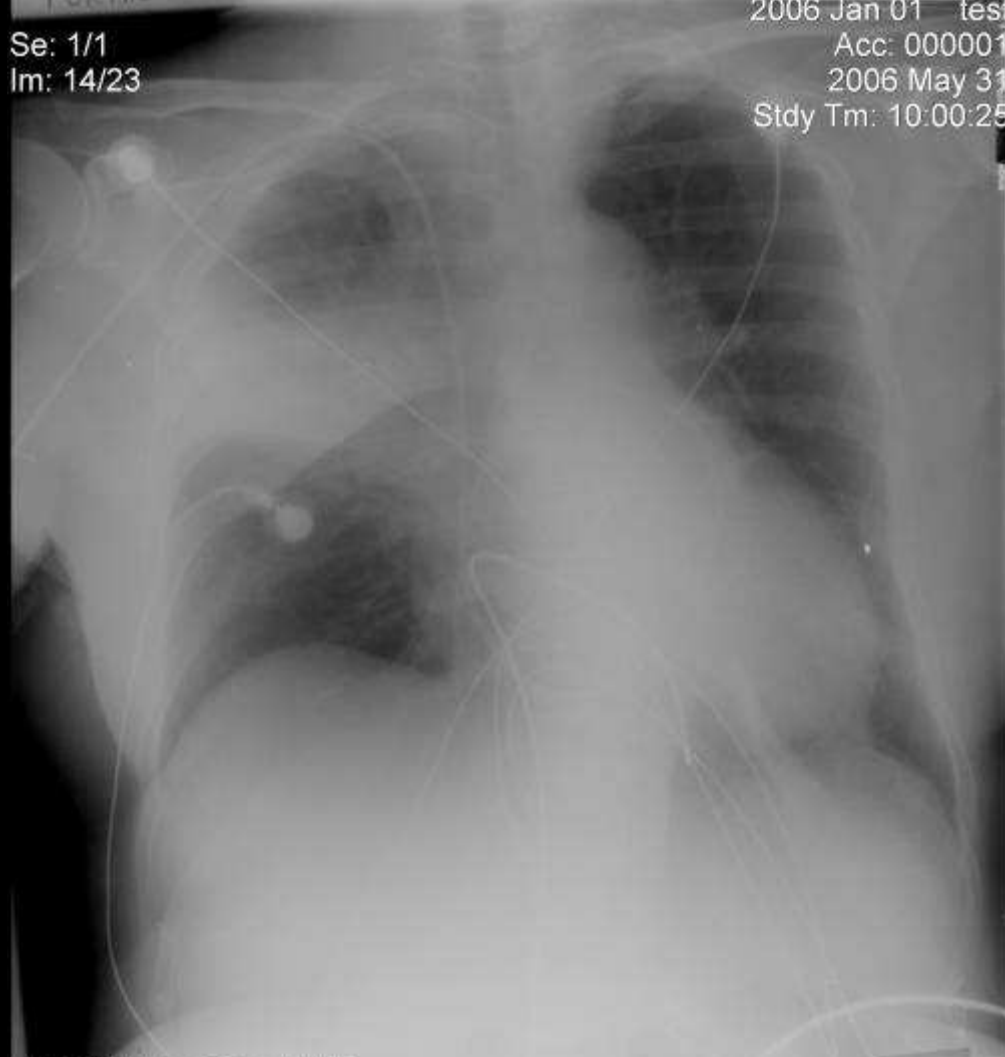
CVICU

2006 Jan 01 test

Acc: 000001

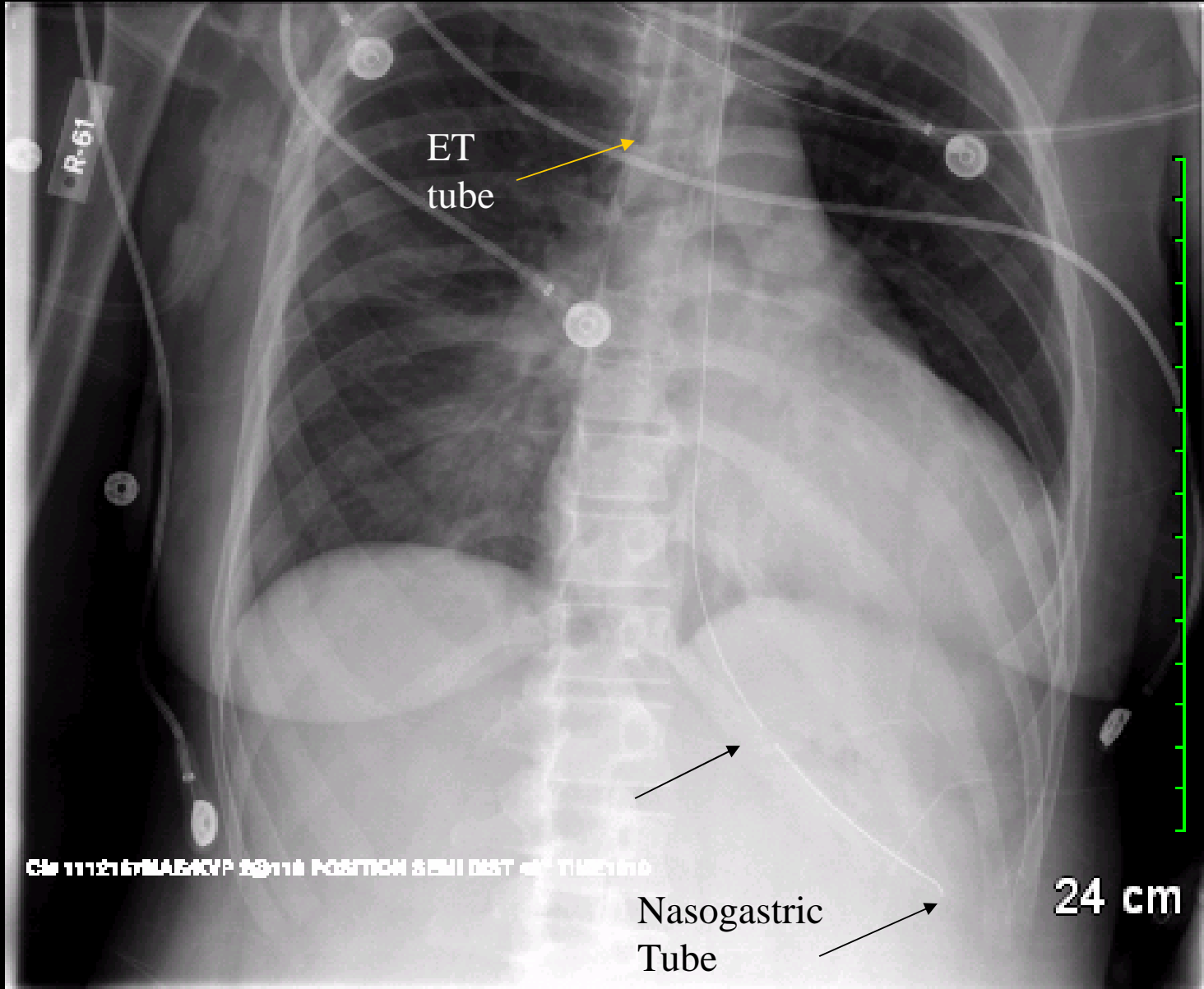
2006 May 31

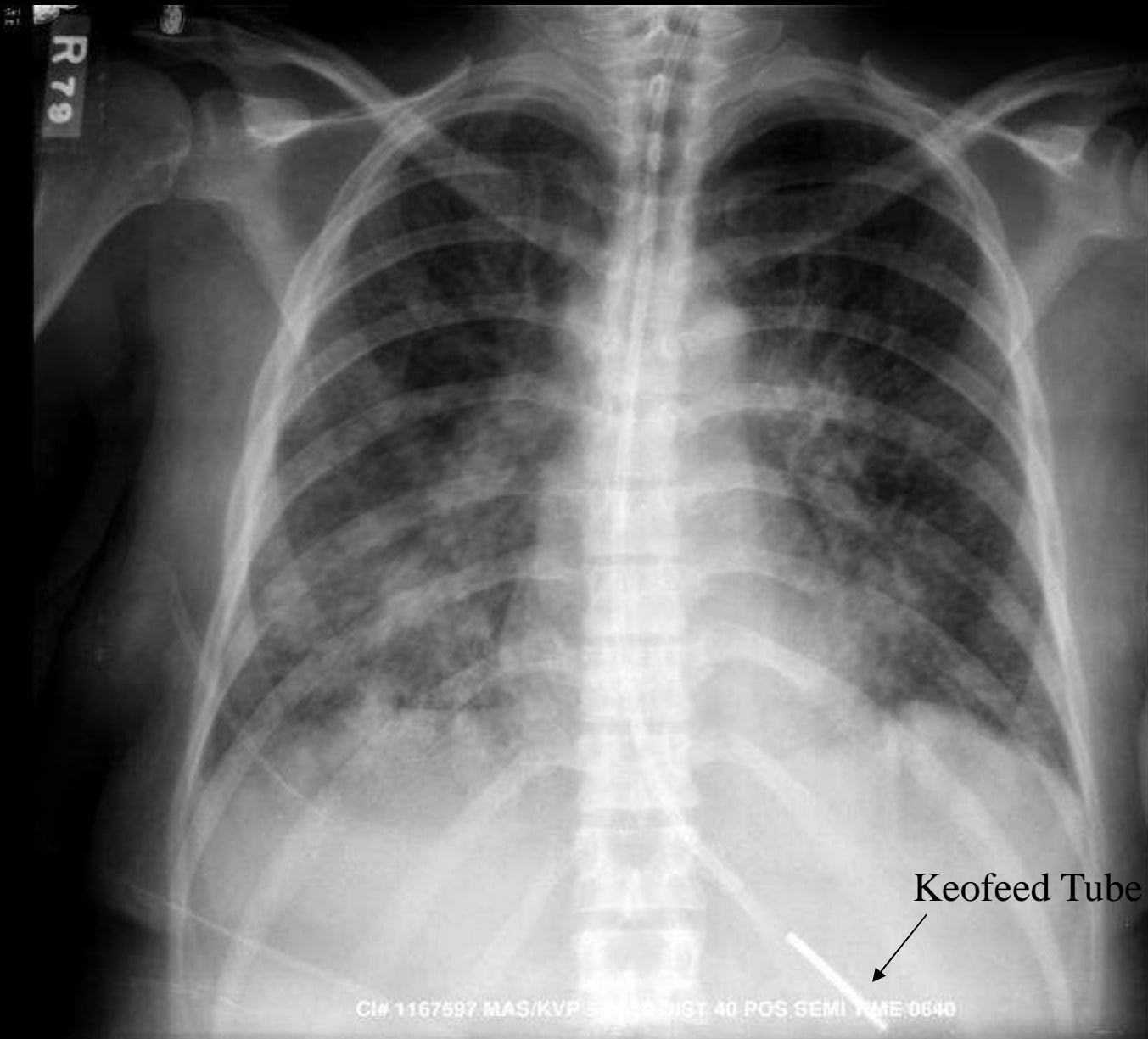
Stdy Tm: 10:00:25



Id:DCM / Lin:DCM / Id:ID

W:2741 L:3053





R 79

11/08/08A.T  
Study Date: 01/07/08  
Study Time: 02:02 AM  
Moby

Keofeed Tube



CIN# 1167597 MAS/KVP 50 100 DIST 40 POS SEMI TIME 0640

CSI  
WUSA

0086

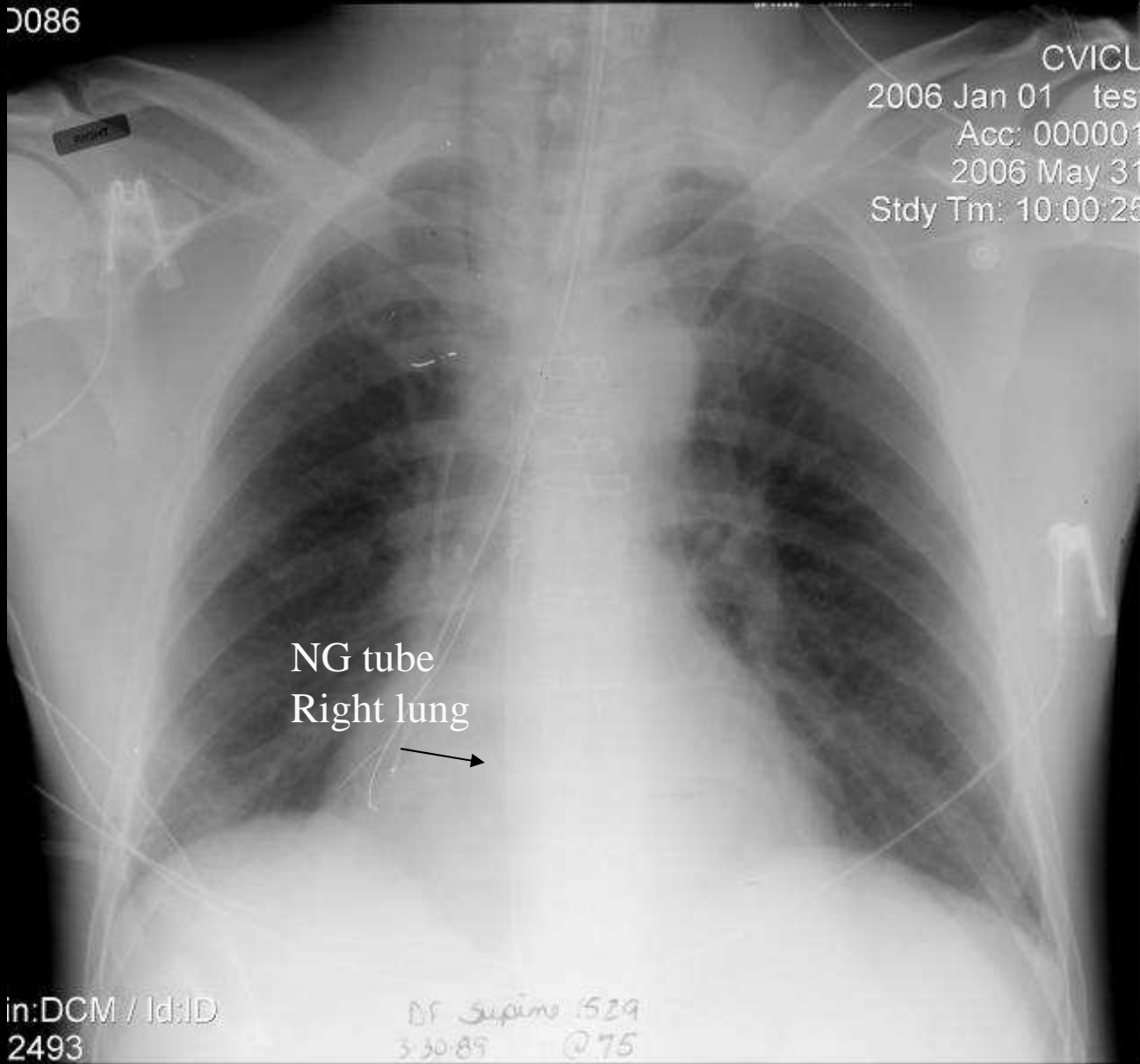
CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

