急重症與心血管影像判讀

中國附醫胸腔內科暨重症系
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大綱

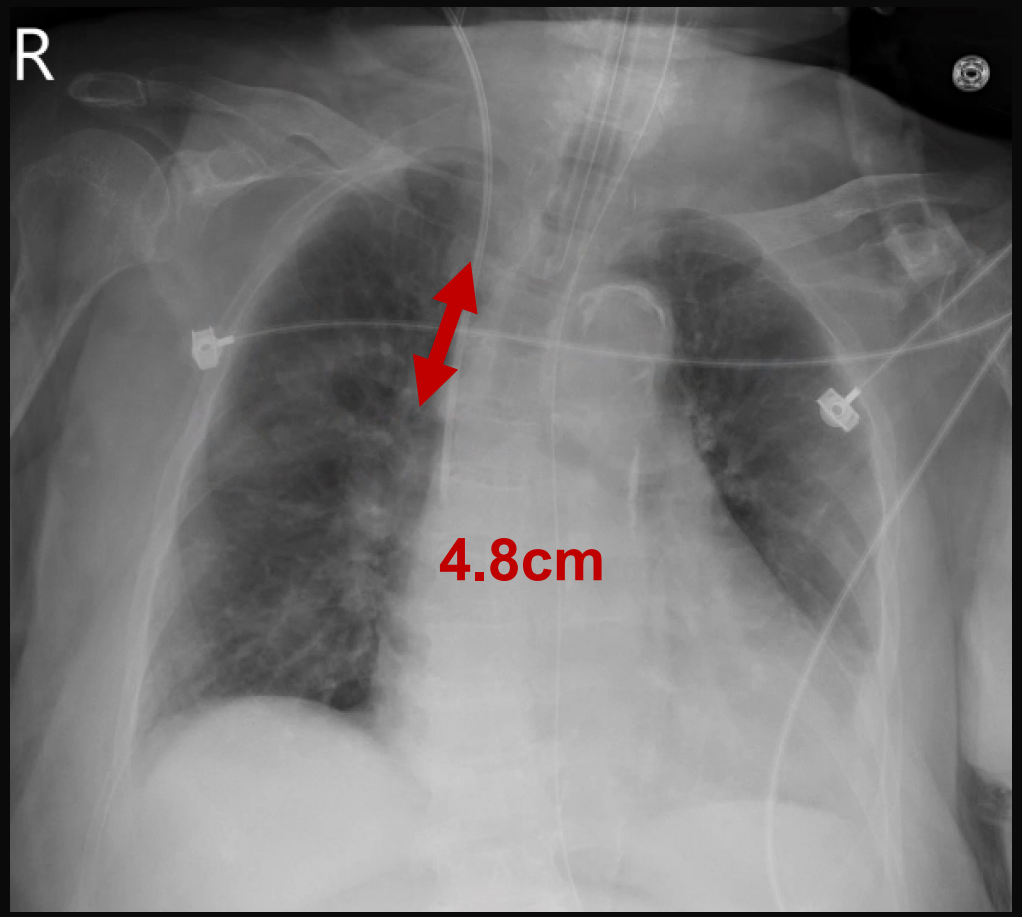
管路位置與併發症
急症疾病
心血管影像

Ideal location of endotracheal tube tip

Mid trachea

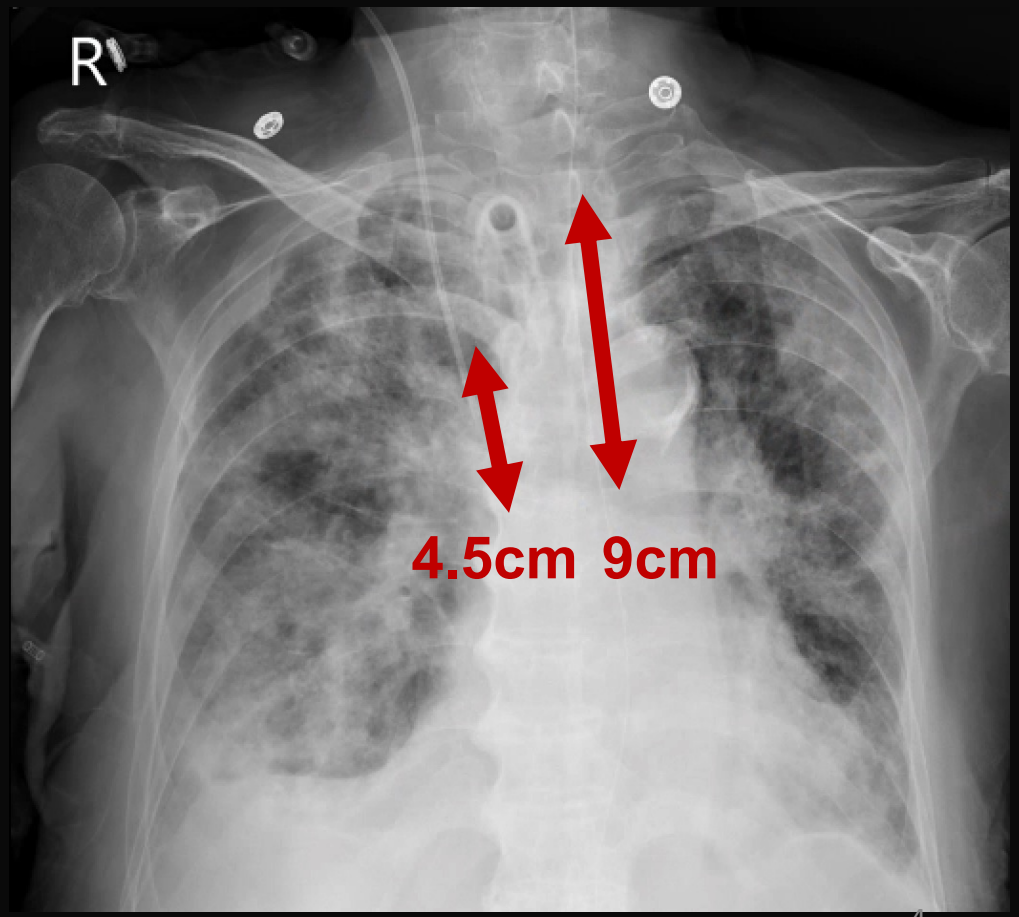
5±2 cm above carina: neutral head position (3-7cm)

3cm distal to vocal cord: avoid vocal cord injury



Ideal location of tracheostomy tube tip

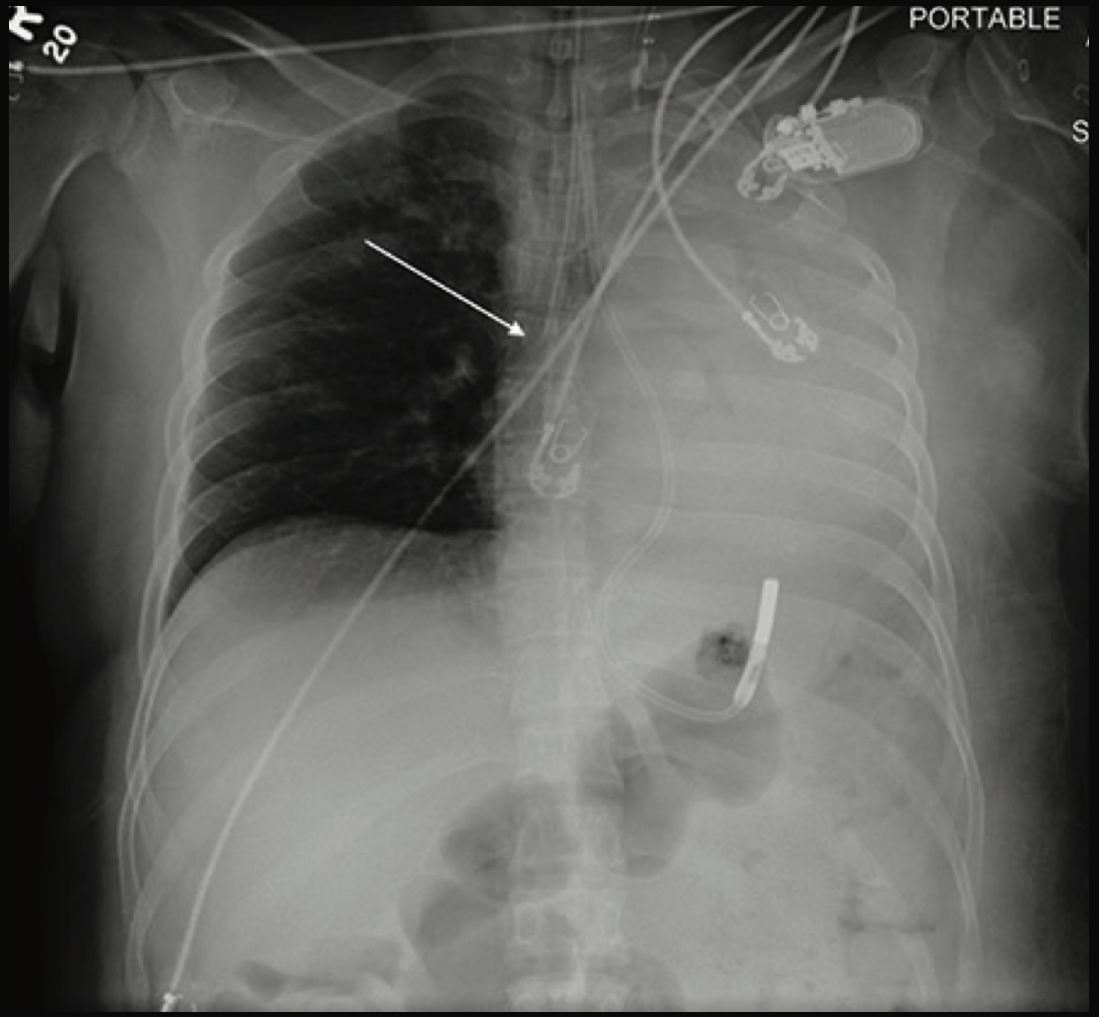
1/2 – 2/3 of the distance from the stoma to the carina



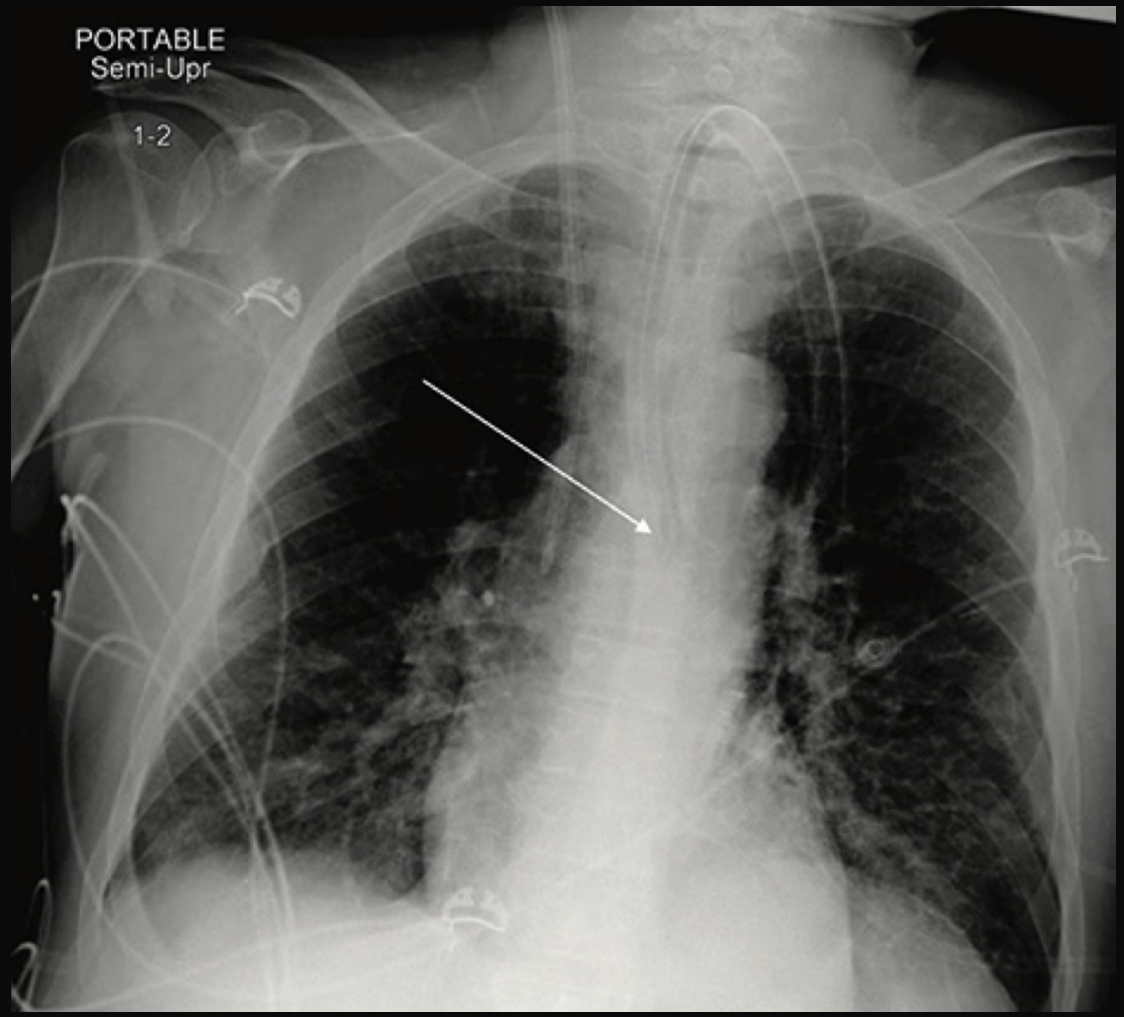
Godoy, et al. Chest Radiography in the ICU: Part 1, Evaluation of Airway, Enteric, and Pleural Tubes. AJR 2012; 198:563–571

Malposition of endotracheal tube: too low of tip

Right main bronchus intubation



Left main bronchus intubation

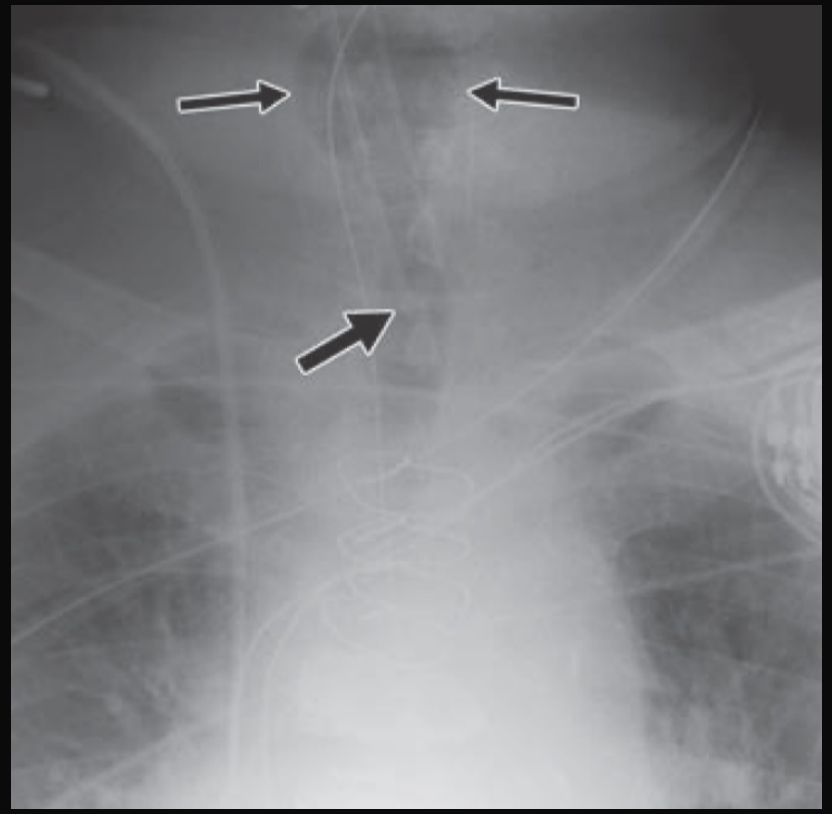


Sakthivel MK, et al. Malpositioned Lines and Tubes on Chest Radiograph – A Concise Pictorial Review. J Clin Imaging Sci 2020;10:66

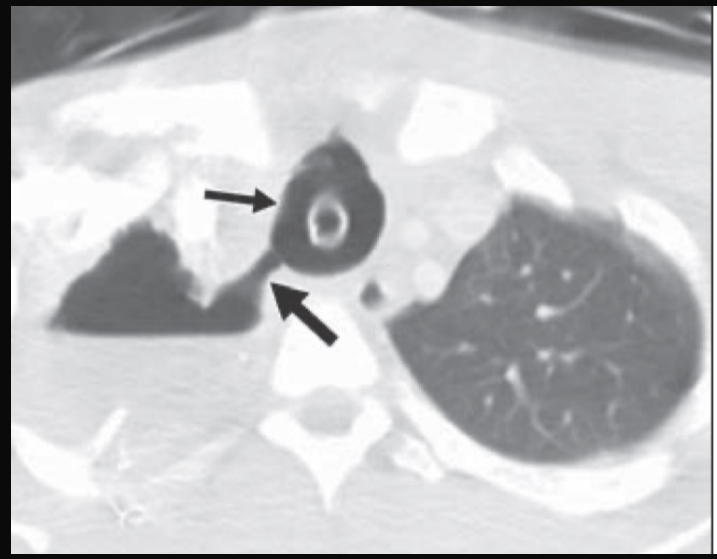
Overdistension of endotracheal tube cuff

≥ 1.5x tracheal diameter or ≥ 2.8cm

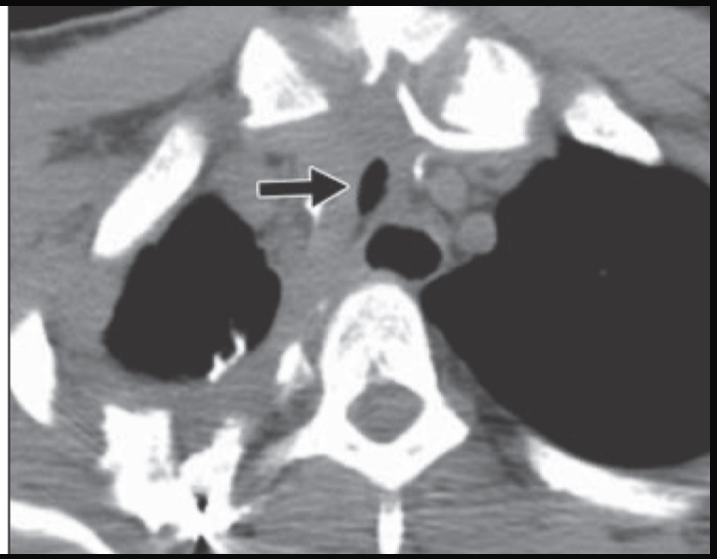
The position of tip is too high with risk of dislocation



Resulted in tracheoesophageal fistula



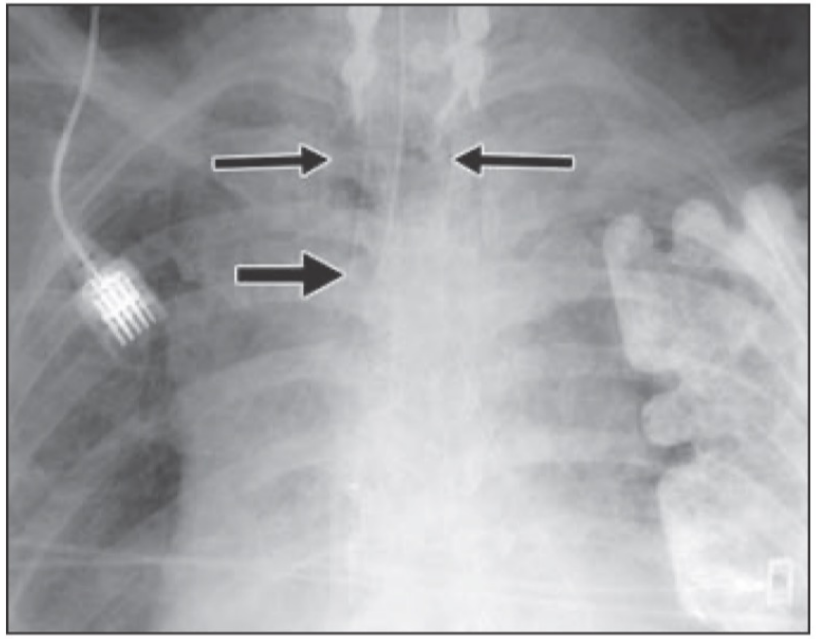
Tracheal stenosis months later

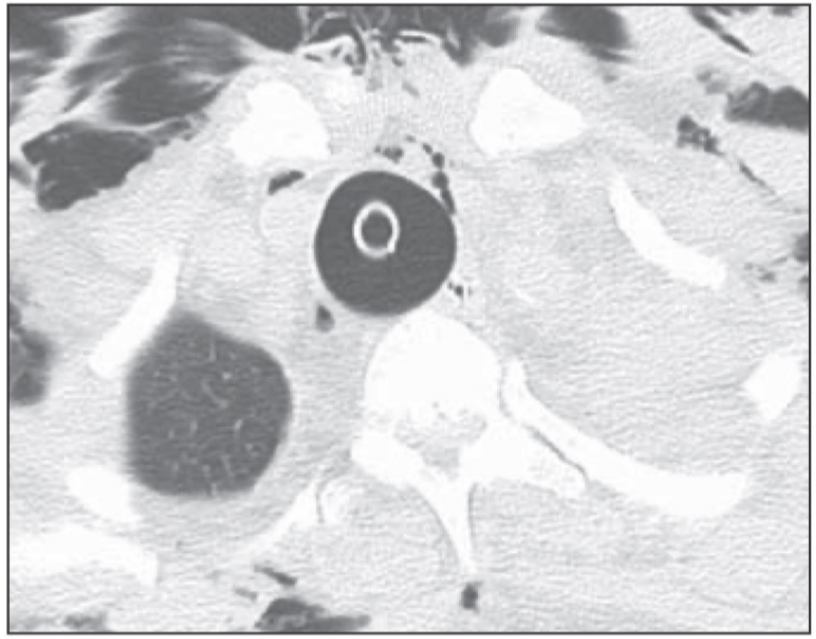


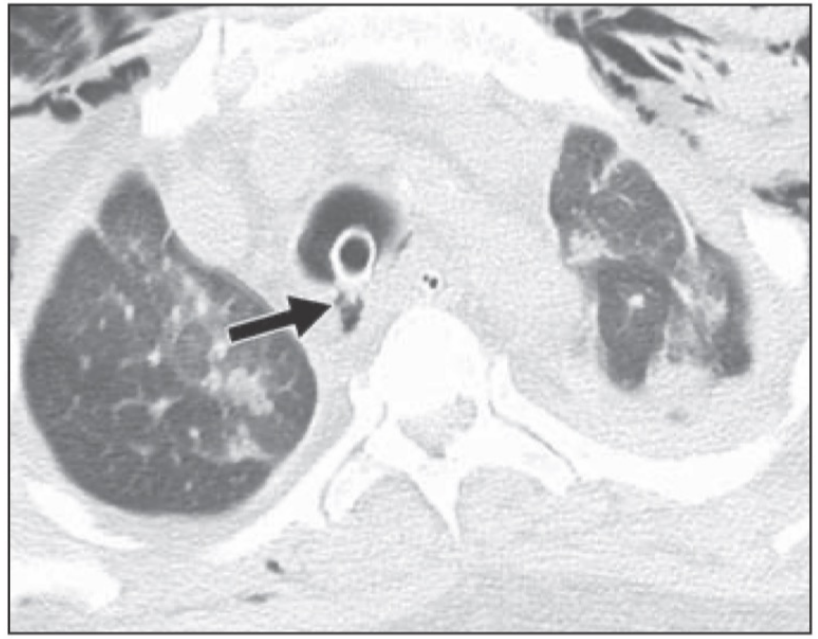
Godoy, et al. Chest Radiography in the ICU: Part 1, Evaluation of Airway, Enteric, and Pleural Tubes. AJR 2012; 198:563–571

Overdistension of endotracheal tube cuff because of tracheal laceration (usually posterior wall of membranous trachea)

Overdistended balloon
Reduced balloon-to-tip distance
(< 1.3cm; normal: 2.5cm)

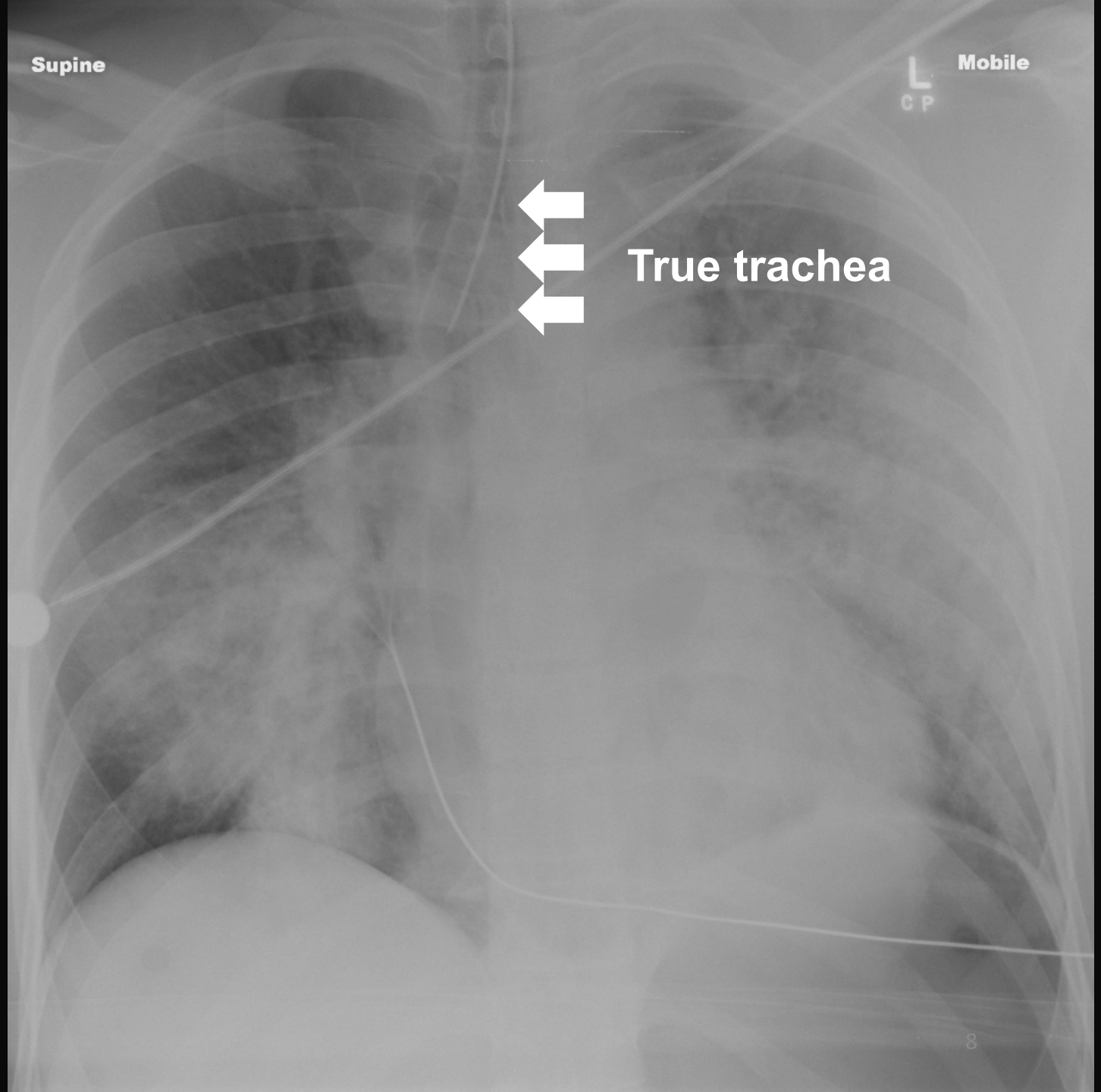






Godoy, et al. Chest Radiography in the ICU: Part 1, Evaluation of Airway, Enteric, and Pleural Tubes. AJR 2012; 198:563–571

Malposition of endotracheal tube to esophagus

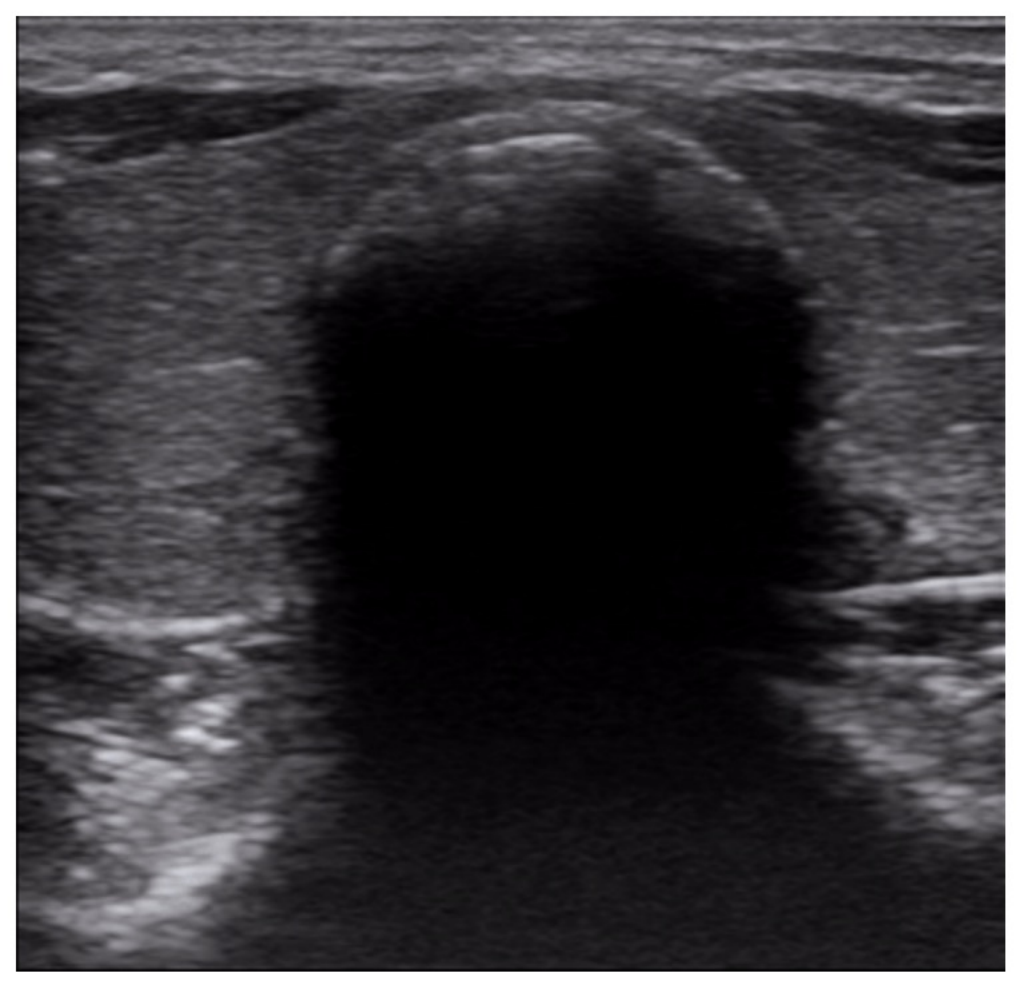


Godoy, et al. Chest Radiography in the ICU: Part 1, Evaluation of Airway, Enteric, and Pleural Tubes. AJR 2012; 198:563–571