Stdy Tm: 10:00:25



NG tube  
Right lung



in:DCM / Id:ID  
2493

Dr. Supina 1529  
3-30-89 @75

309MCRAD086

Ex: 000001

Se: 1/1

Im: 19/23

CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

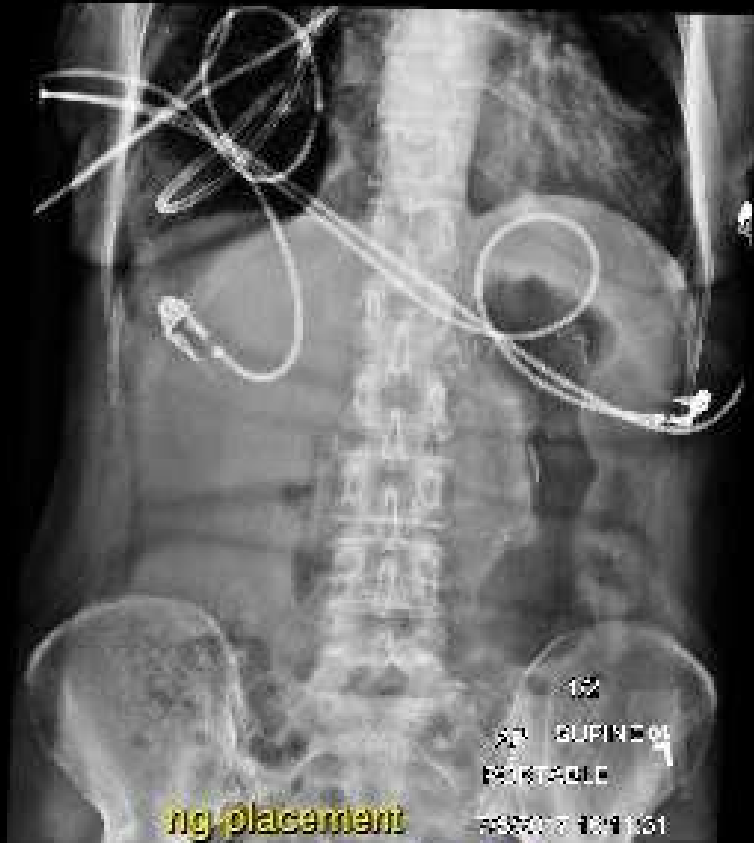
Stdy Tm: 10:00:25

1-3-00  
SemiF  
AP 40"  
0602  
3.270  
DDF

Keofed Tube  
Right Lung

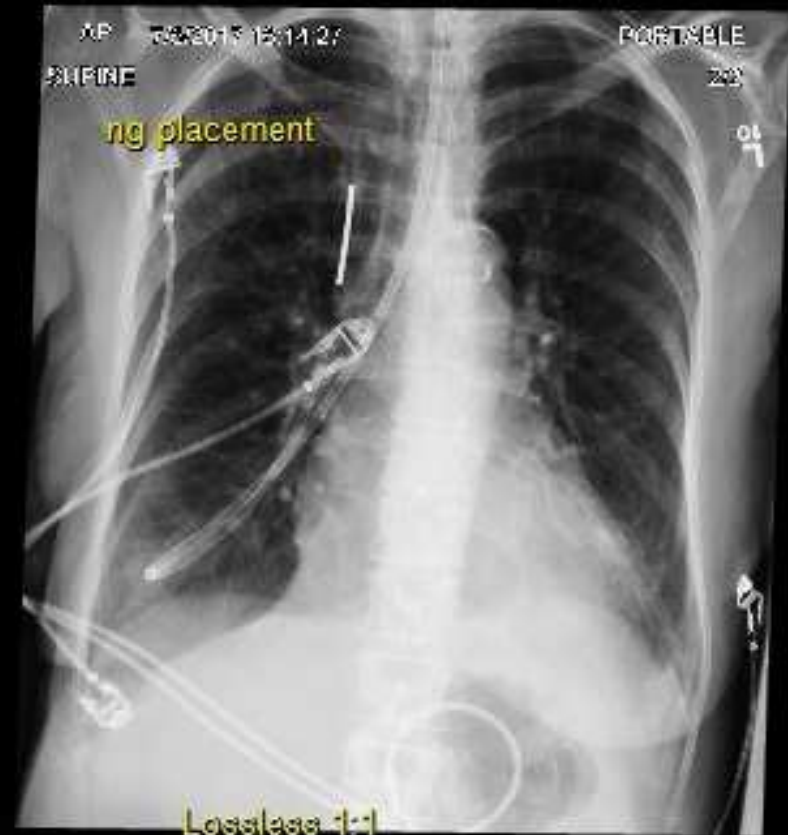
Id:DCM / Lin:DCM / Id:ID

W:3064 L:2580



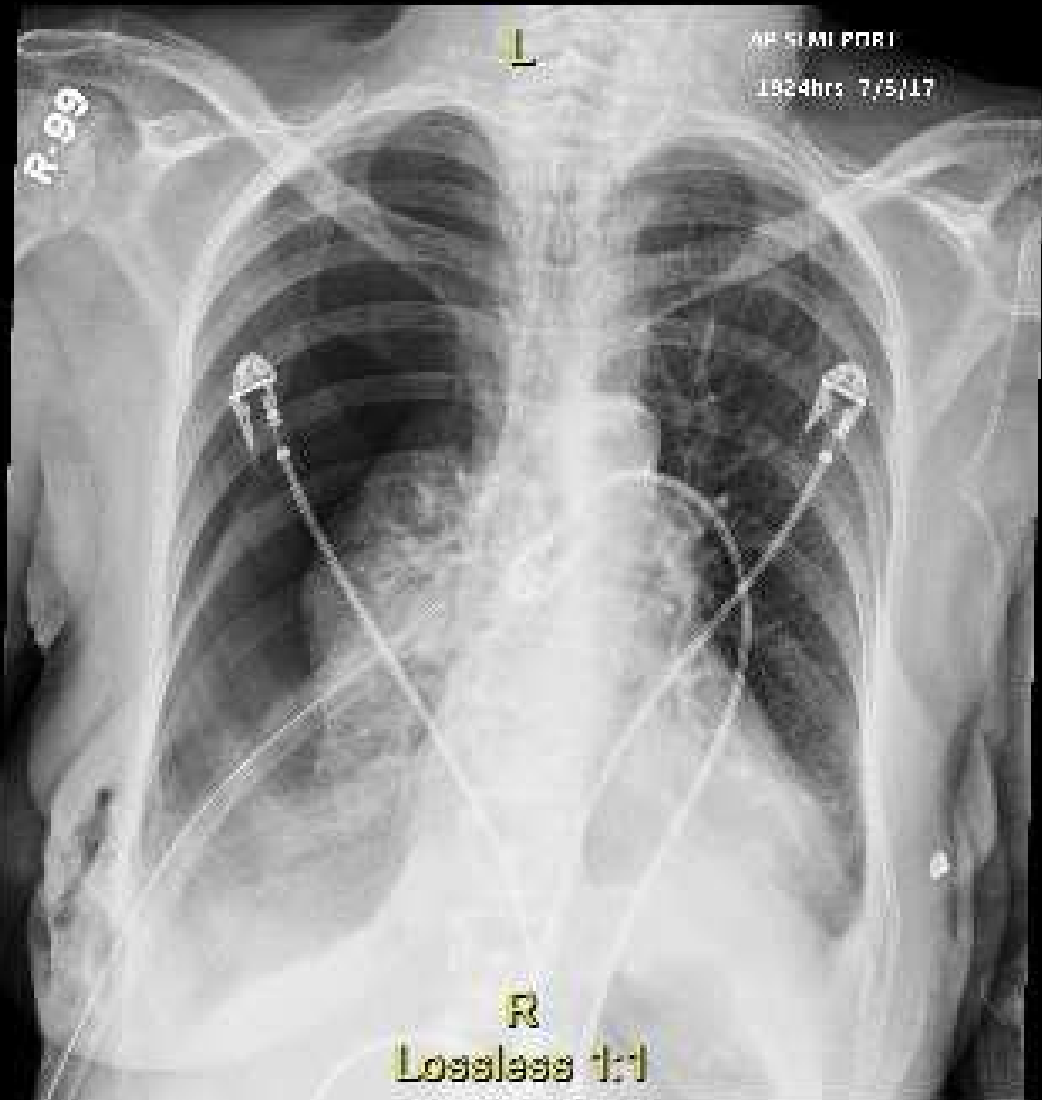
Lossless 1:1

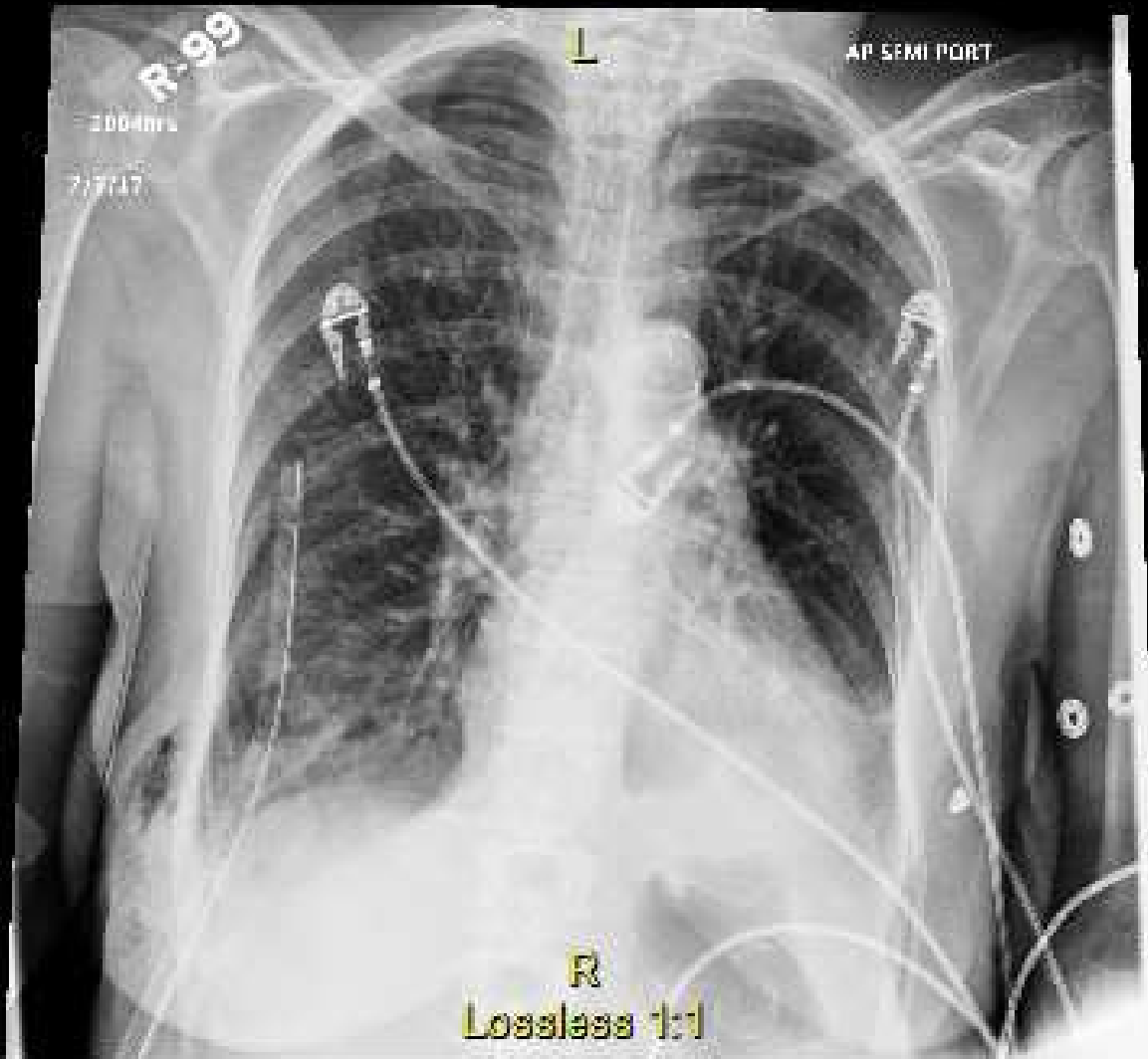
KUB after NG inserted



CXR NG

CXR  
2 hours later

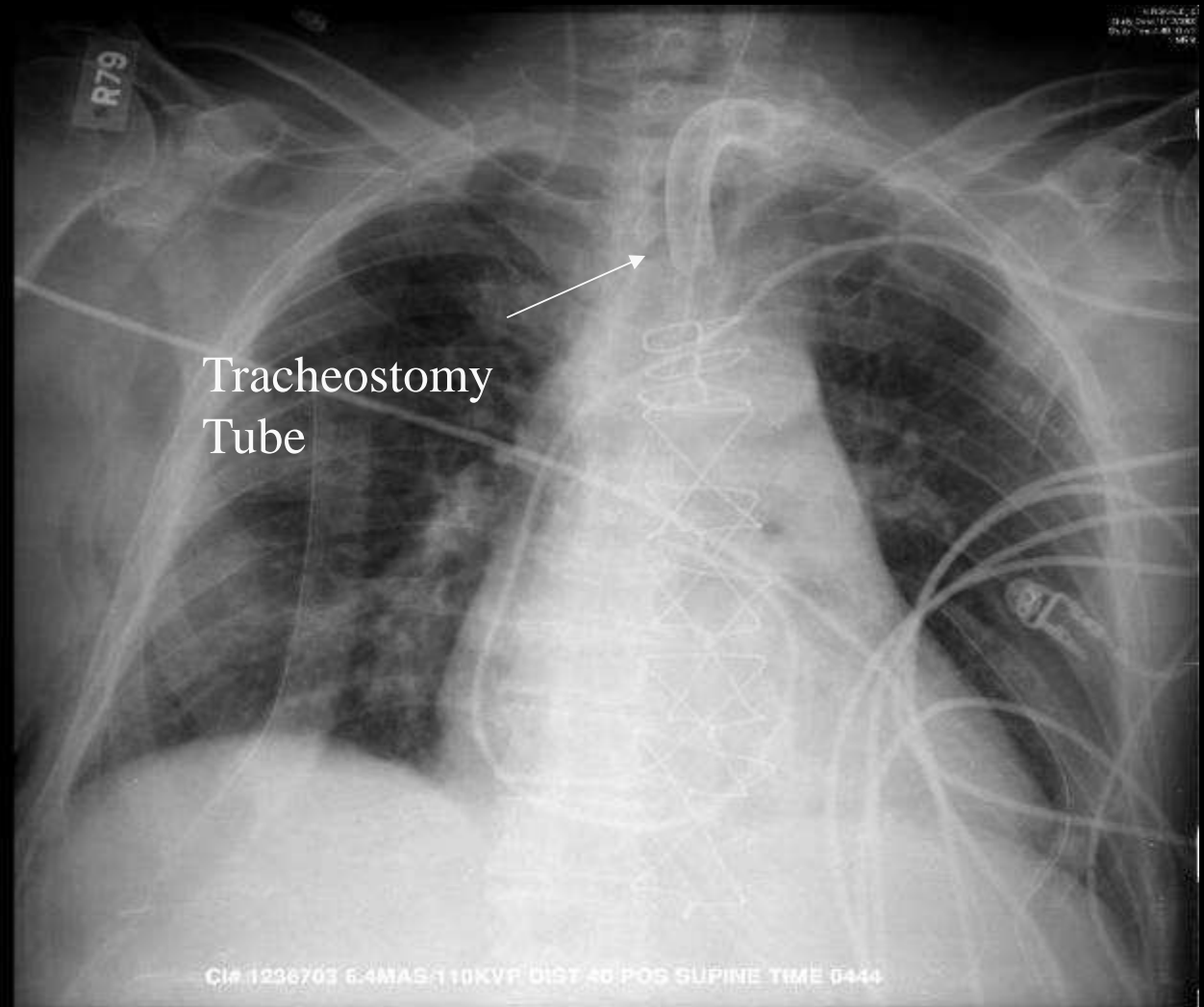




CXR after CT inserted



## Tracheostomy tubes: Check Position

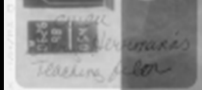


309IMCRAD086

Ex: 000005

Se: 171

Im: 4/14



*DDF  
6/26/98  
AP Erect  
40"  
2095*

CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

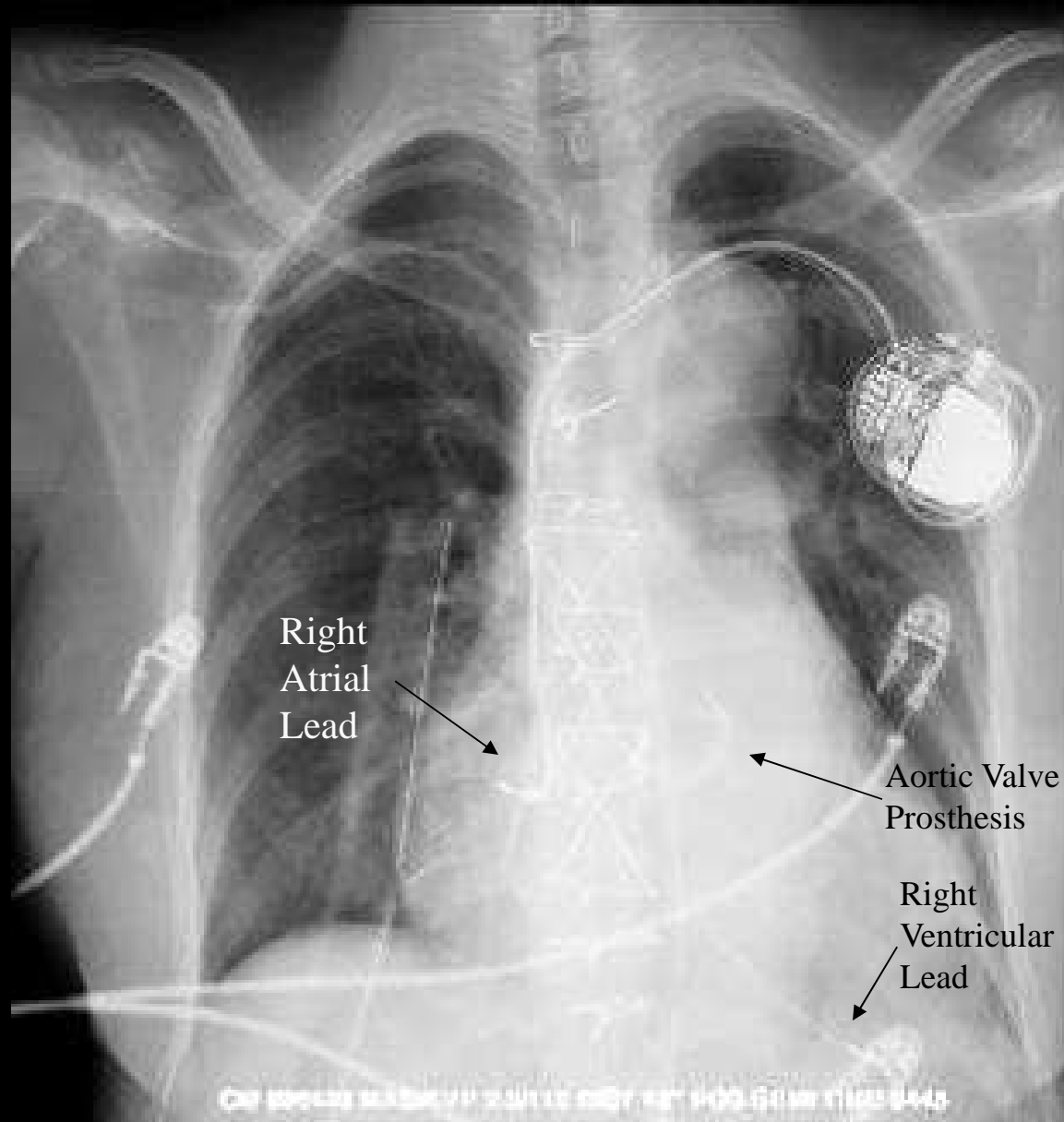
StdY Tm: 07:50:09

Id:DCM / Lin:DCM / Id:ID

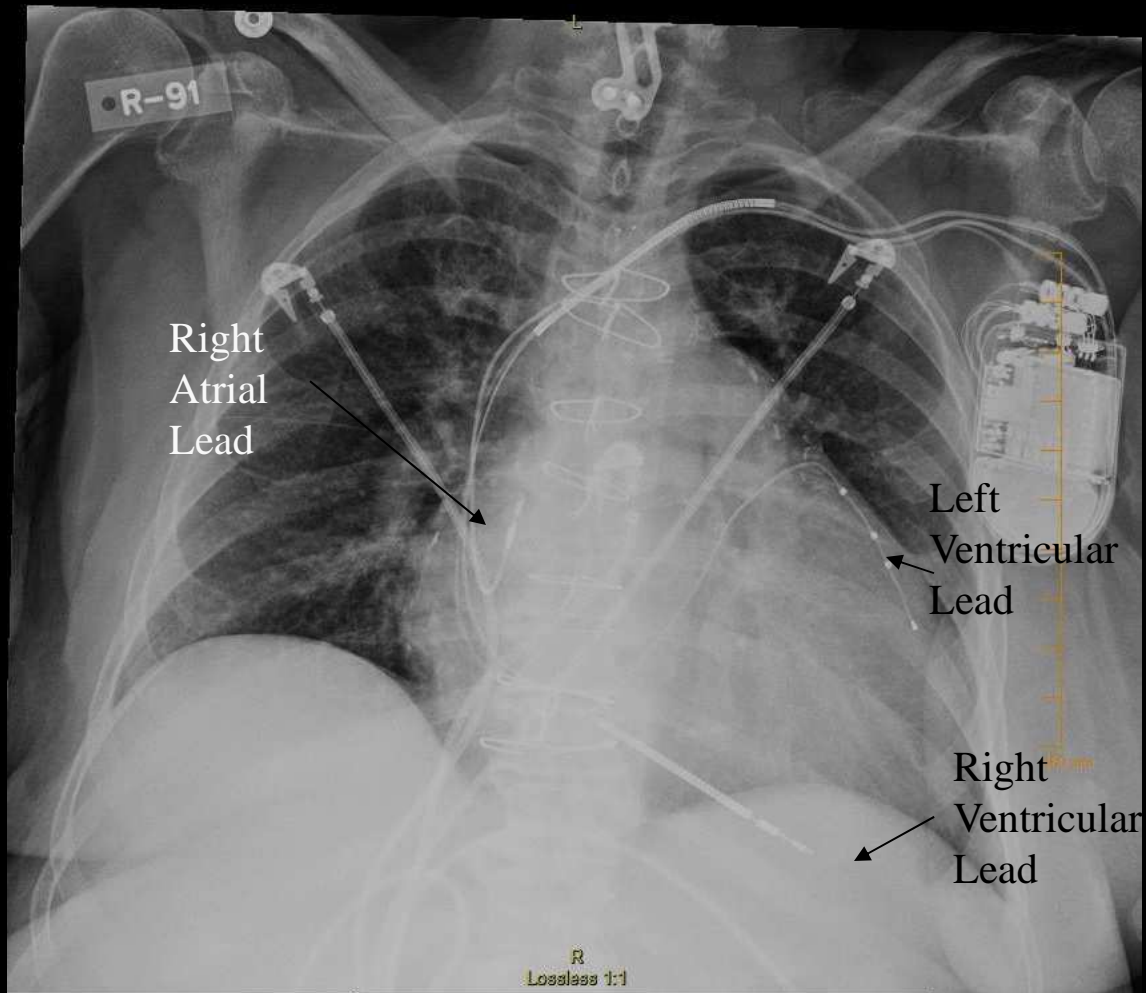
W:3395 L:2361

Right  
Atrial Lead

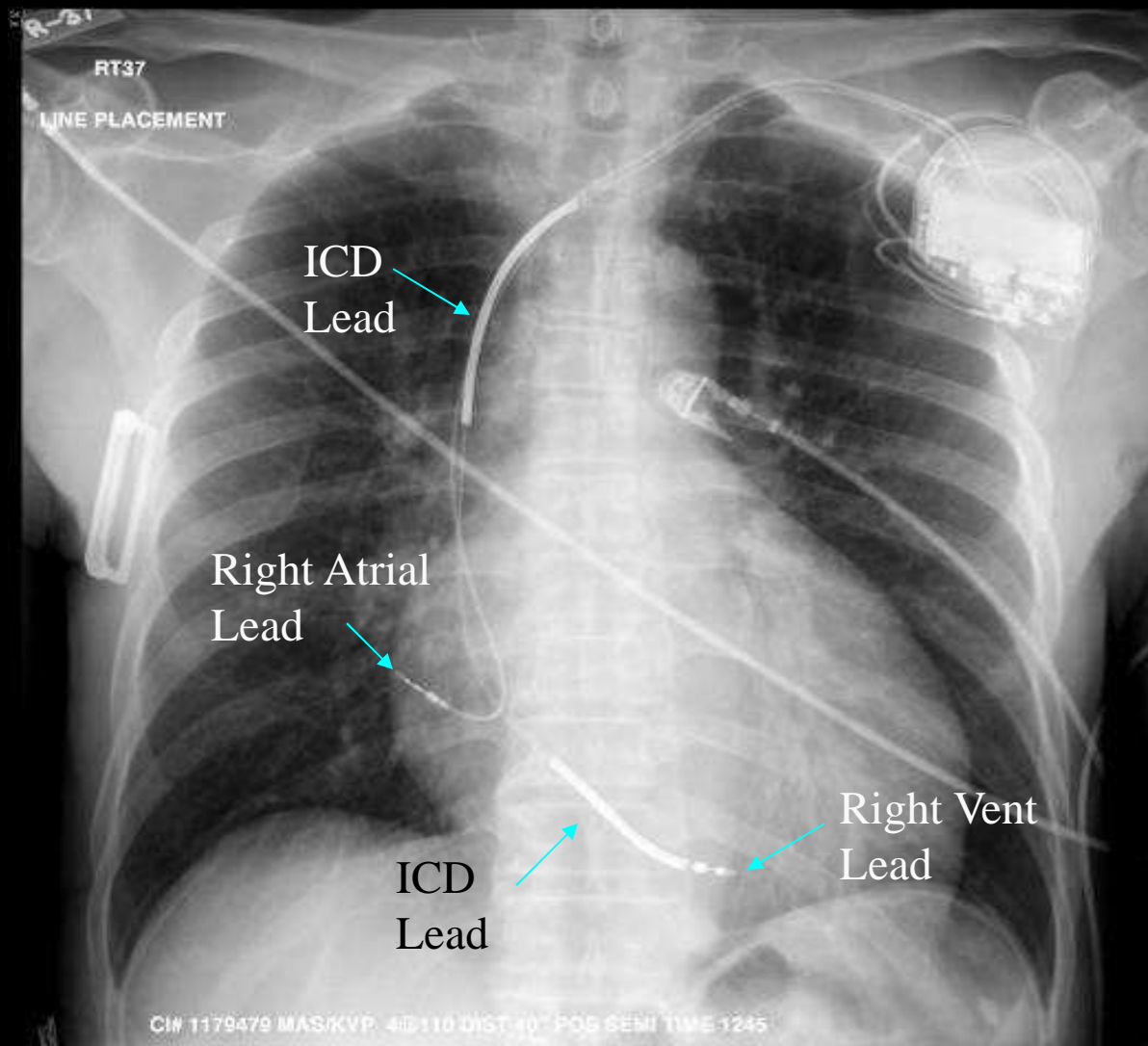
Right  
Ventricular  
Lead



# Biventricular Pacemaker



# DDD pacer and ICD



04-2008  
Page 2

WACHSLEB, J.  
Study Date: 05/05/09  
Study Time: 7:21:00 PM  
14941

L

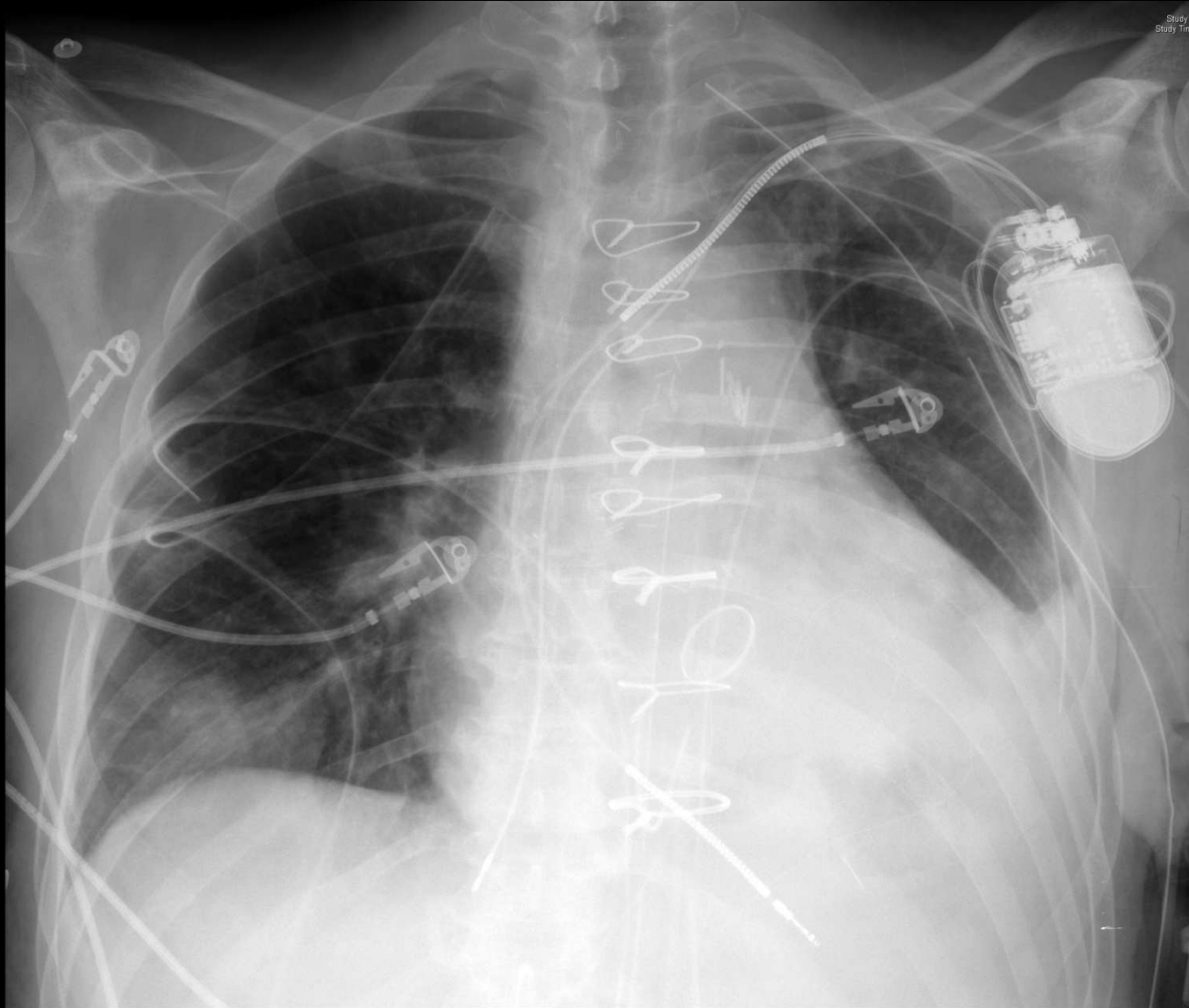
LT22



# CXR post DDD placement

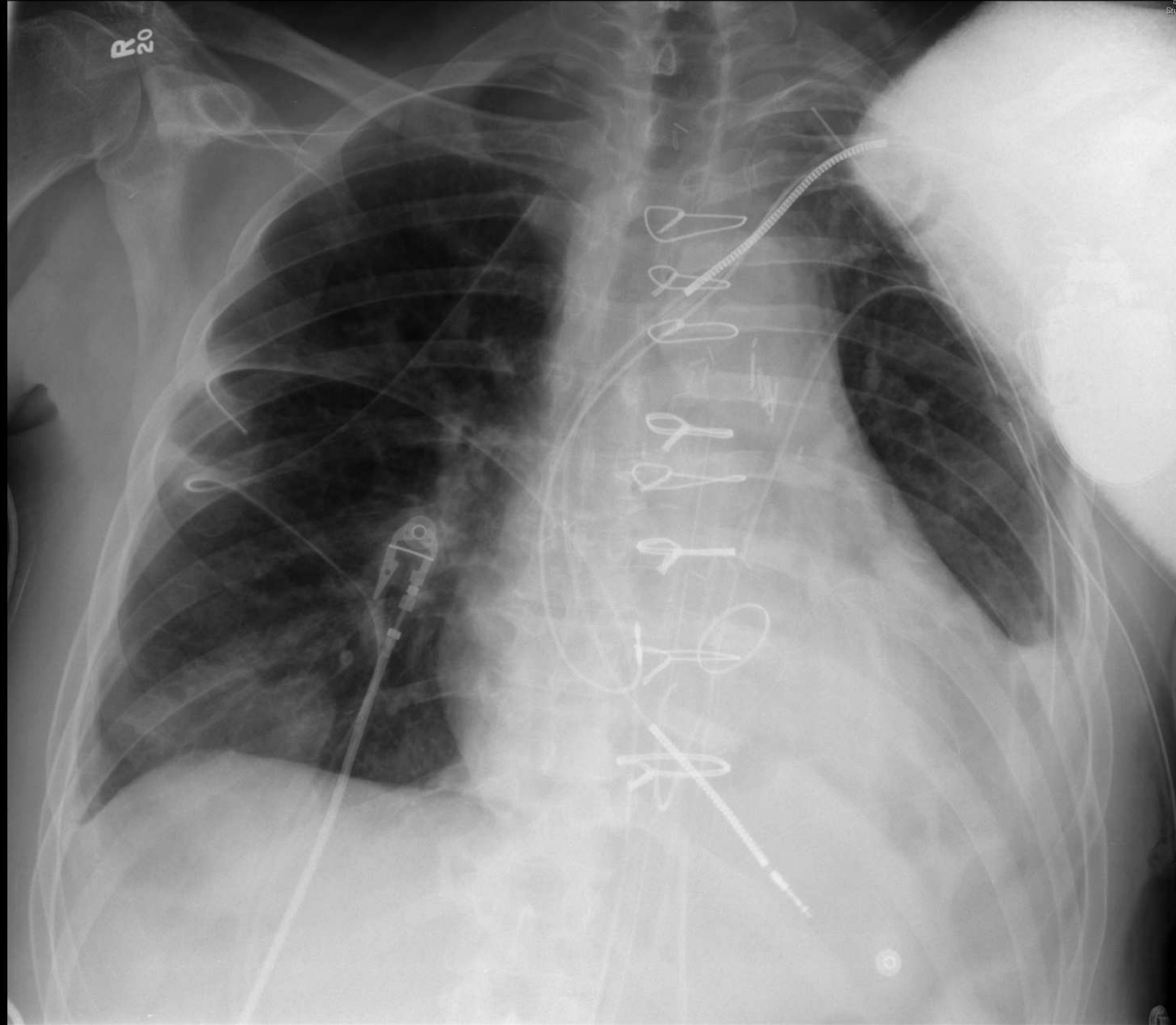
Se 1  
Im 1

C: MICHAEL, A  
Study Date: 4/20/2011  
Study Time: 11:04:37 AM  
MRN



# Same patient after atrial lead repositioned

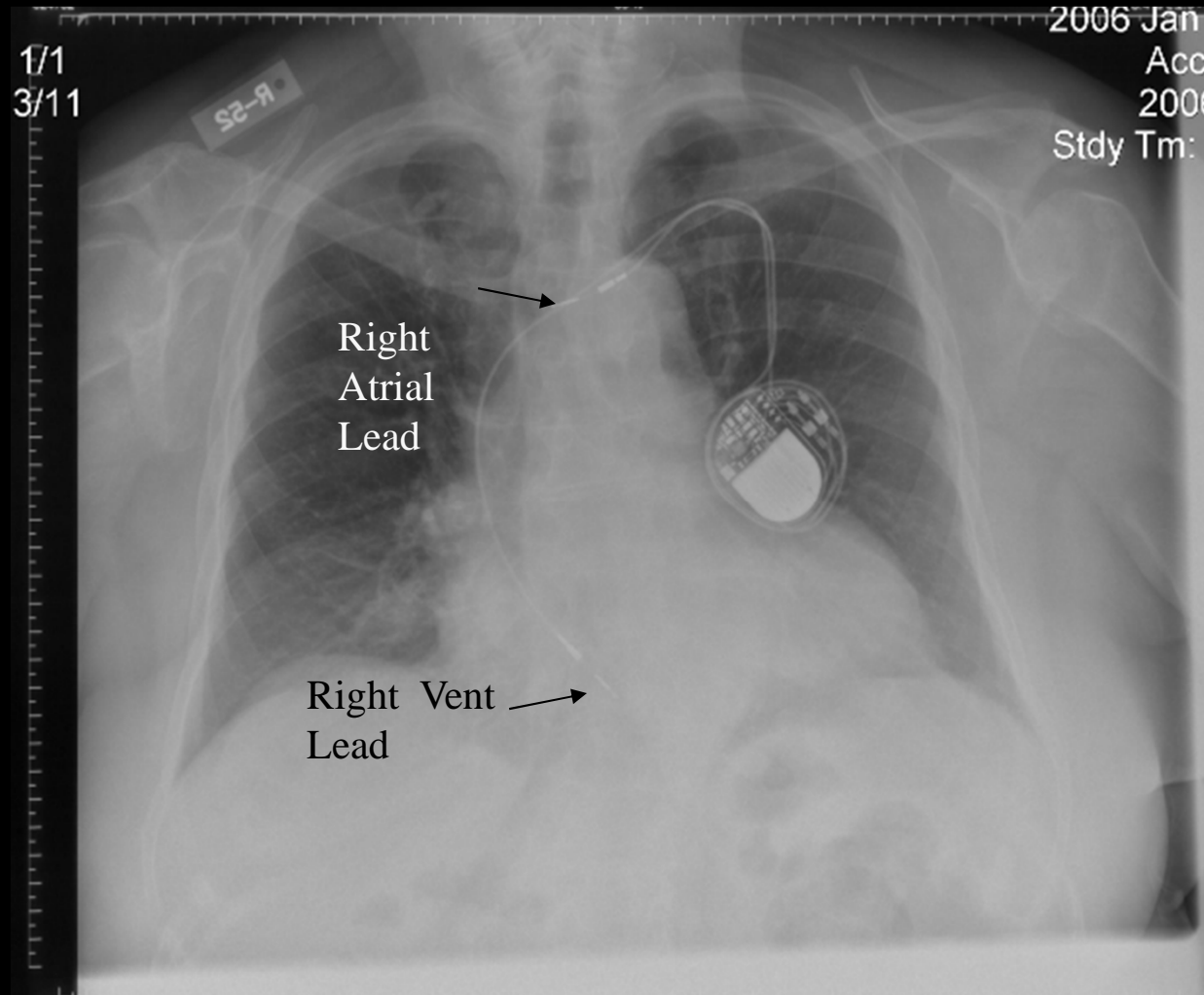
Sr 1  
Im 1



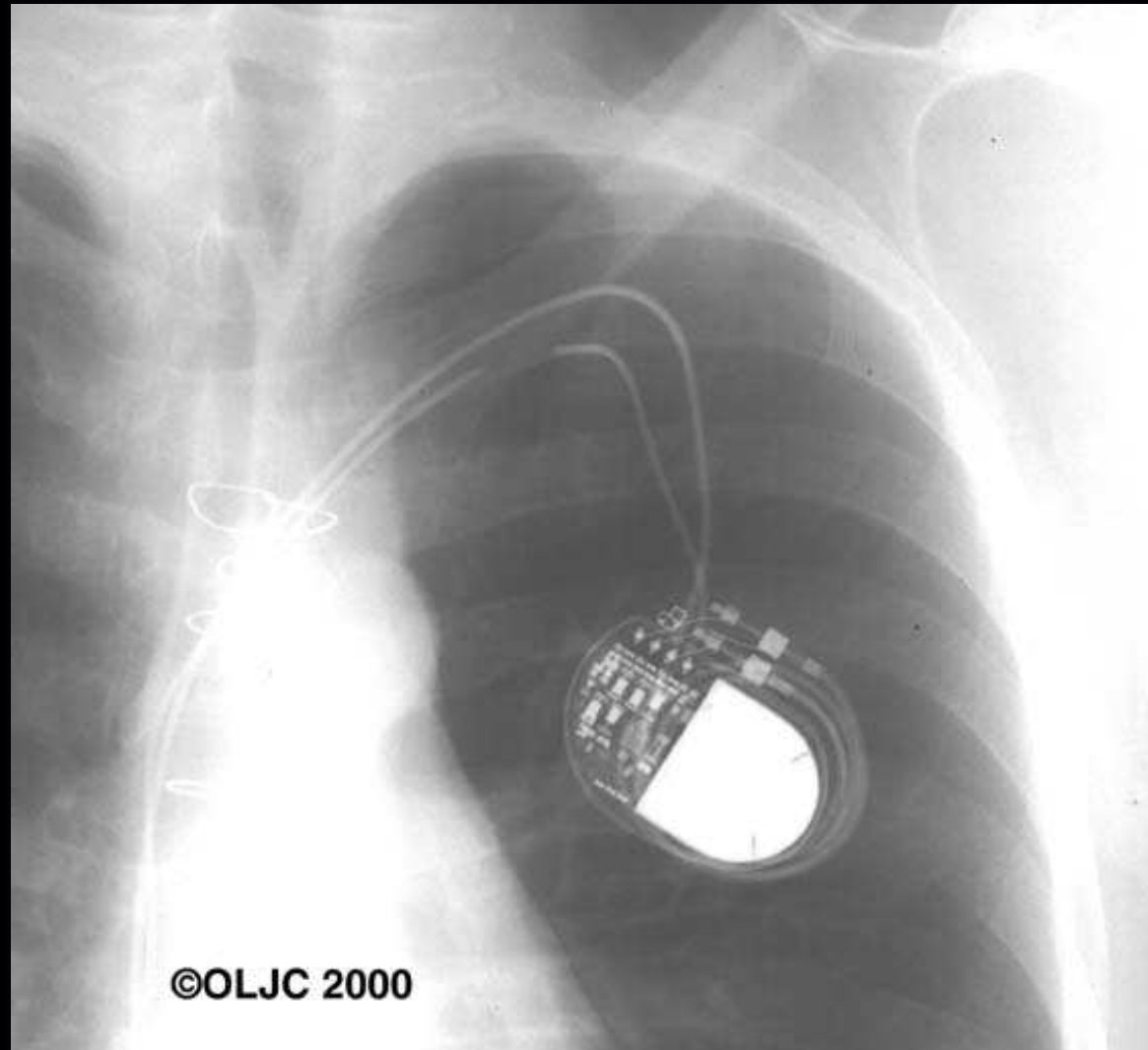
C MICHAEL, A  
Study Date: 4/21/2011  
Study Time: 8:29:48 AM  
MRN:



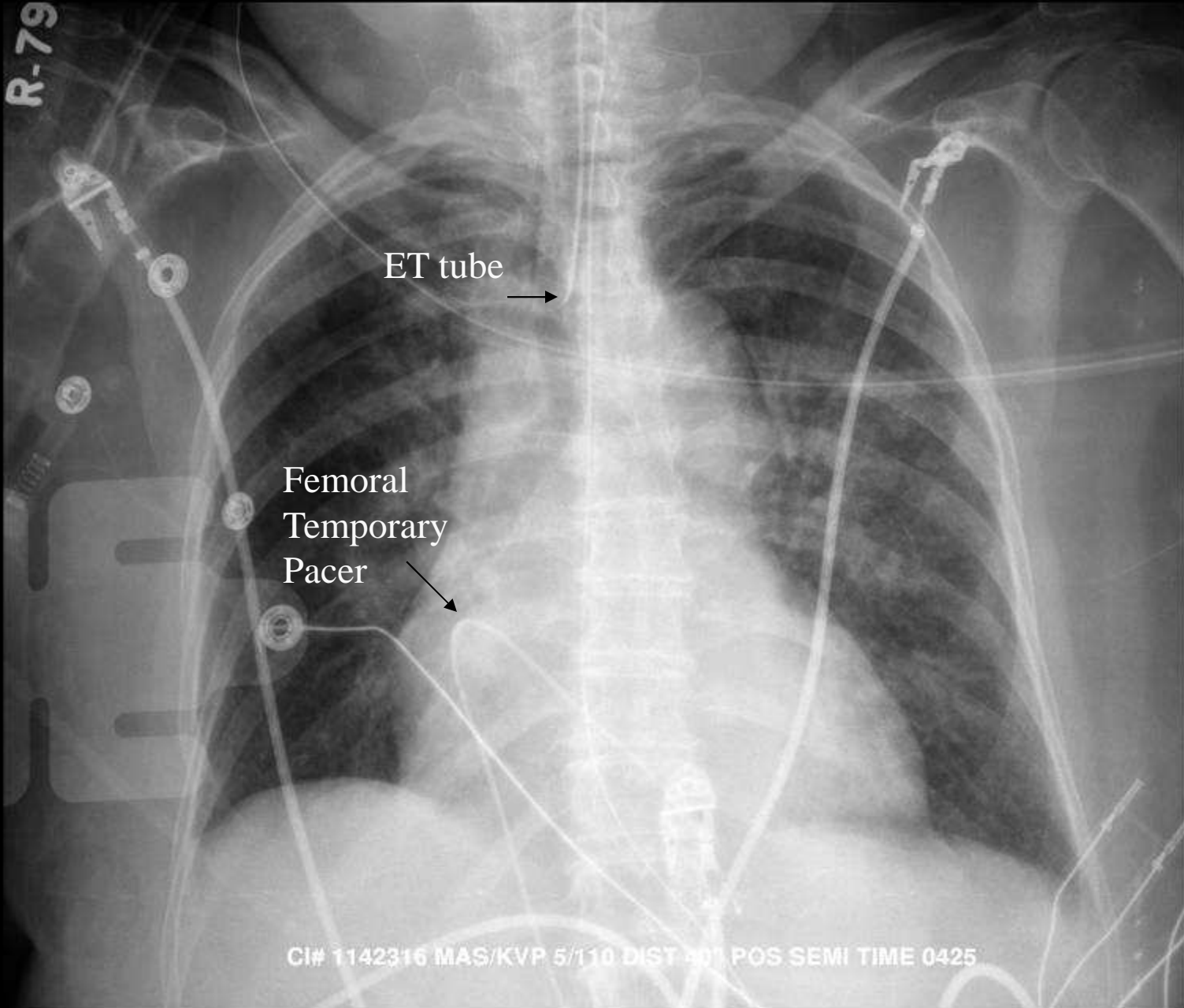
# Patient c/o syncope



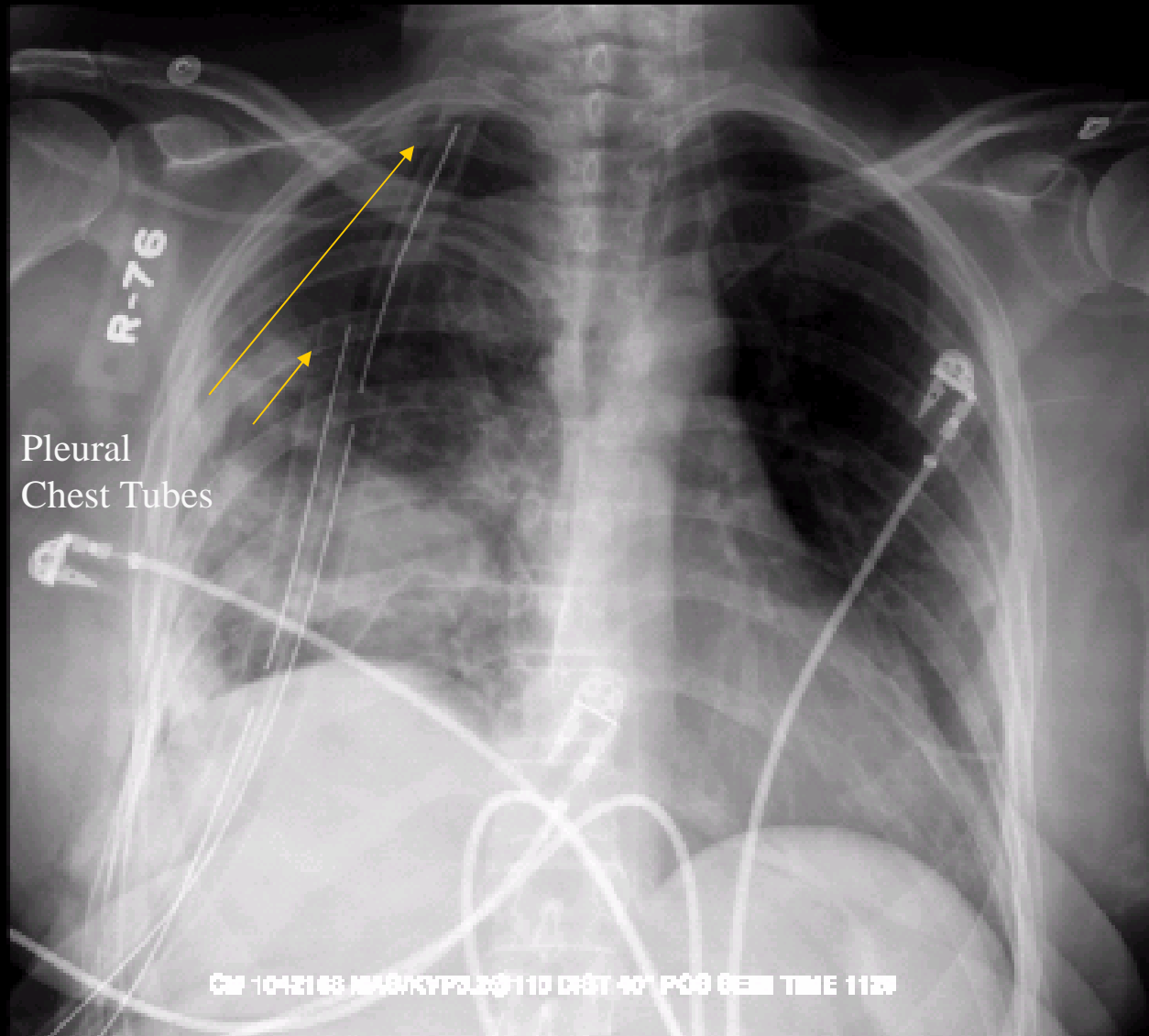
# Lead Fracture

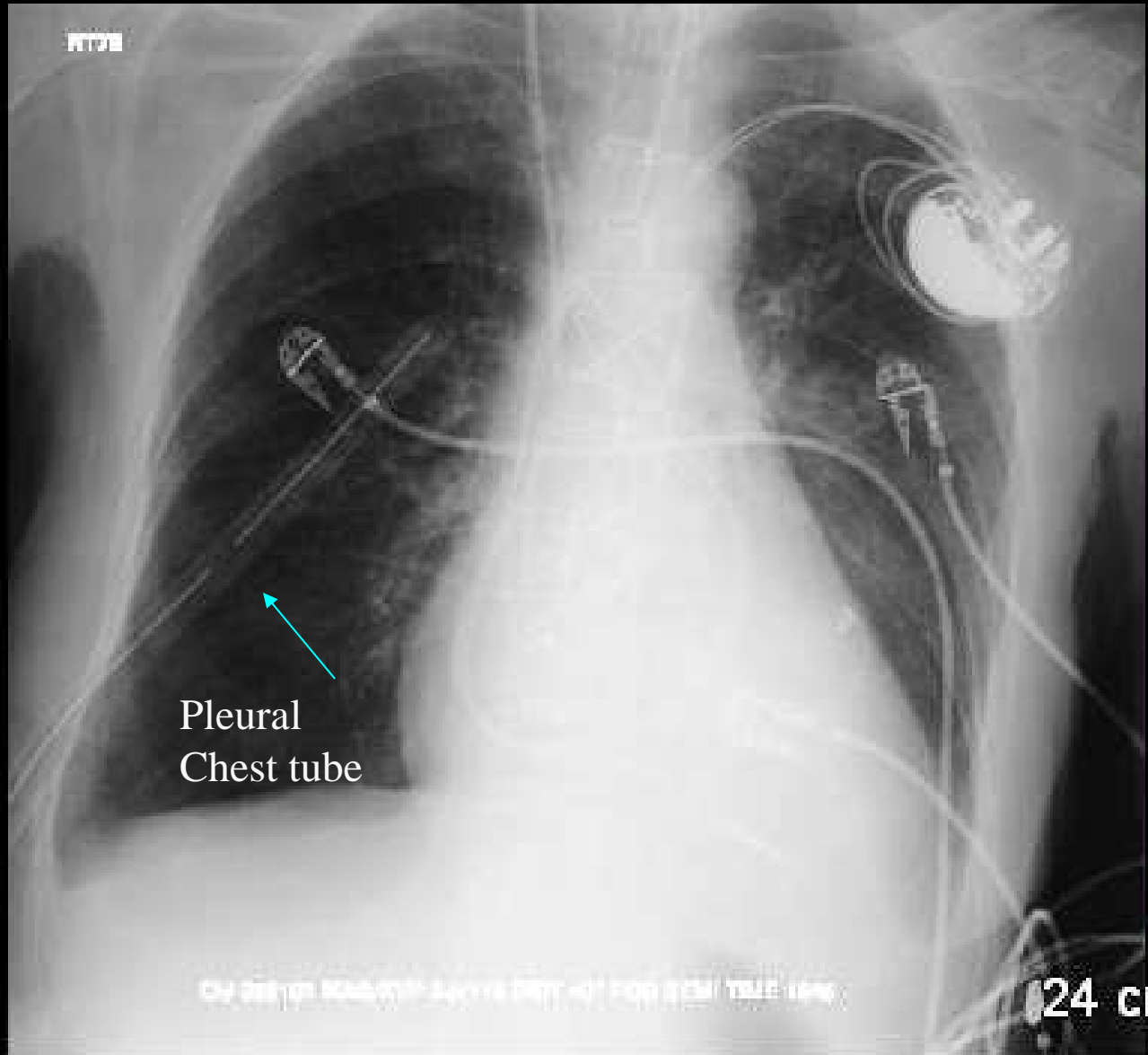


R-79



CI# 1142316 MAS/KVP 5/110 DIST 401 POS SEMI TIME 0425



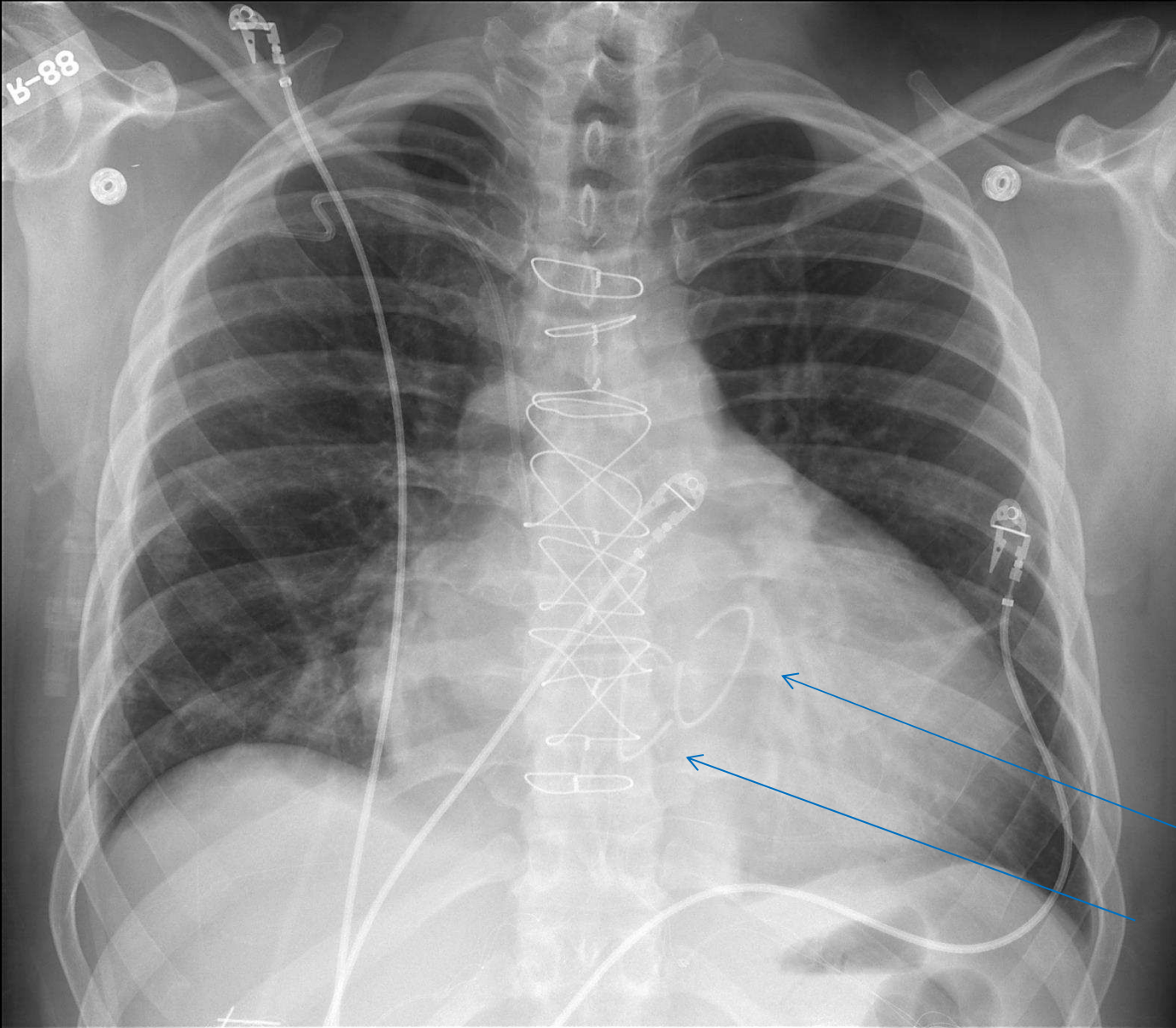


RTD

Pleural  
Chest tube

24 cm

Se:1  
Im:1



Mitral and  
Tricuspid  
Valve  
repair  
rings

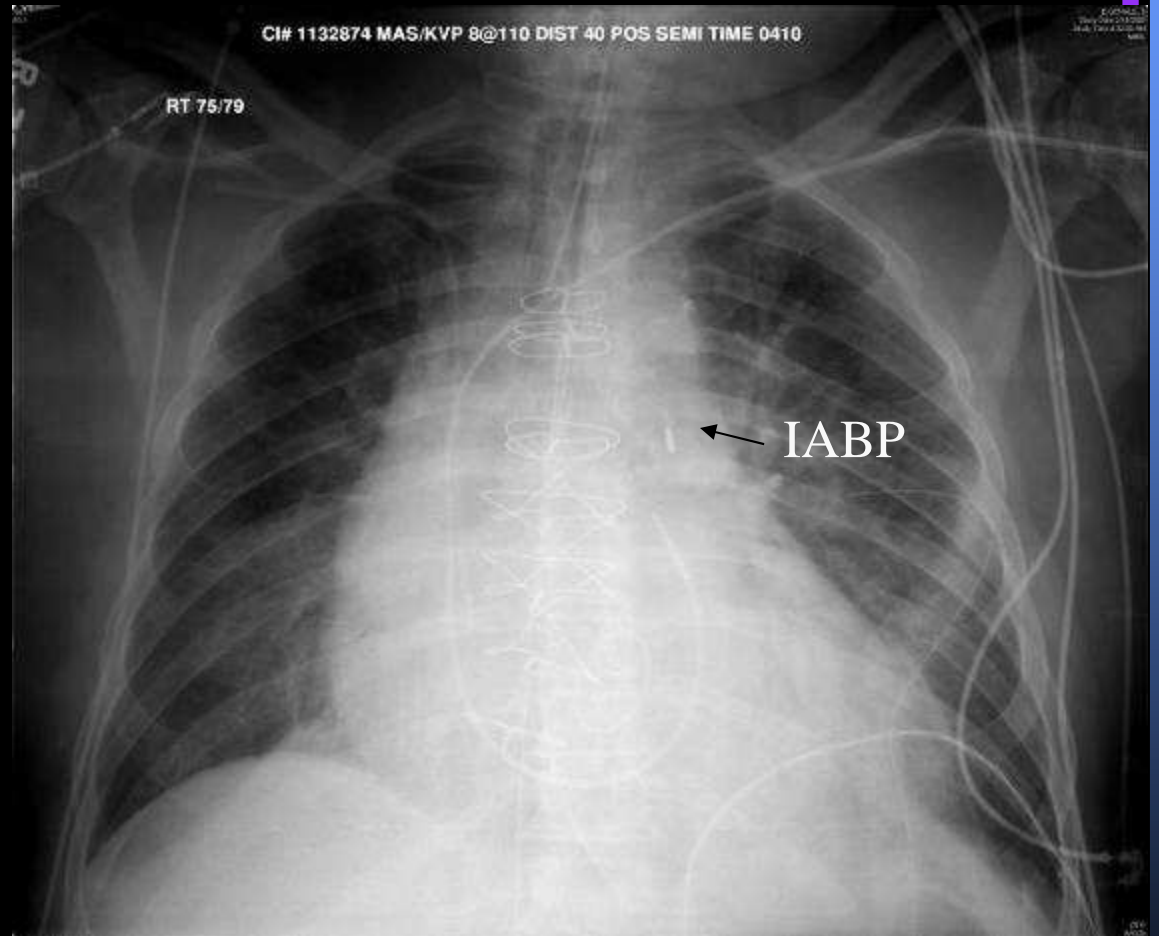
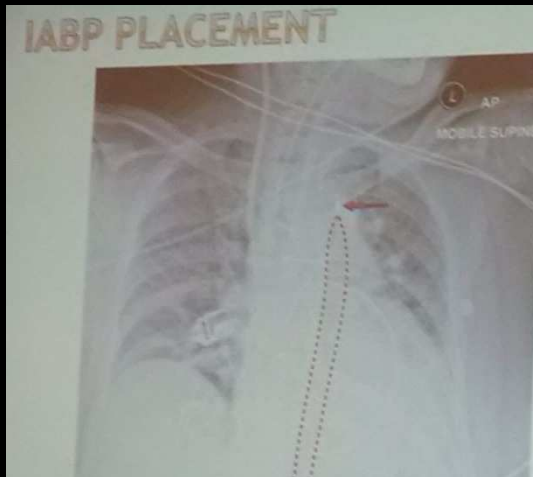
Lateral view of same patient with mitral and tricuspid valve ring repair



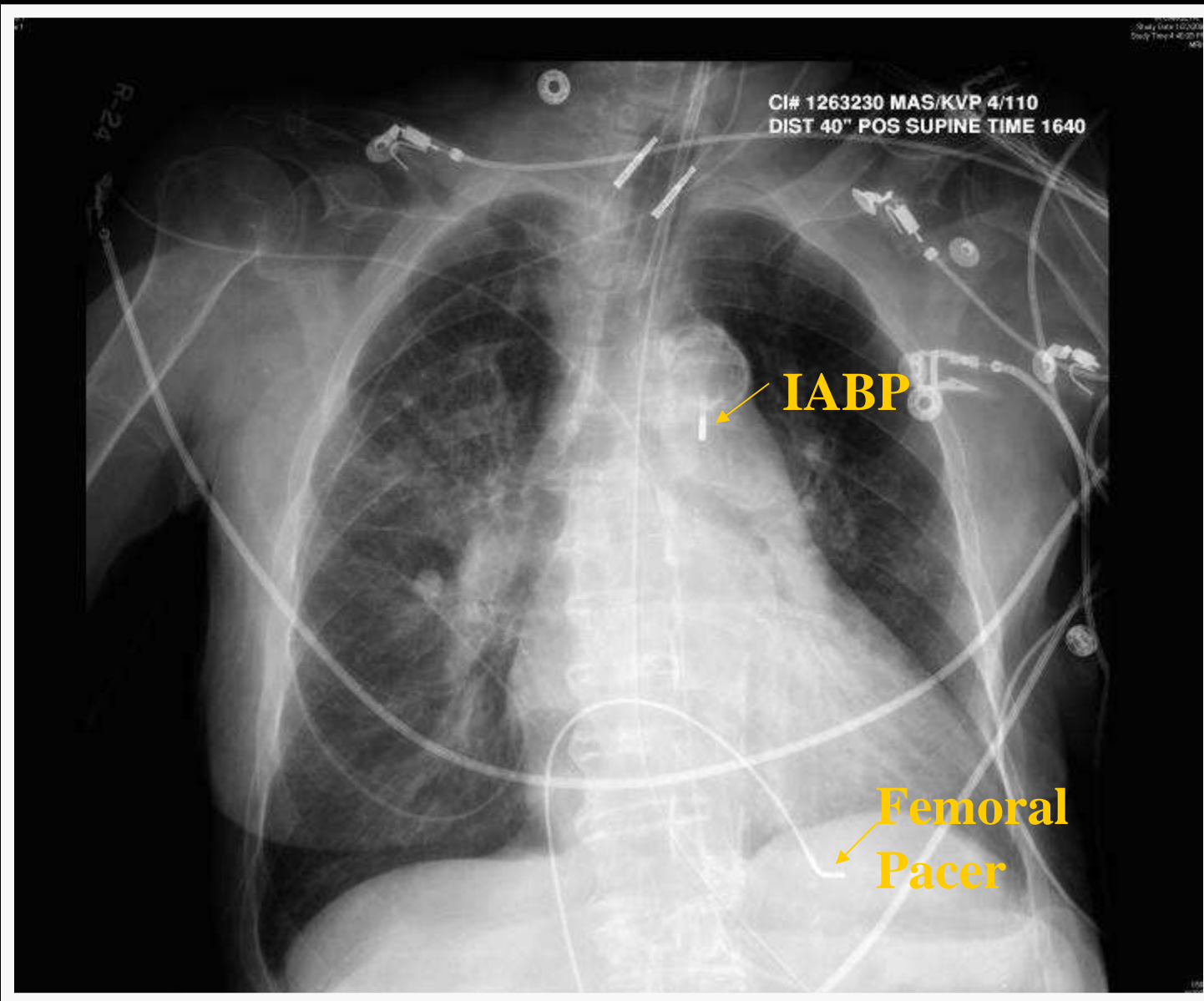
# IABP

## Intra-aortic balloon pump

- Tip should lie distal to the origin of the left subclavian artery



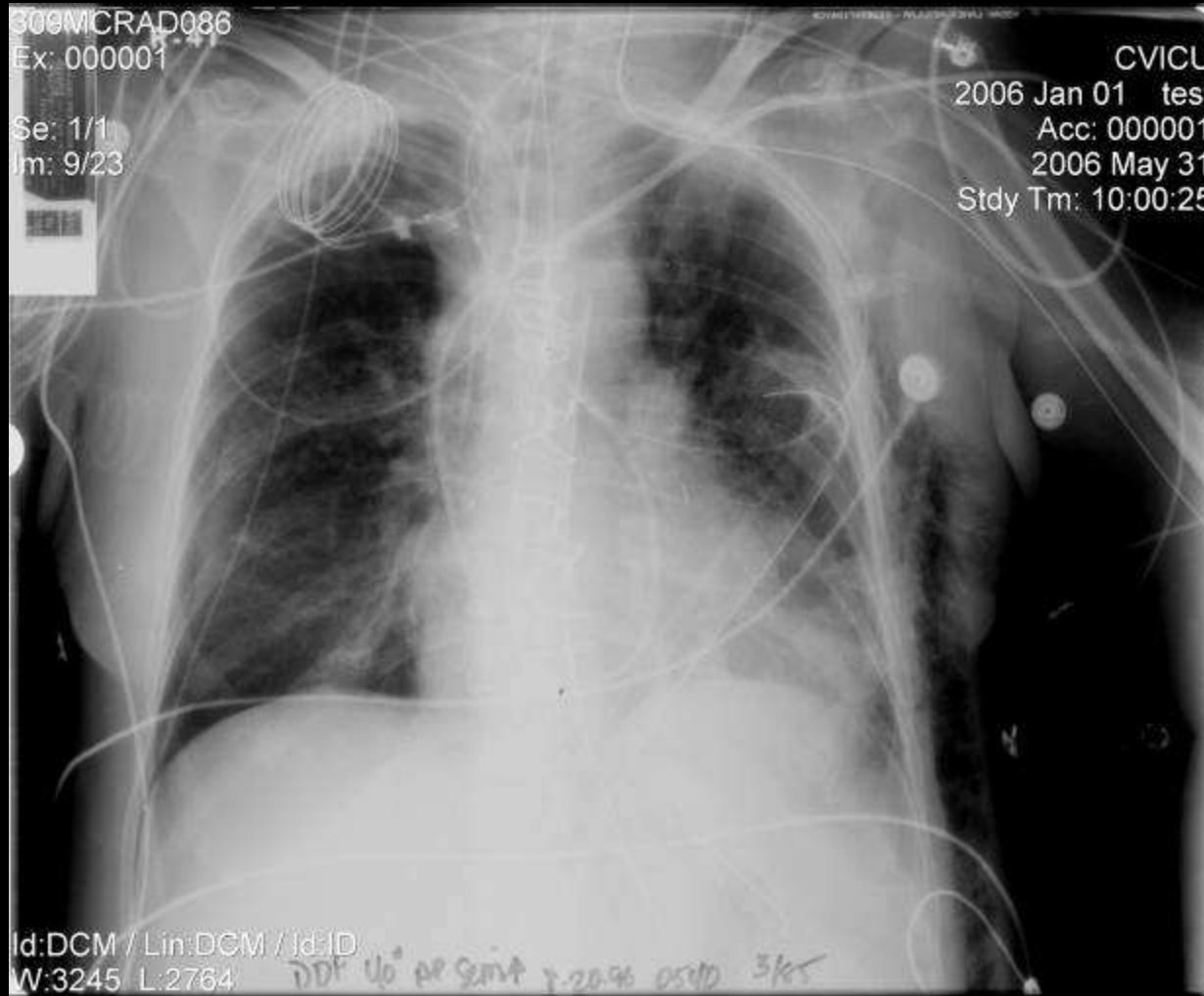




# IABP Inflated

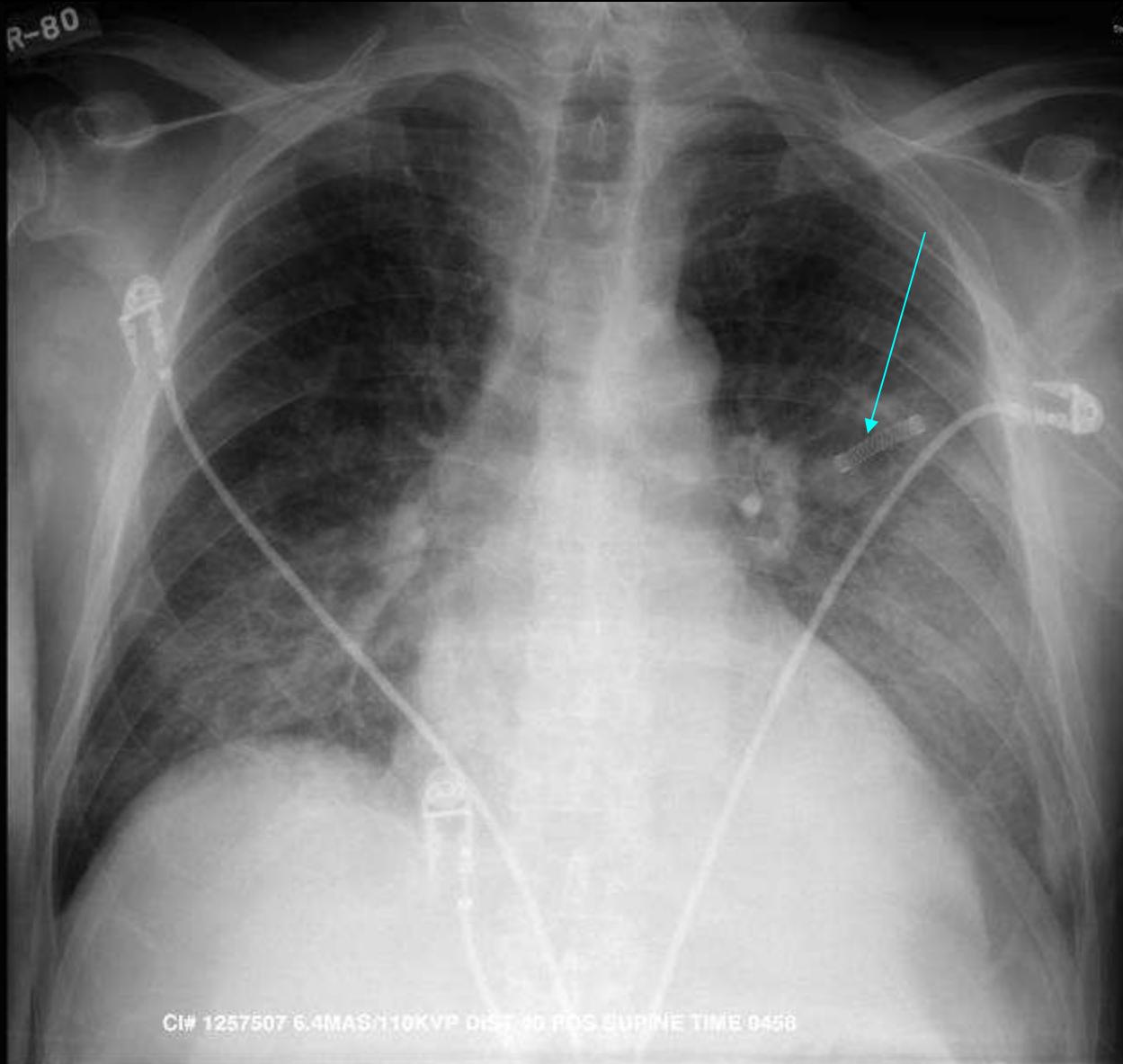


# ICU RN responsibility to clear lines off chest



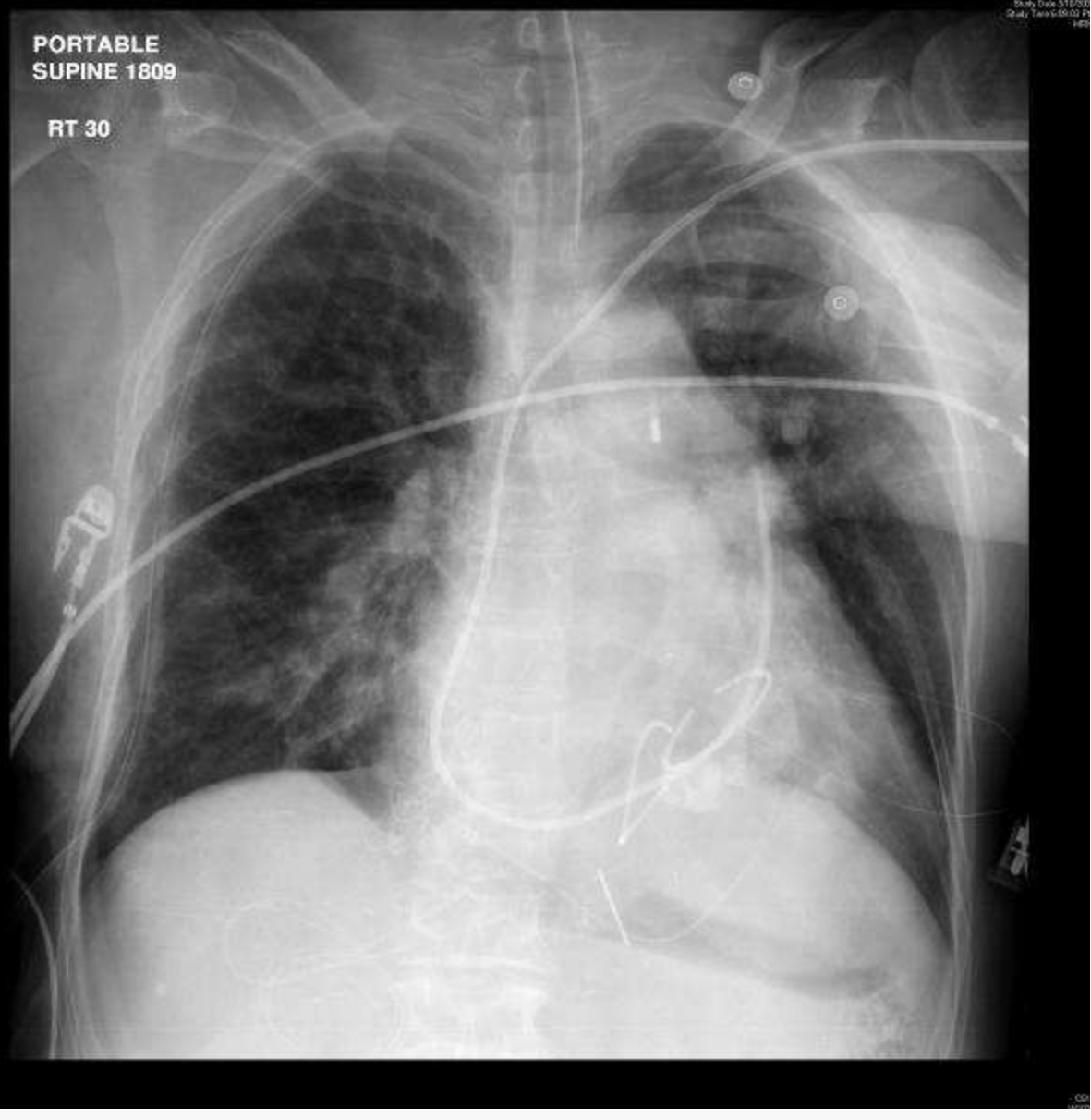
R-80

Distal  
Tubing



- Spring from nebulizer

CI# 1257507 6.4MAS/110KVP DIST 40 POS SUPINE TIME 0458



Hand on chest

# Clinical Findings

# As Easy As White







## Clinical Findings that show up *White*

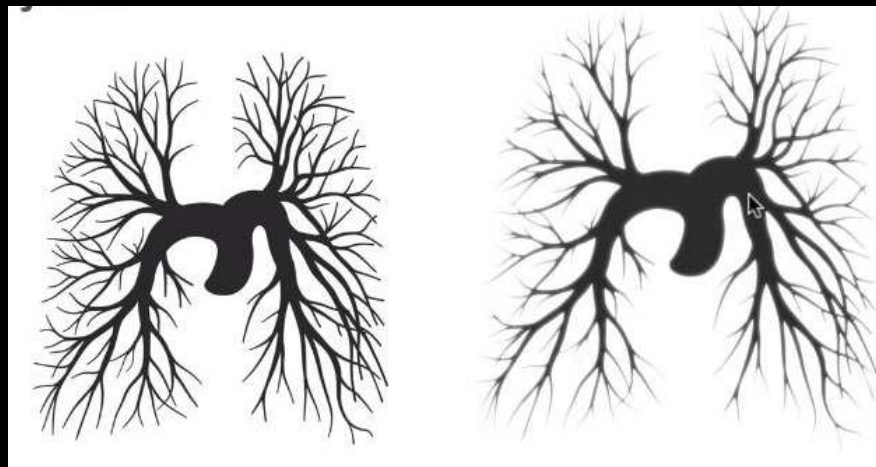
- Pulmonary Edema
- Pneumonia
- Pleural Effusion
- Atelectasis
- Tumors
- ARDS

# Pulmonary Edema

- Fluid in the pulmonary vasculature
- Will appear white on CXR
- Butterfly or batwing pattern
- Kerley B lines: thin linear pulmonary opacities caused for fluid or cellular infiltration into the interstitium of the lungs
- Treatment:
  - Diuretics