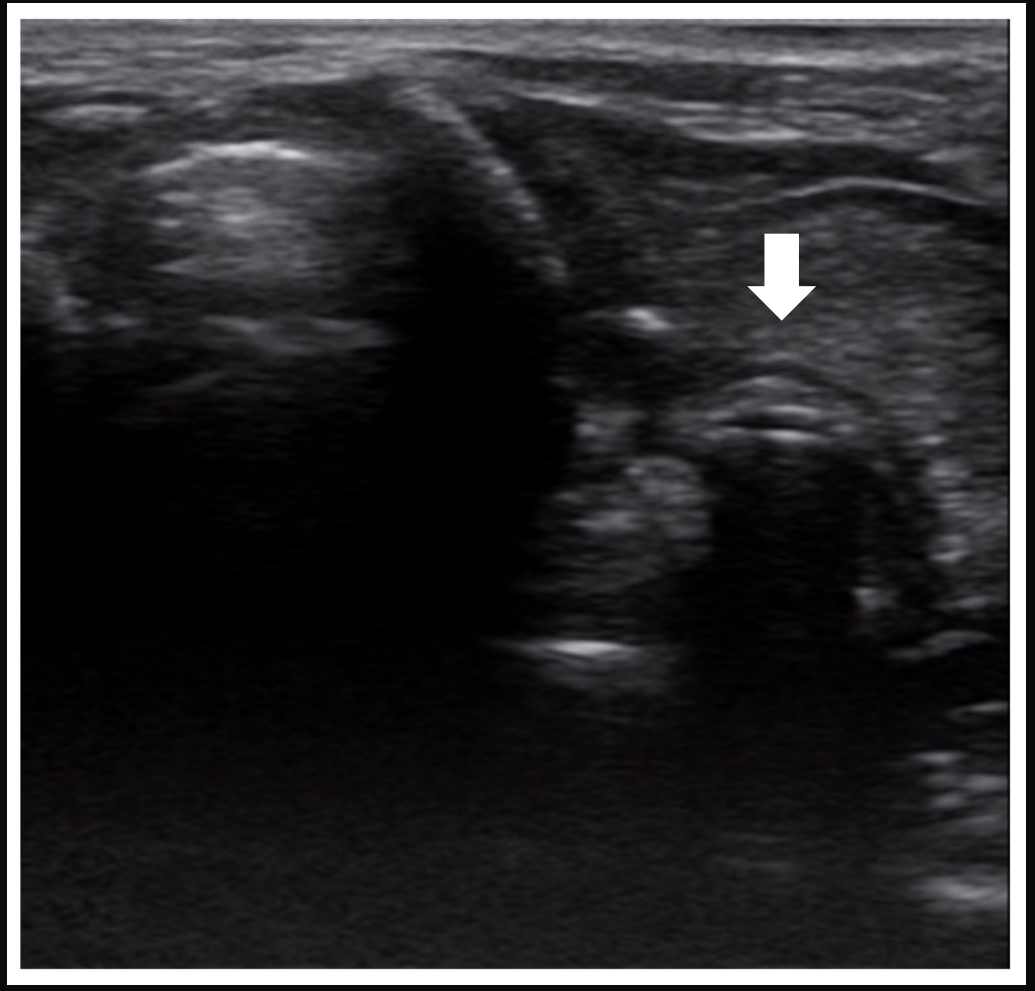
Ultrasound confirmation of endotracheal tube position

Linear probe, transverse, above supra-sternal notch

Air-mucosa interface
with posterior shadow and artifact

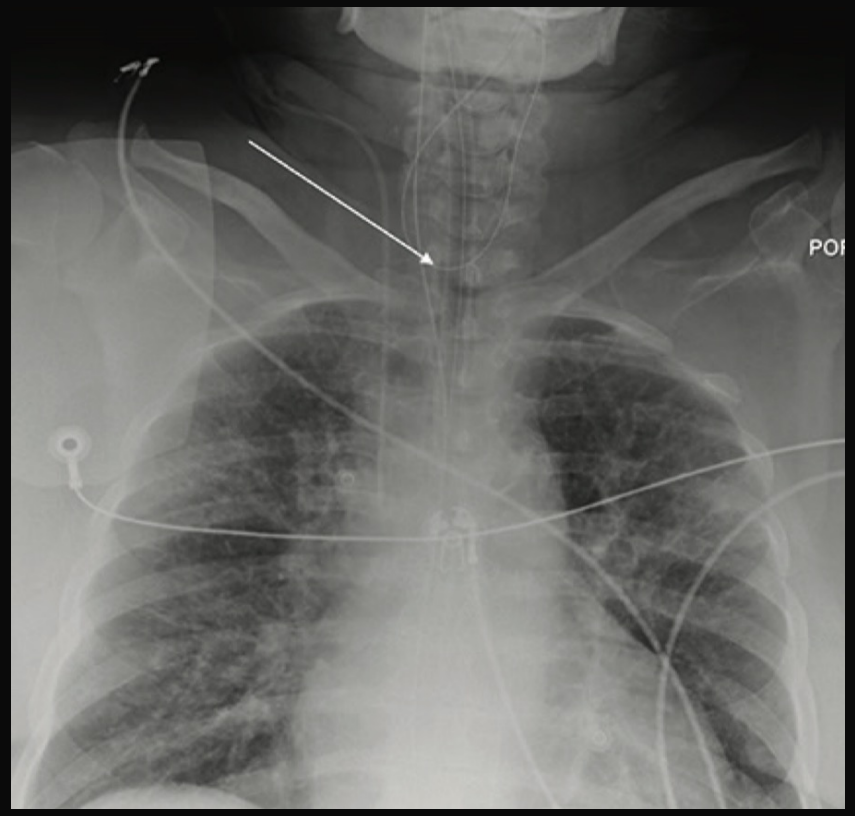


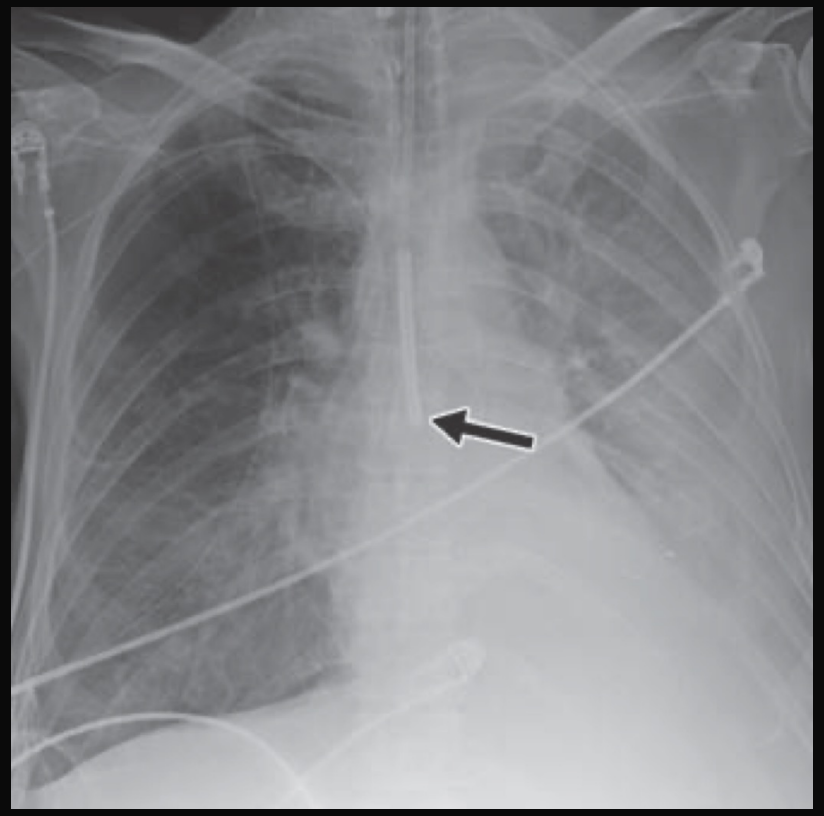
Double-tract sign: esophageal intubation

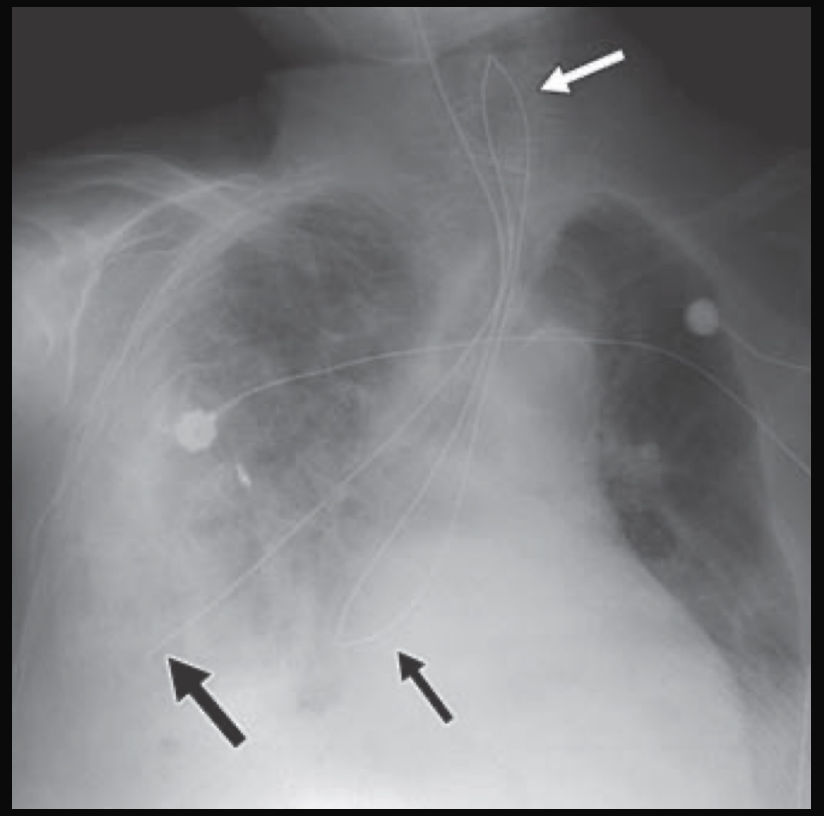


Hajjar M, Ireland A. (2019, Nov 4). Ultrasound Confirmation of ETT Placement. [NUEM Blog. Expert Commentary by Bailitz J]. Retrieved from http://www.nuemblog.com/blog/us-ett.

Naso-gastric or – enteric tube malposition or misplacement
Risk of aspiration pneumonia







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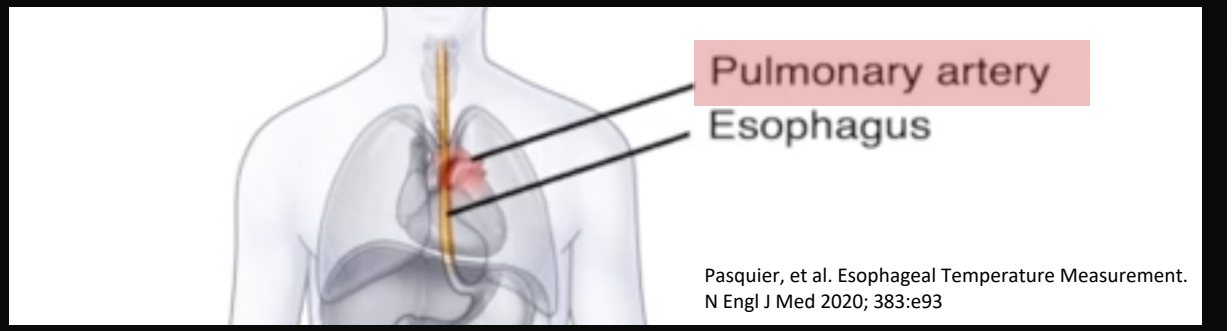
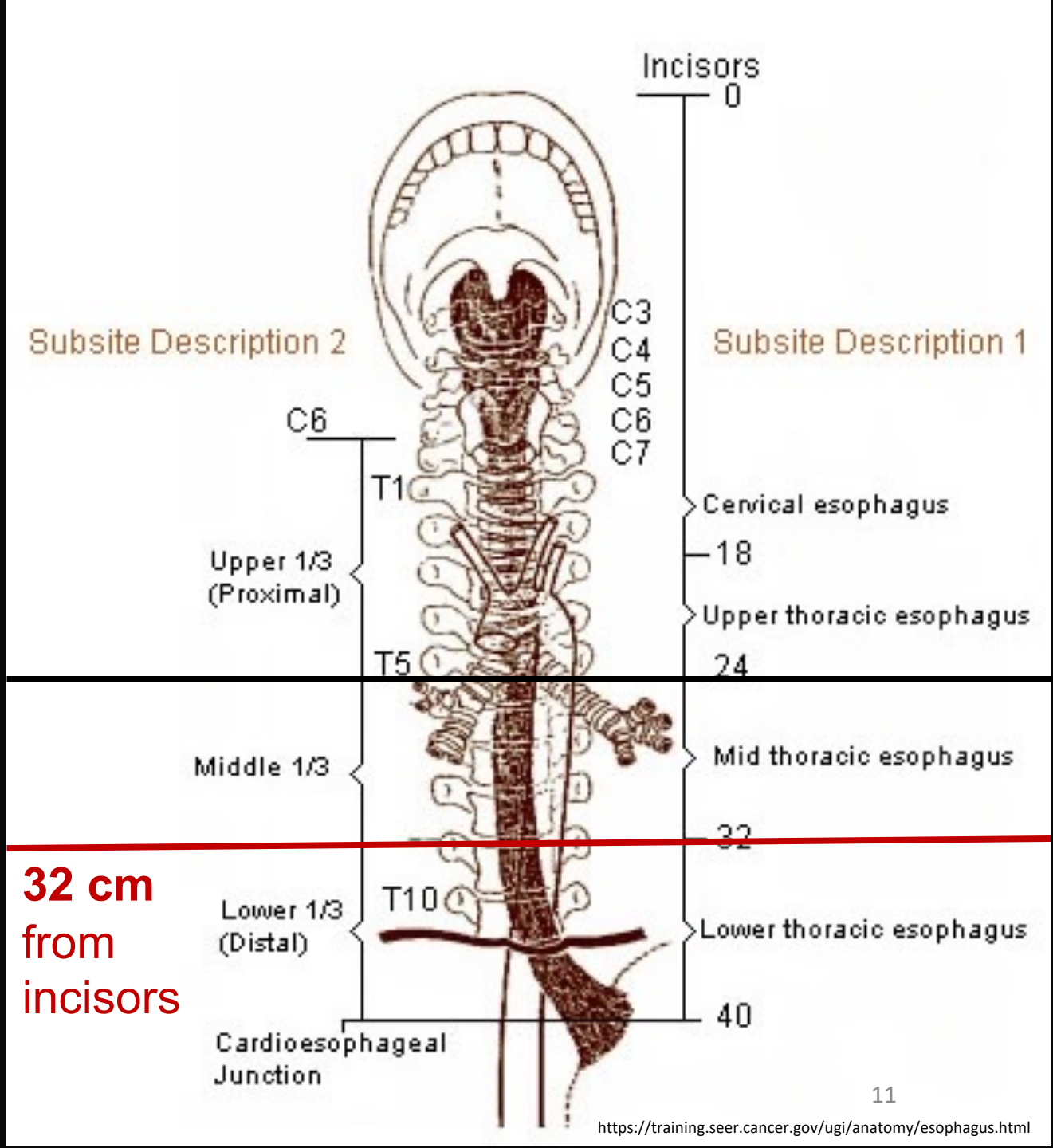
Targeted temperature management

Esophageal temperature :

Lower 1/3 esophagus: 32cm

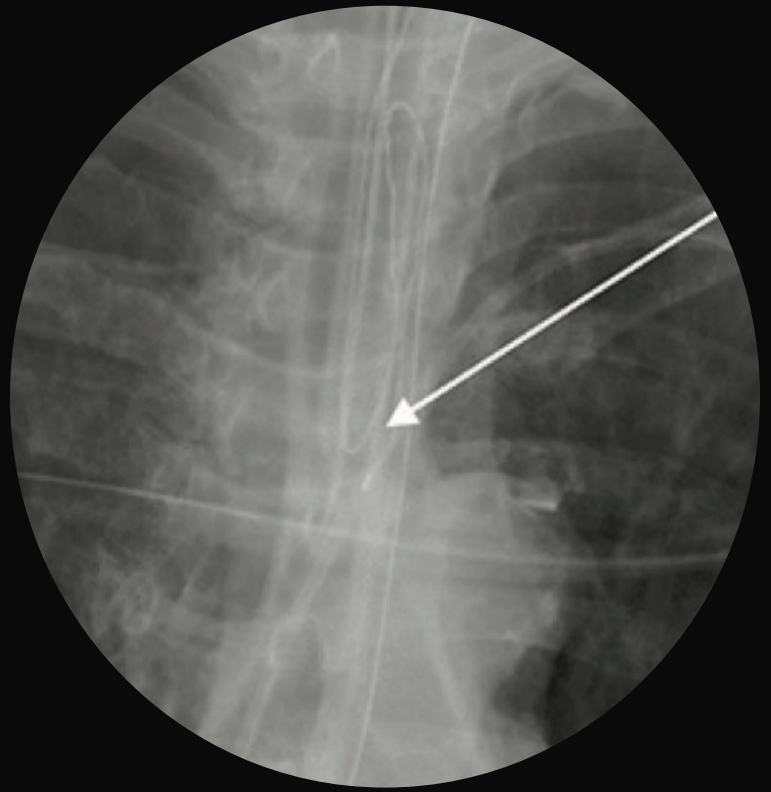


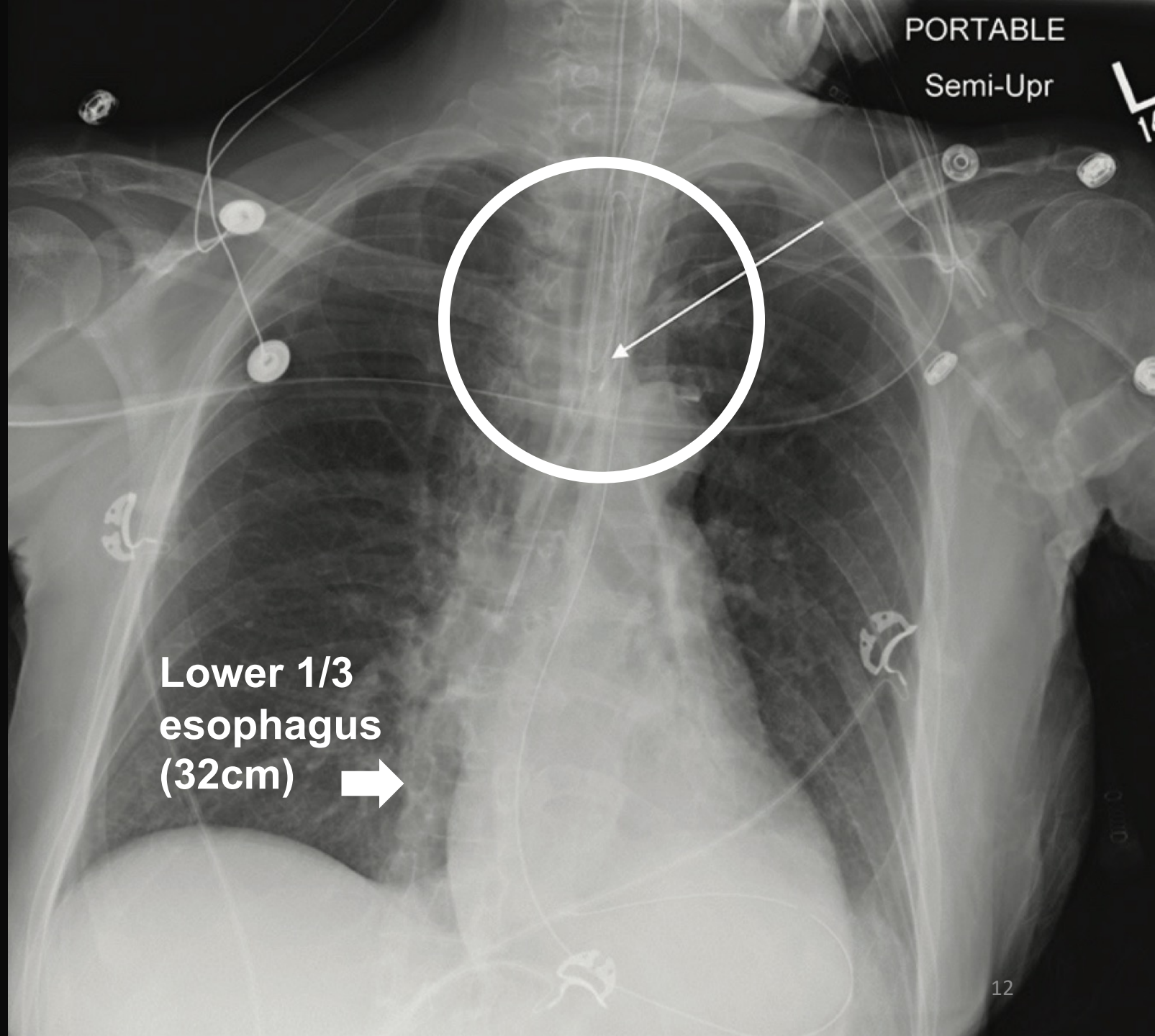
Pasquier, et al. Esophageal Temperature Measurement. N Engl J Med 2020; 383:e93



https://training.seer.cancer.gov/ugi/anatomy/esophagus.html

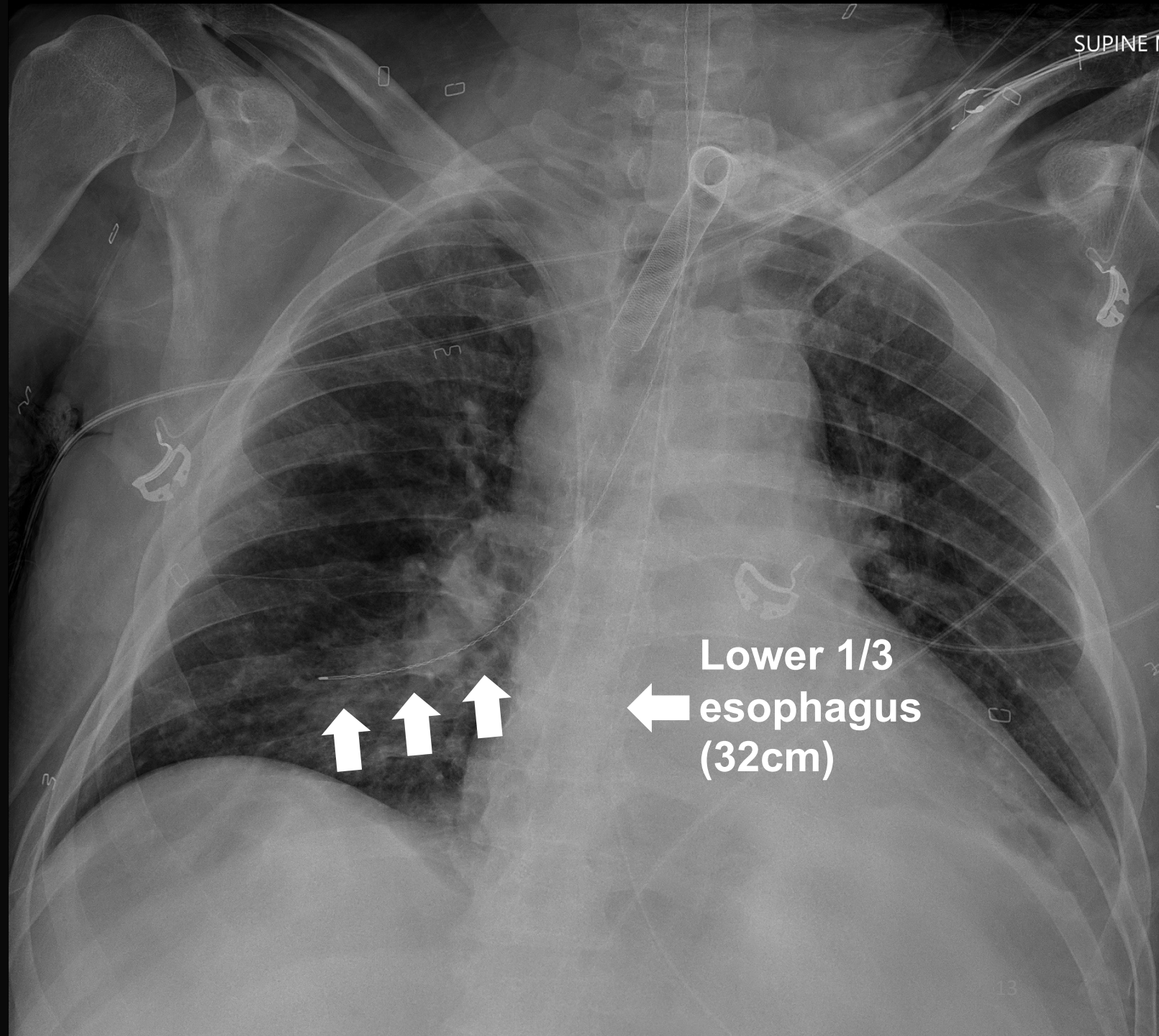
Coiling of esophageal temperature probe with its tip in the proximal thoracic esophagus





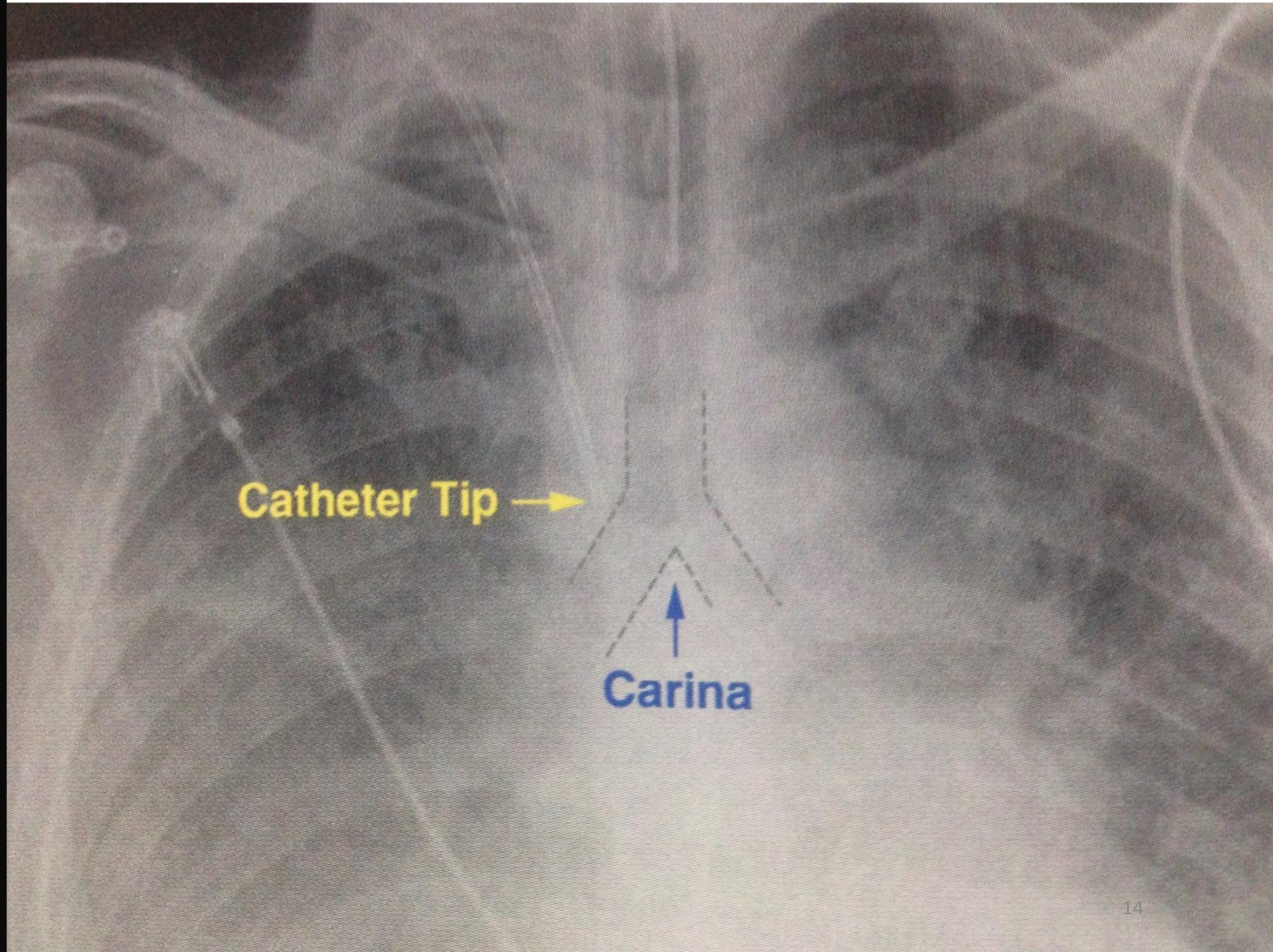
Sakthivel MK, et al.Malpositioned Lines and Tubes on Chest Radiograph - A Concise Pictorial Review. J Clin Imaging Sci. 2020;10:66

Malposition of esophageal temperature probe to right main bronchus



Case courtesy of Assoc Prof Craig Hacking, Radiopaedia.org, rID: 82135

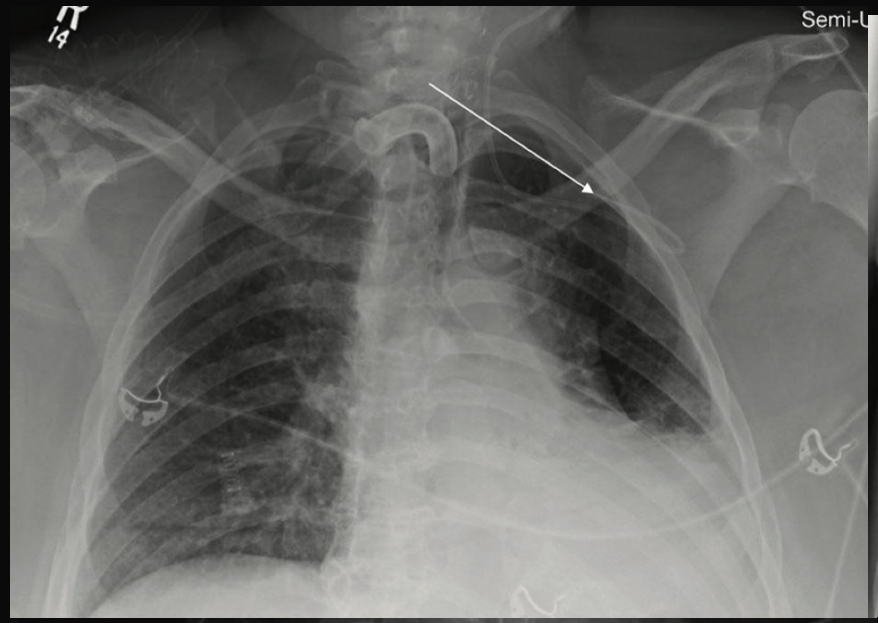
Optimal position of central venous catheter

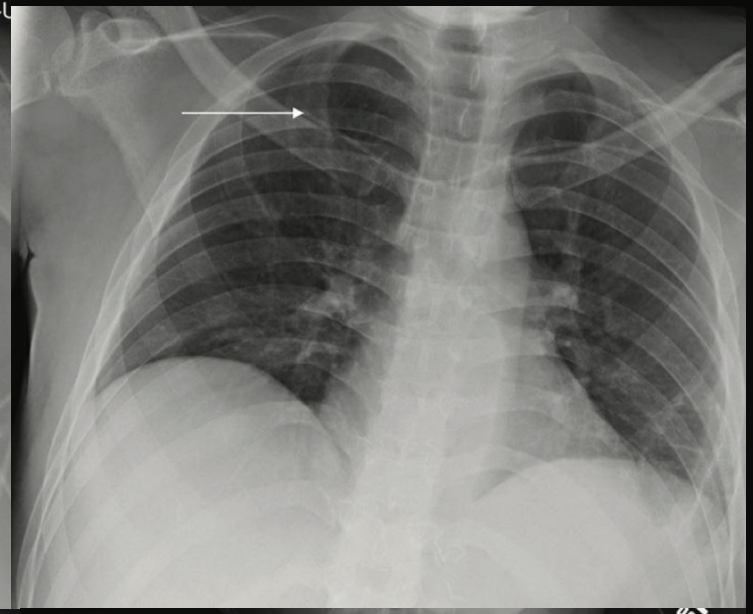


Marino, et al. Marino's the ICU Book. 4th ed

Malposition of central venous catheter：Incidence rate: 3.3%

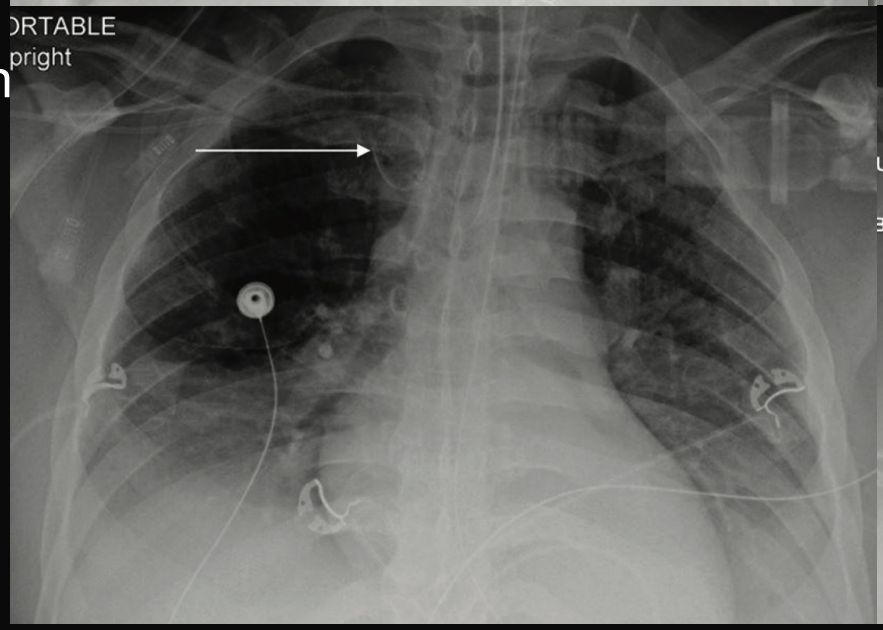
Left internal jugular v. to left subclavian v.