# Hazy Hila

Pulmonary Edema



Normal

Hazy



309MCRAD086

EX: 000002 54

Se: 1/1  
Im: 1/14

STATE  
DATE  
EYES  
EARS  
NIP  
LIP  
E NO  
EYES  
EARS  
NIP  
LIP

CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

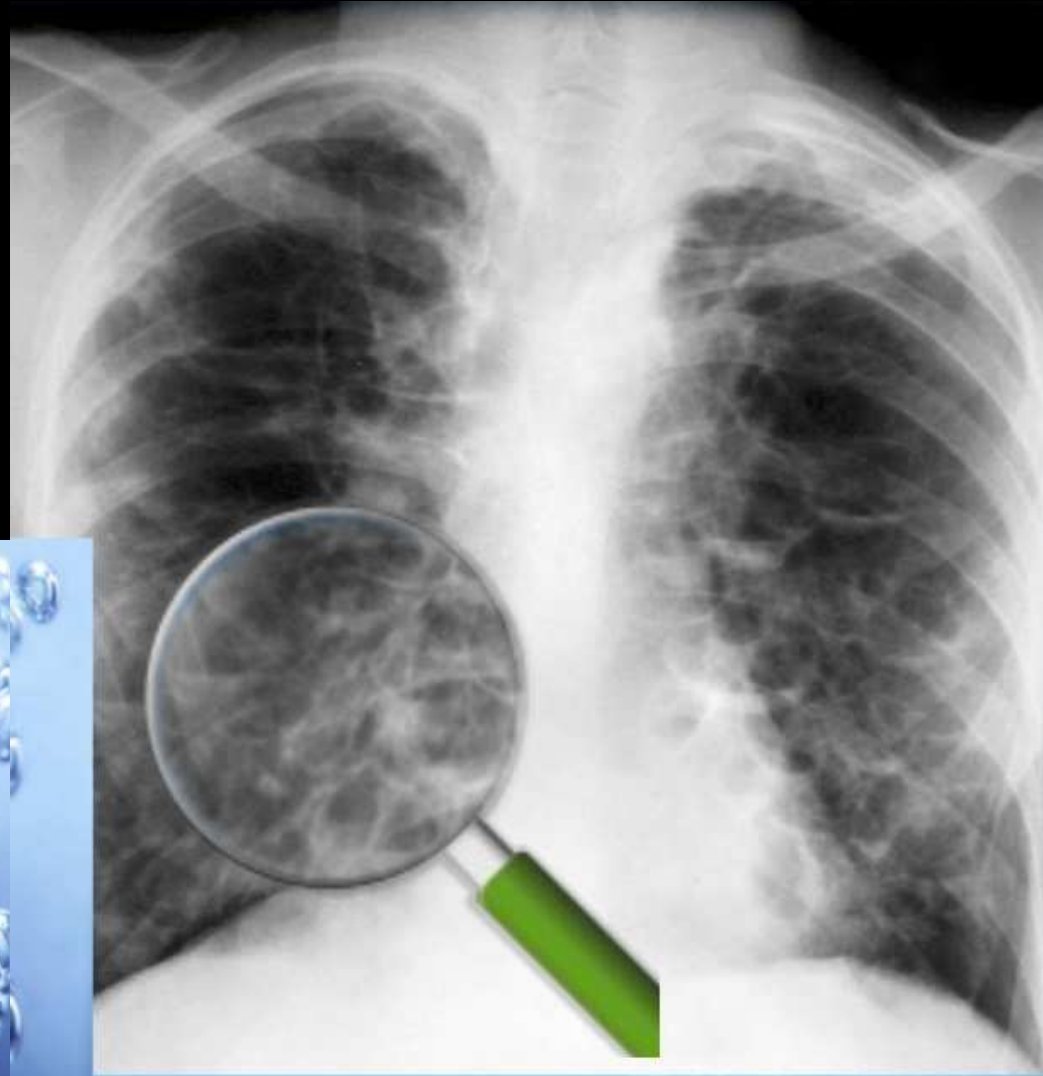
Stdy Tm: 06:44:30

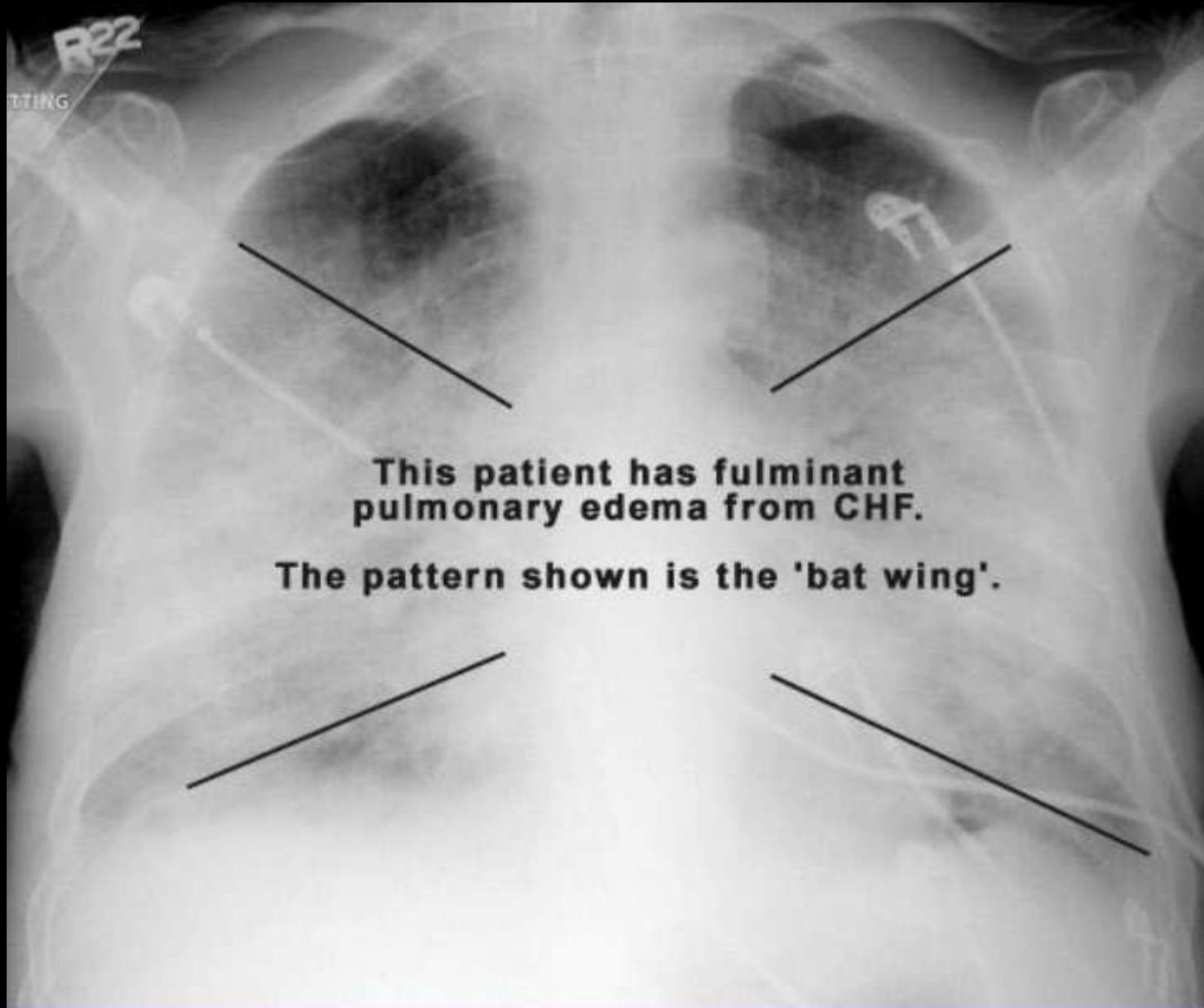
Id:DCM / Lin:DCM / Id:ID  
W:2411 L:2670

D35/MAS/001/Sun 1/19/05 0210

3

# Pulmonary Edema





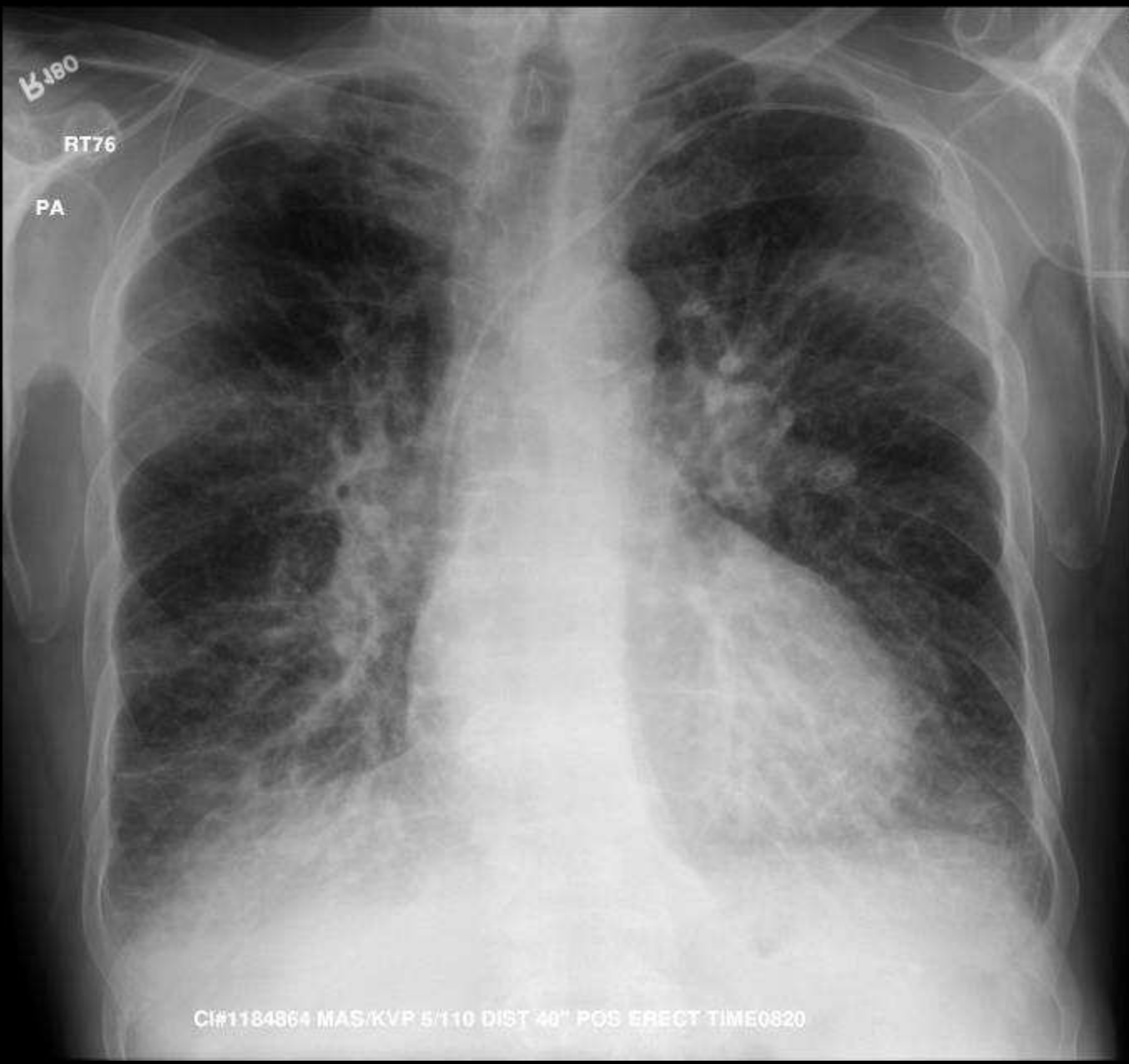
**This patient has fulminant  
pulmonary edema from CHF.  
The pattern shown is the 'bat wing'.**

# Butterfly or batwing pattern



2x1  
10.1

© ROBERT D  
Study Date: 00072008  
Study Time: 02:19 AM  
VPH



B 180

RT76

PA

CI#1184864 MAS/KVP 5/110 DIST 40" POS ERECT TIME0820

CR11  
RT024



309MCRAD086

Ex: 0000020

Se: 1/1

Im: 2/14



130

CVICU

2006 Jan 01 test

Acc: 000001

2006 May 31

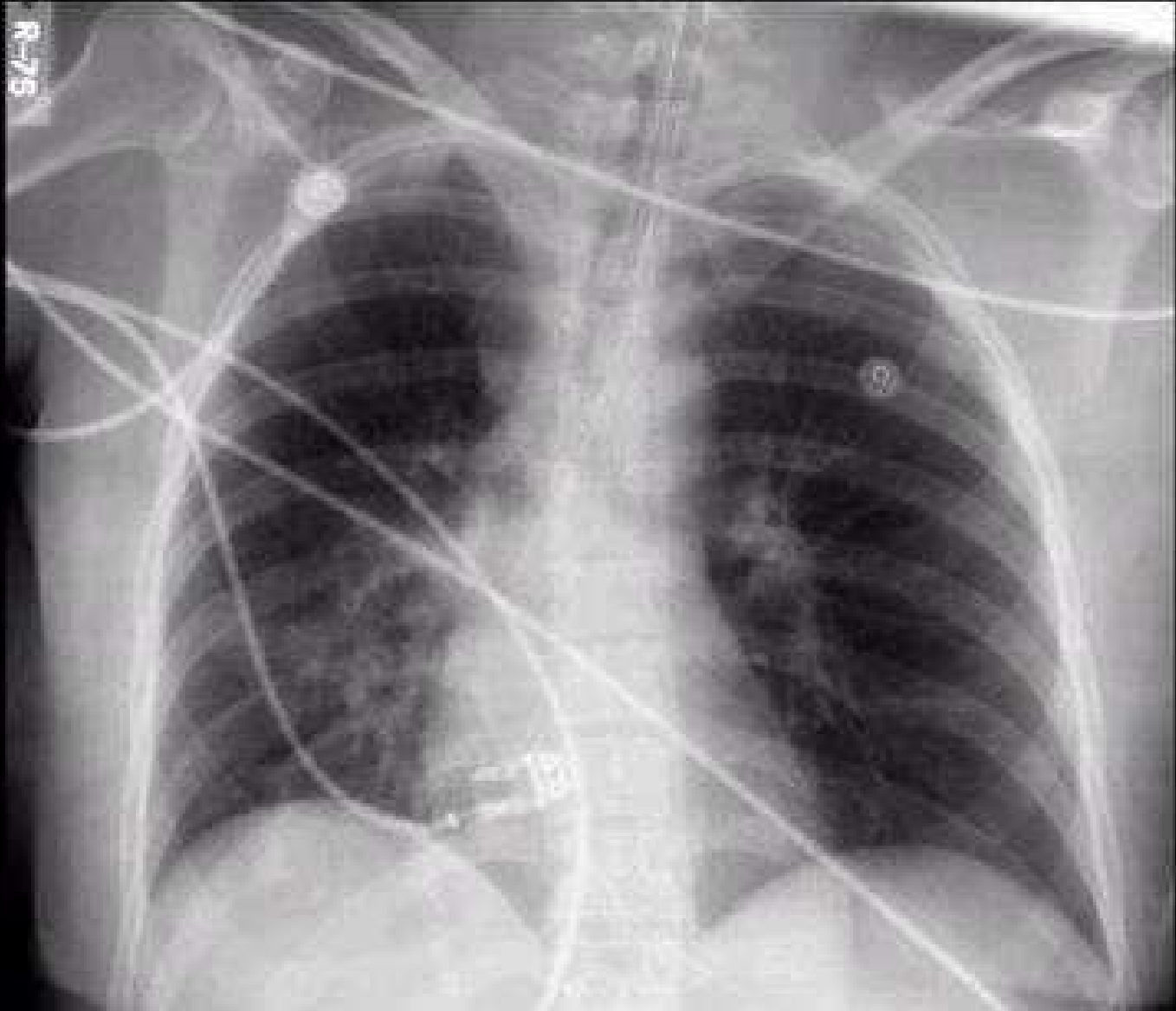
Stdy Tm: 06:44:30

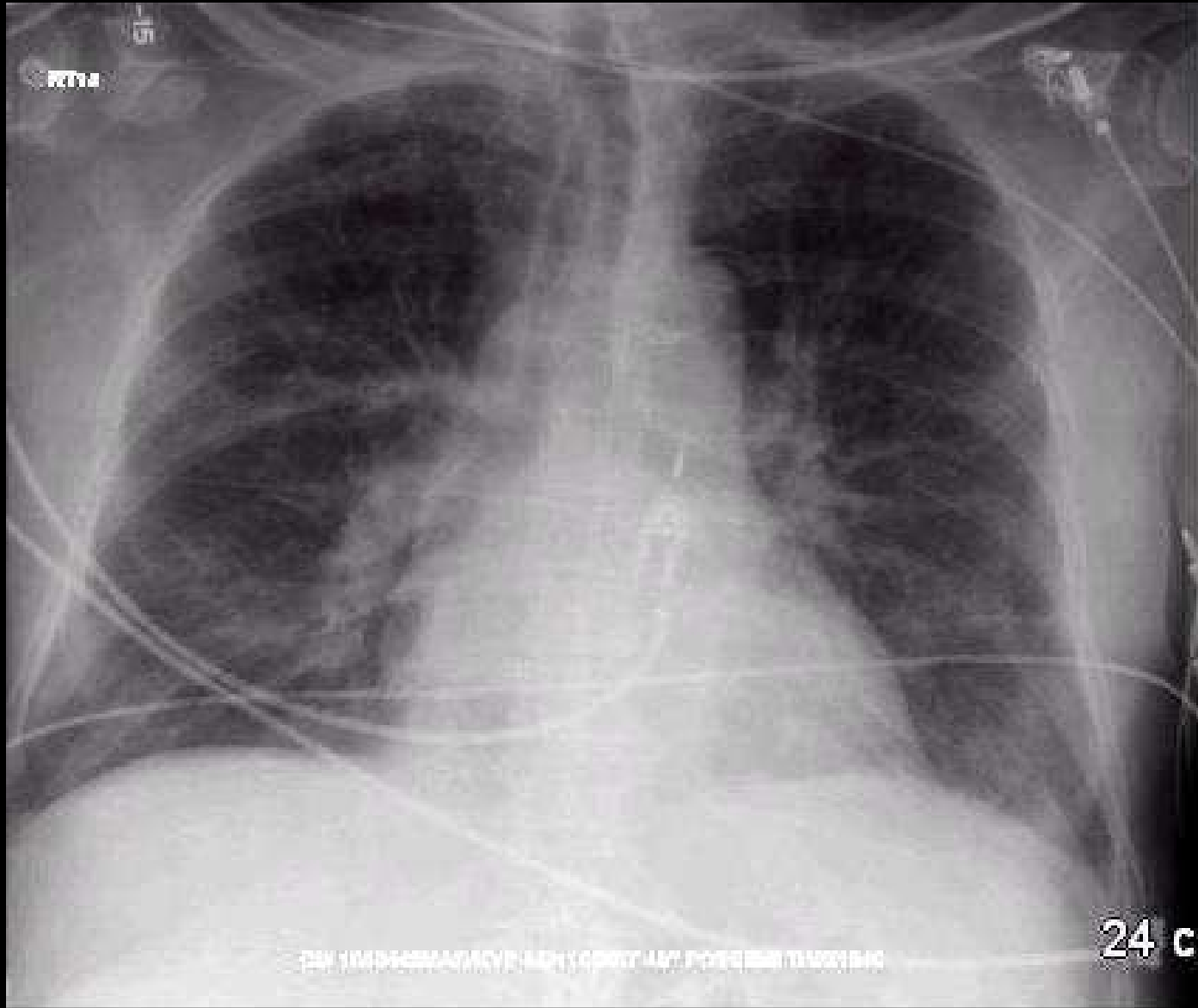
Id:DCM / Lin:DCM / Id:ID

W:4037 L:2019

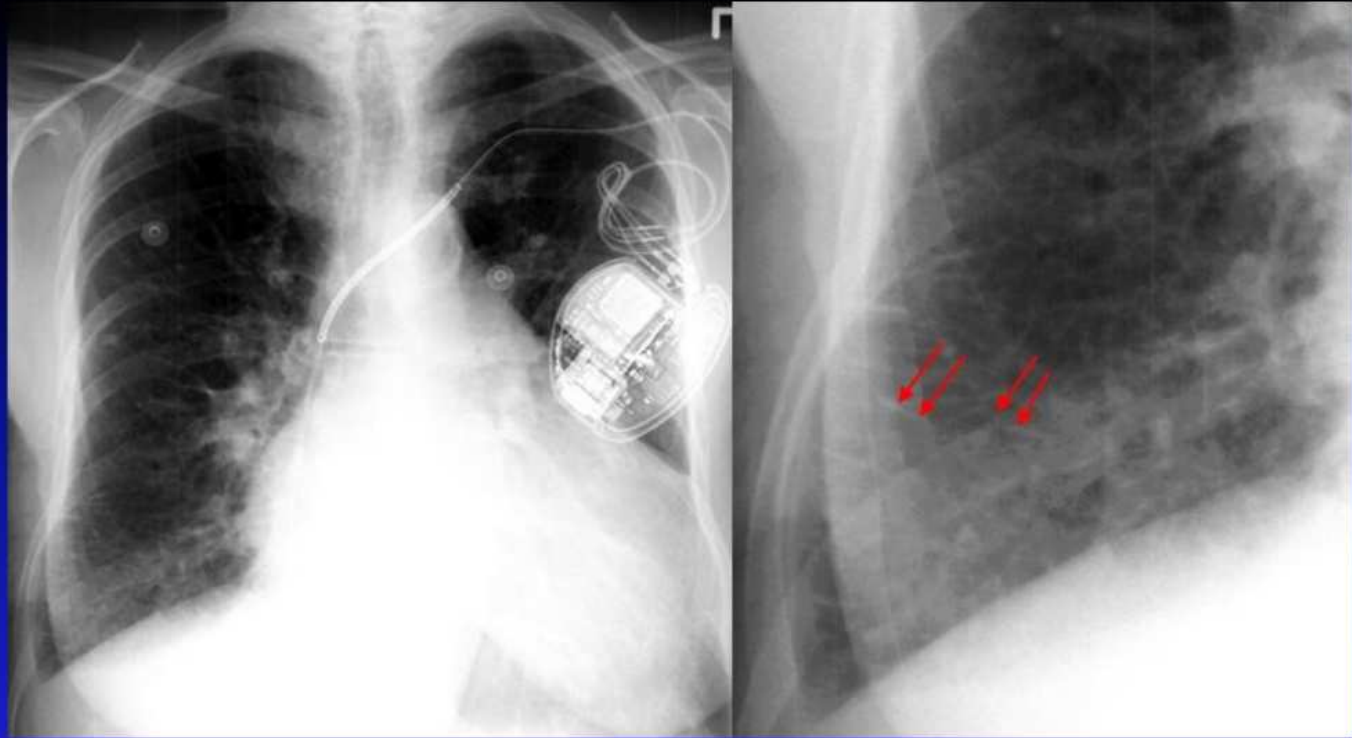
2006-01-01 06:44:30 4/10 1-2

SAVE





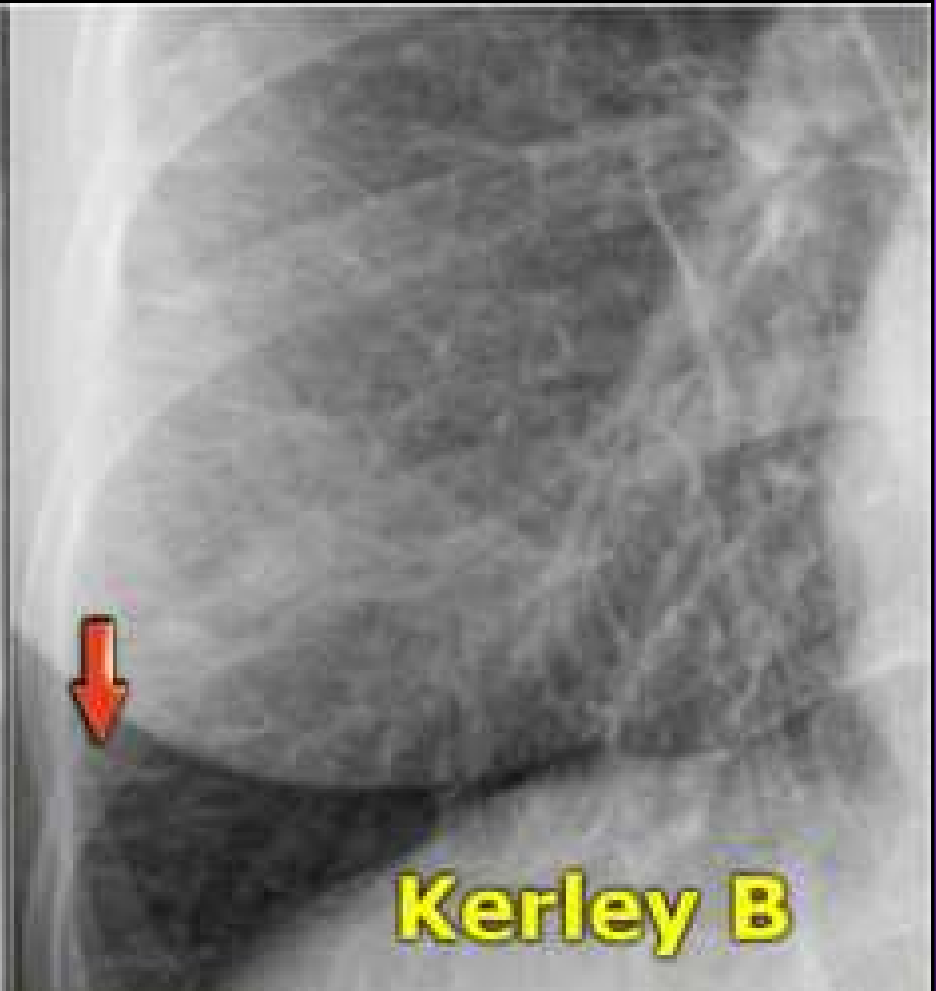
- Kerley B Lines -- Horizontal lines < 2 cm long found in the lower zone periphery
- These lines are the thickened, edematous interlobular septa



**The patient above is suffering from congestive heart failure resulting in interstitial edema. Notice the Kerley's B lines in right periphery (arrows).**