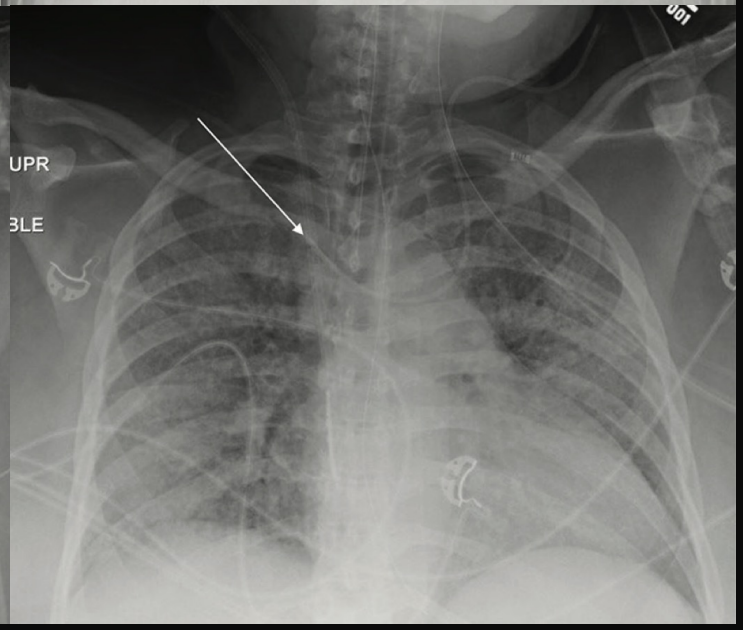




Left subclavian v. to right subclavian v.

Right subclavian v. to right brachiocephalic v.





Left internal jugular v. to right brachiocephalic v.

Sakthivel MK, et al.Malpositioned Lines and Tubes on Chest Radiograph - A Concise Pictorial Review. J Clin Imaging Sci. 2020;10:66

Smit, et al. Ultrasound to Detect Central Venous Catheter Placement Associated Complications. ANESTHESIOLOGY 2020; 132:781-

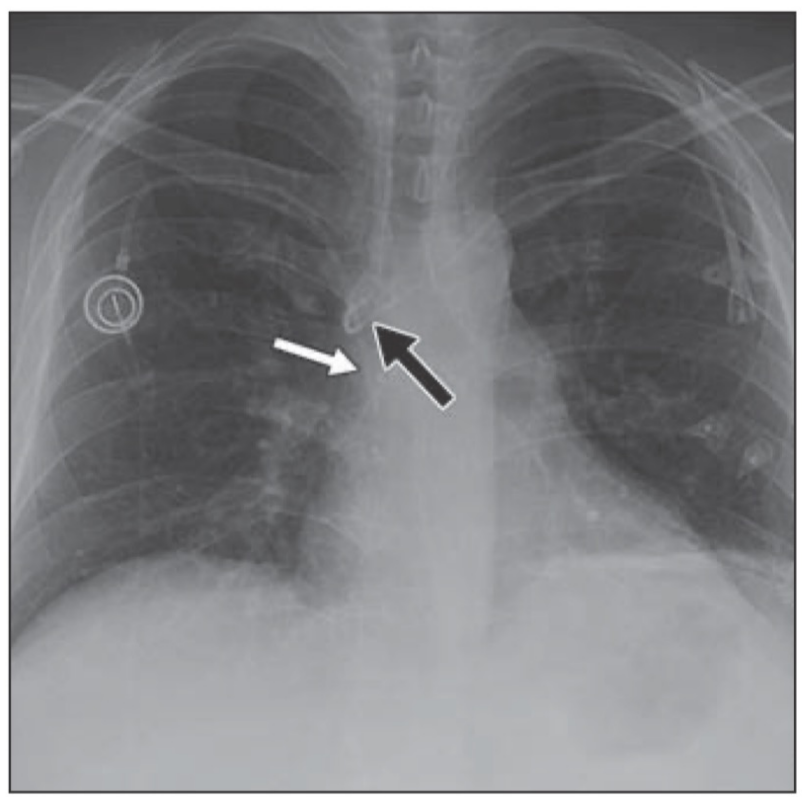
Misplaced central venous catheter in azygos arch

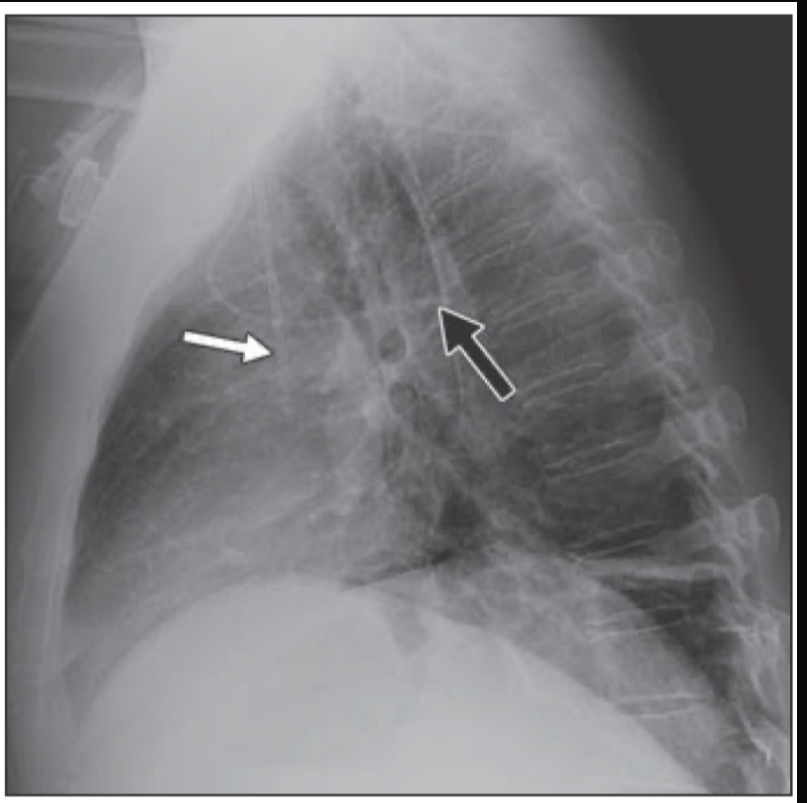
A catheter in the azygos vein may appear to be looped within the SVC at the level of the junction of the trachea and the right main bronchus.

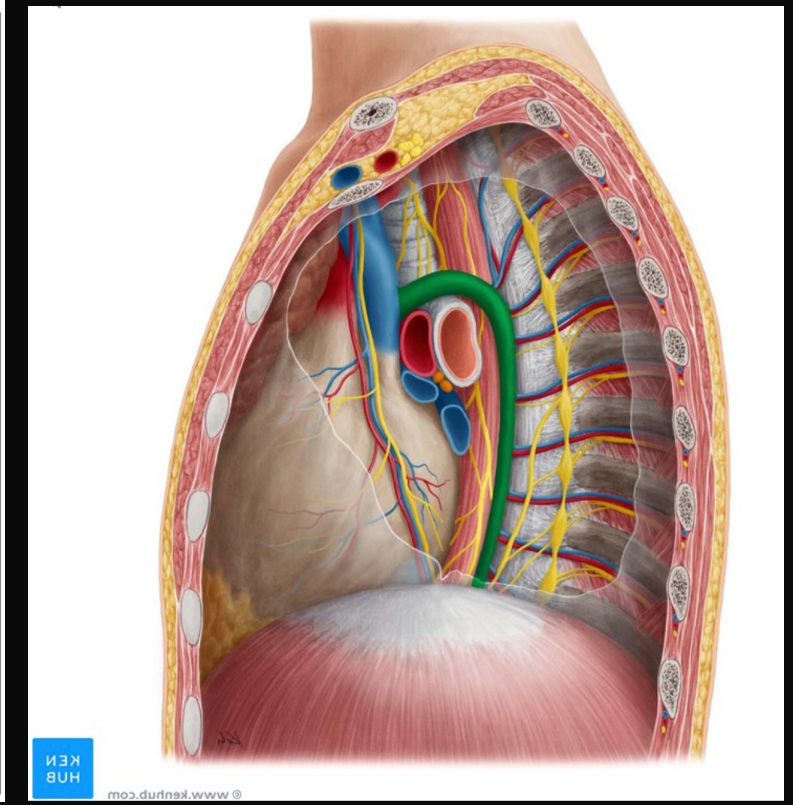
Confirmed by **lateral view**.

CVC coursing posteriorly along the arch of the azygos vein at a level just below the aortic arch.

Azygos vein: green one







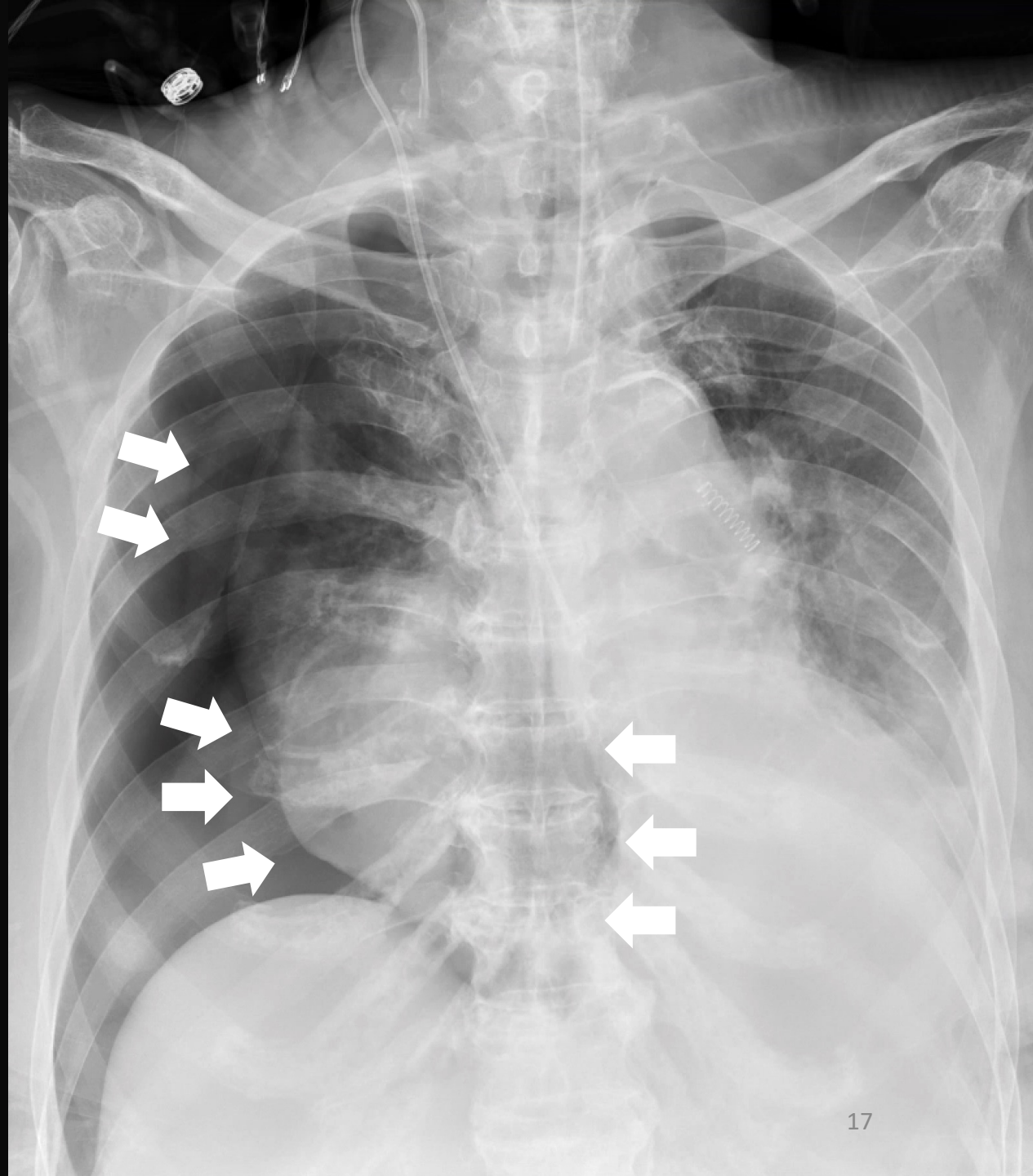
Godoy, et al. Chest Radiography in the ICU: Part 2, Evaluation of Cardiovascular Lines and Other Devices. AJR 2012; 198:572–581

https://www.kenhub.com/en/library/anatomy/azygos-vein

Complication after CVC insertion
Pneumothorax

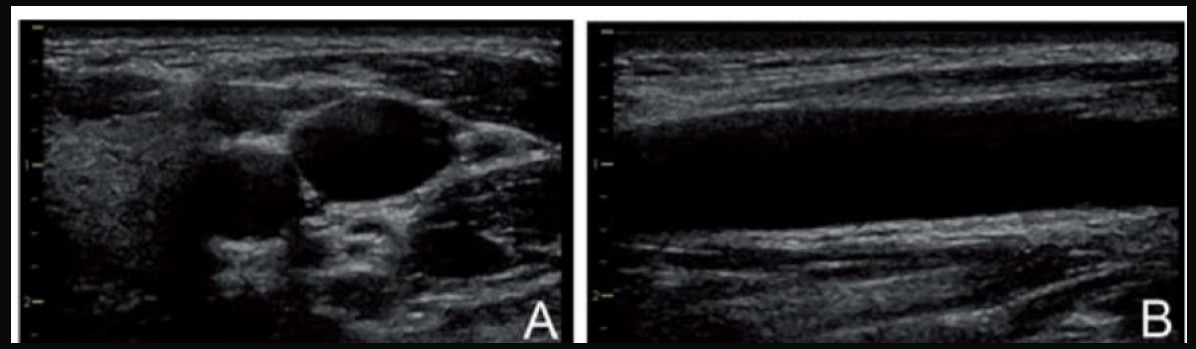
Incidence rate:
CXR diagnosed: 0.7%
vs
Ultrasound diagnosed:1.5%

Smit, et al. Ultrasound to Detect Central Venous Catheter Placement Associated Complications. ANESTHESIOLOGY 2020; 132:781–94)

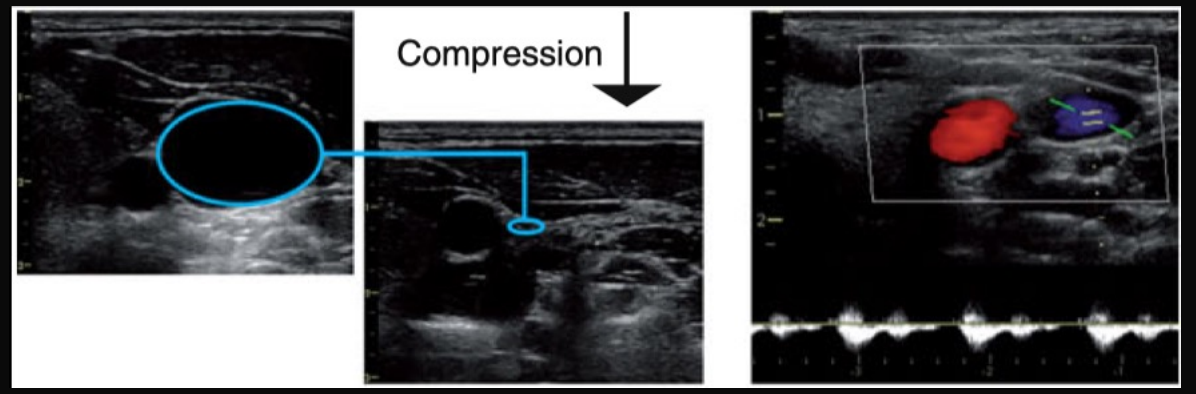


Ultrasound-guided CVC insertion

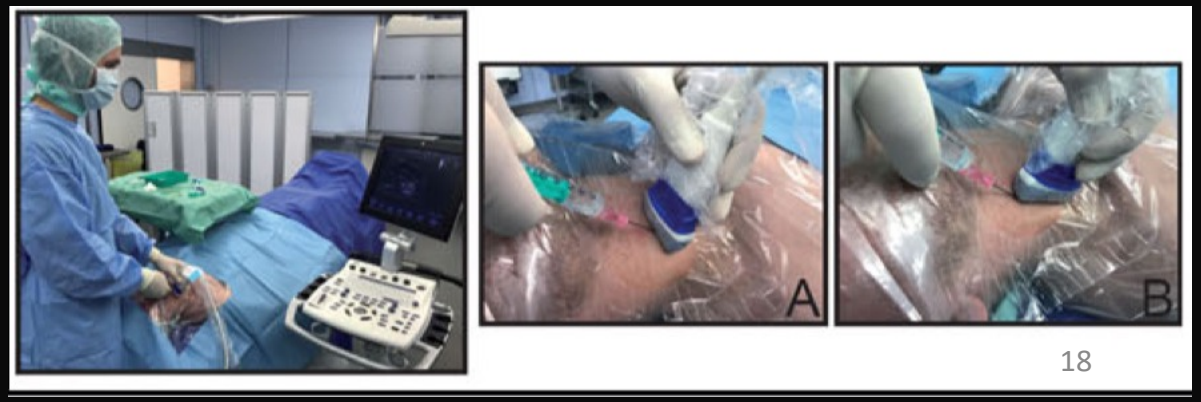
1. Anatomy identification
   of insertion site and localization of the vein



2. Patency confirmation of the vein



3. Real-time US guidance
   for puncture of the vein



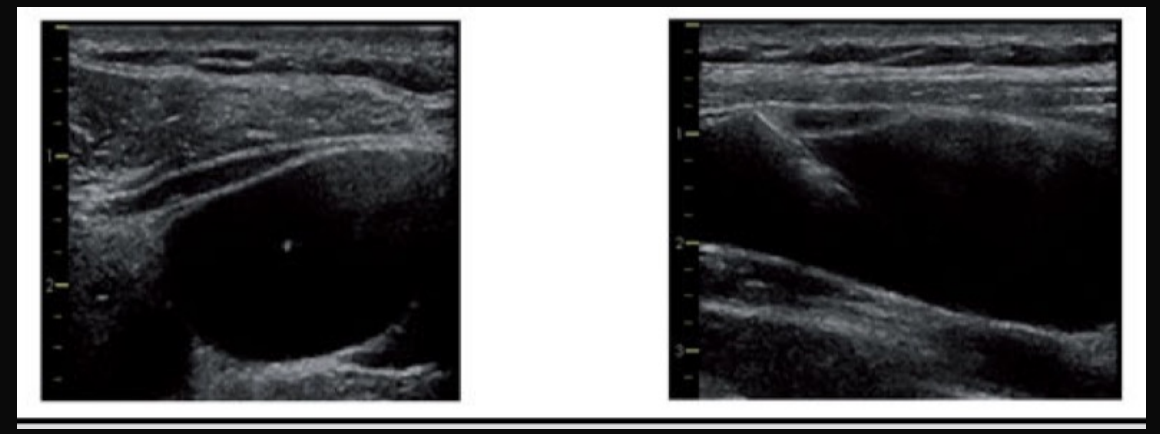
Saugel et al. Critical Care (2017) 21:225

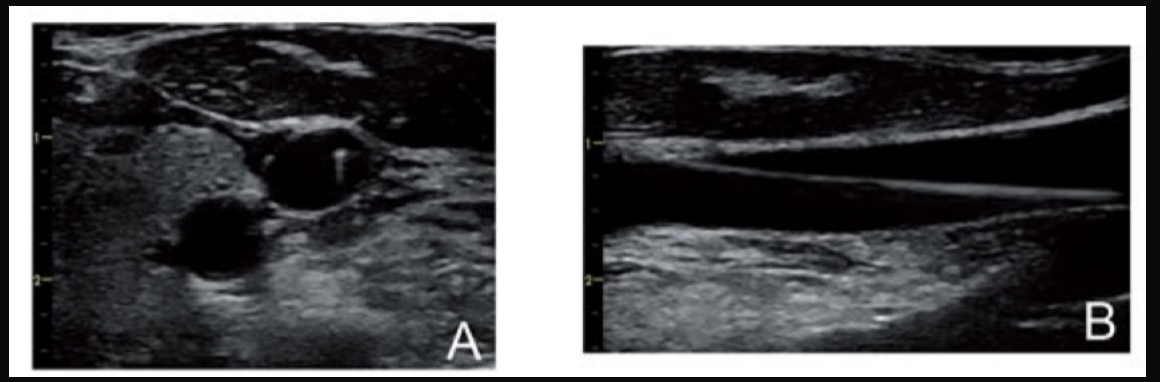
Ultrasound-guided CVC insertion

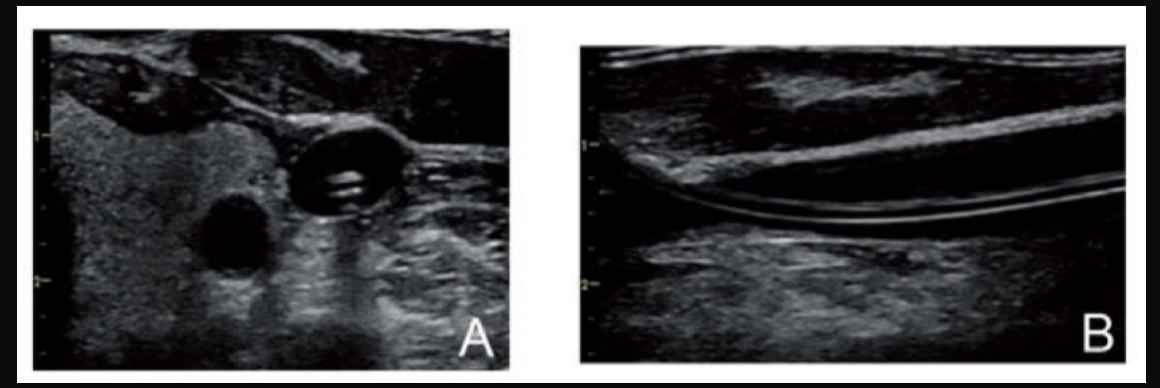
4. Confirm needle position in vein

5. Confirm guidewire position in vein

6. Confirm catheter position in vein







Saugel et al. Critical Care (2017) 21:225

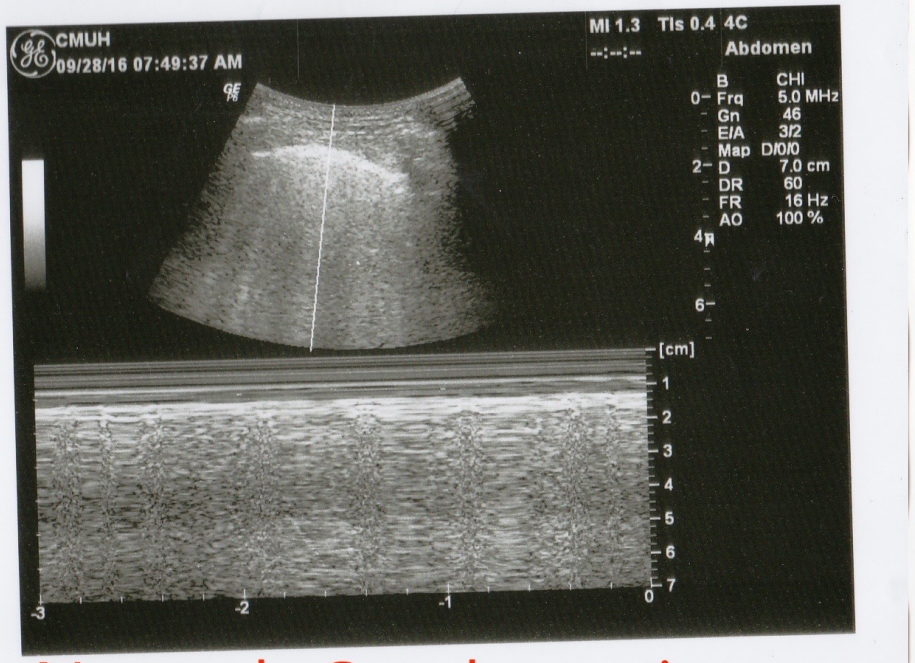
Ultrasound-guided CVC insertion

7. Confirm the pneumothorax

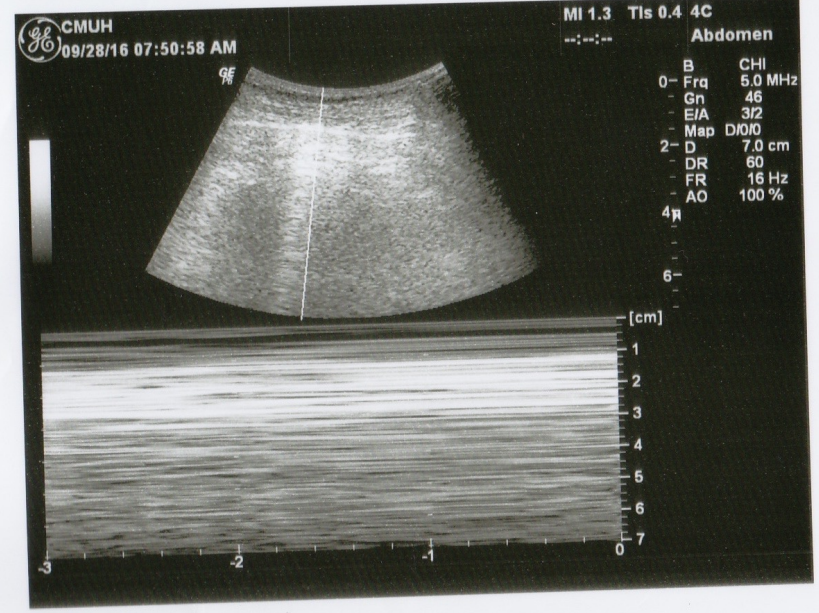
8. Confirm the tip of CVC

   Contrast-enhanced ultrasound (CEUS)

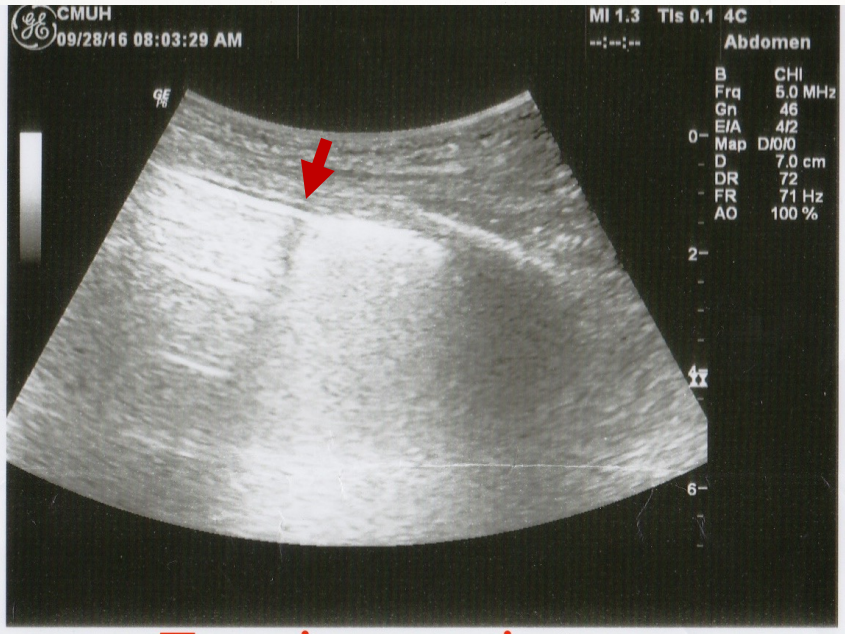
   10-20 ml NaCl with 1ml air (bubble seen within 2s)



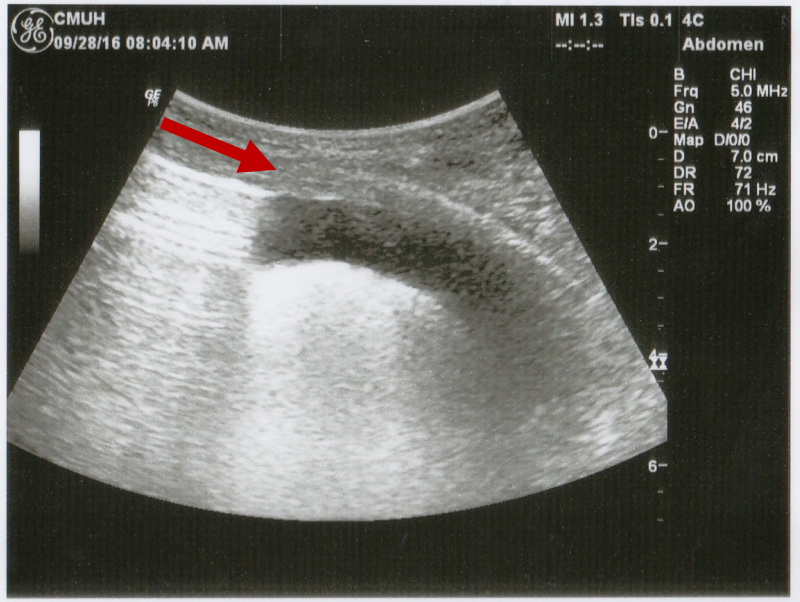
Normal : Seashore sign



PNX: Stratosphere sign



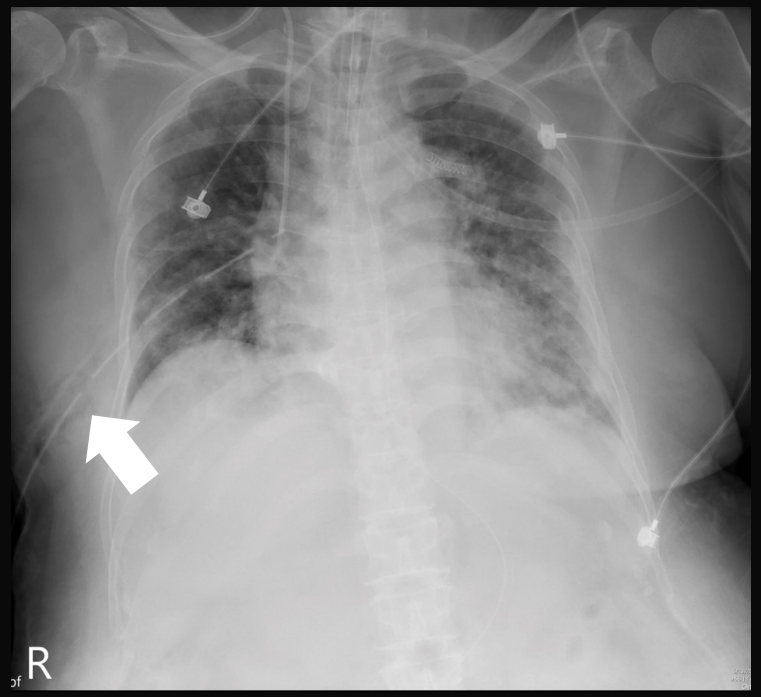
Turning point

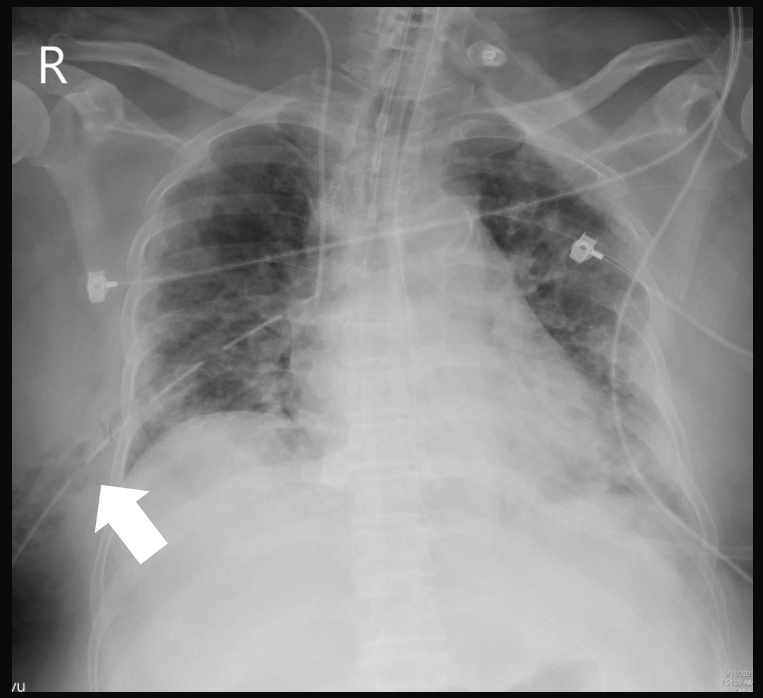


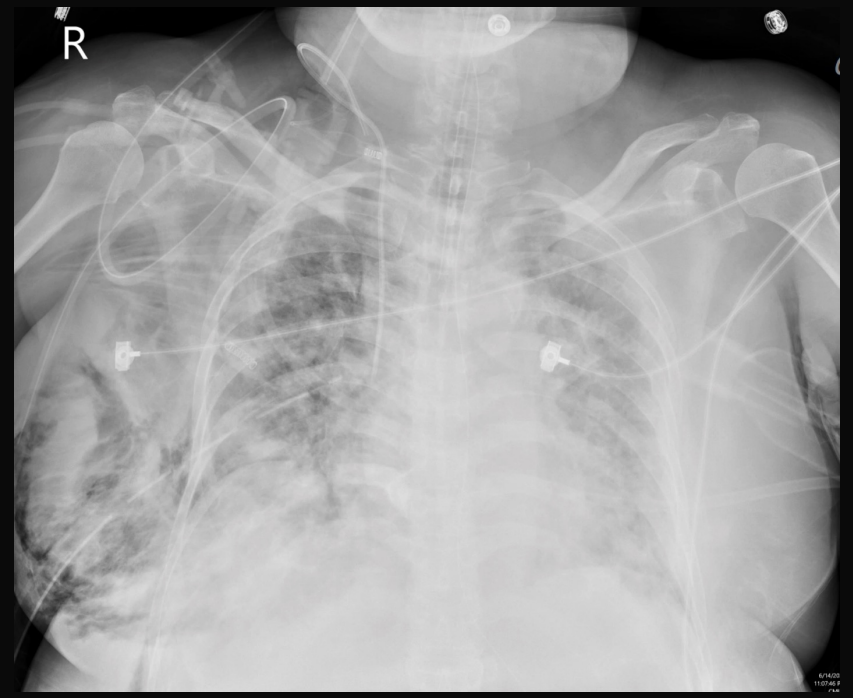
Curtain sign

Malposition of chest tube

The **side hole** *should* be always positioned **medial to the inner margin of the ribs**.