**Normal**

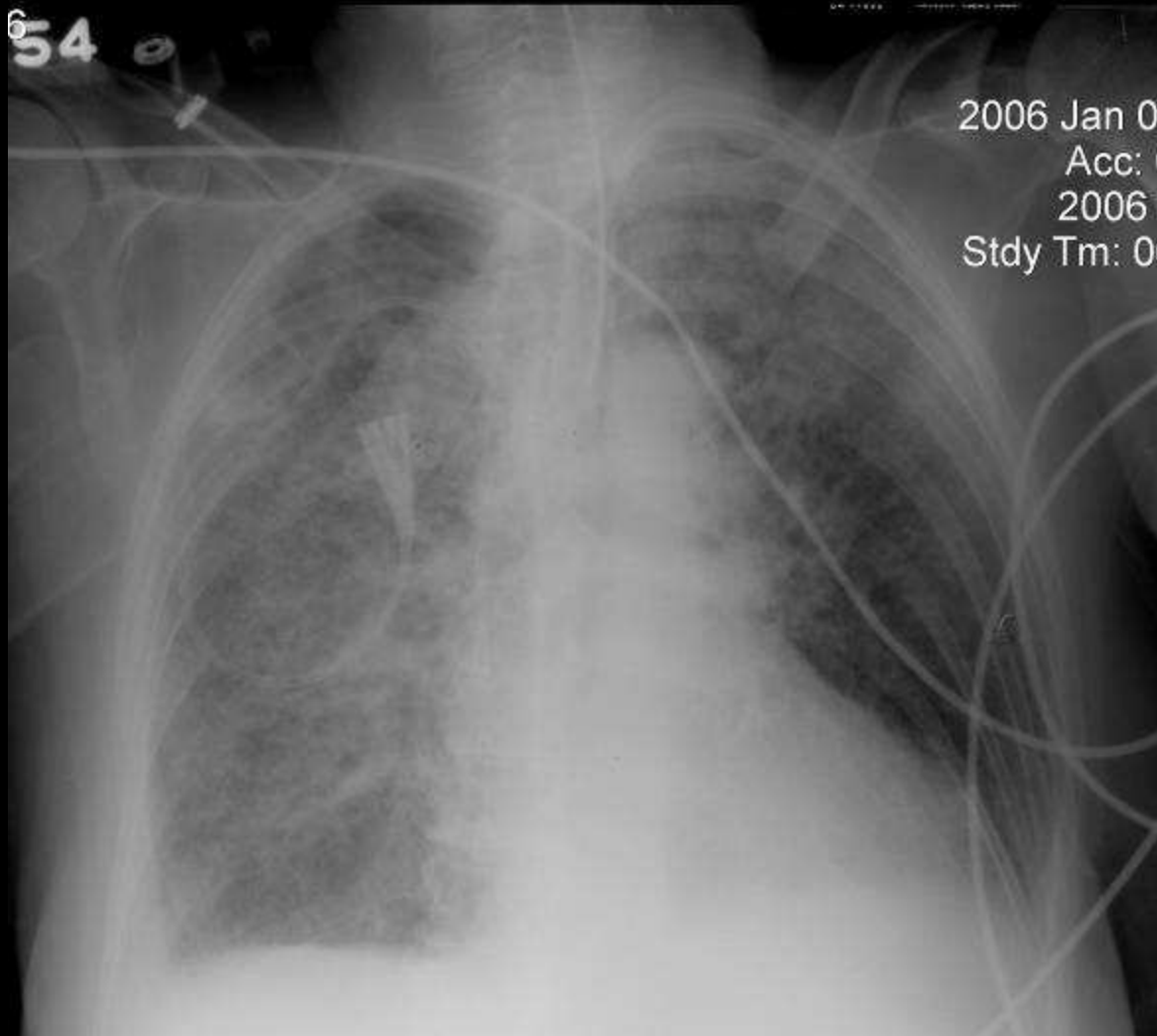


**Kerley B**

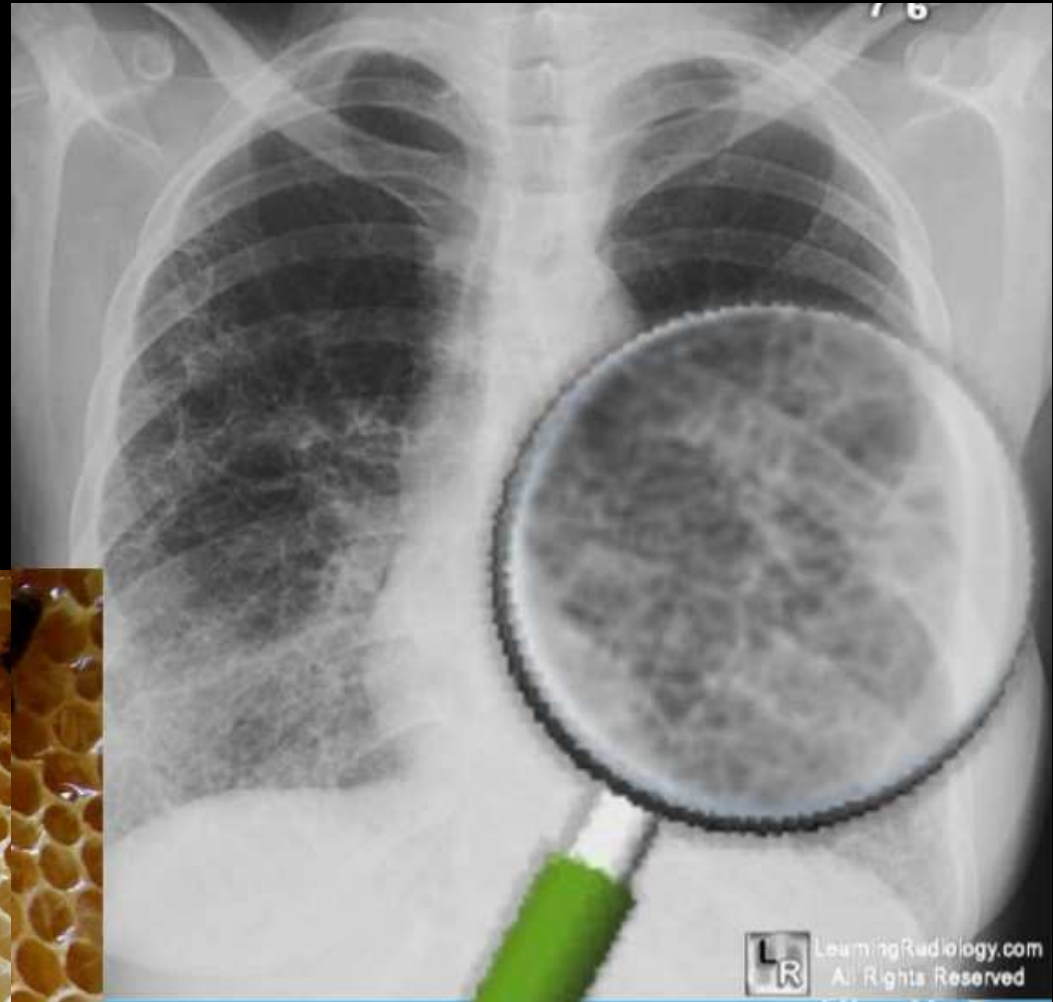
# Pneumonia

- A pattern of localized alveolar infiltrates
- May be localized to a single lobe or be more diffuse
- Will appear white on CXR
- Cause:
  - Infection
- Treatment
  - Antibiotics