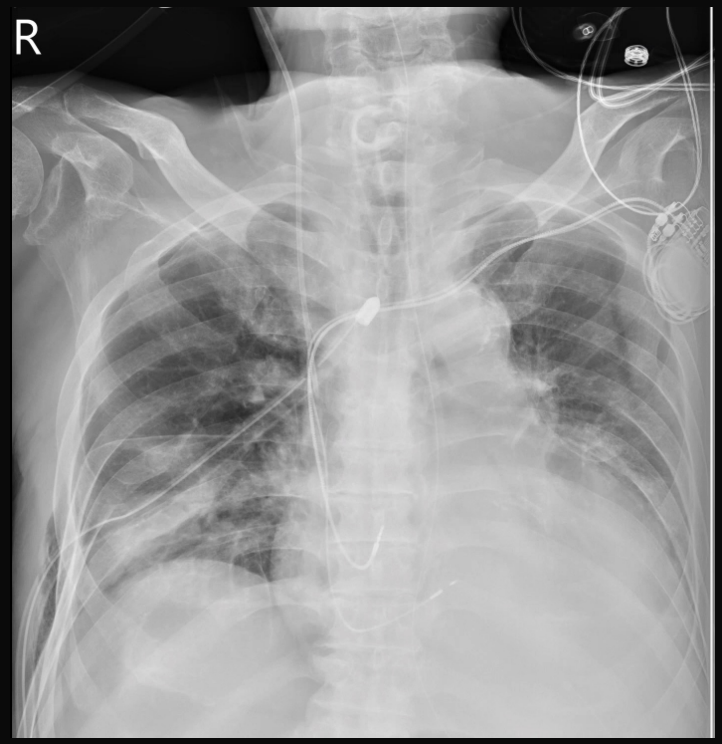


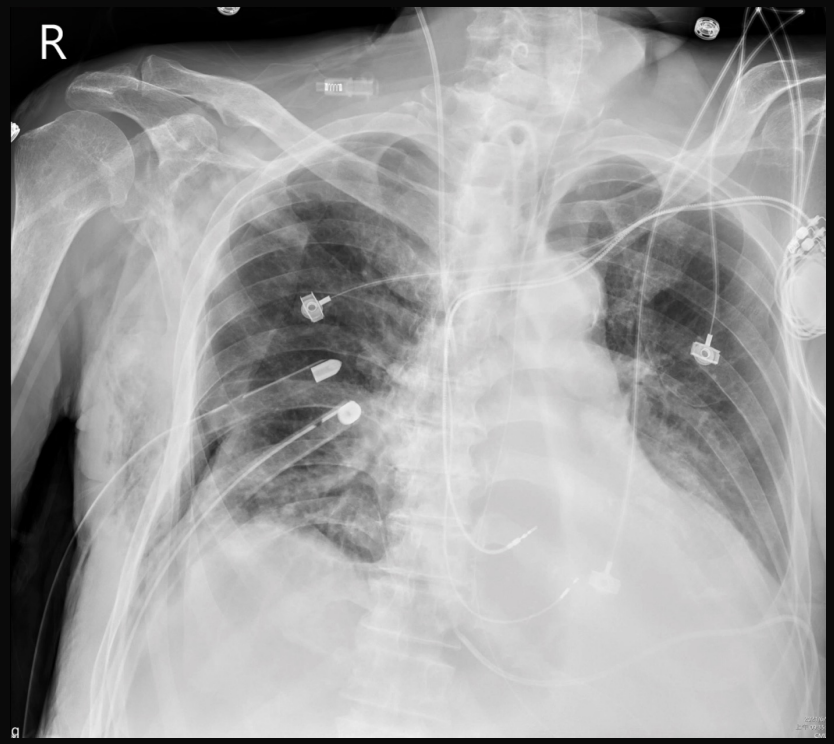


Malfunction of chest tube

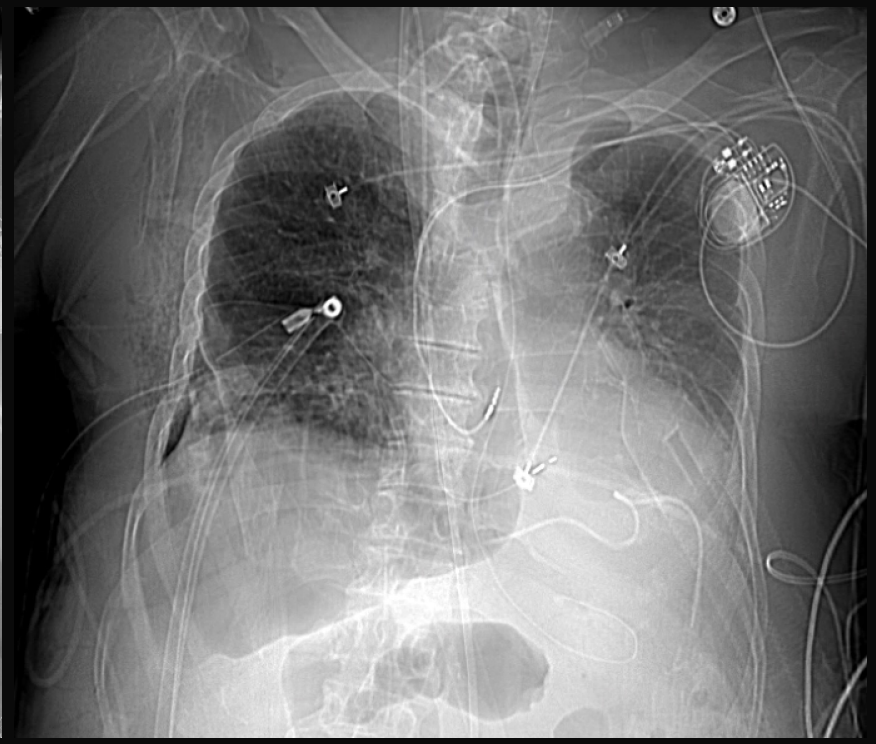
Occlusion by blood clot, pus, fluid, lung parenchyma

Hyper-translucency over liver



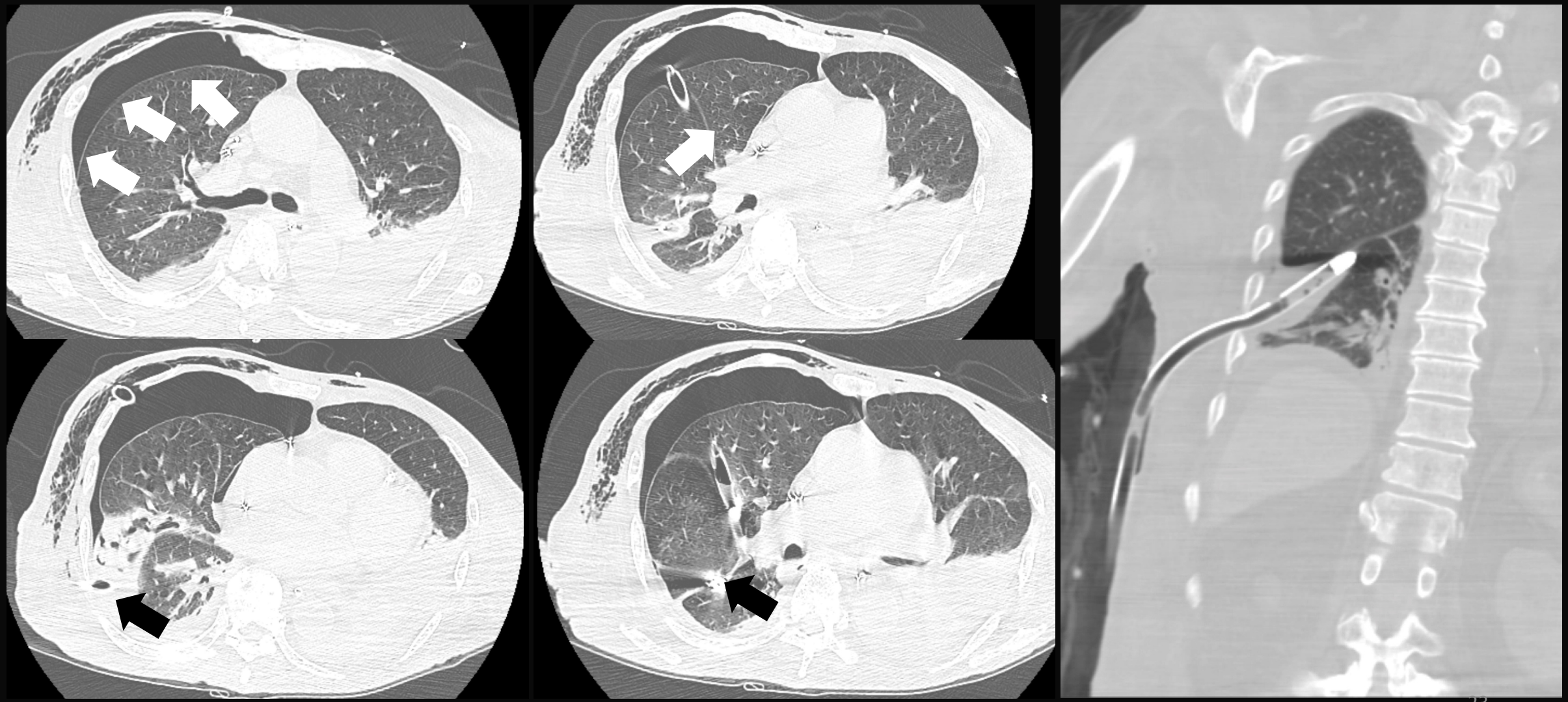


CT: still can see the PNX



Malfunction of chest tube

Entrapped in major and minor fissue

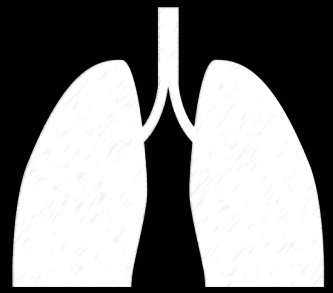


大綱

管路位置與併發症
急症疾病
心血管影像

Daily patient evaluation

Circulation
BP, HR, Perfusion



Respiration
RR, SpO_2, MV

Urination
UO, acidosis,
Electrolyte

Acute respiratory failure
BLUE protocol

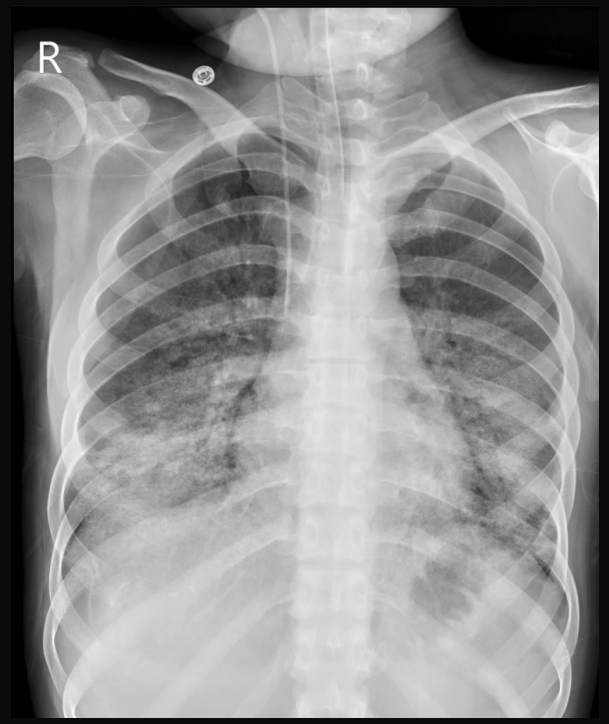
Infection
Sepsis
MDR

Sedation
PADIS

清晨三點，ARDS病人大喘，100%氧氣下，血氧只剩 82%

放射科正在急做栓塞，portable CXR至少 一小時 後才能來

值班的我，該怎麼診斷？



?

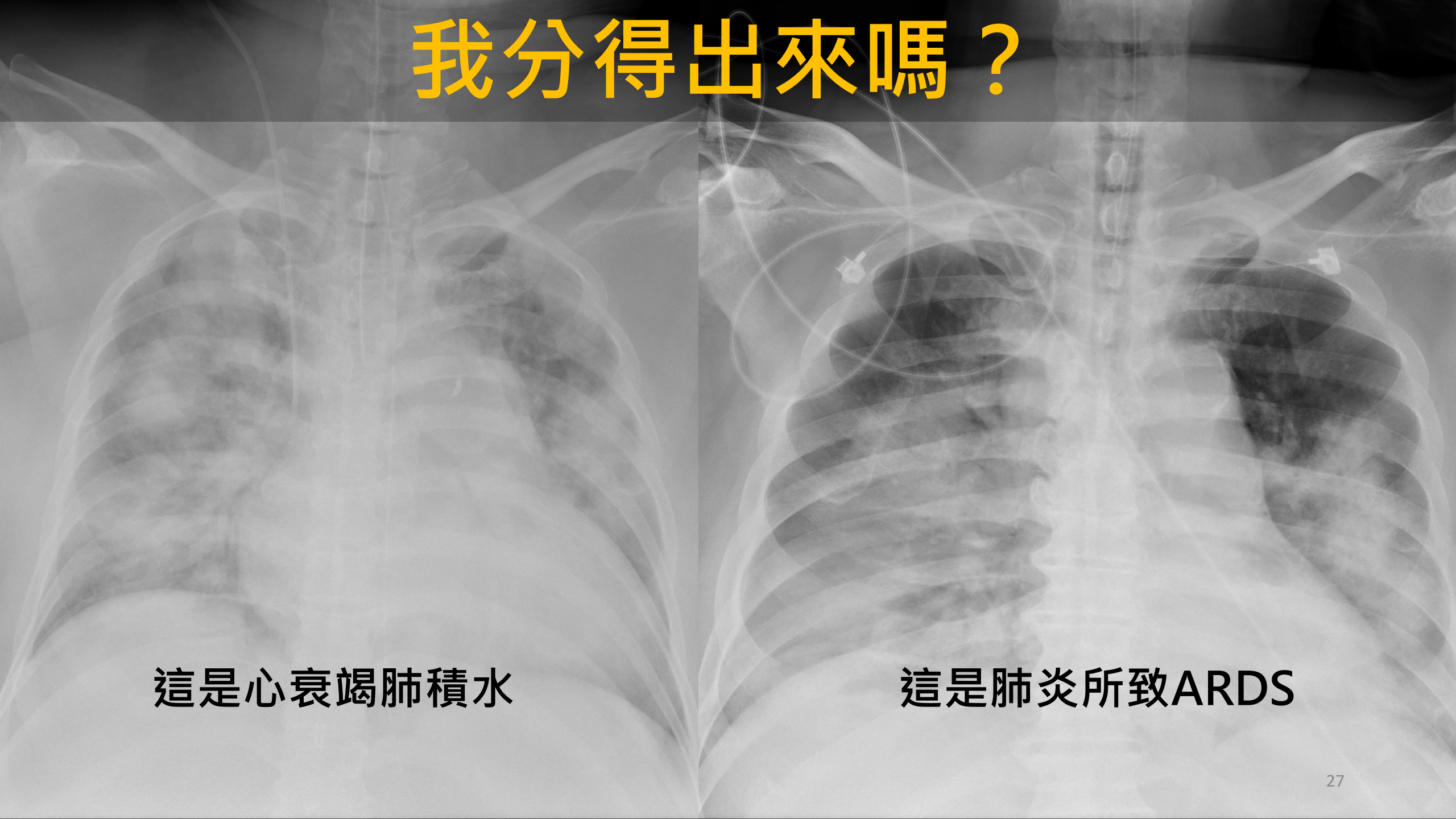
肺炎惡化

氣胸

心衰竭

肺栓塞

我分得出來嗎？



這是心衰竭肺積水

這是肺炎所致ARDS

Bedside Lung Ultrasound in Emergency
BLUE protocol

3

三個點 —邊　2 BLUE point / PLAPS point

三個Sign　A-line / B-line / Sliding sign

三分天下

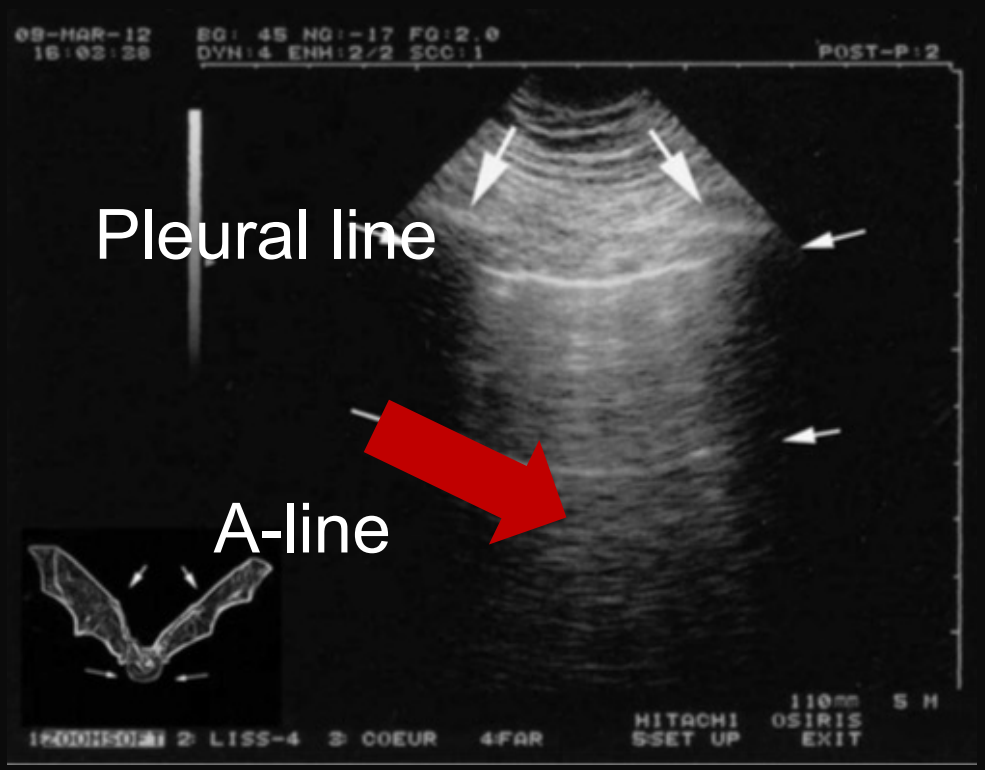
- **A profile:** Airway disease / PE / Extrapulmonary
- **B profile:** Cardiogenic edema / ARDS
- **Others:** Lung parenchymal problem, PNX, pleural effusion, pneumonia

Ultrasound: radiation free, less time-consumption, bedside available

Smit et al. Critical Care (2018) 22:65
Lichtenstein et al, CHEST 2015; 147(6):1659-1670

三個Sign

① A-line



② B-line

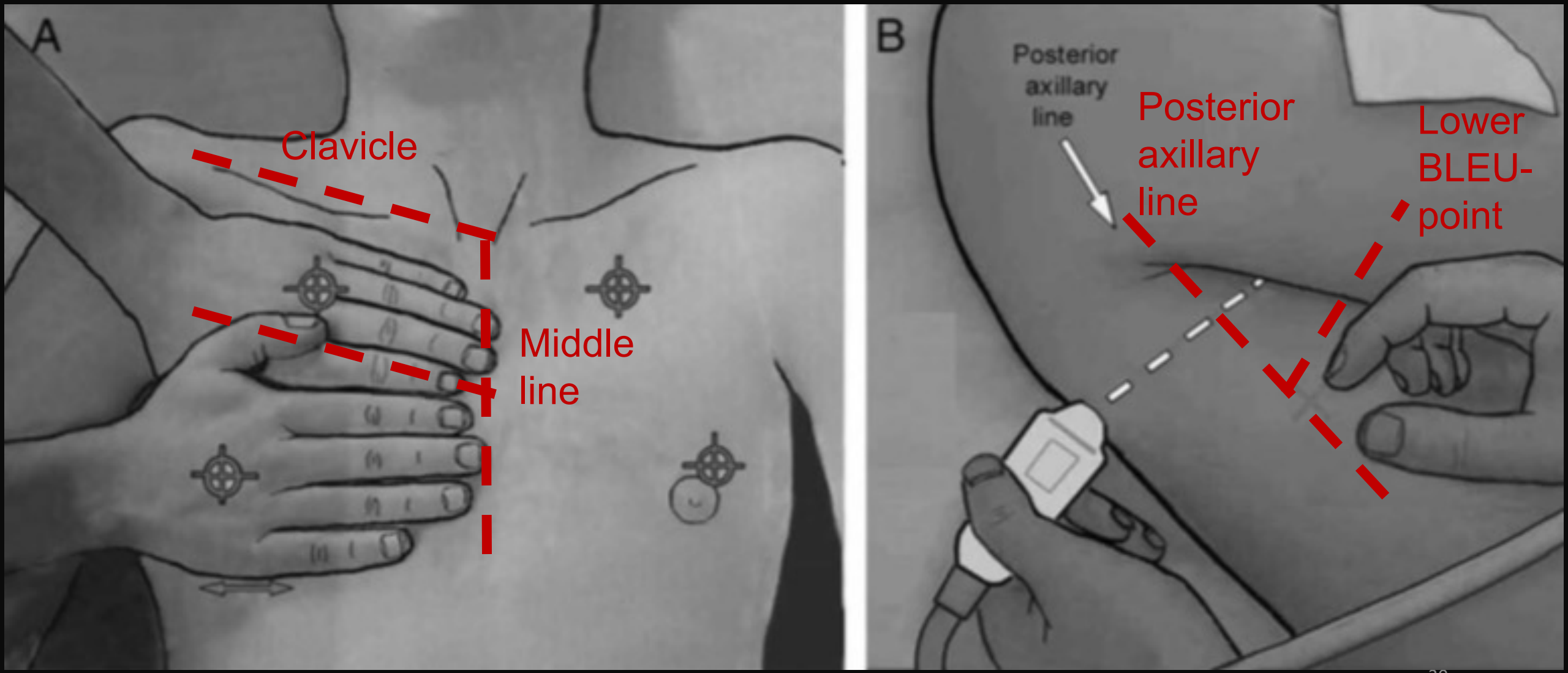
③ Sliding sign

Lichtenstein et al, CHEST 2015; 147(6):1659-1670

Pulmonary edema
Infiltration
Interstitial lung disease

一邊三個點

4 **BLUE points** + 2 **PLAPS points** (Posterolateral alveolar and/or pleural syndrome)



Lichtenstein et al, CHEST 2015; 147(6):1659-1670

Bedside Lung Ultrasound in Emergency
BLUE protocol

3

三個點 —邊　2 BLUE point / PLAPS point

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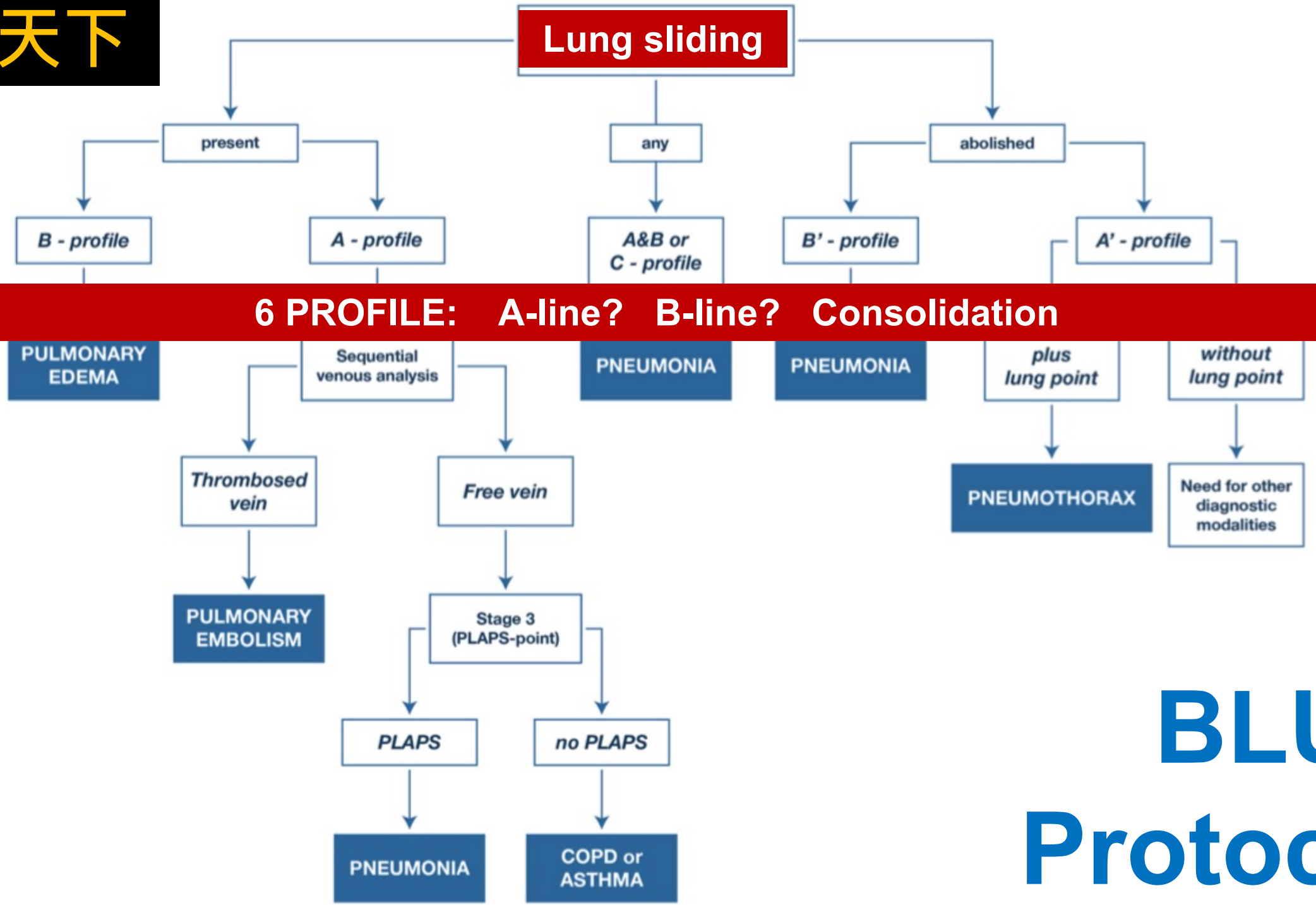
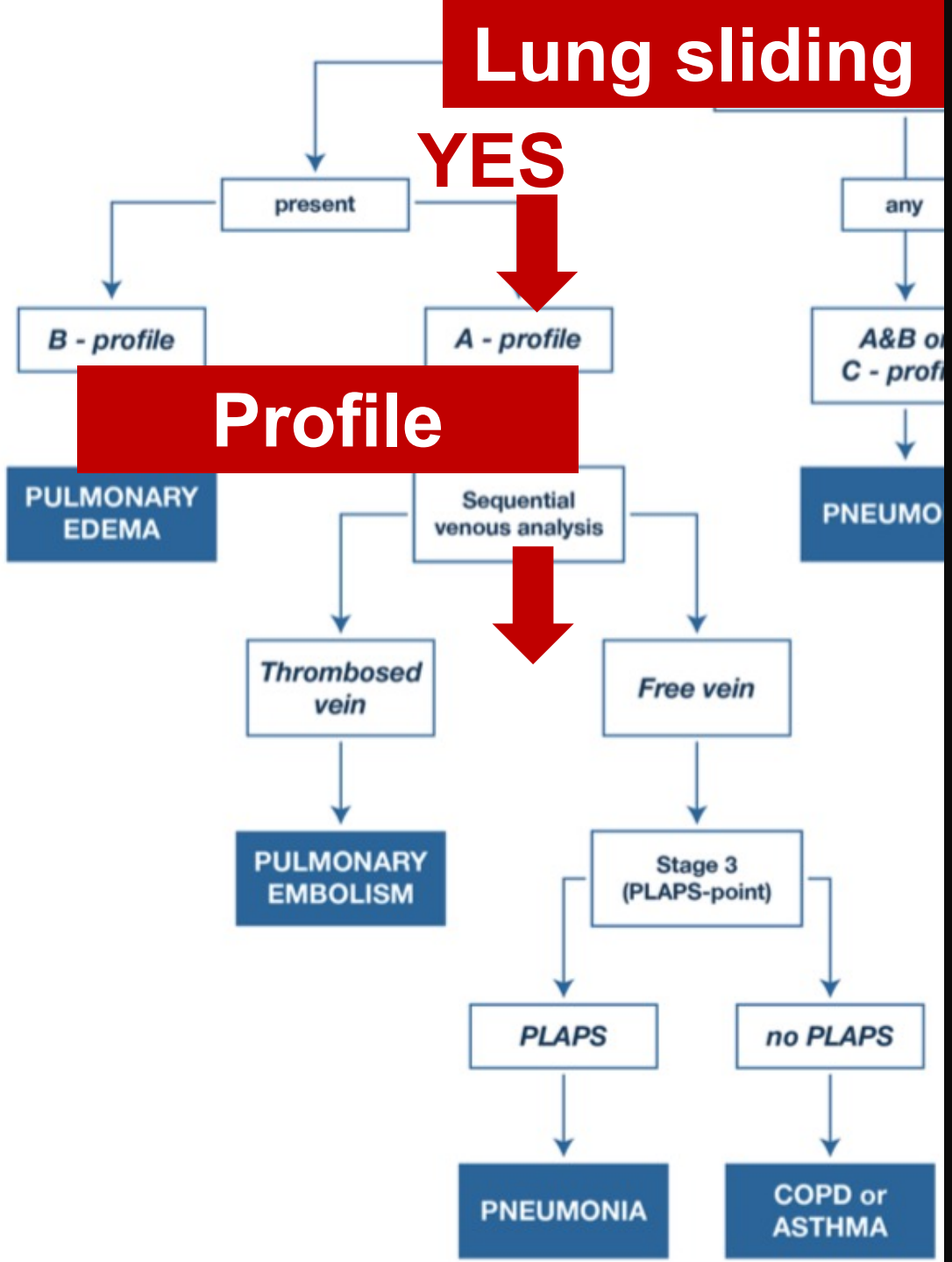
Lichtenstein et al, CHEST 2015; 147(6):1659-1670