# Pneumonia

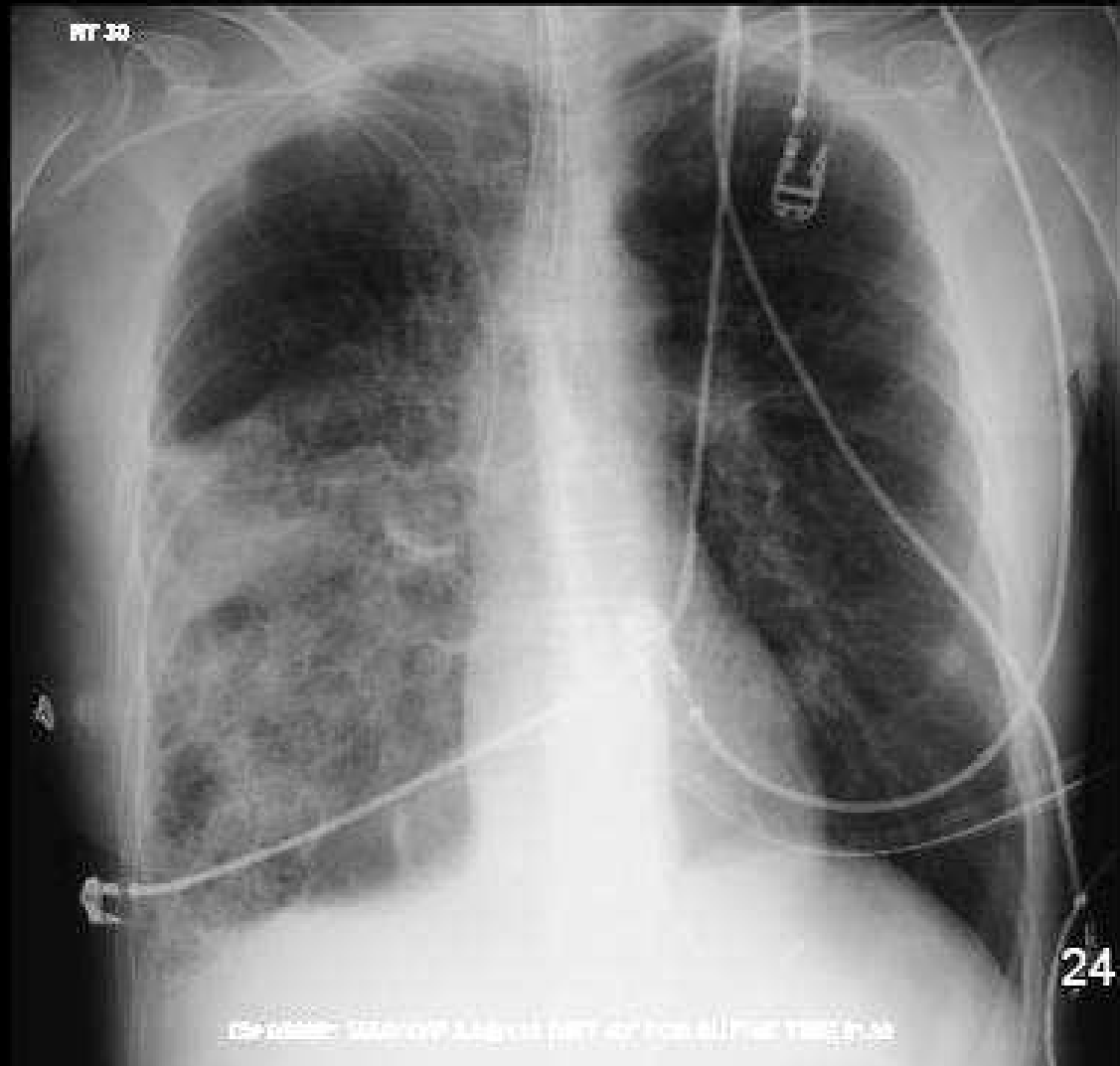


# Pneumonia

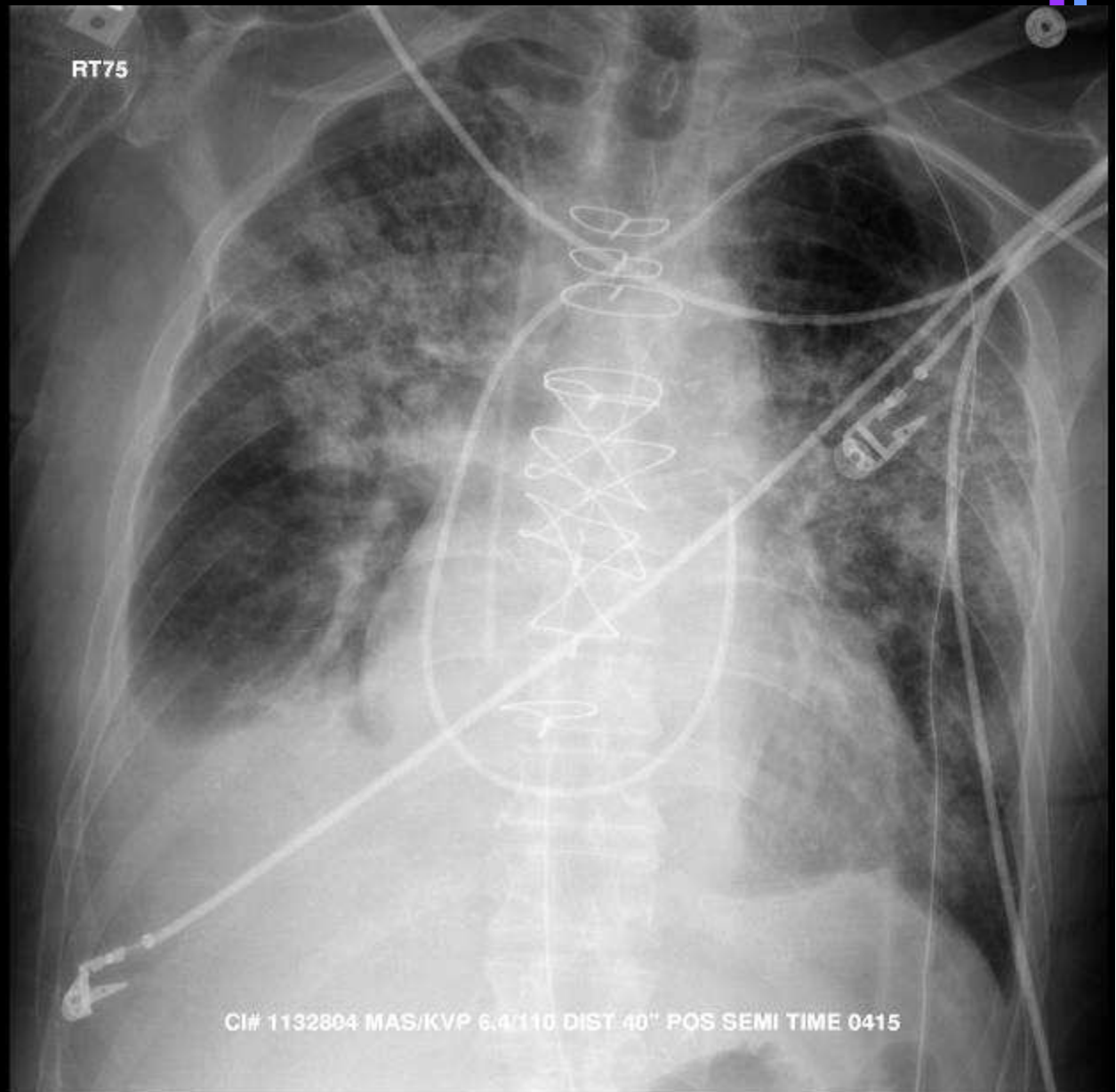




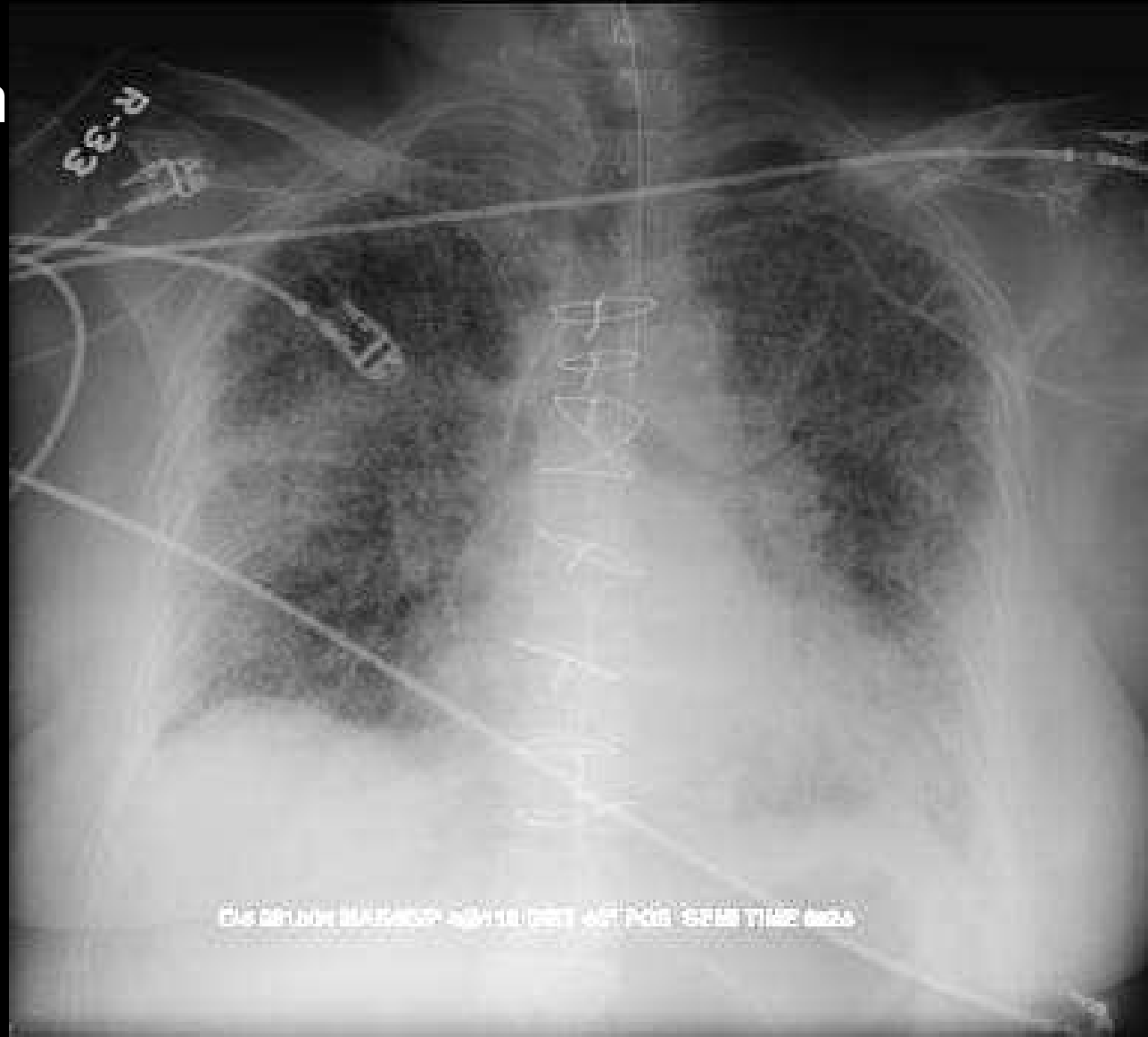
# Aspiration Pneumonia



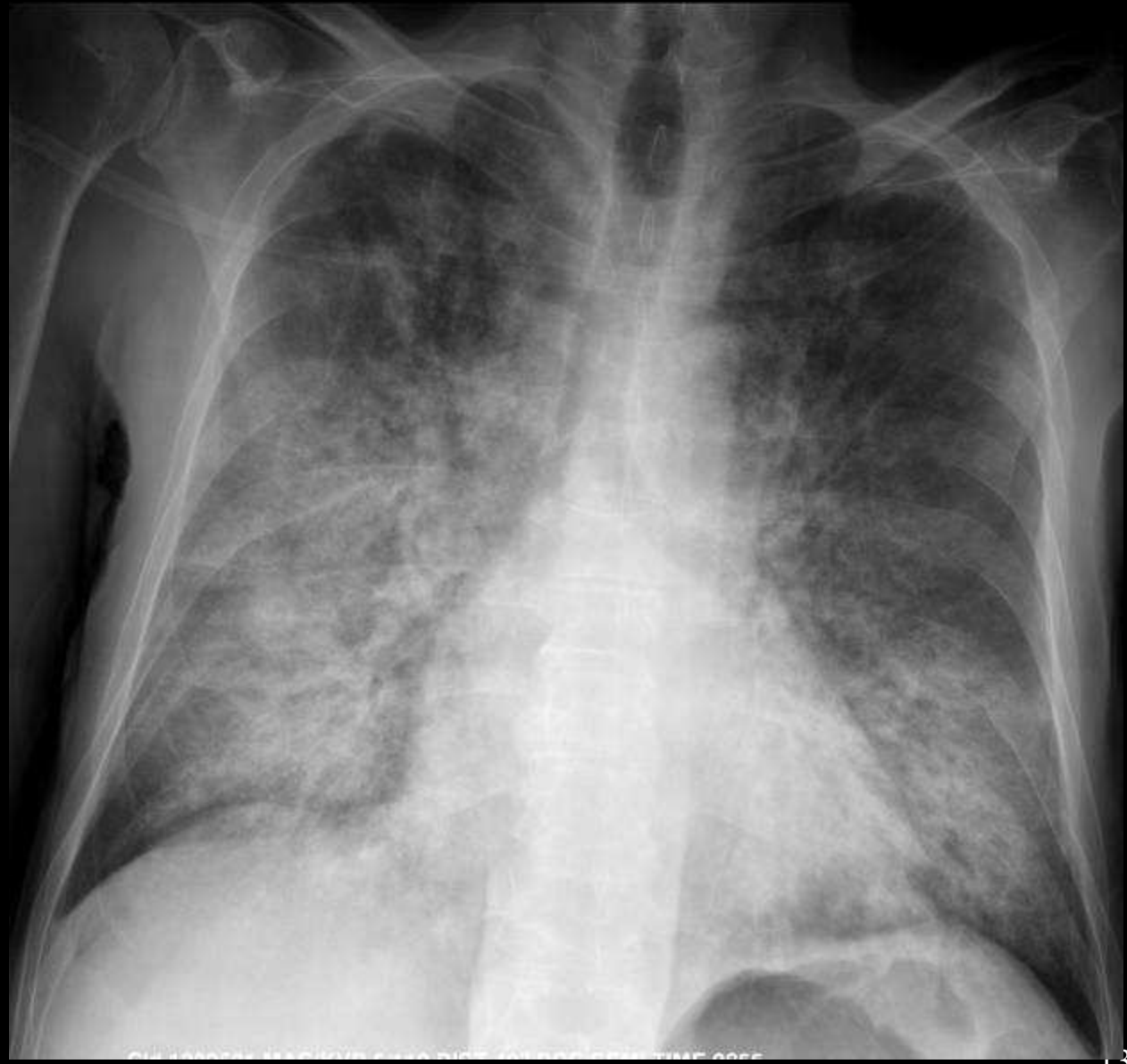
# Pneunomia



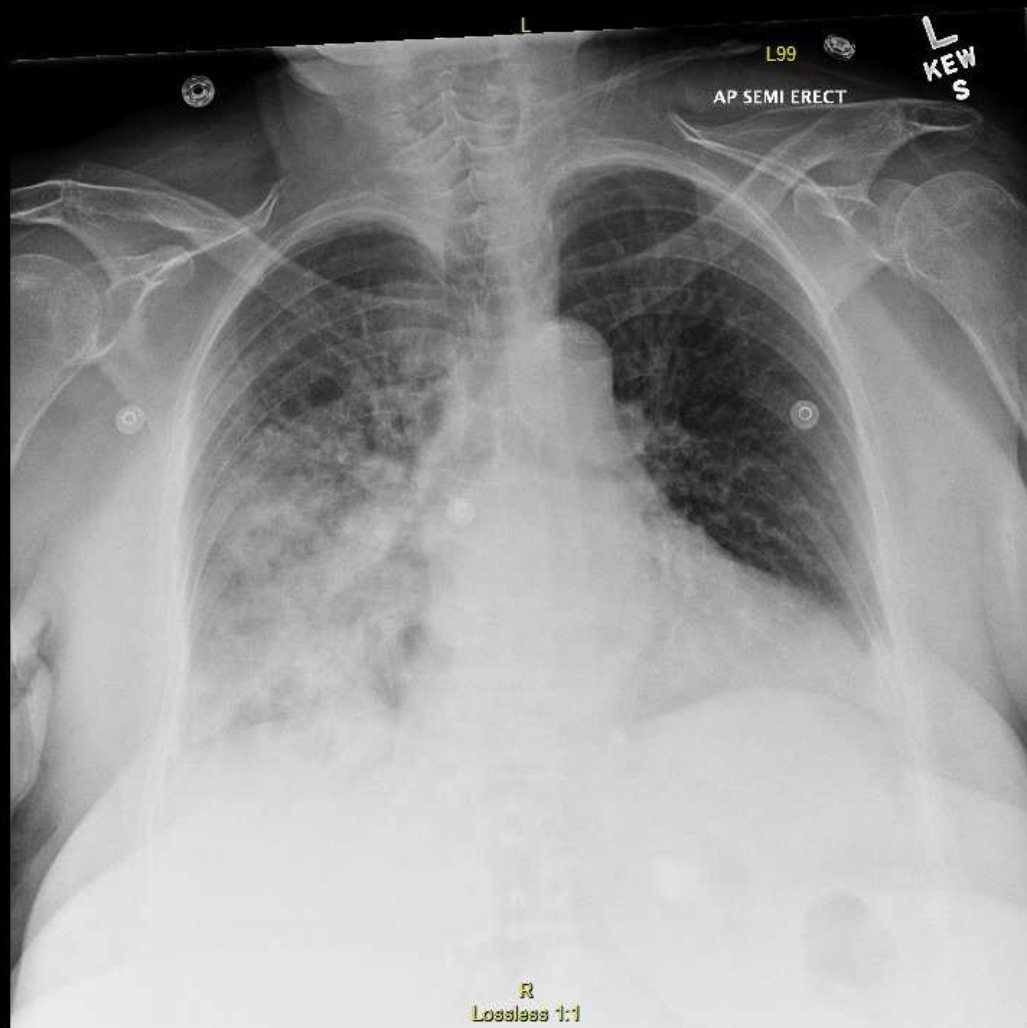
# Pneumonia



# Pneumonia



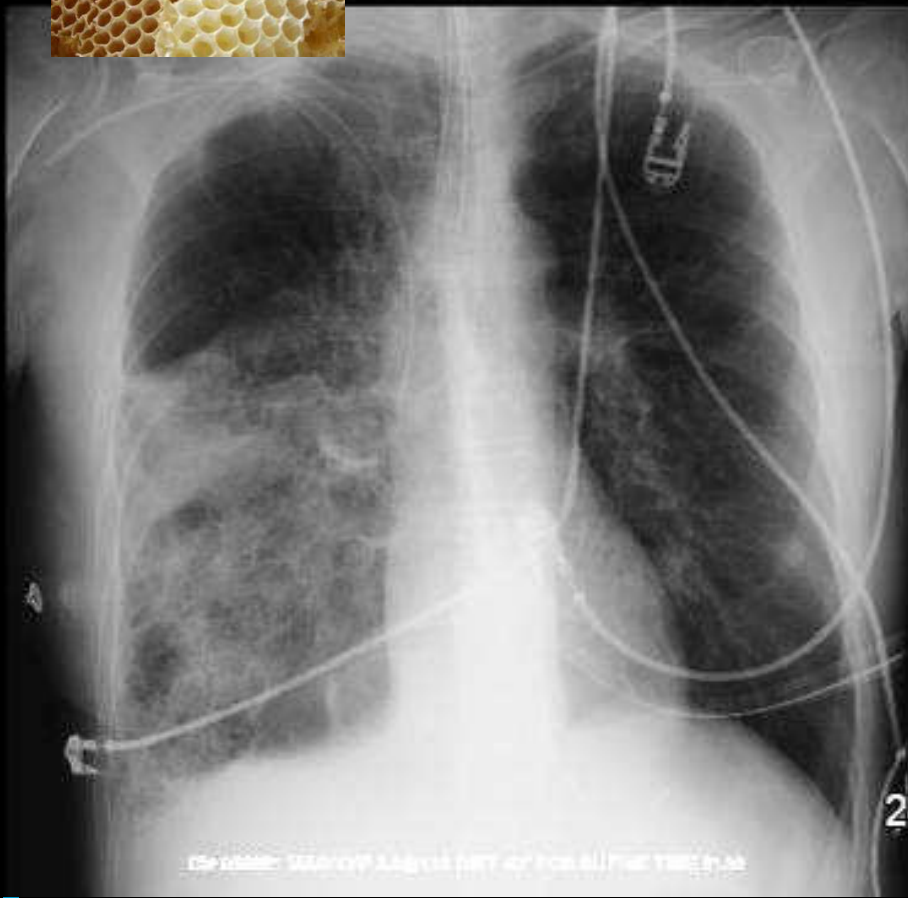
# Pneumonia



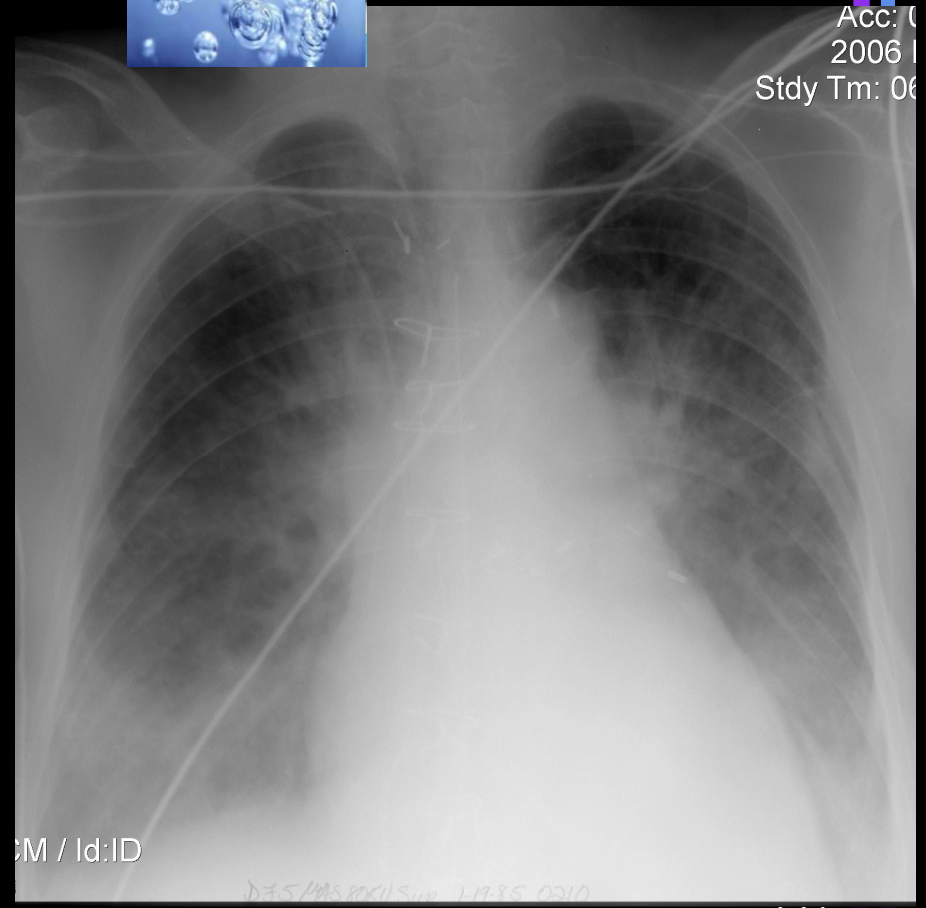
# RLL Pneumonia



- Pneumonia



- Pulmonary Edema



Acc: 0  
2006  
Stdy Tm: 06

- Pneumonia



- Pulmonary Edema







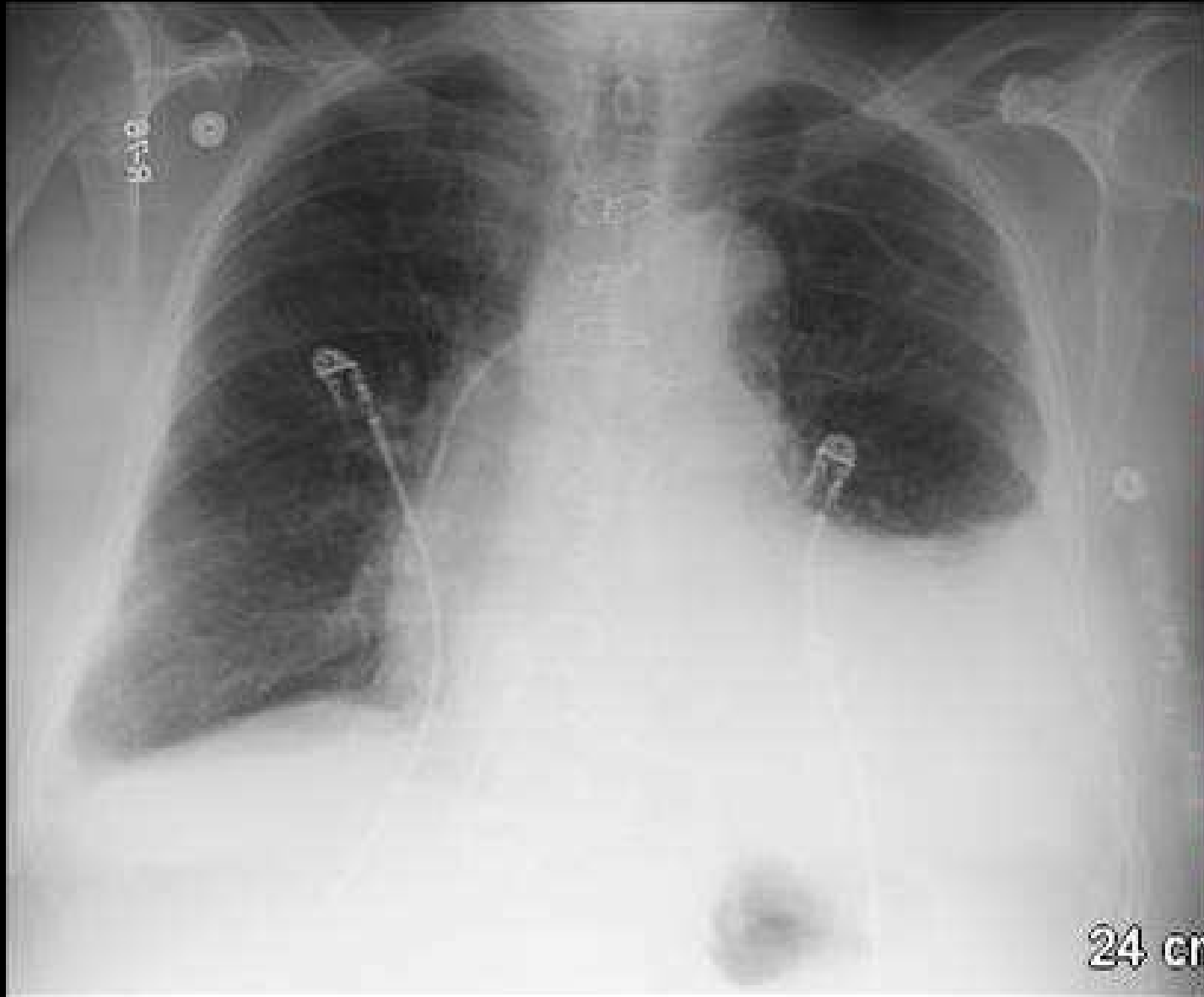
Pneumonia vs Pulmonary Edema  
Looking for polar bear in a snowstorm

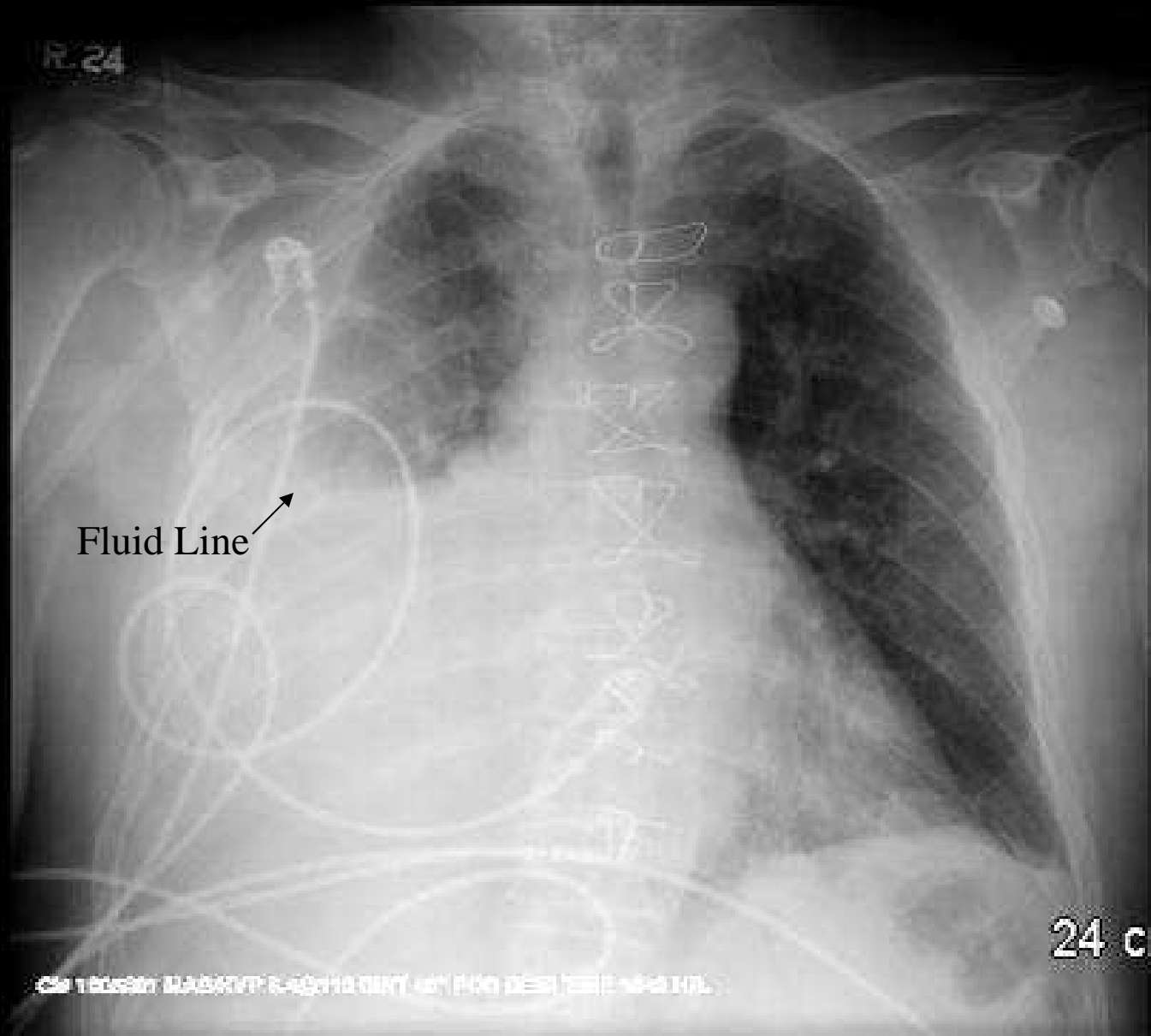
# Pleural Effusion

- Fluid in the pleural space
- At least 200 – 300 ml must be present in the pleural space to cause costophrenic blunting
- Treatment
  - Chest tube or thoracentesis to remove the fluid

# Pleural Effusion

- Fluid will be white or greyish in color
- Expect to see white in the pleural space
- Fluid Levels:
  - An upright CXR will ensure that fluid levels will drop to the bottom of the cavity.
  - Fluid levels taken on a patient lying will displace the fluid laterally over the cavity and will therefore not be detected as a distinct line



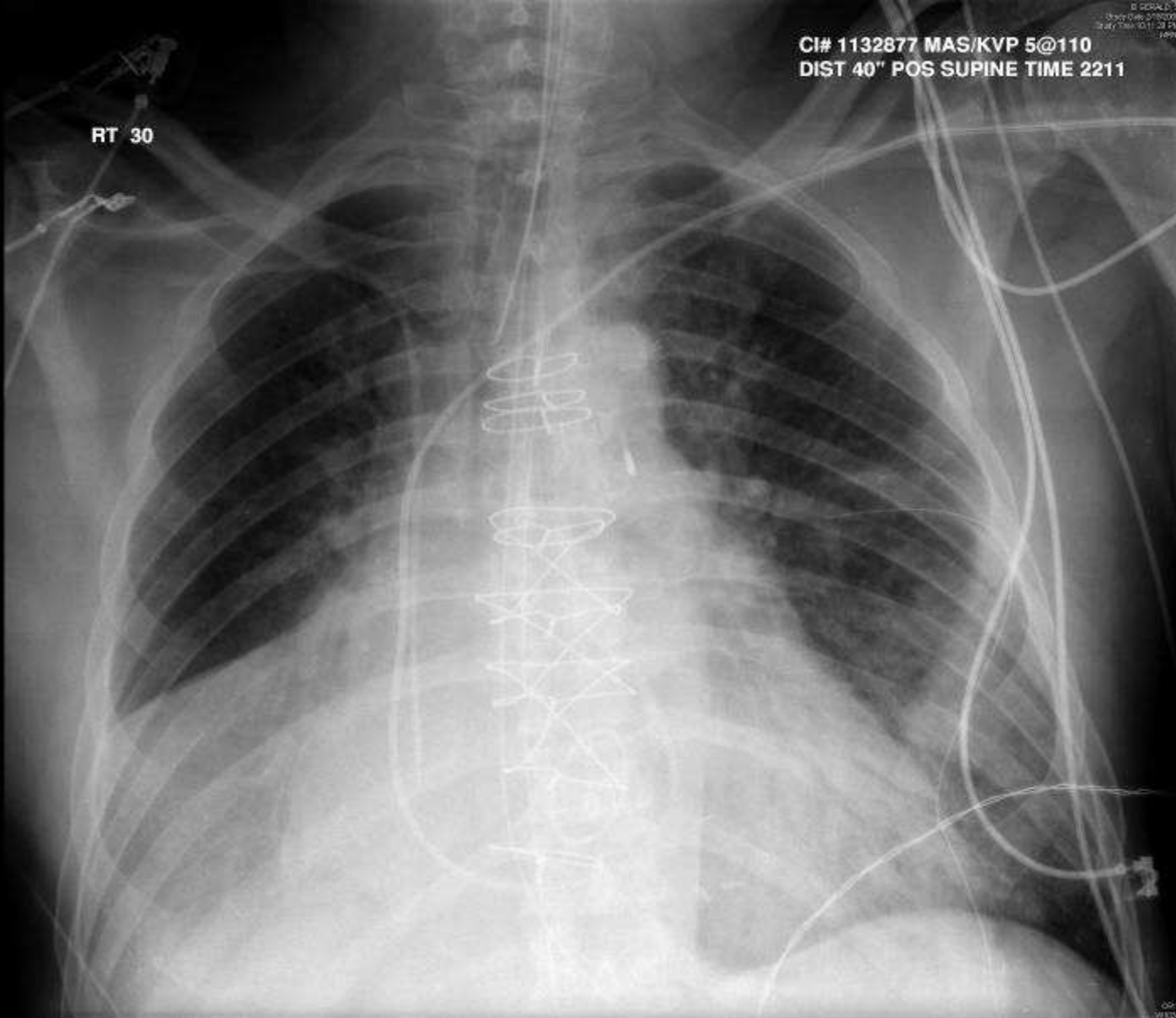


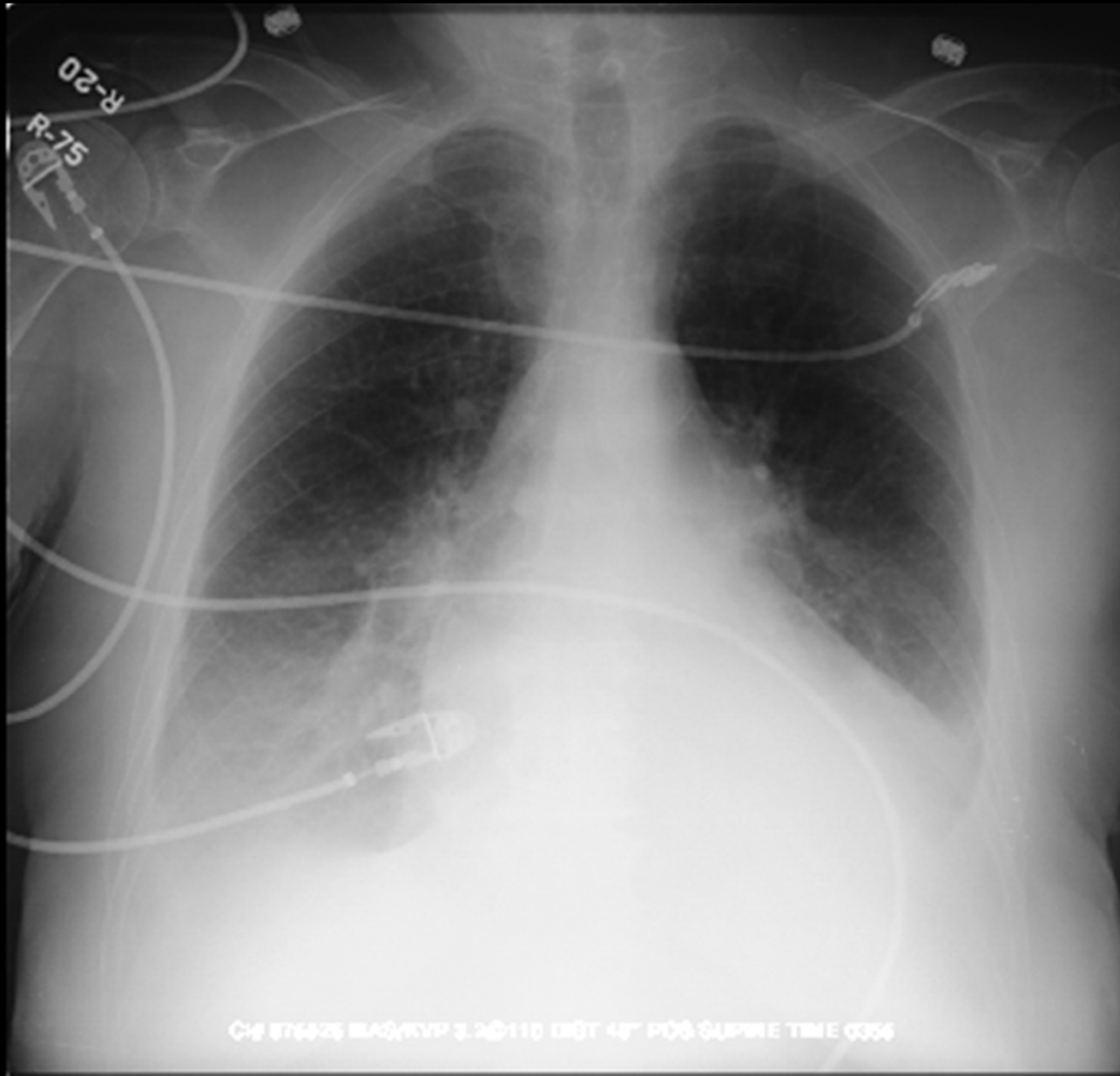
541  
101

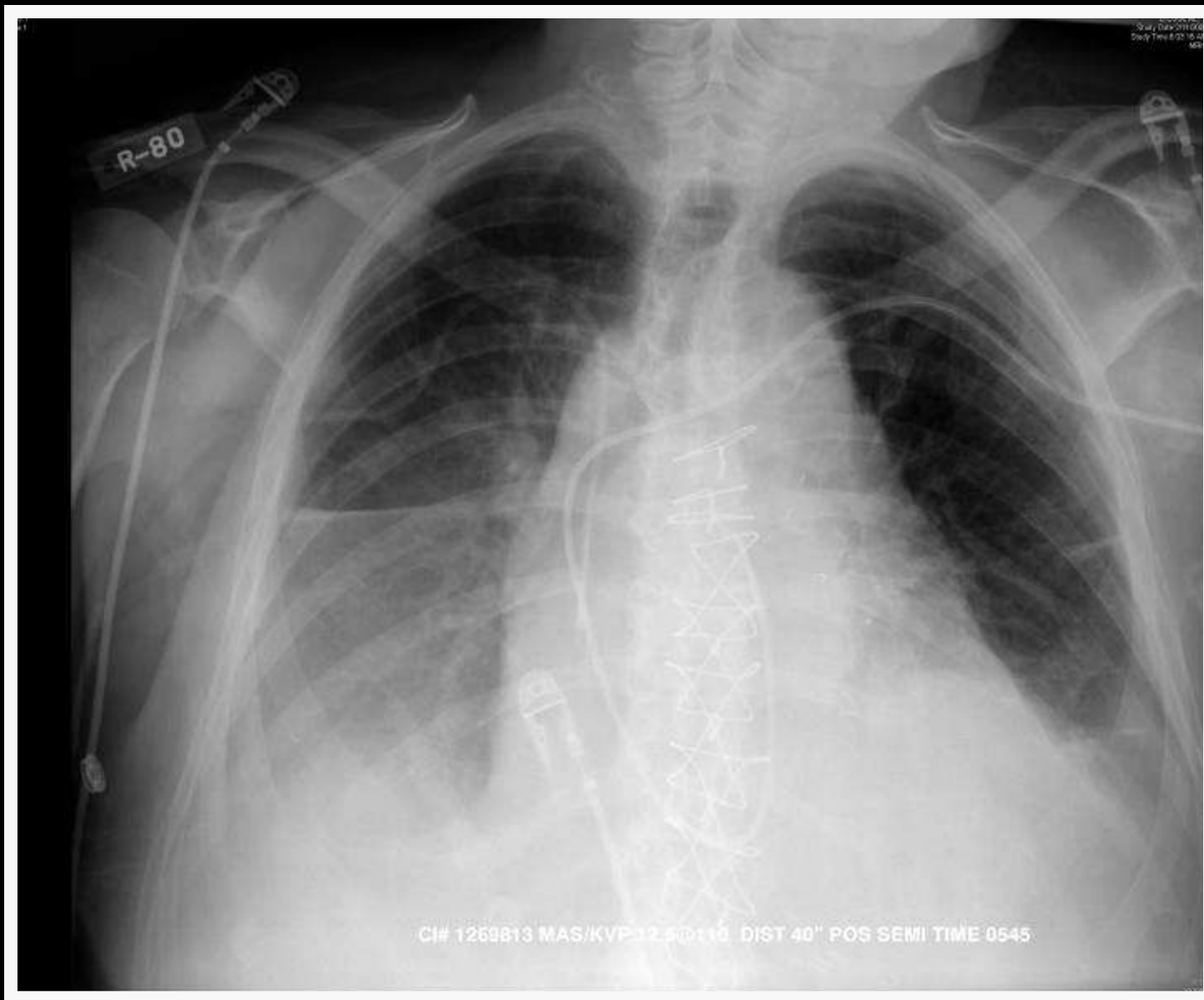
D. GERALD  
3/20/06 3:00:05  
3/27/06 10:11:23 PM  
149K