三分天下



BLUE Protocol



A-profile

Sliding sign +A-line

+ PLAPS

Pneumonia

+ Thrombosed vein

Pulmonary embolism

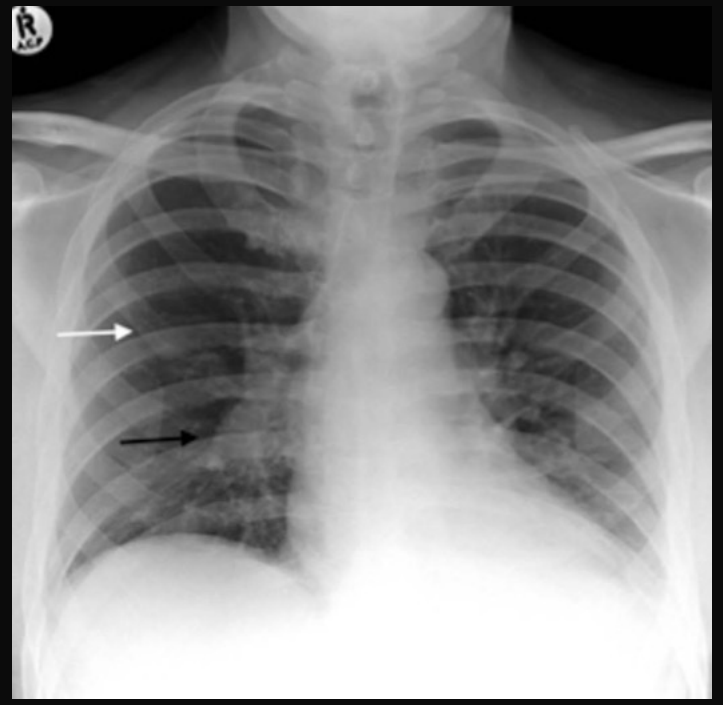
NO

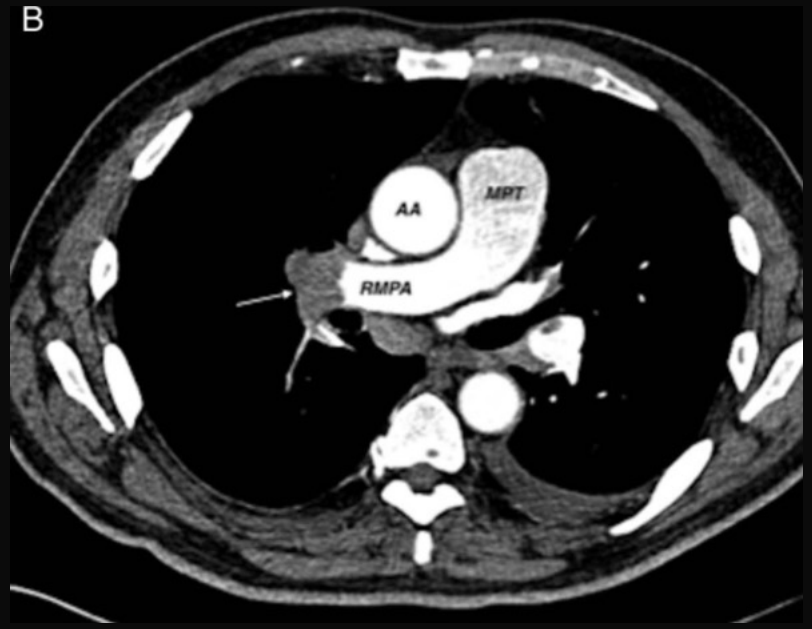
COPD / Asthma

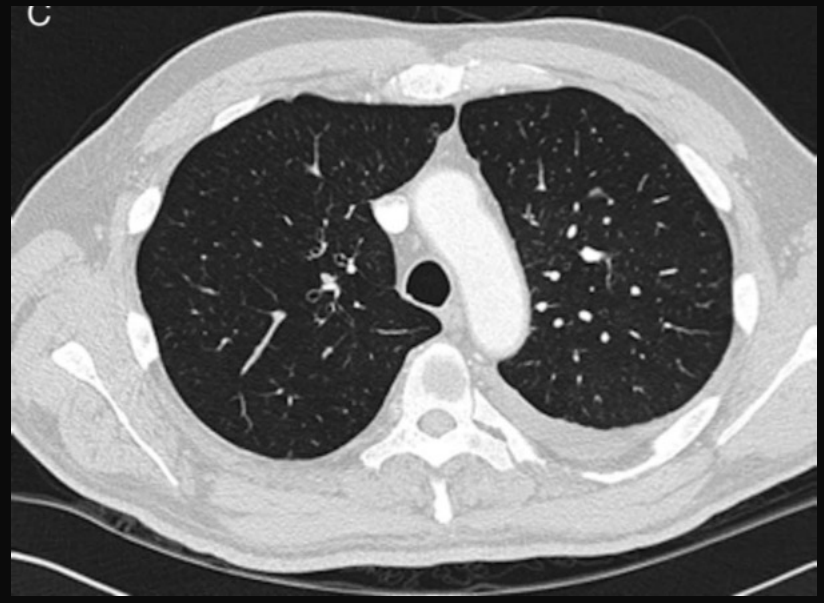
Extrapulmonary problems

Pulmonary embolism

Westermark sign: regional pulmonary oligaemia
Palla sign: enlargement of the descending pulmonary artery

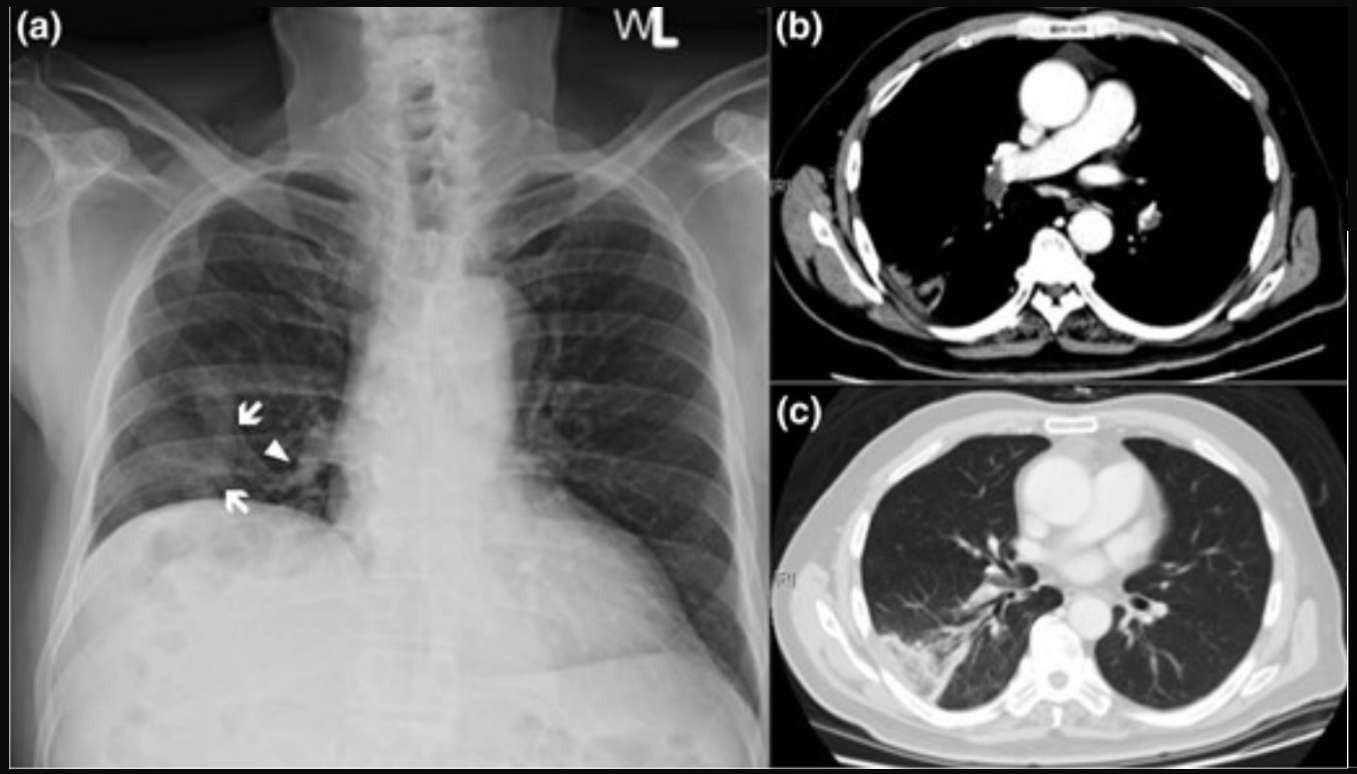


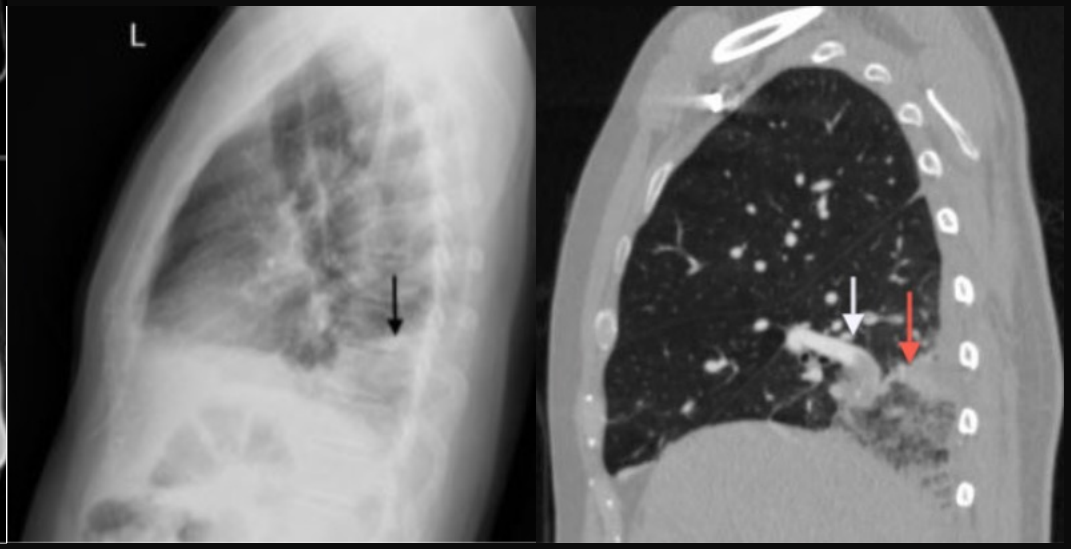




Pulmonary embolism

Hampton's hump sign: wedge-shaped consolidation with the base of the triangle against the pleura. It means pulmonary **infarction (** High specificity:82%, but low sensitivity: 22%)





C.-W. Hsu, H.-Y. Su, Palla's sign and Hampton's hump in pulmonary embolism, QJM: An International Journal of Medicine, Volume 110, Issue 1, January 2017, Pages 49–50,

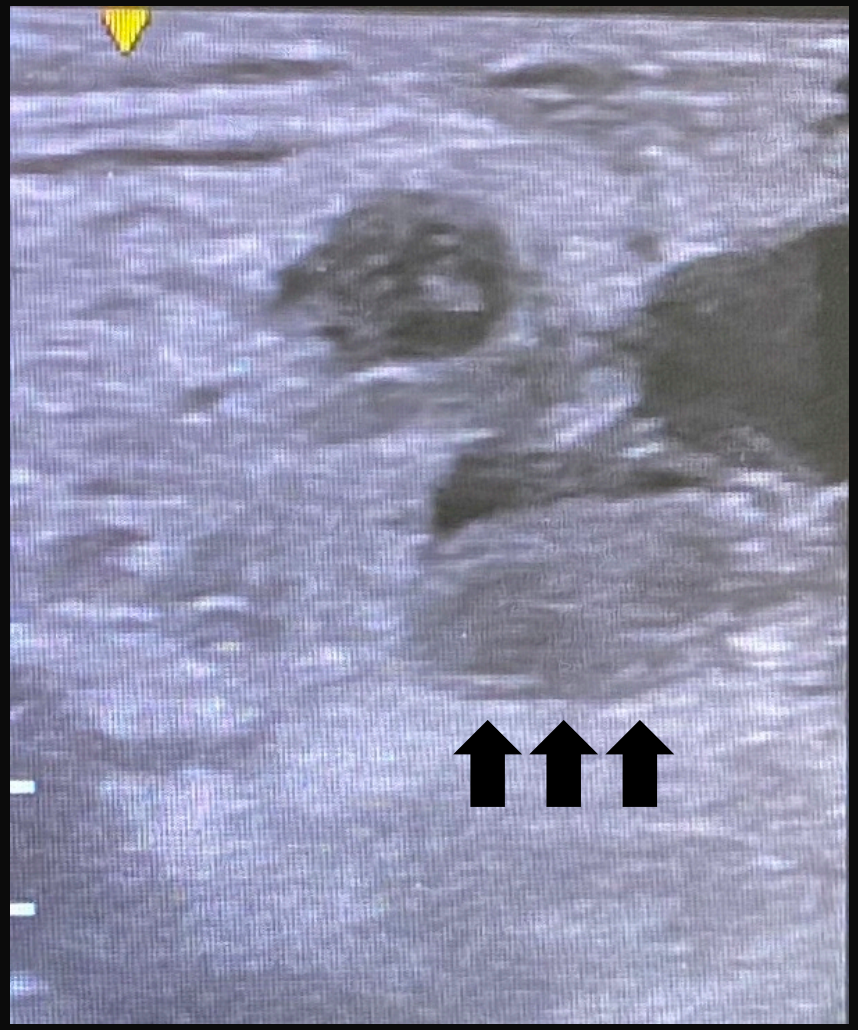
Patane, et al. Hampton's Hump in Pulmonary Embolism. DOI: https://doi.org/10.21980/J83W27

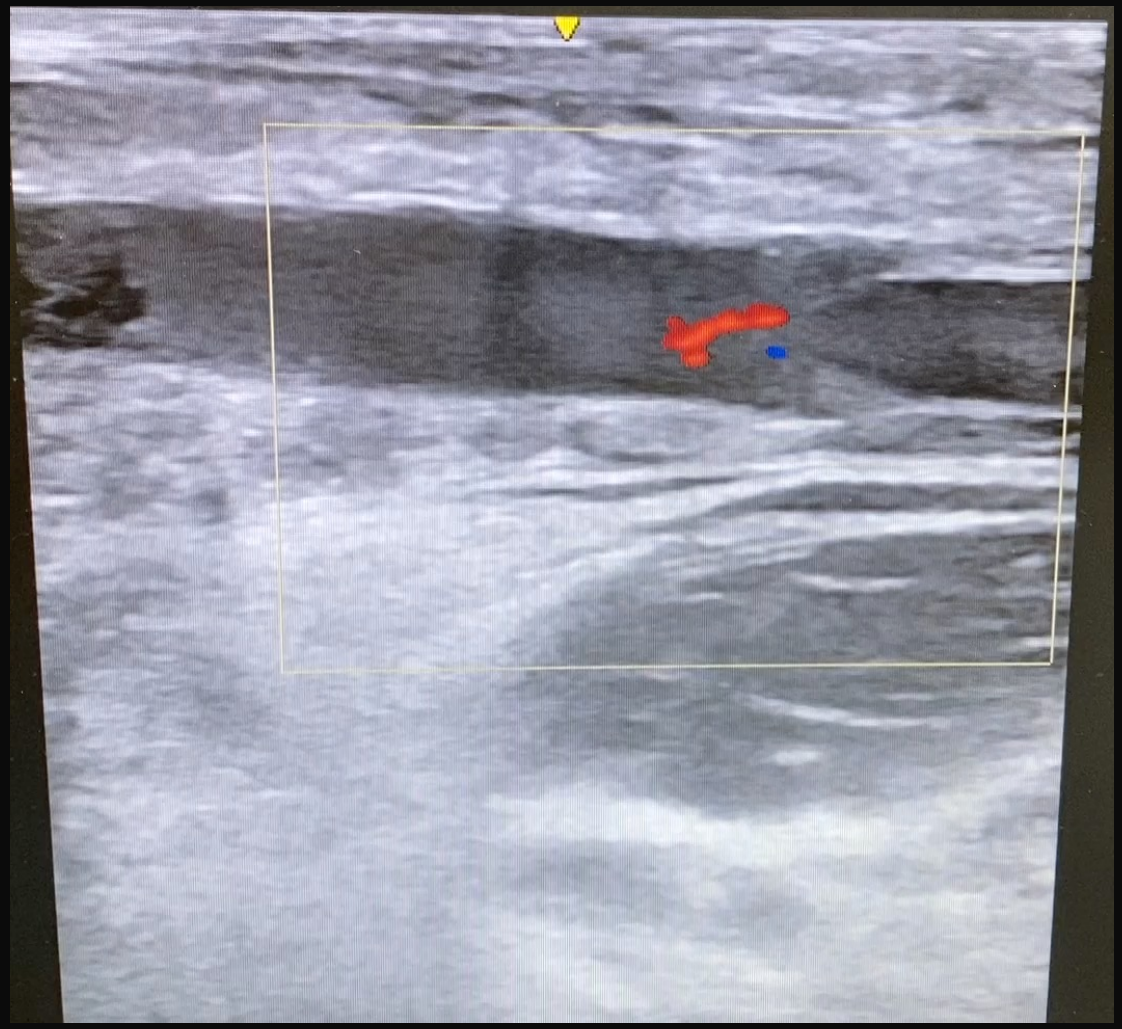
65 man with ITP under prednisolone use
admitted for dyspnea for 3 days
diagnosed with PJP under sevatrium

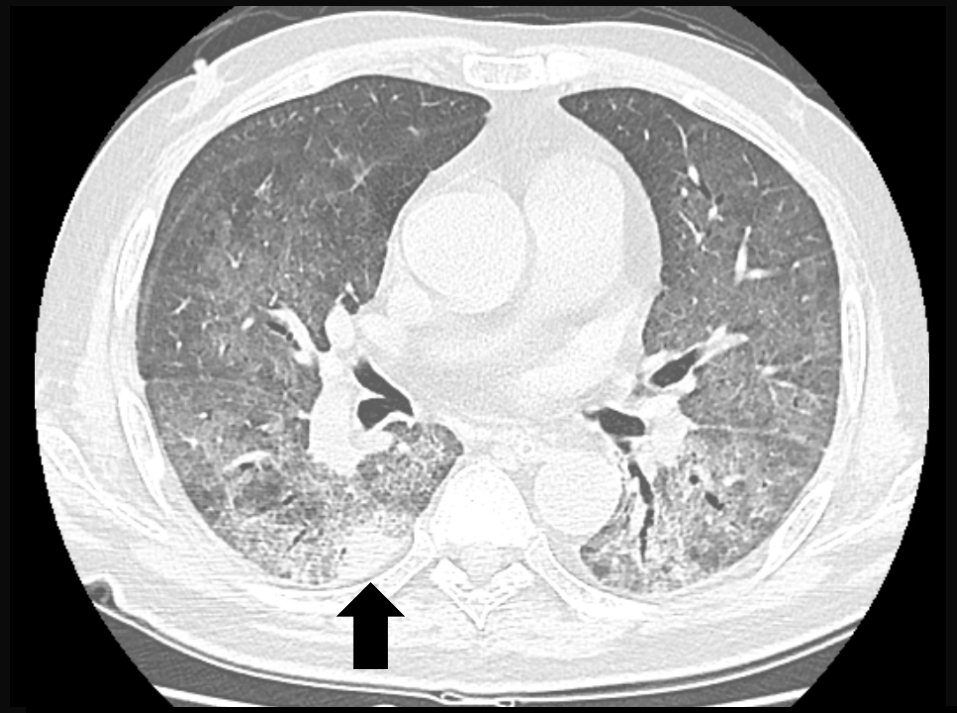
But still poor saturation with
relative fair lung compliance

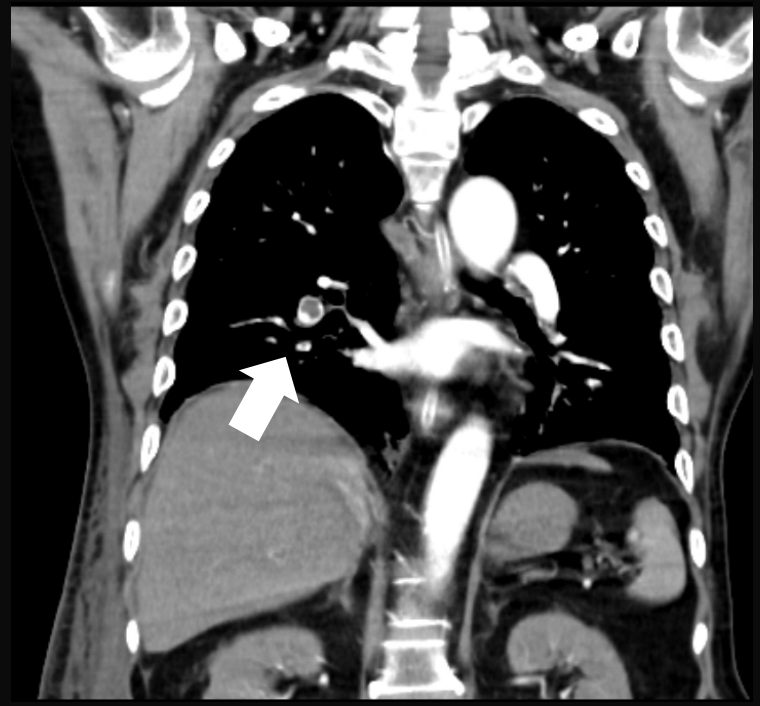
Bil legs swelling, esp. right leg

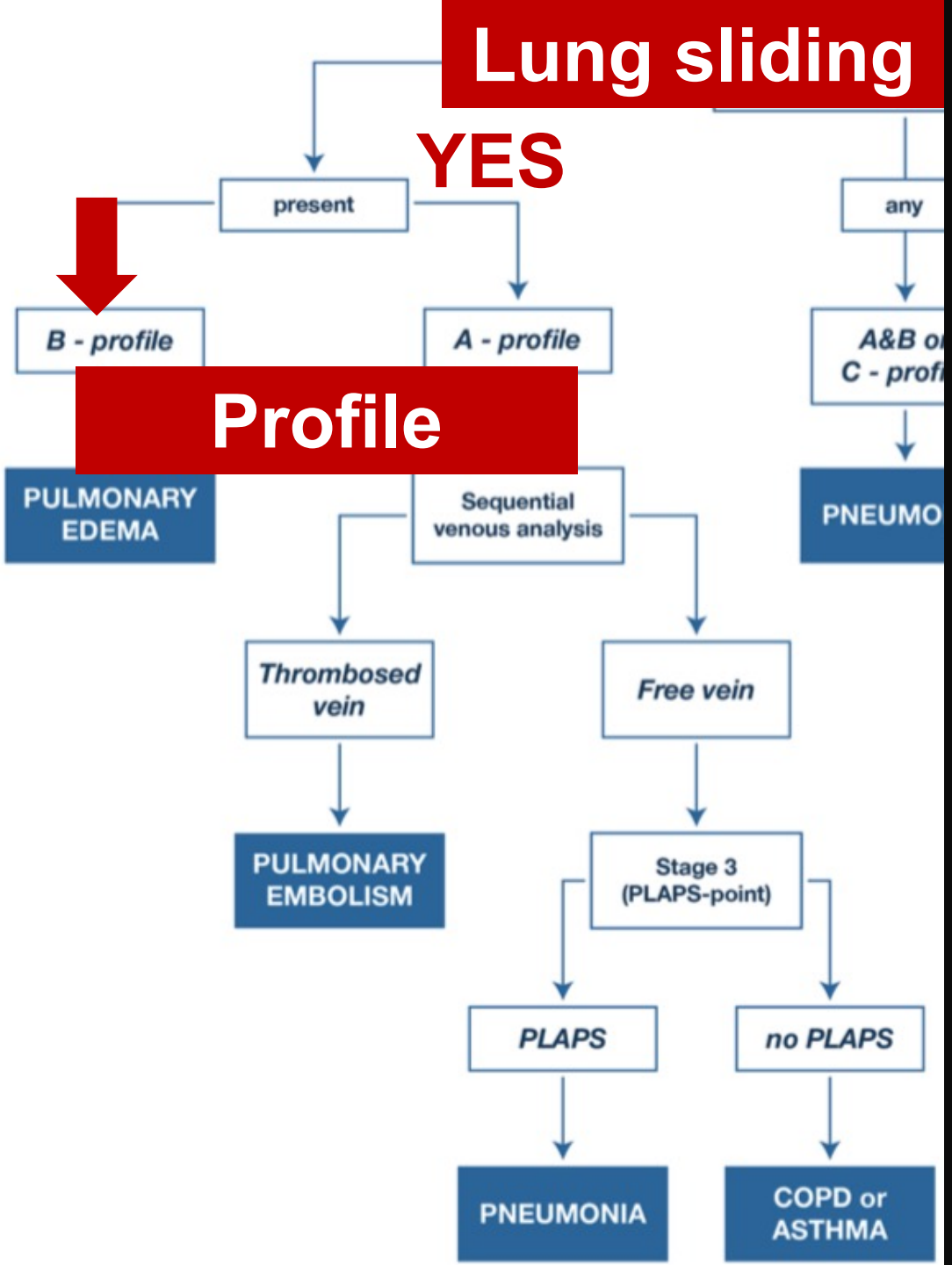
Evidence of deep venous thrombosis by ultrasound