CI# 1132877 MAS/KVP 5@110  
DIST 40" POS SUPINE TIME 2211

RT 30

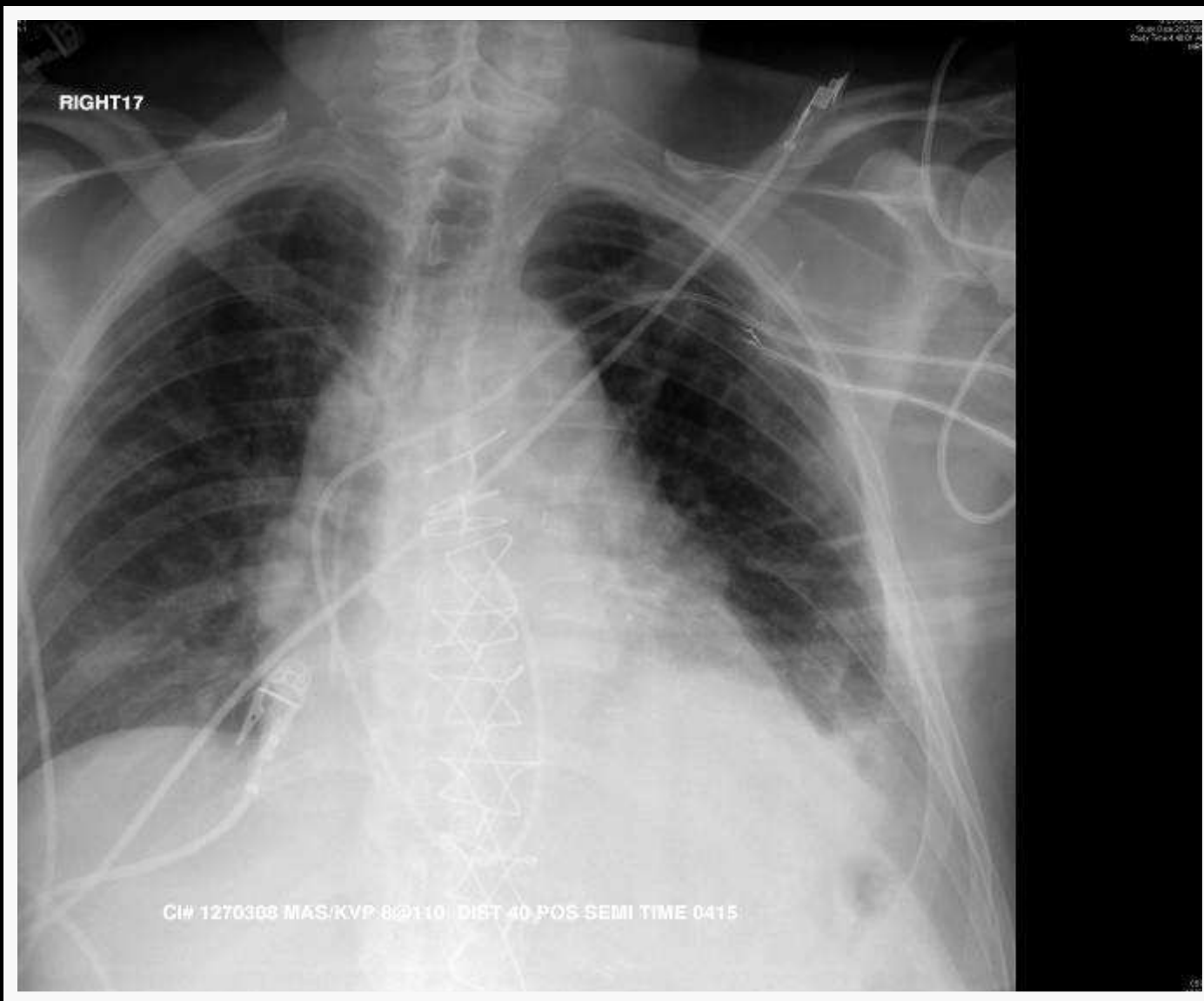






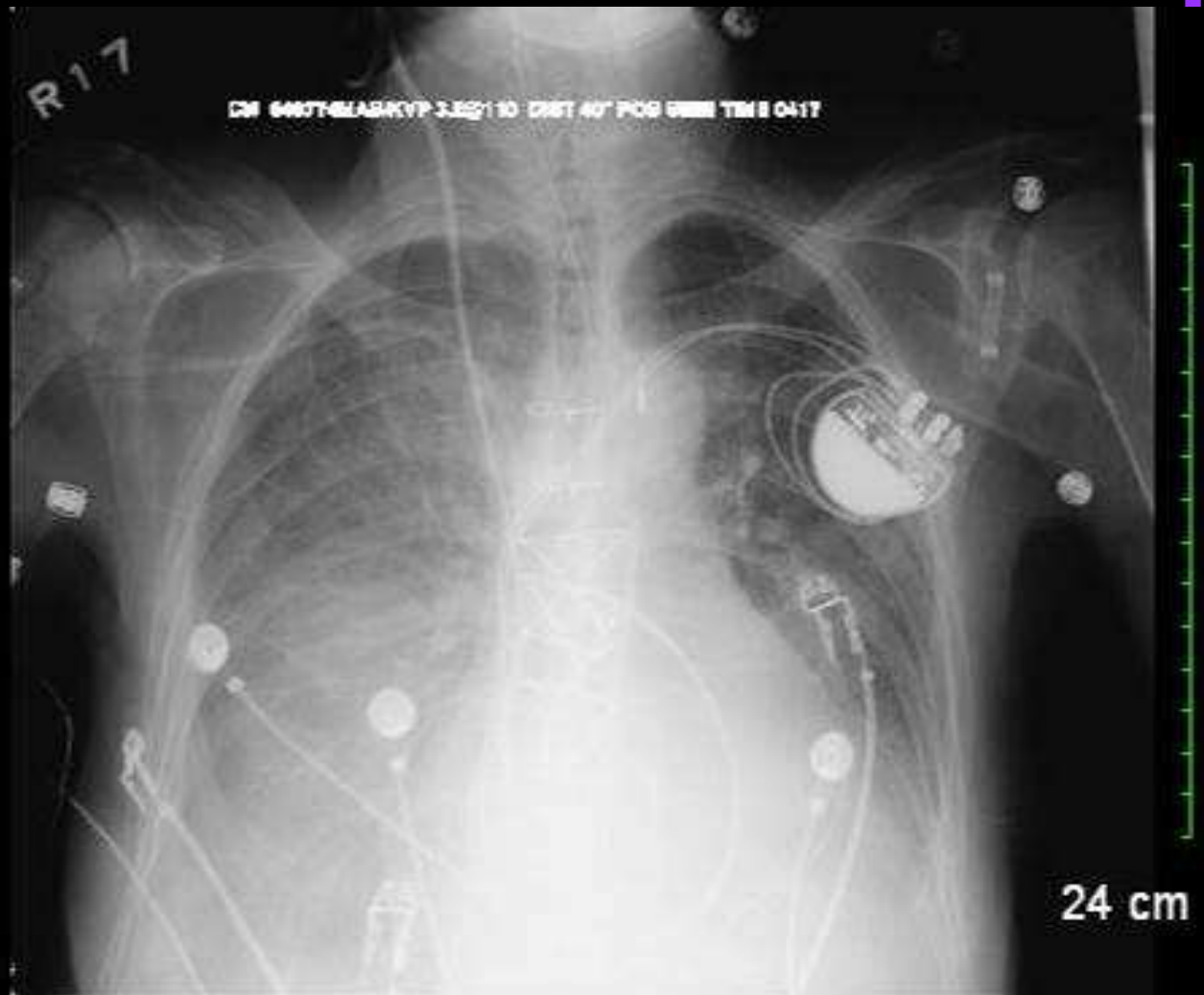
GB pleural effusion



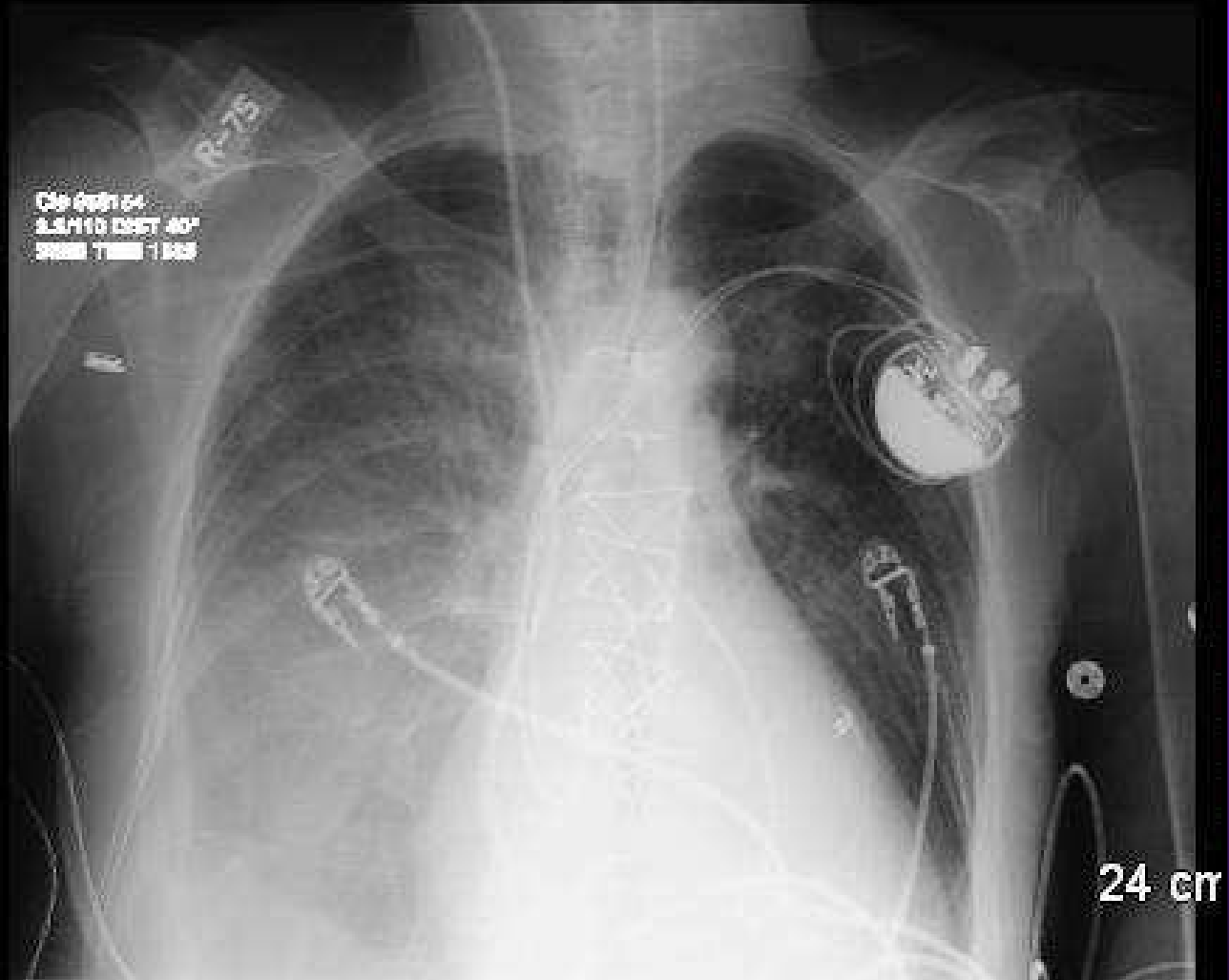


GB pleural effusion post removal 900 ml

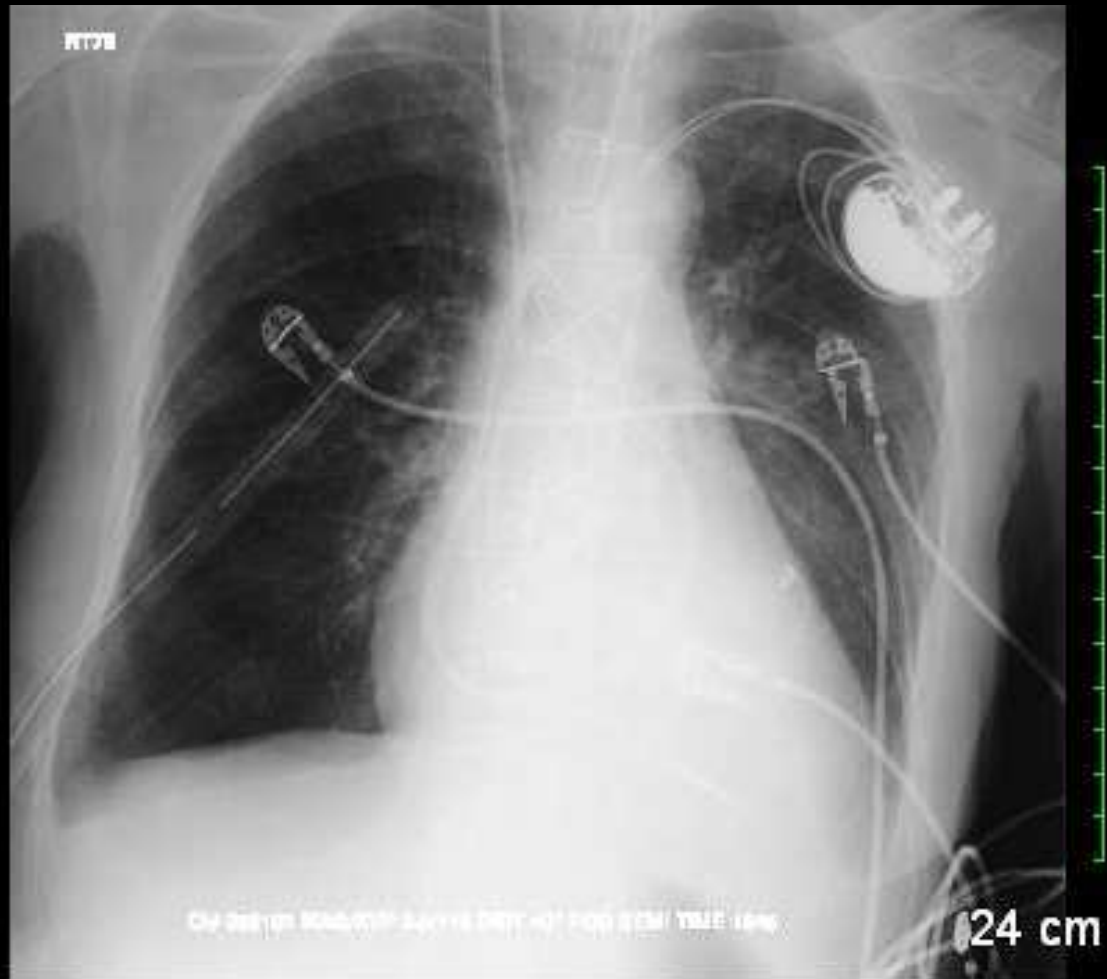
- Post Cardiac Surgery Patient (SS)
- 0400 CXR



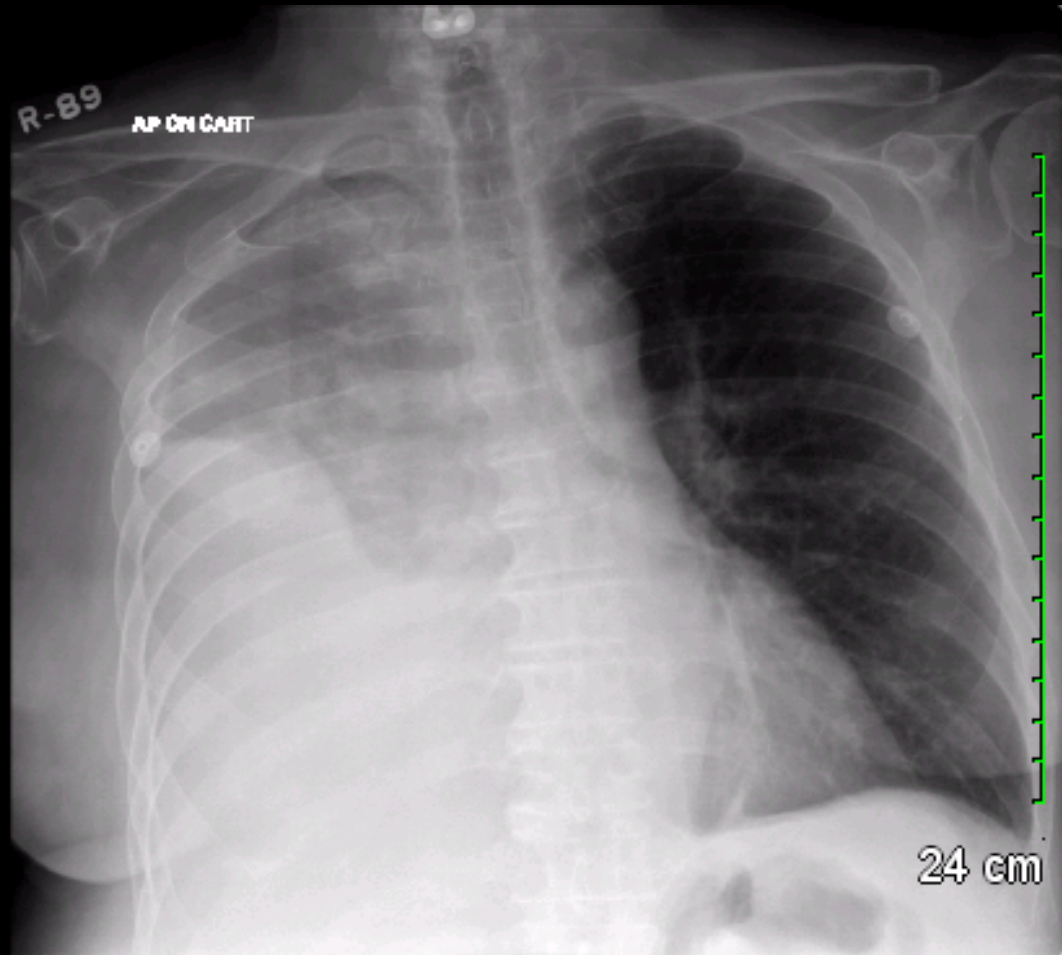
- Post Cardiac Surgery Patient (SS)
- 1600 CXR



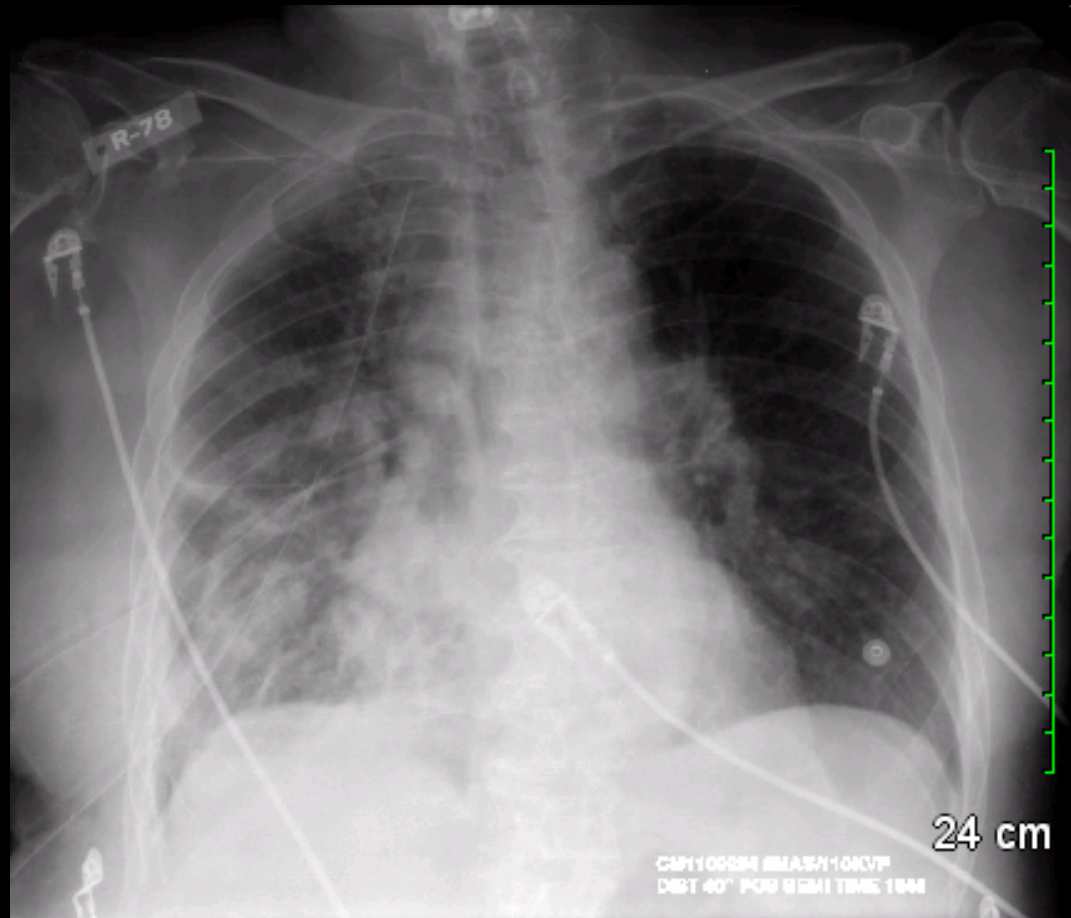
- Post Cardiac Surgery Patient (SS)
- 1630 after chest tube insertion and 1 liter fluid removal



- Pt (CM) right pleural effusion from cancer metastasis

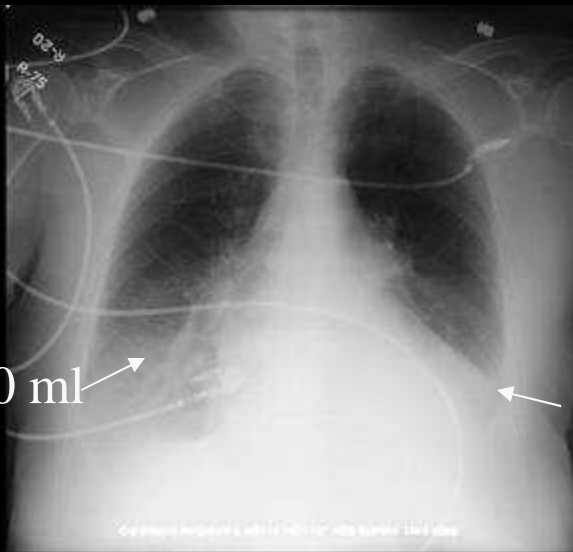


- Pt (CM) Day after 3 liters removed on right.
- Pleural effusion from cancer metastasis



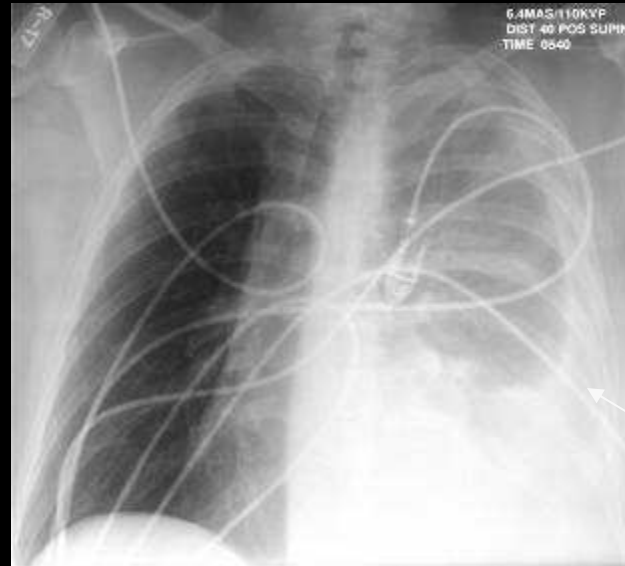
# Estimate of volume of pleural fluid

200 – 300 ml to cause costophrenic angle blunting



> 300 ml

300 + ml



2800 ml



Approx  
5 liters

# Kyphosis with right pleural effusion