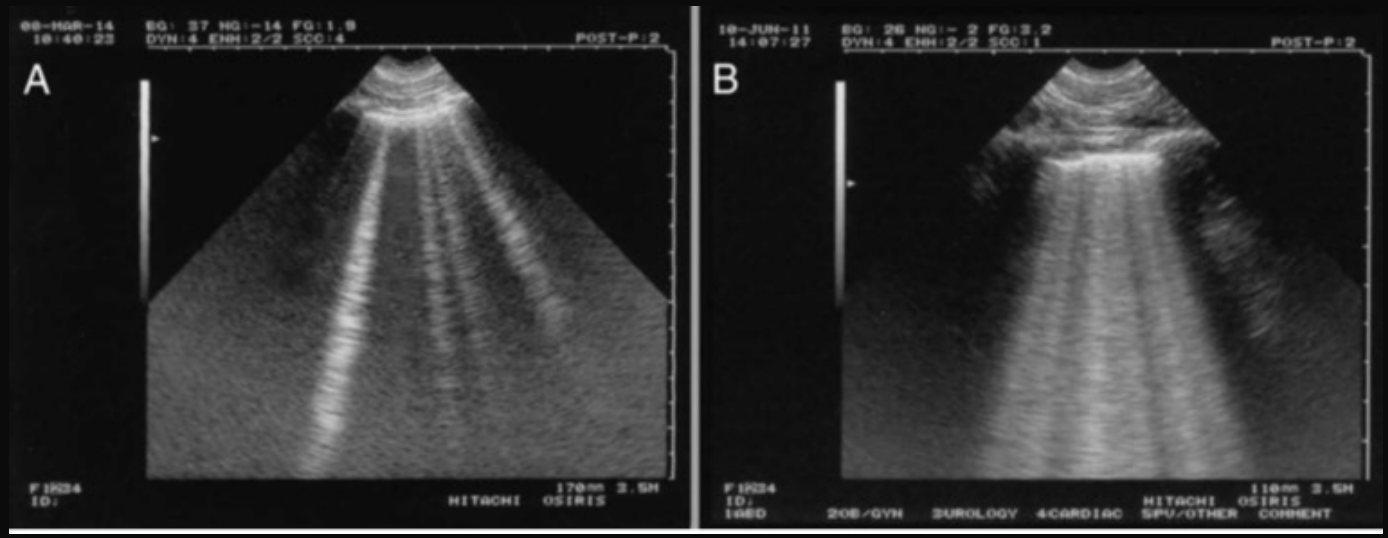
B-profile

Sliding sign + B-line: **diffuse**

Pulmonary edema

Cardiogenic/Fluid overload

Acute respiratory distress syndrome



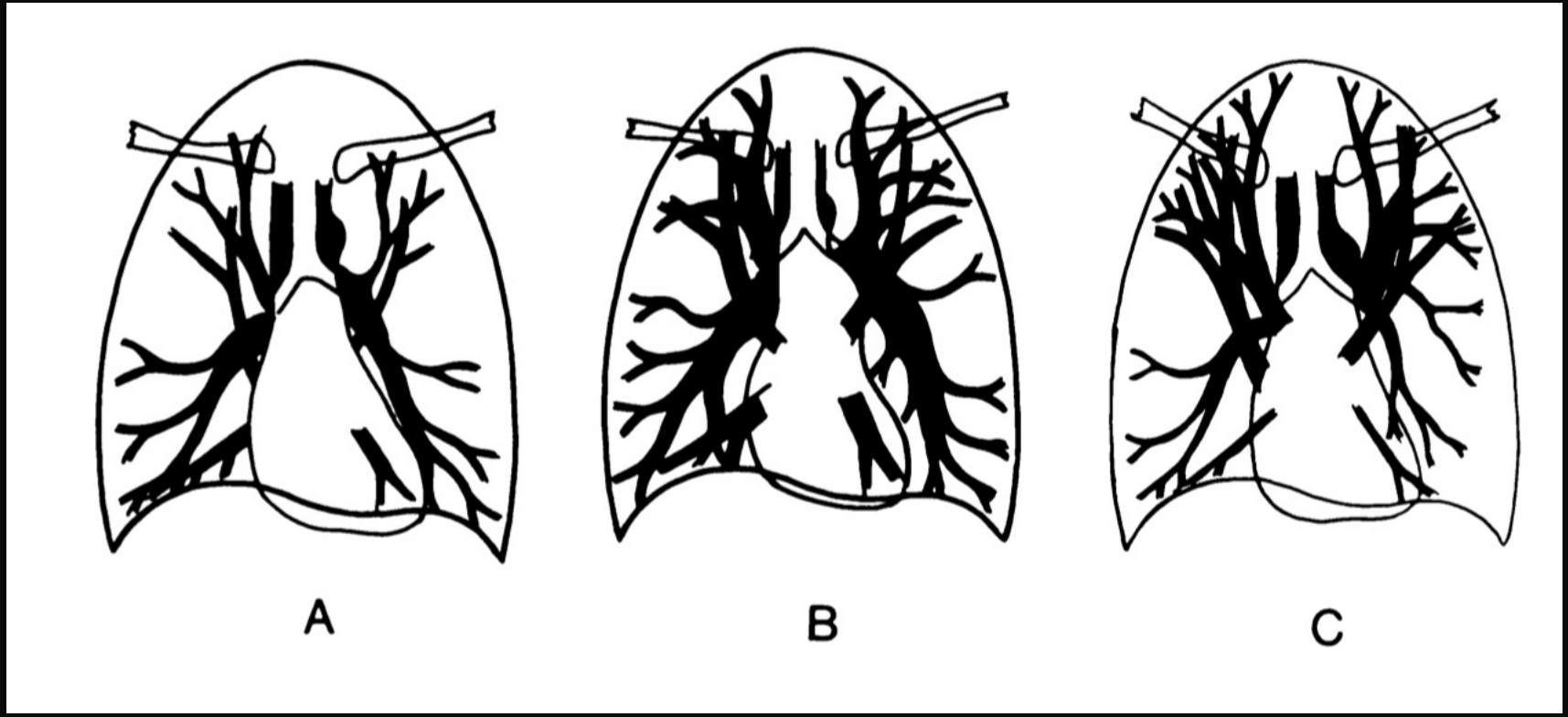
B-line

Lung Rockets

≥ 3 B-line

Distribution of pulmonary blood flow

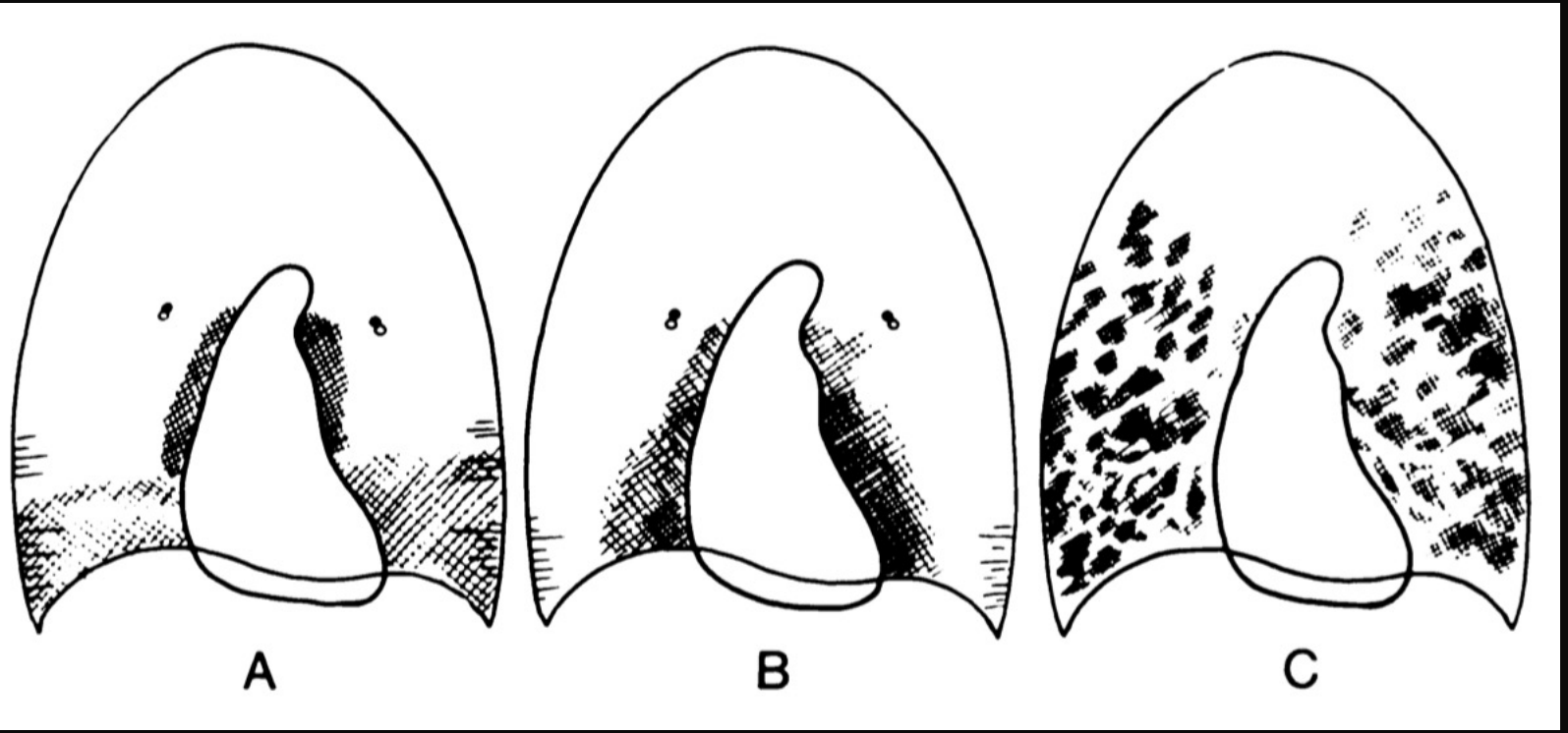
A, Normal; occurs principally in capillary permeability edema.
B, Balanced; occurs principally in overhydration or renal failure.
C. Inverted; occurs principally in cardiac failure.



Miln, et al. AJR. 144:879-894,

Distribution of pulmonary edema

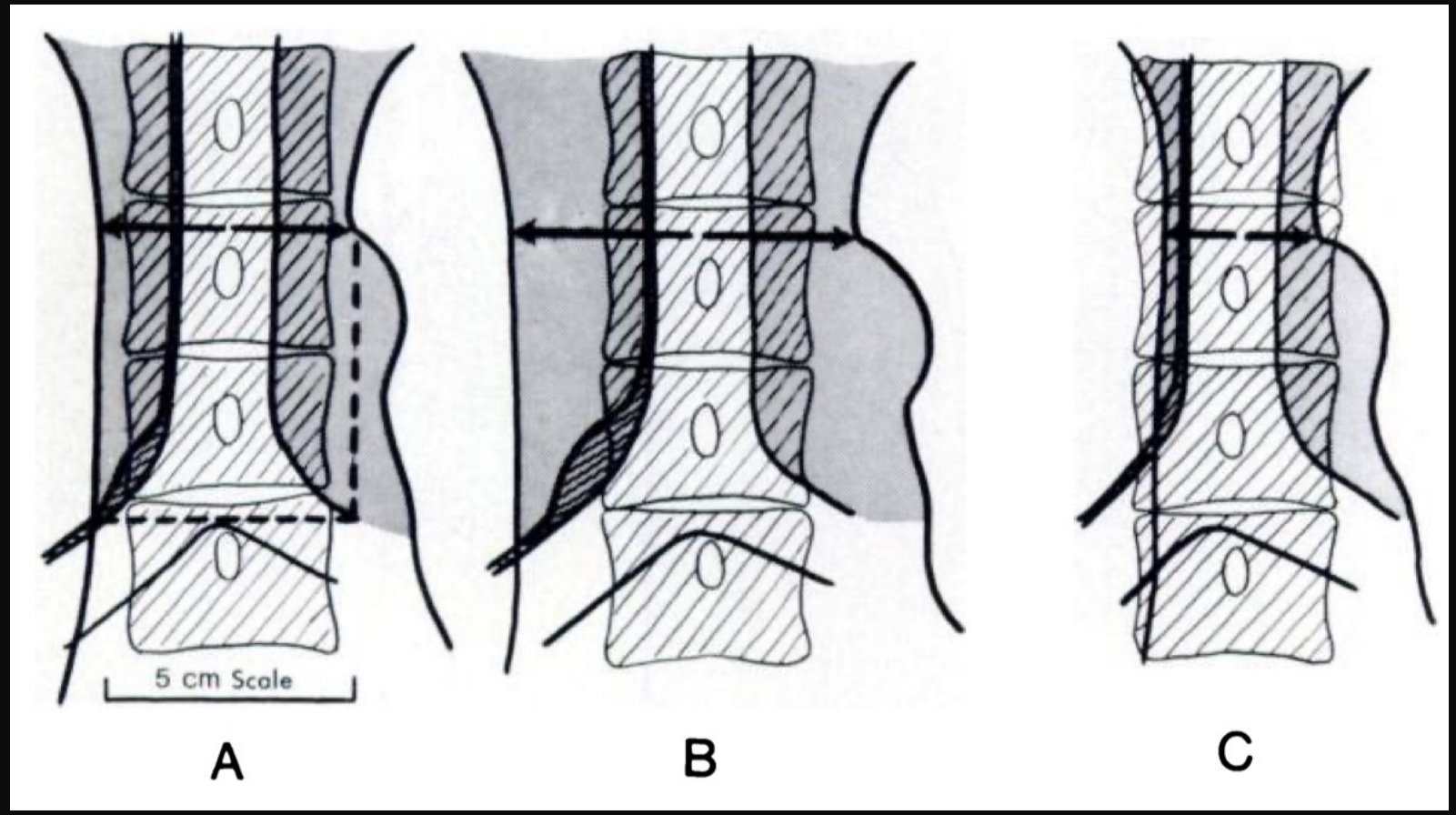
A. Even: principally basal (gravitational) and homogeneous from chest wall to heart but with perihilar component also. Principally occurs in cardiac edema.
B. Central; occurs principally in overhydration or renal failure.
C. Peripheral; markedly patchy-it often spares costophrenic angles. Note air bronchograms. This type of distribution occurs almost exclusively in capillary permeability.



Miln, et al. AJR. 144:879-894,

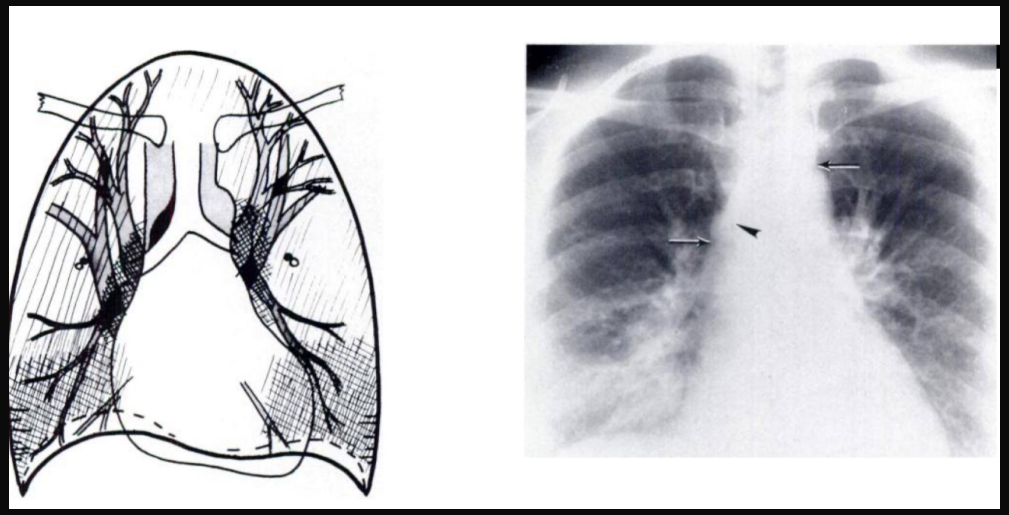
Vascular pedicle

A, Normal; commonest in capillary permeability or acute cardiac failure.
B, Widened; commonest in overhydration/renal failure and chronic cardiac failure.
C, Narrowed; commonest in capillary permeability edema.

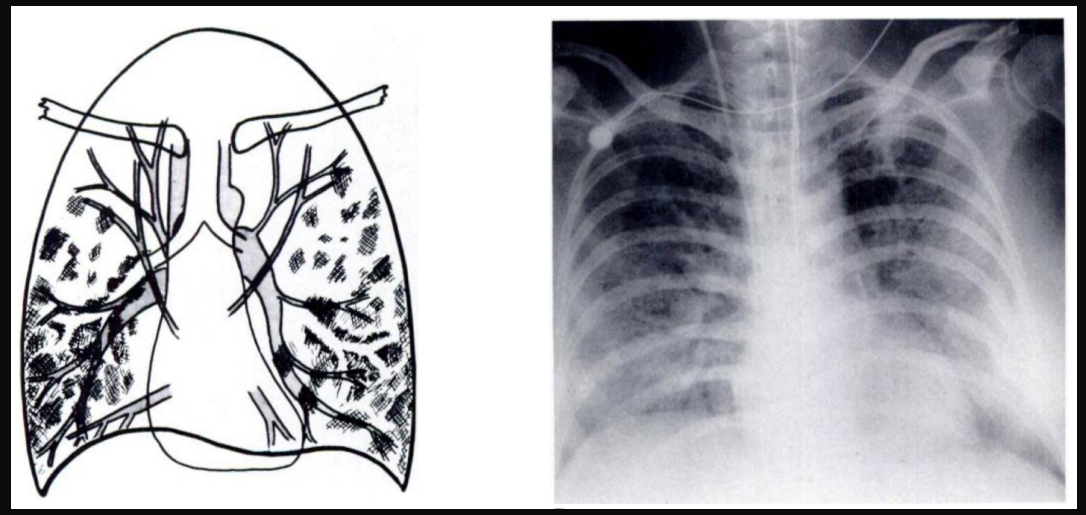


Miln, et al. AJR. 144:879-894,

這是心衰竭肺積水



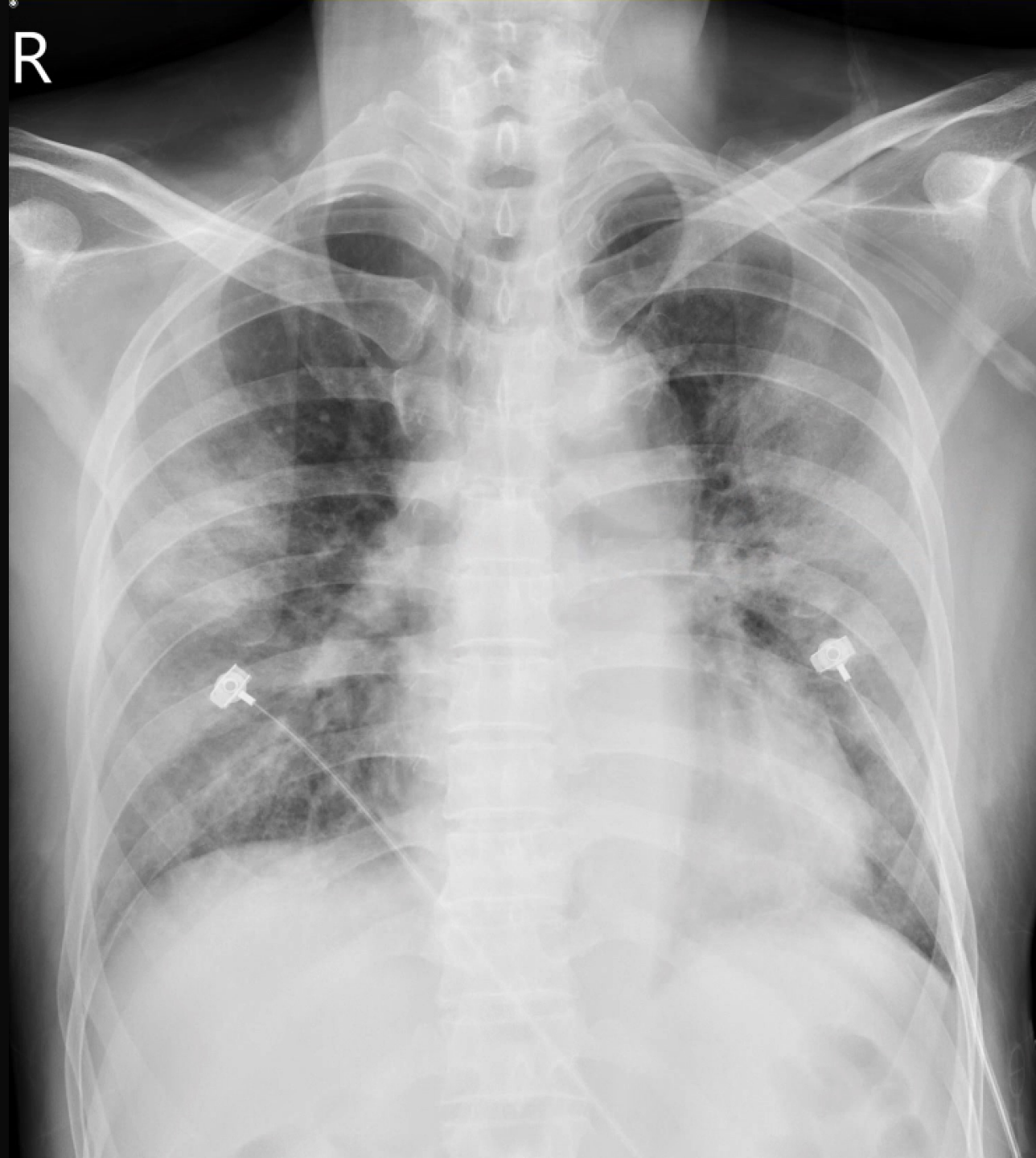
這是肺炎所致ARDS



	High hydrostatic	High permeability
Distribution of blood flow	**inverted**, indicating elevated pulmonary venous pressure.	Normal
Distribution of edema	**Central**	**Peripheral**
Vascular pedicle	**Width**, indicating increased systemic blood volume.	Normal

Miln, et al. AJR. 144:879-894,

Distribution of blood flow	Normal
Distribution of edema	Peripheral
Vascular pedicle	*Width*



Difference between cardiogenic pulmonary edema and ARDS by **ultrasound**

Acute cardiogenic pulmonary edema ARDS

	ACPE	ARDS
Clinical setting	Acute	Acute
B-lines	Always present	Always present
Distribution of B-lines	Bilateral and symmetric distribution	Non-homogeneous distribution, presence of spared areas
Pleural line abnormalities	Absent	Present, typical
Reduction or absence of lung sliding	Absent	Present
Lung pulse	Absent	Present
Consolidations	Absent	Frequent in the posterior areas

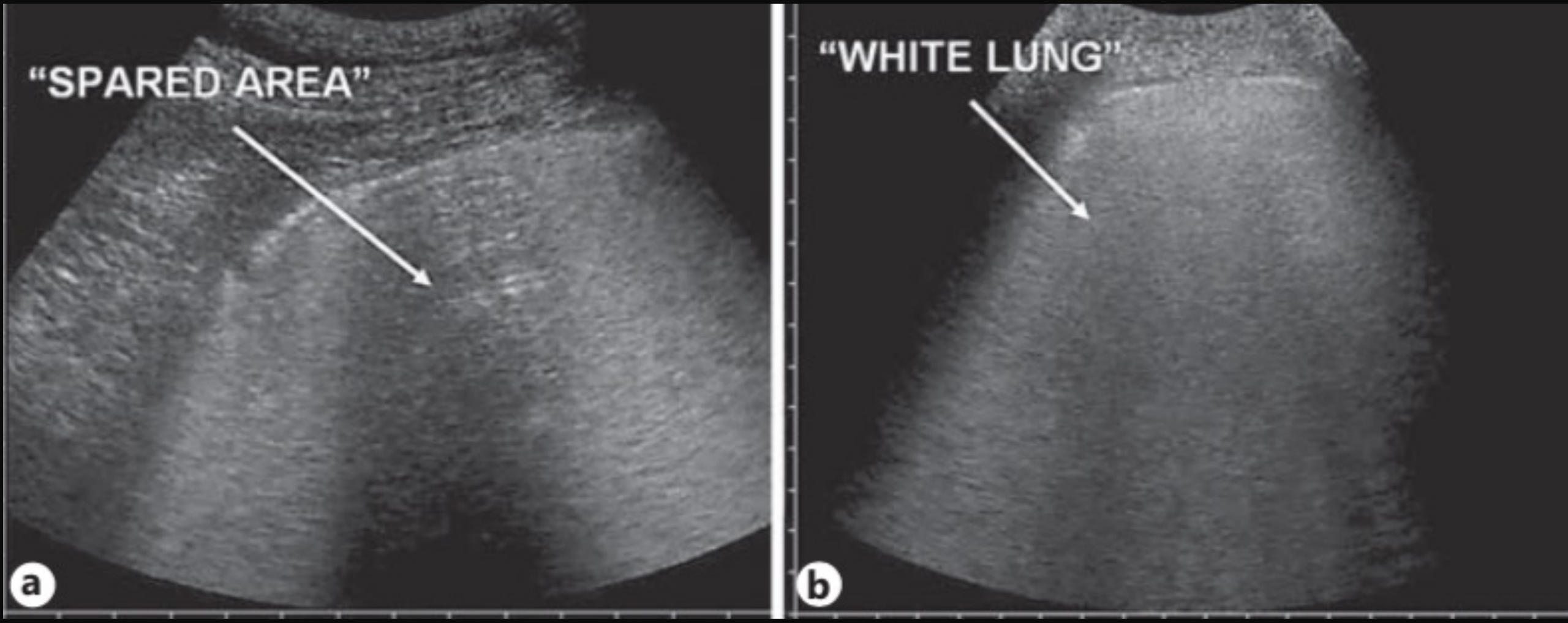
ACPE acute cardiogenic pulmonary edema, *ARDS* adult respiratory distress syndrome

Mayo et al, Intensive Care Med. 2019; 45(9):1200 -121

B-line distribution

ARDS- Non-homogeneous / sparing area

Acute cardiogenic pulmonary edema

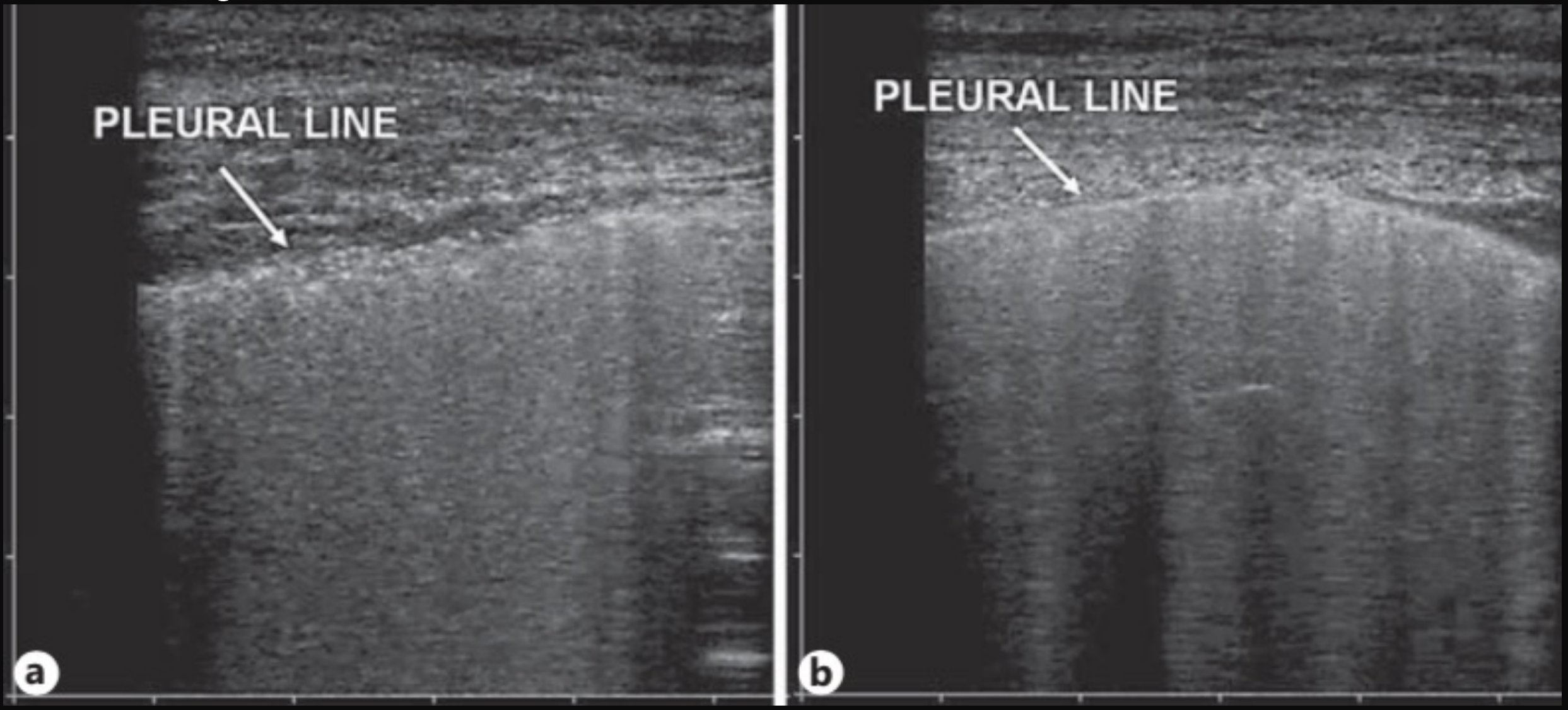


Reissig et al, Respiration. 2014; 87(3):179-89

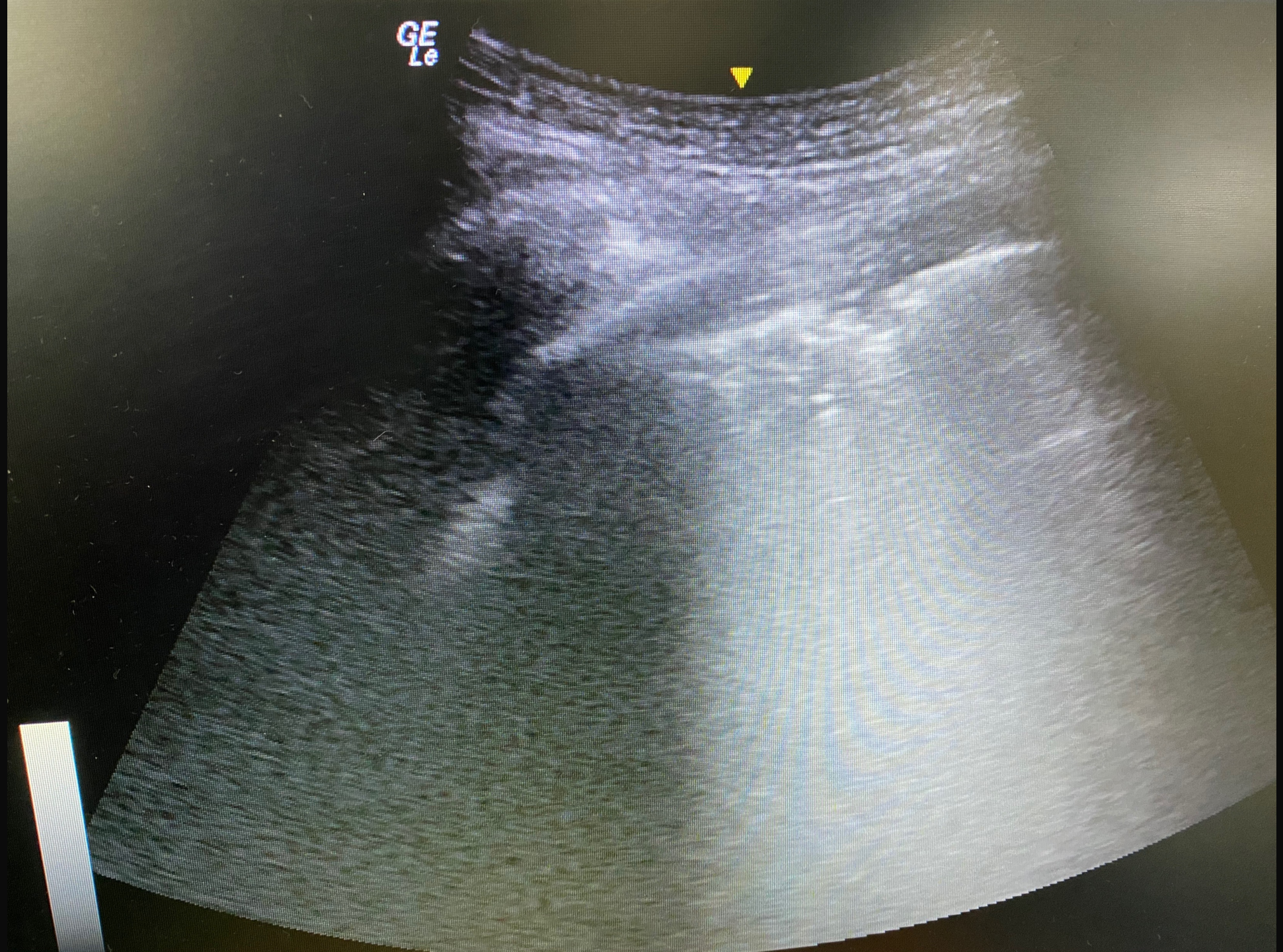
Pleural line

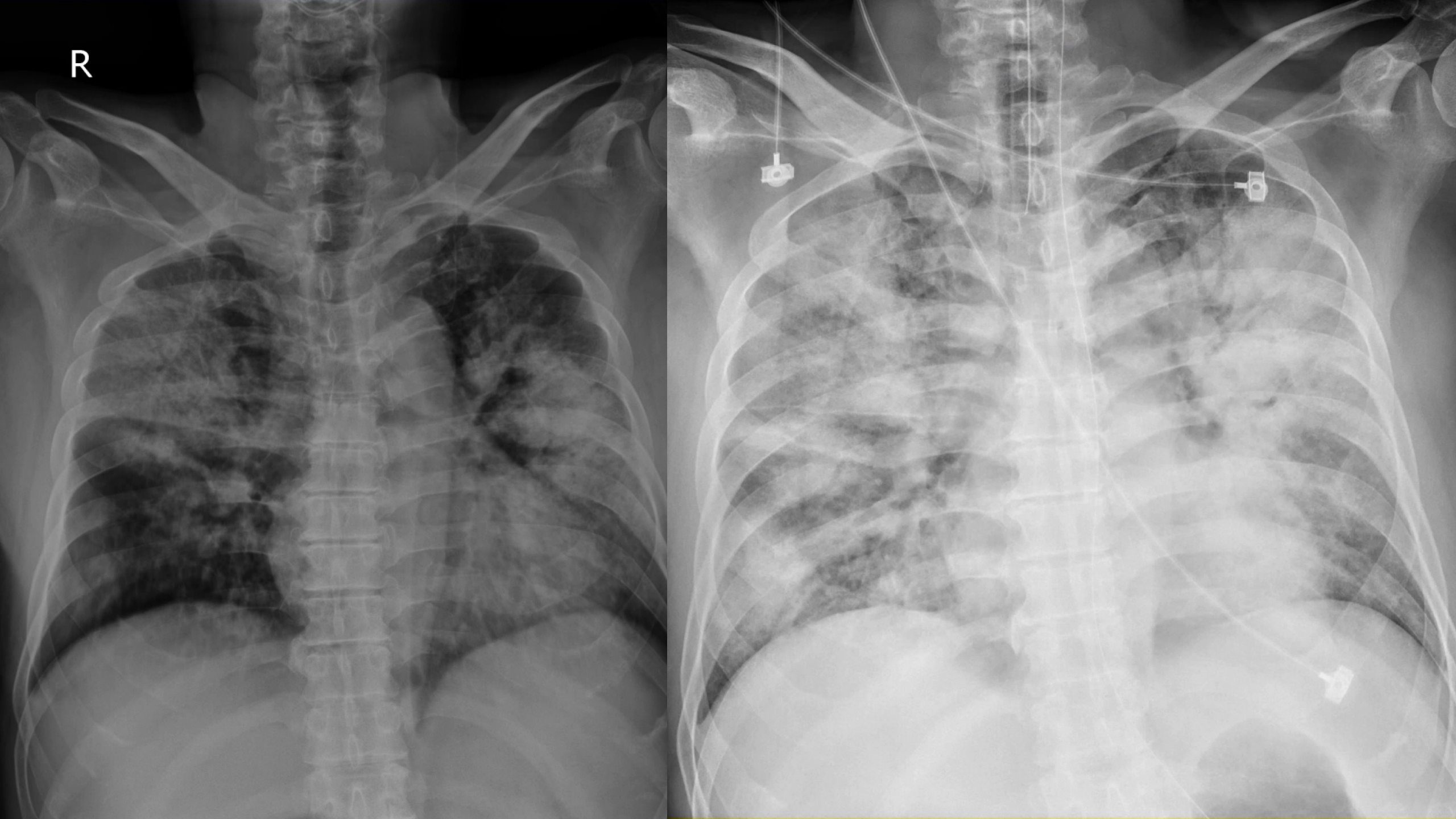
ARDS- Irregular / thickened / coarse

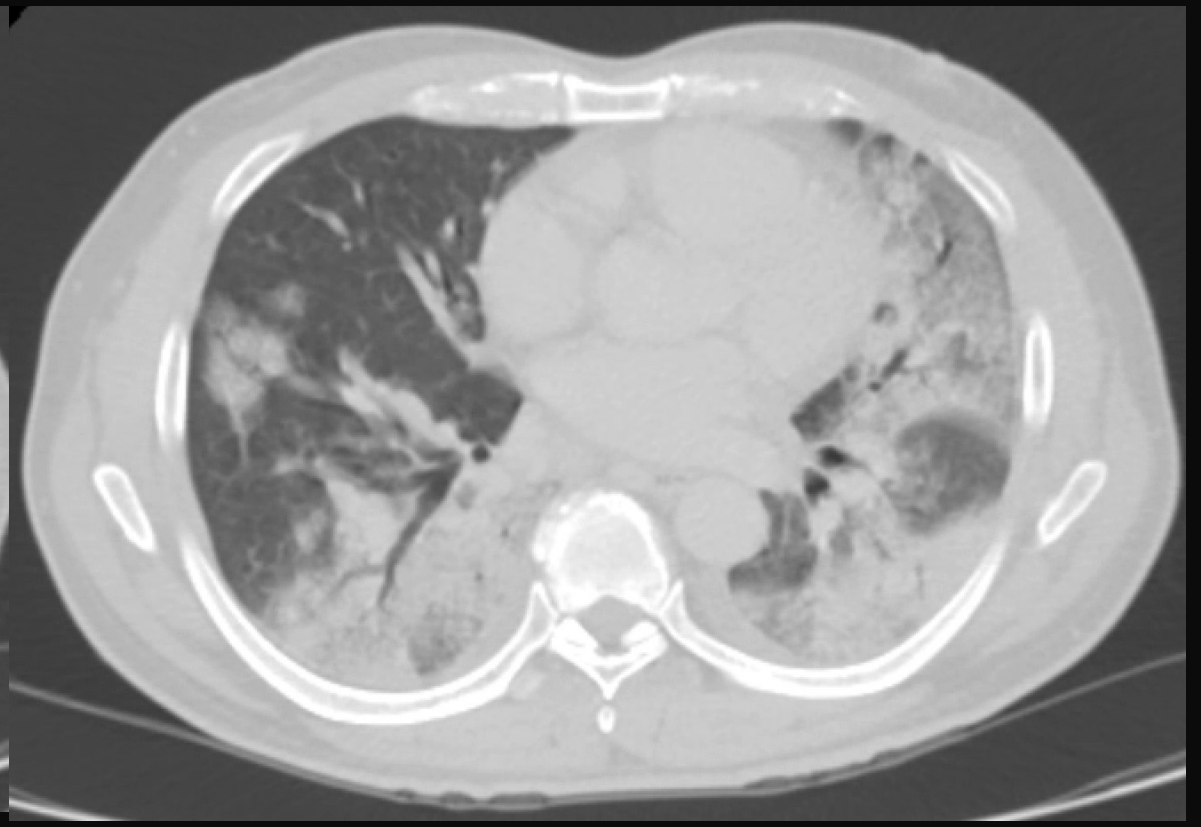
Acute cardiogenic pulmonary edema



Reissig et al, Respiration. 2014; 87(3):179-89


GE
Le


R

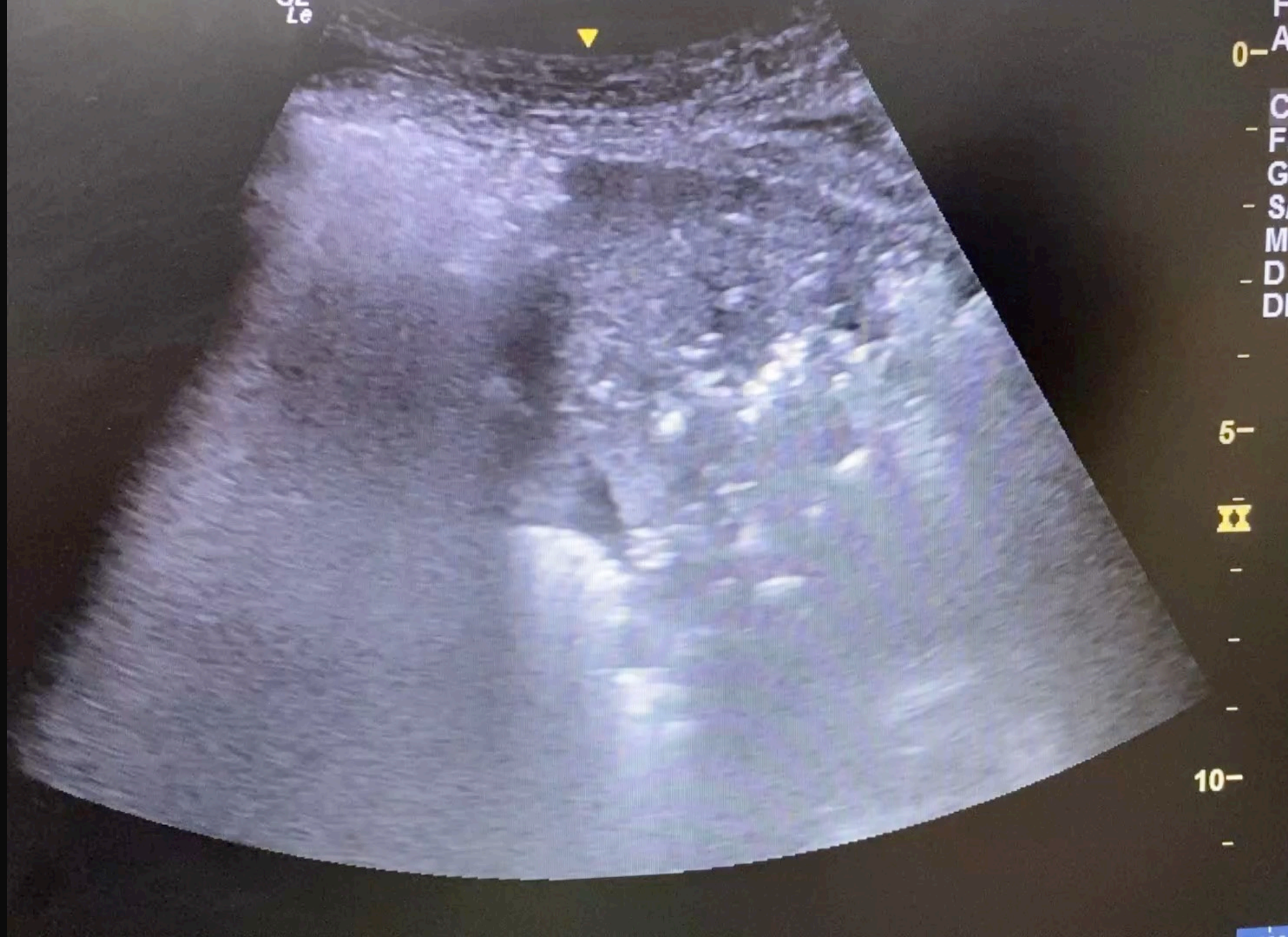


ARDS

B-line
Heterogenous

Irregular coarse pleural line

Consolidation




ADM
Abdomen
FR 31
AO% 100
CHI
Frq 4.0
Gn 40
S/A 2/3
Map D/0
D 15.0
DR 69
0
5
10
15

Bedside Lung Ultrasound in Emergency
BLUE protocol

3

三個點 —邊　2 BLUE point / PLAPS point

三個Sign　A-line / B-line / Sliding sign

三分天下

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- **B profile:** Cardiogenic edema / ARDS
- **Others:** Lung parenchymal problem, PNX, pleural effusion, pneumonia

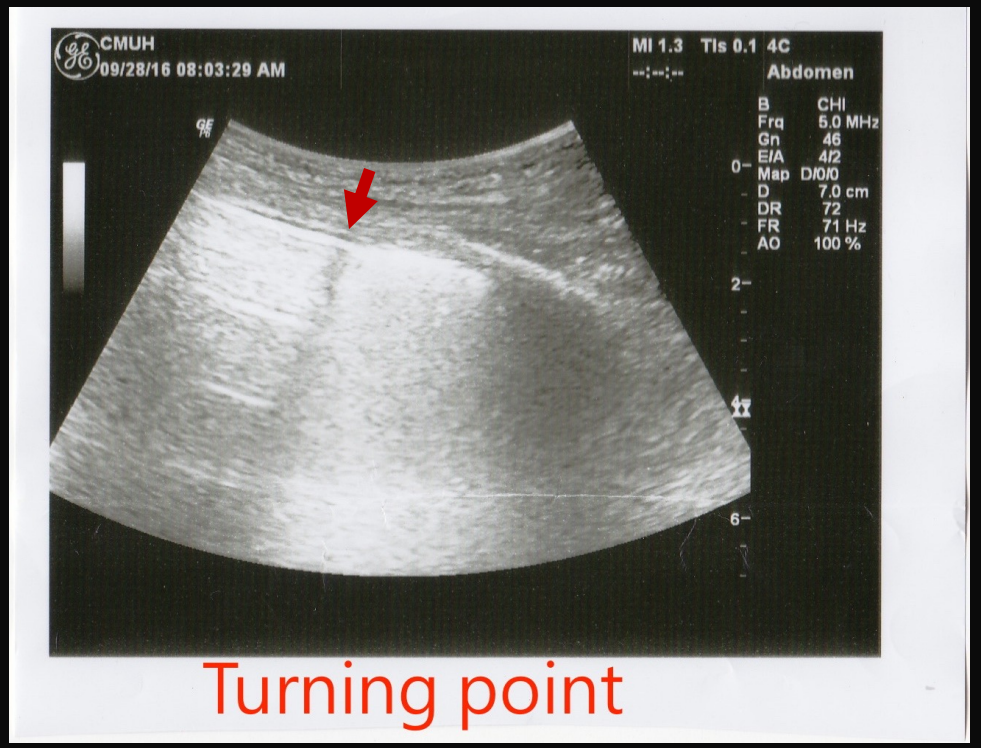
Lichtenstein et al, CHEST 2015; 147(6):1659-1670

A'-profile

No sliding sign + A-line

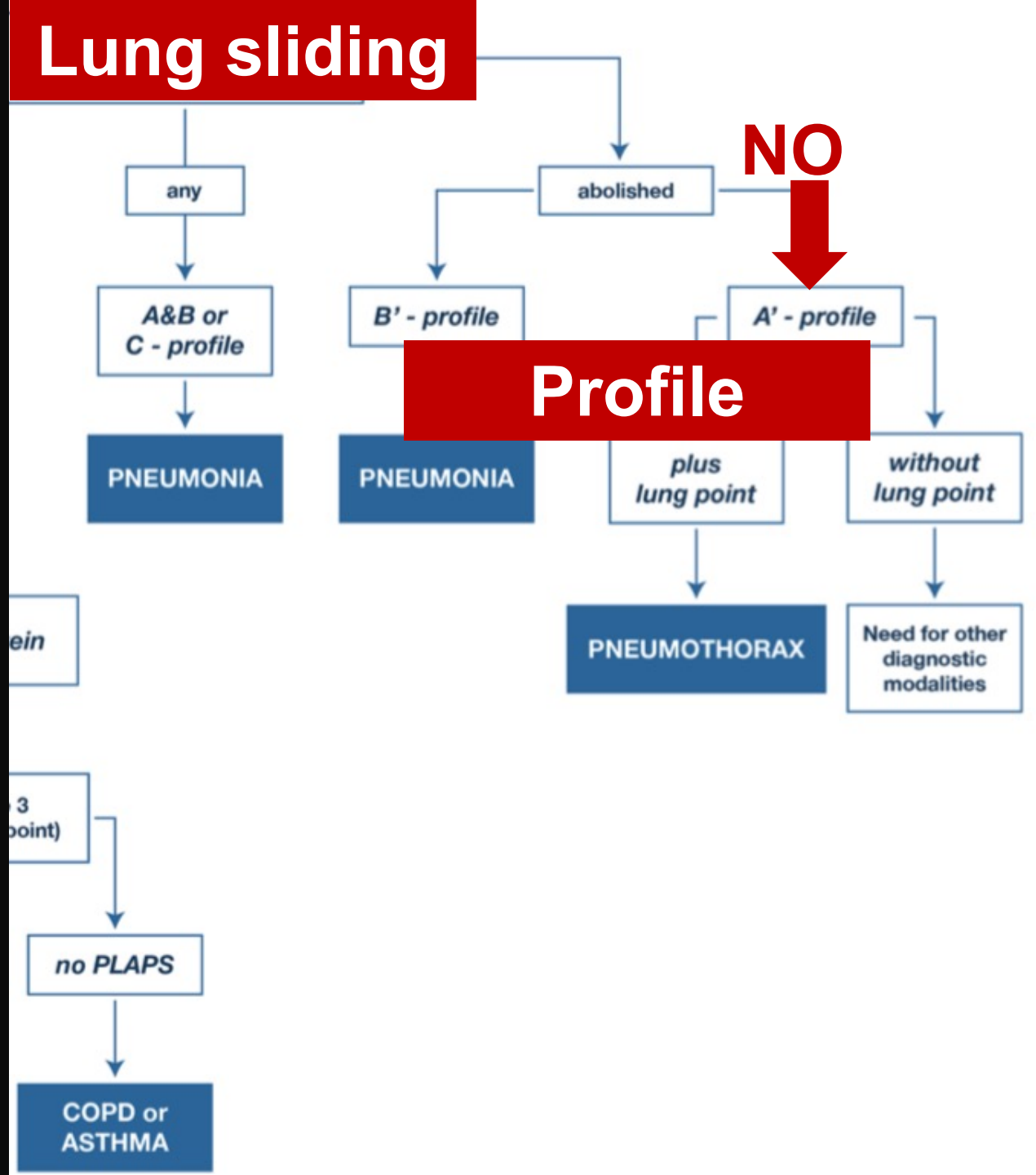
+ *Lung point*

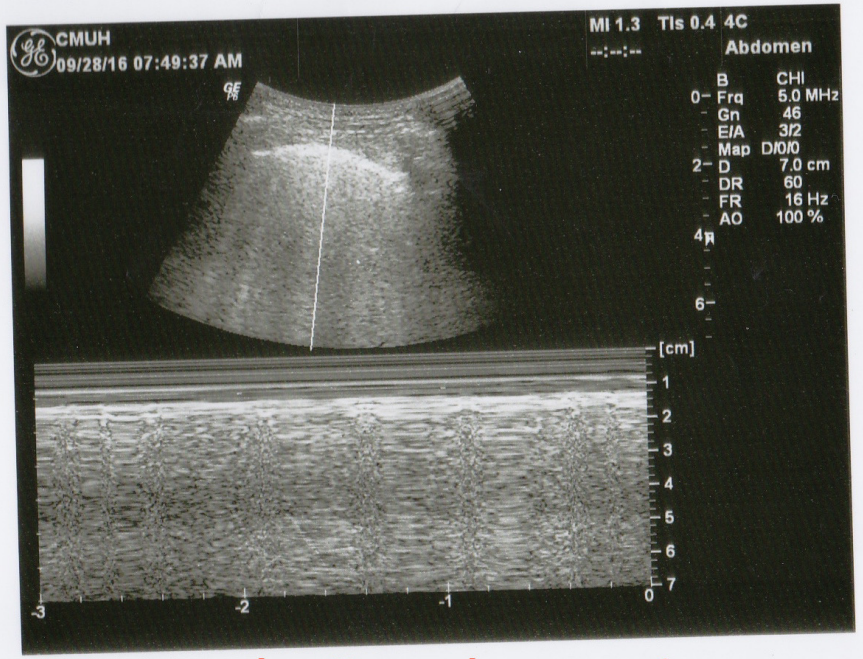
Pneumothorax



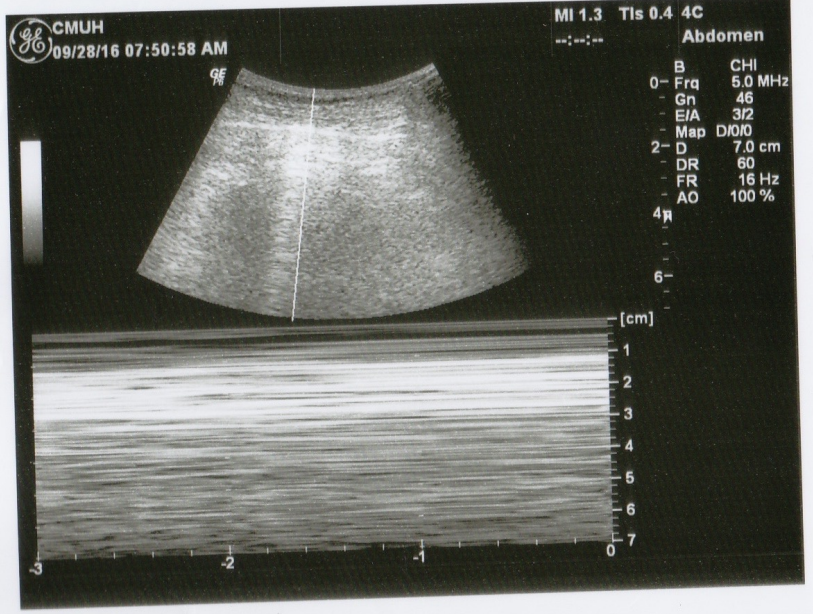
Mayo et al, Intensive Care Med. 2019; 45(9):1200 -1211

Lichtenstein et al, CHEST 2015; 147(6):1659-1670

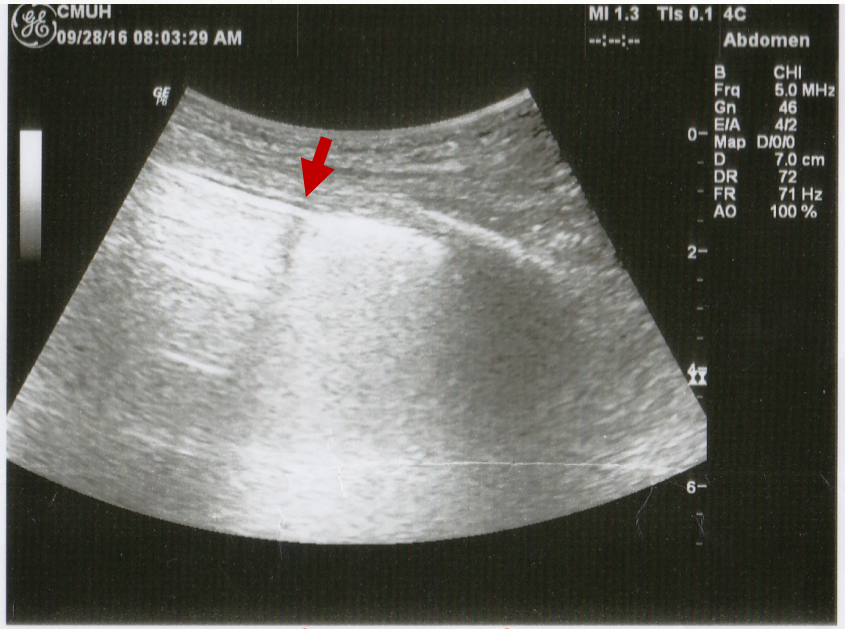




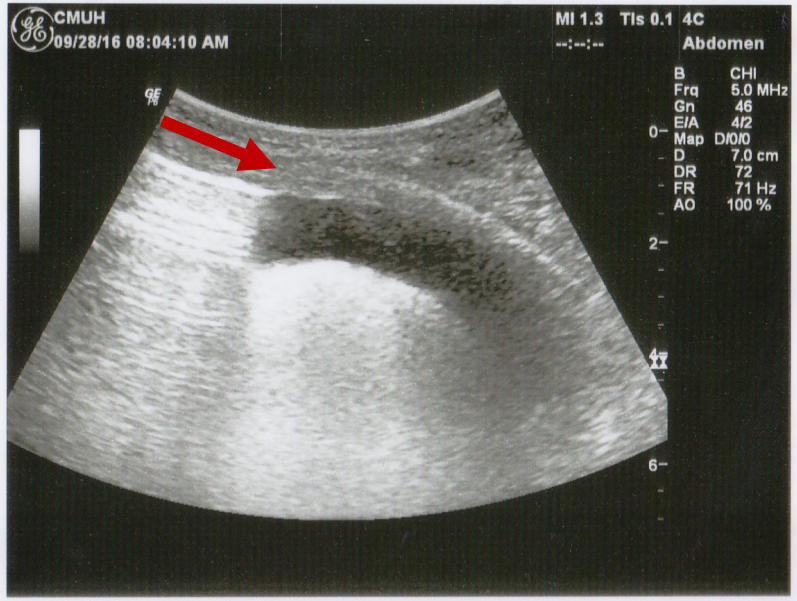
Normal : Seashore sign



PNX: Stratosphere sign



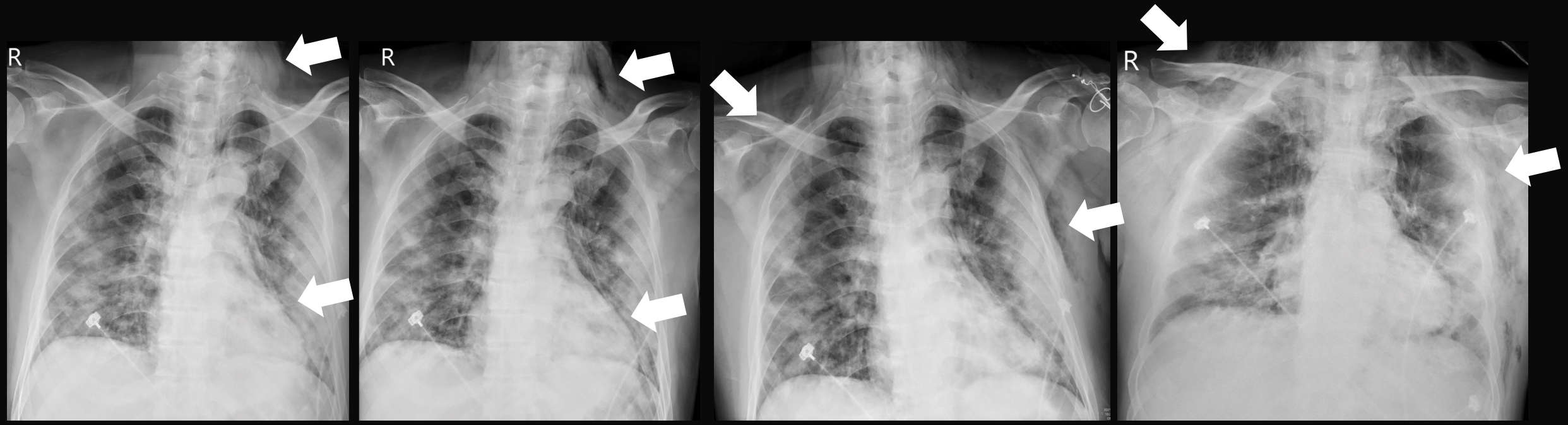
Turning point



Curtain sign

Barotrauma

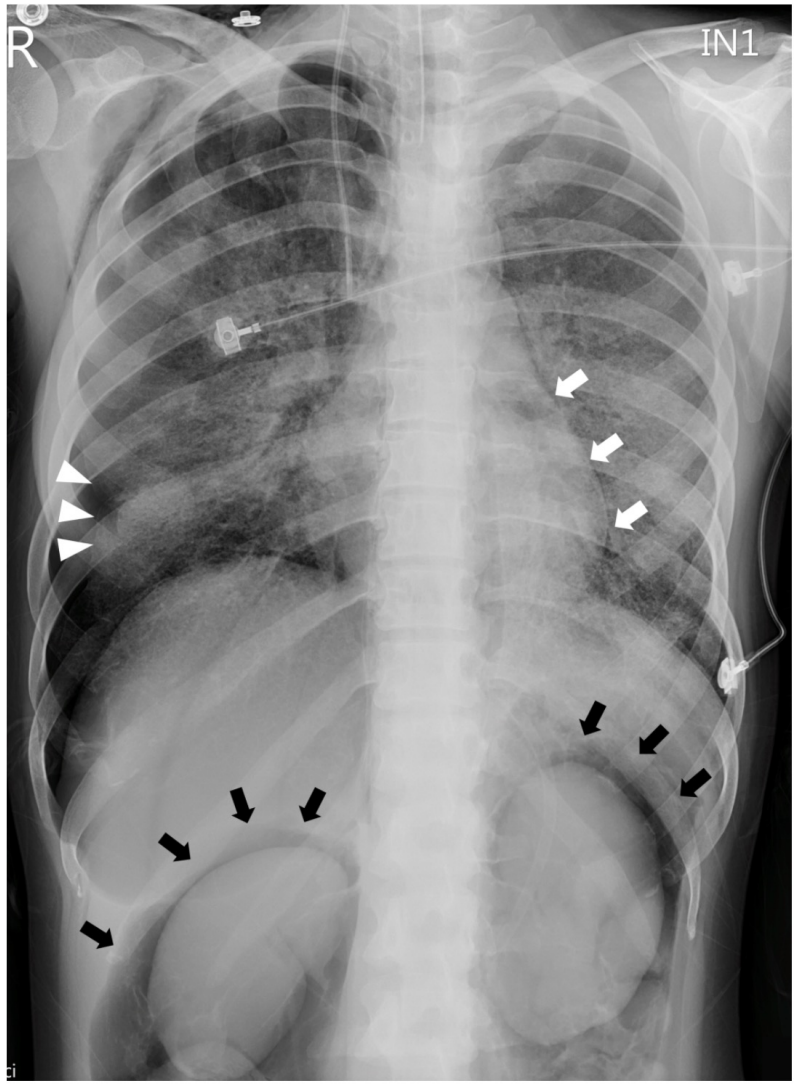
Subcutaneous emphysema
Pneumo-mediastinum
Pneumo-pericardium



Ventilator-induced lung injury results in *Pneumo-retroperitoneum*

https://doi.org/10.1164/rccm.202006-2447IM
PubMed: 33412081

Received: June 19, 2020
Accepted: January 06, 2021

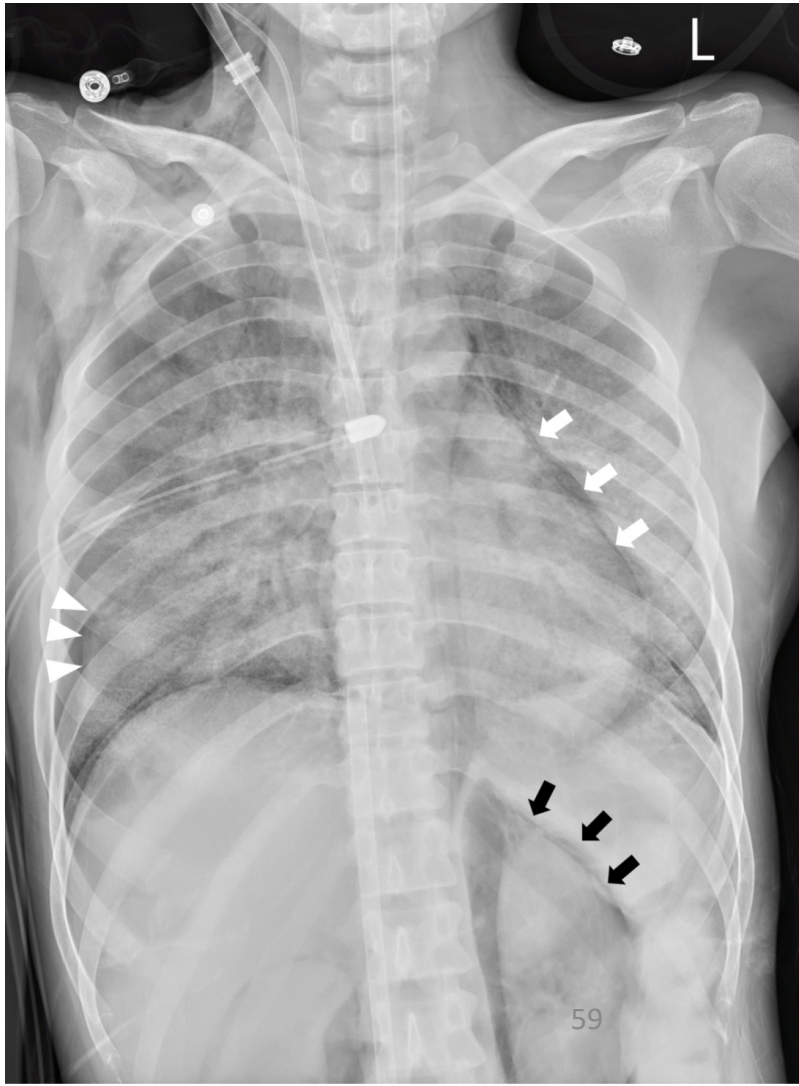


American Journal of Respiratory and Critical Care Medicine

Entire Bilateral Kidneys Enhanced by Air-contrast after Ventilation-induced Alveolar Rupture

Hsin Tseng , Alexander Lee Wang , Hsin-Ti Lin , Chi Chan Lee , and **Wei-Cheng Chen** ; ;

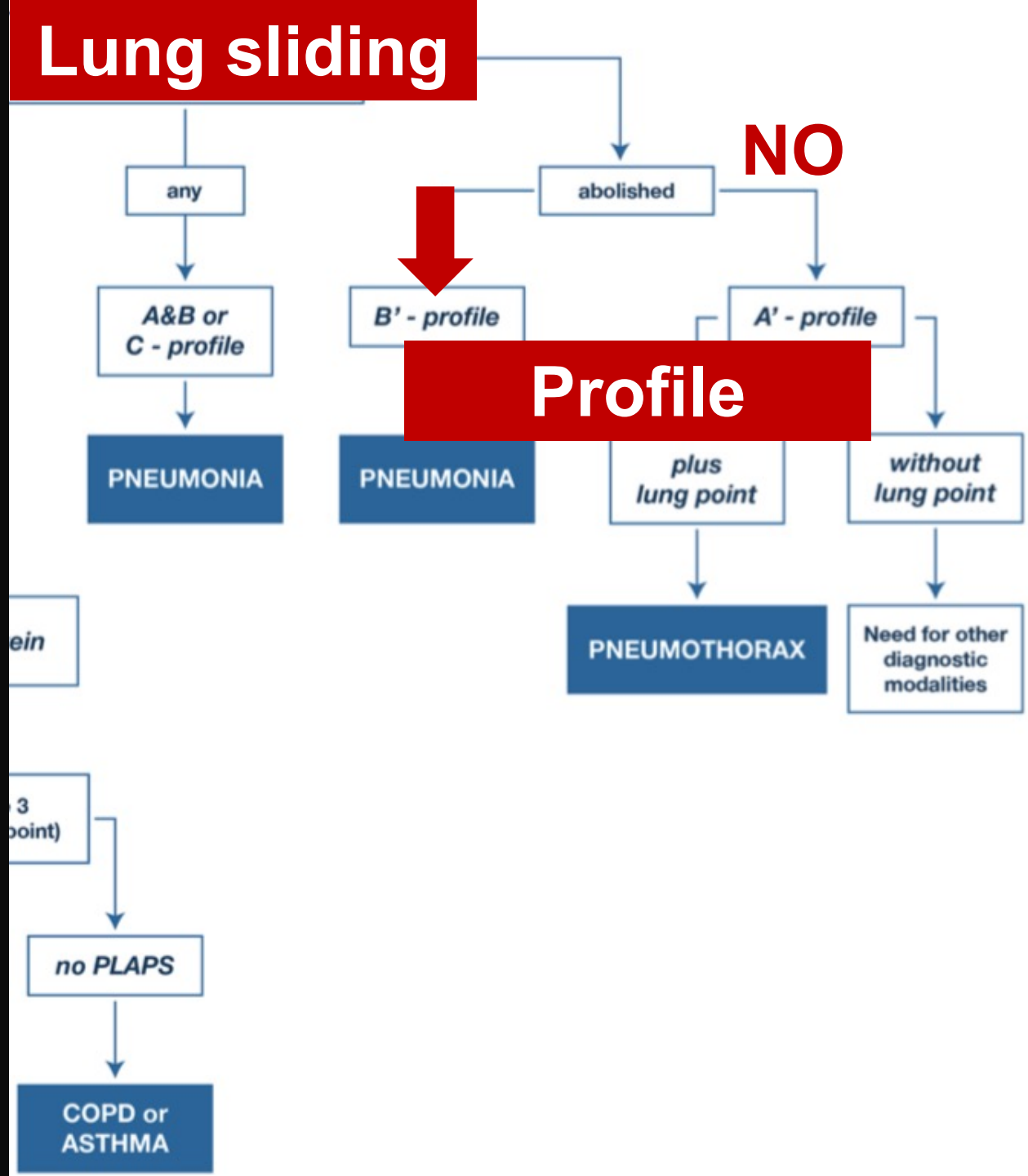
Improved after chest tube insertion



B’-profile

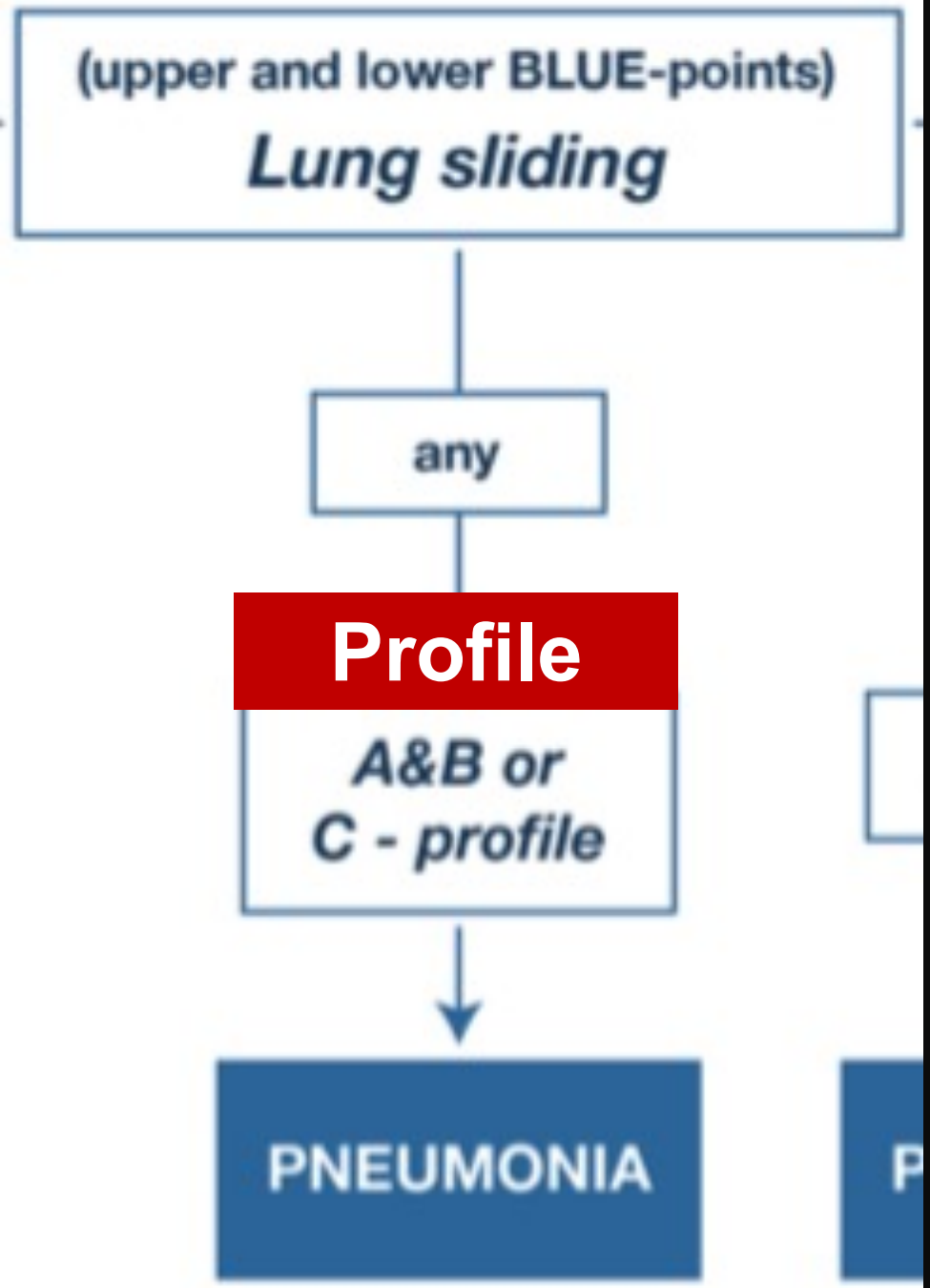
No sliding sign + B-line

Pneumonia



Mayo et al, Intensive Care Med. 2019; 45(9):1200 -1211

Lichtenstein et al, CHEST 2015; 147(6):1659-1670



A/B-profile

Unilateral rockets

C-profile

Consolidation

Pneumonia

Mayo et al, Intensive Care Med. 2019; 45(9):1200 -1211

Lichtenstein et al, CHEST 2015; 147(6):1659-1670

C-profile

Consolidation: air bronchogram / hepatization

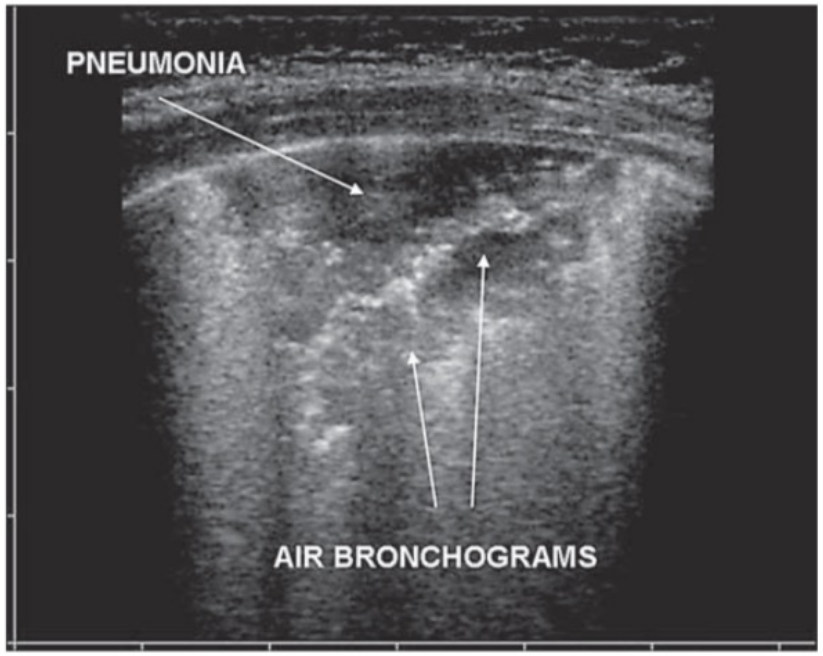


Fig. 2. Transverse thoracic scan of a 9-year-old child with clinically suspected pneumonia. LUS shows the presence of consolidation with evidence of air bronchograms.

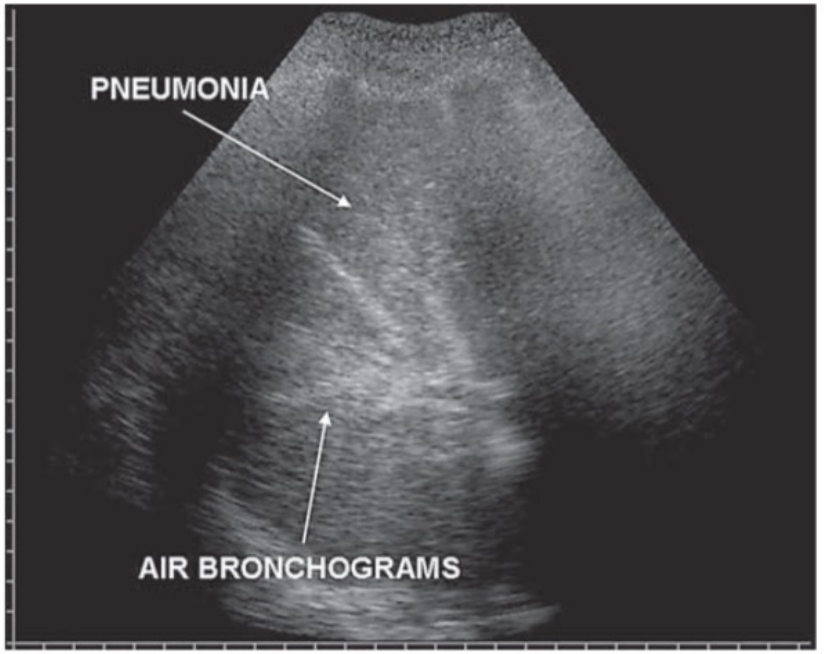


Fig. 3. Lobar pneumonia in an 11-year-old child. Air bronchograms are seen in the infected area as branching echogenic structures.

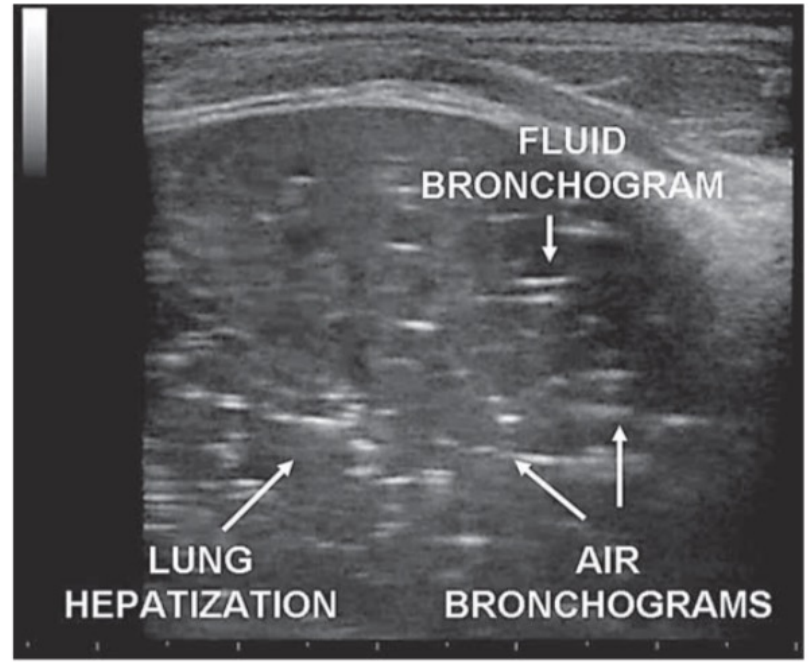
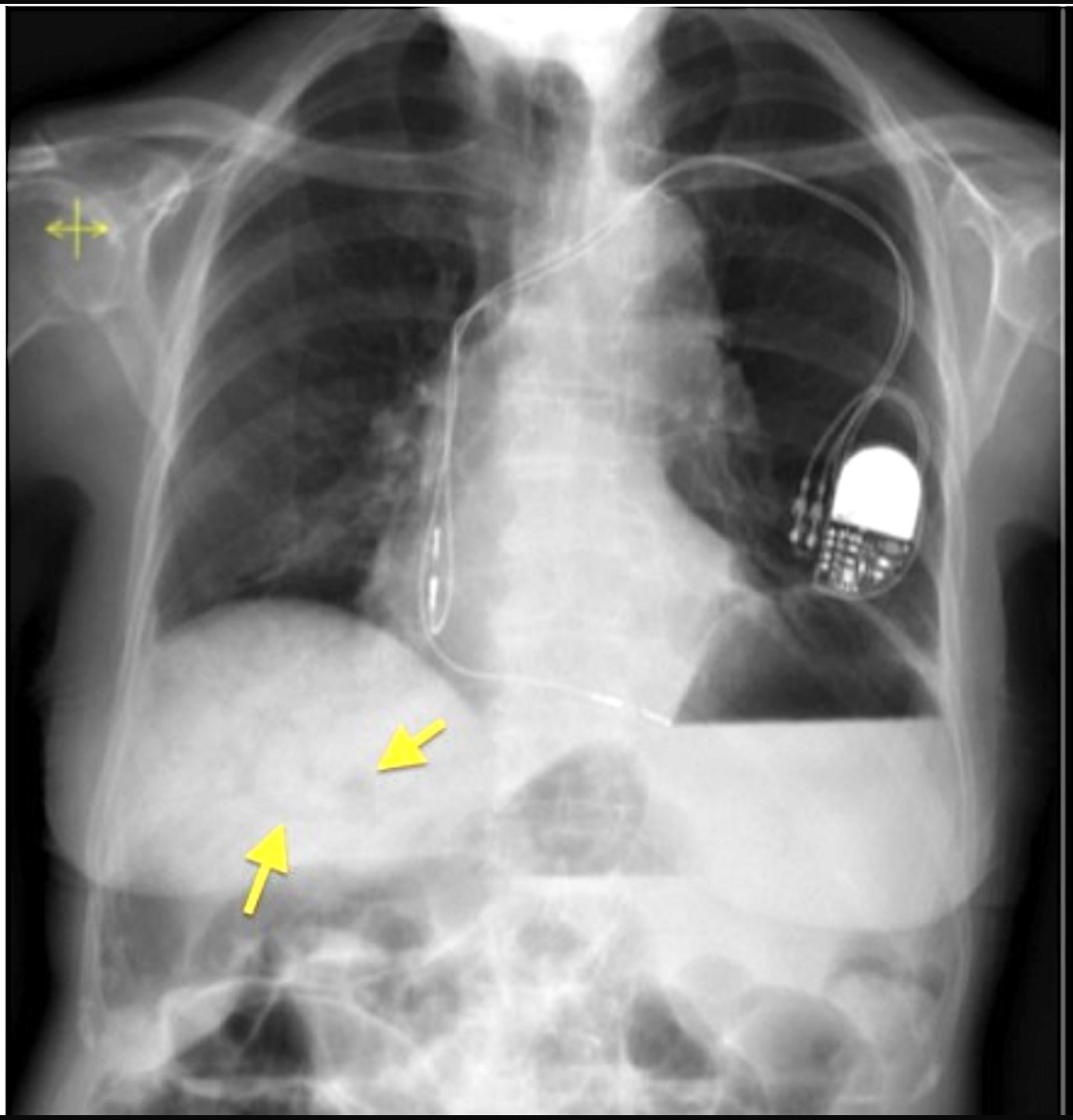
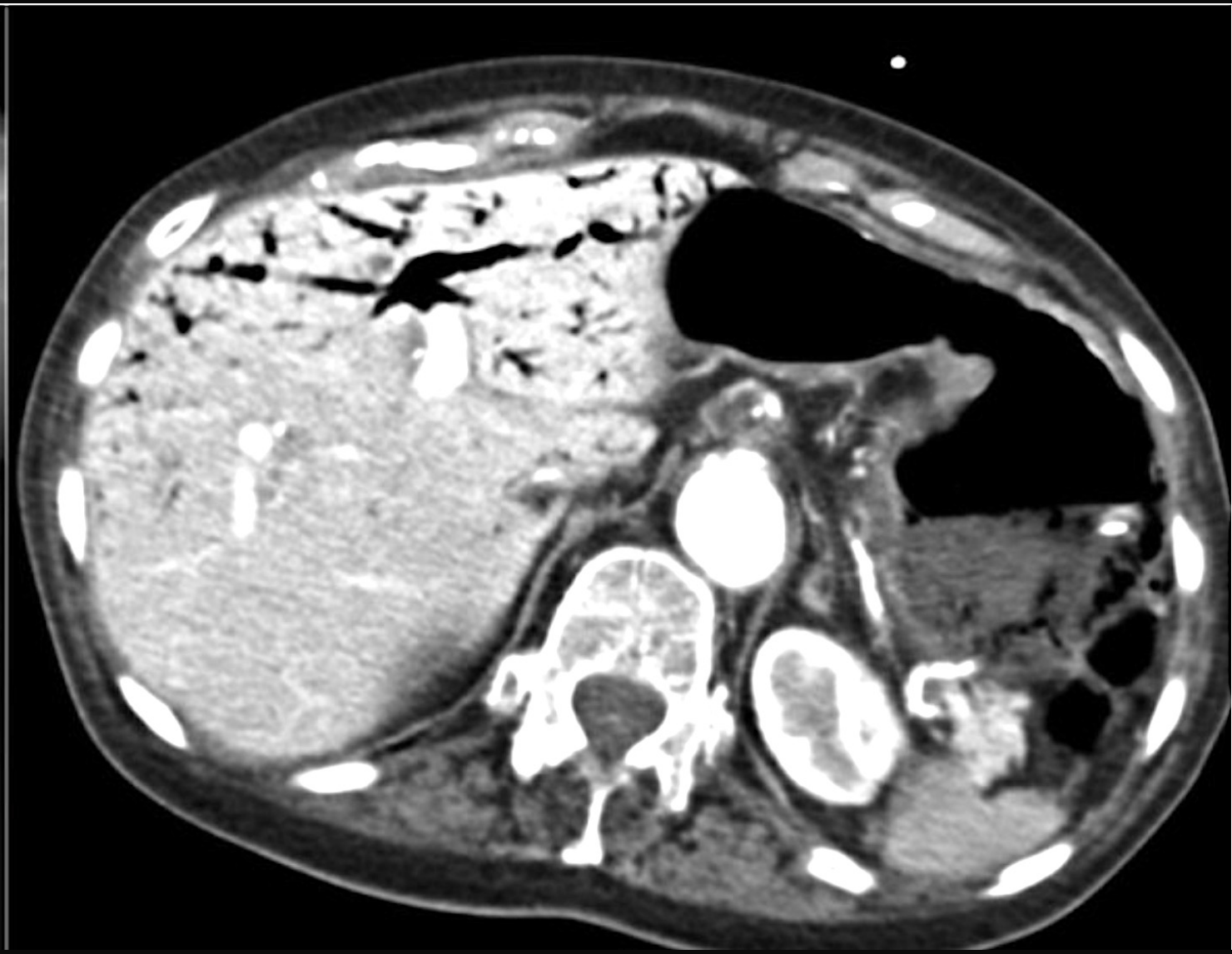


Fig. 5. Lobar pneumonia in a 10-year-old child admitted to the emergency department for fever and cough. LUS reveals air and fluid bronchograms within the affected area.

Reissig et al, Respiration. 2014; 87(3):179-89

Pneumoporta on CXR



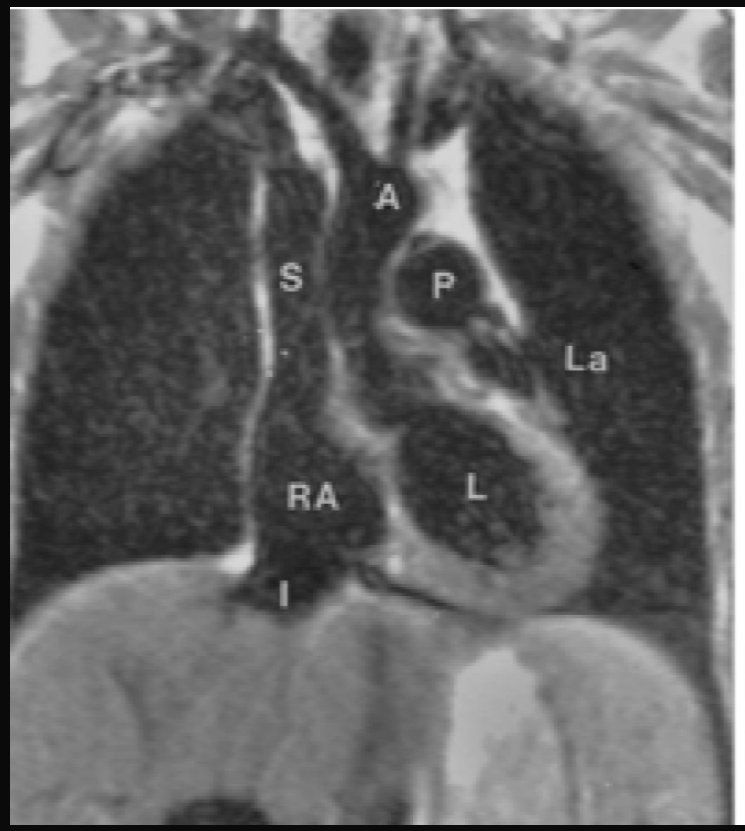


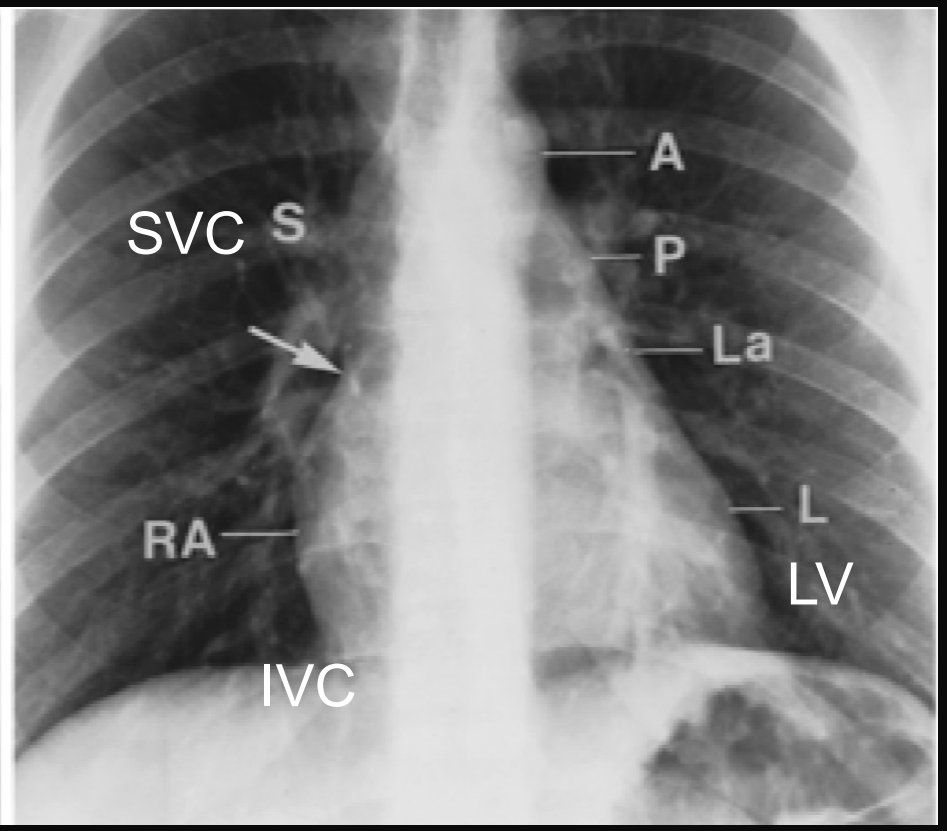
http://www.svuhradiology.ie/case-study/portal-venous-gas/

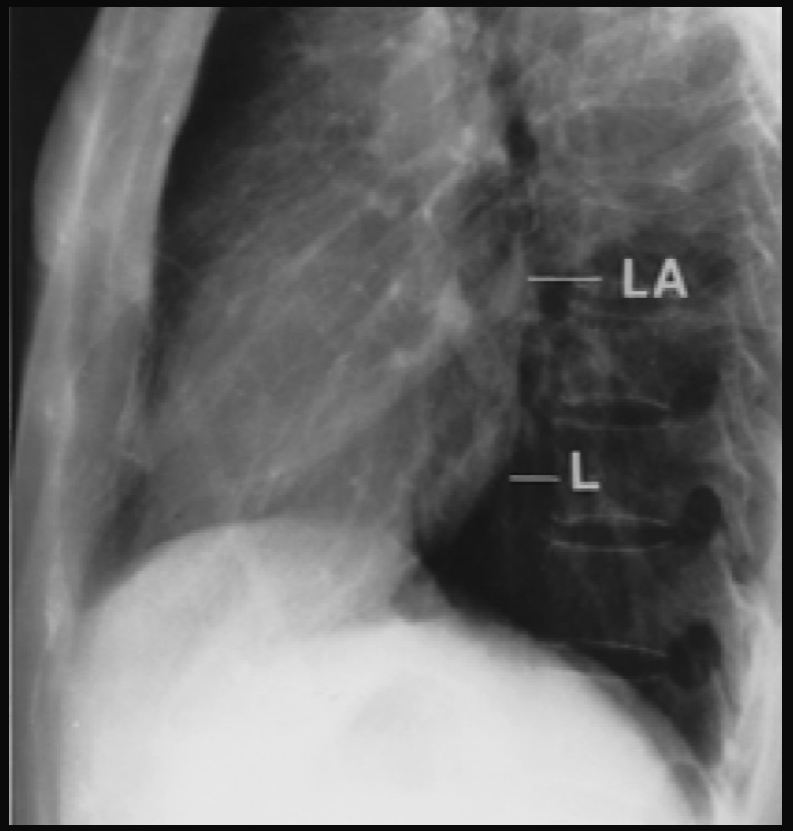
大綱

管路位置與併發症
急症疾病
心血管影像

Cardiac Silhouette

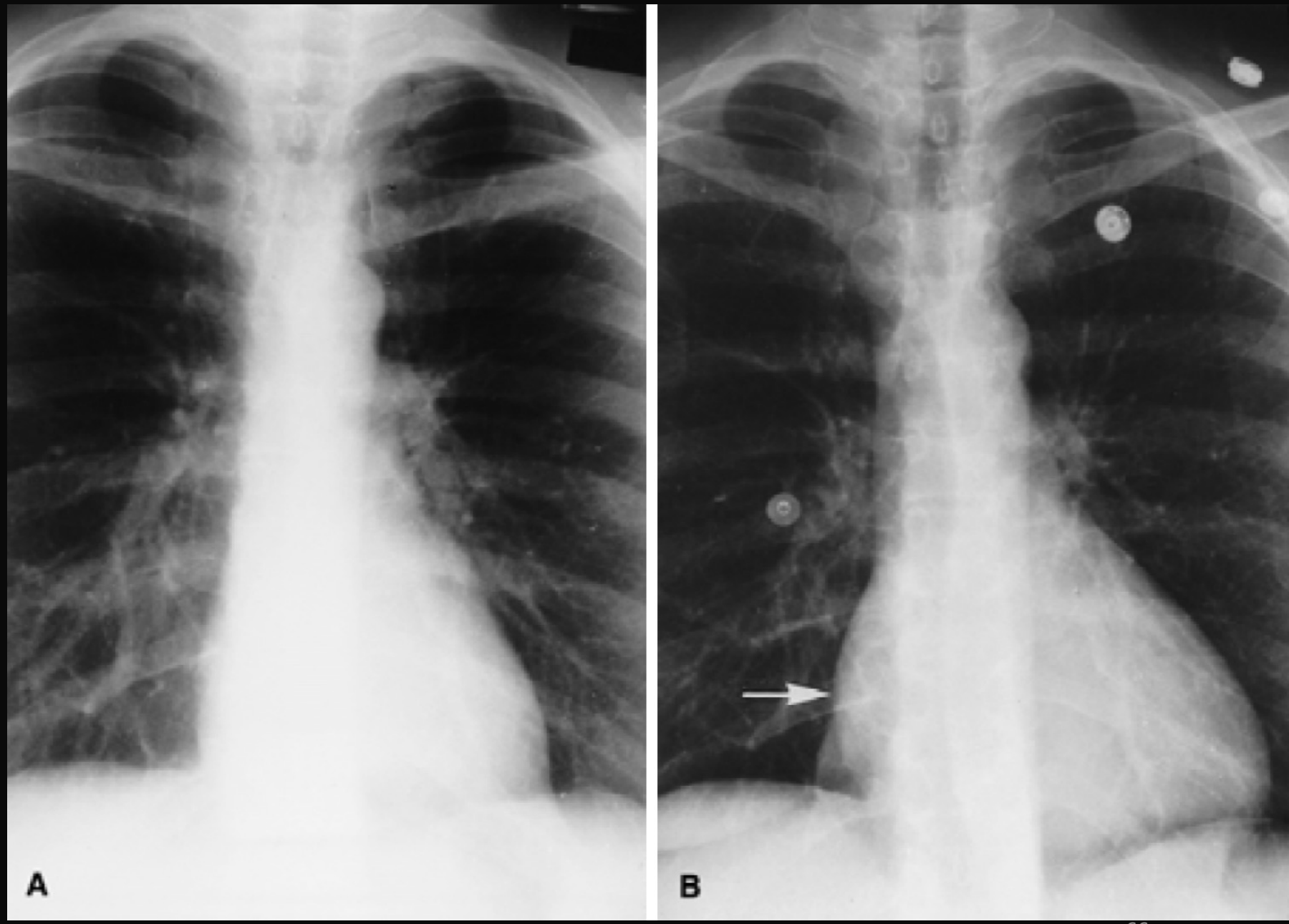






Baron, Murray G. M.D. The Cardiac Silhouette, Journal of Thoracic Imaging: October 2000 - Volume 15 - Issue 4 - p 230-242

Right atrium enlargement: tricuspid or pulmonary valve disease



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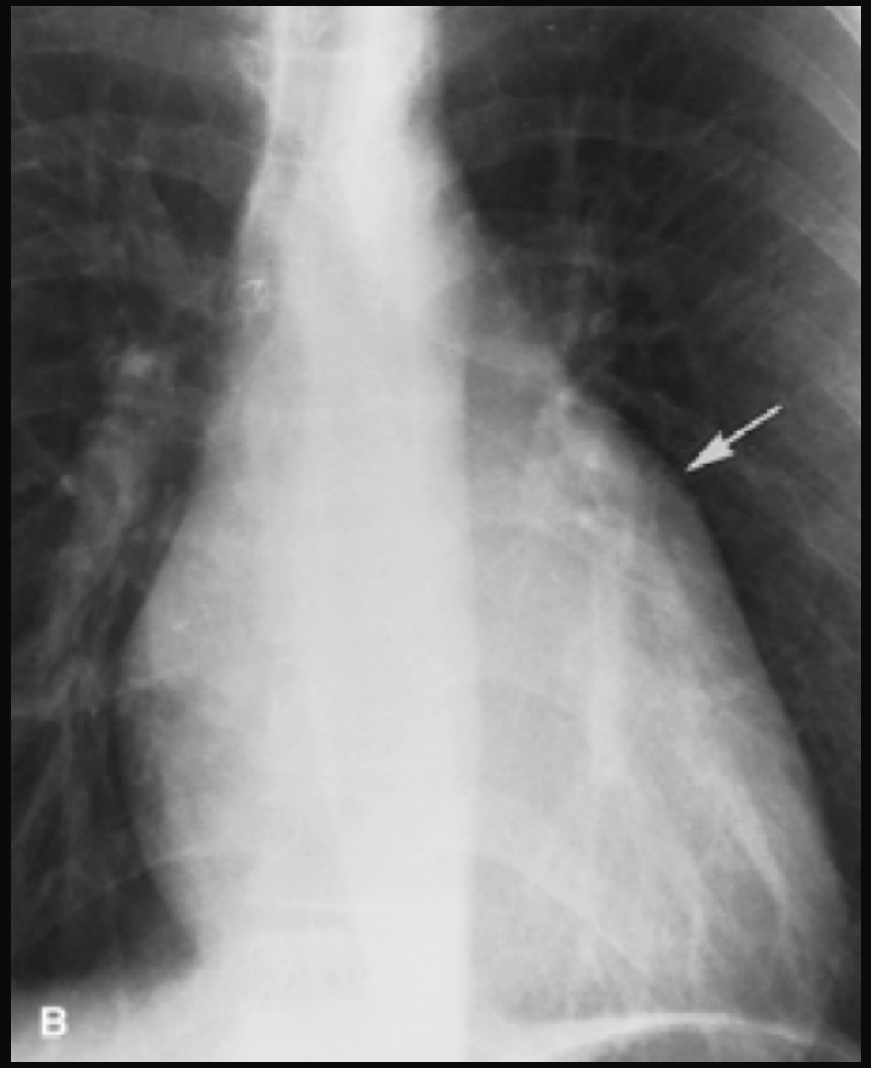
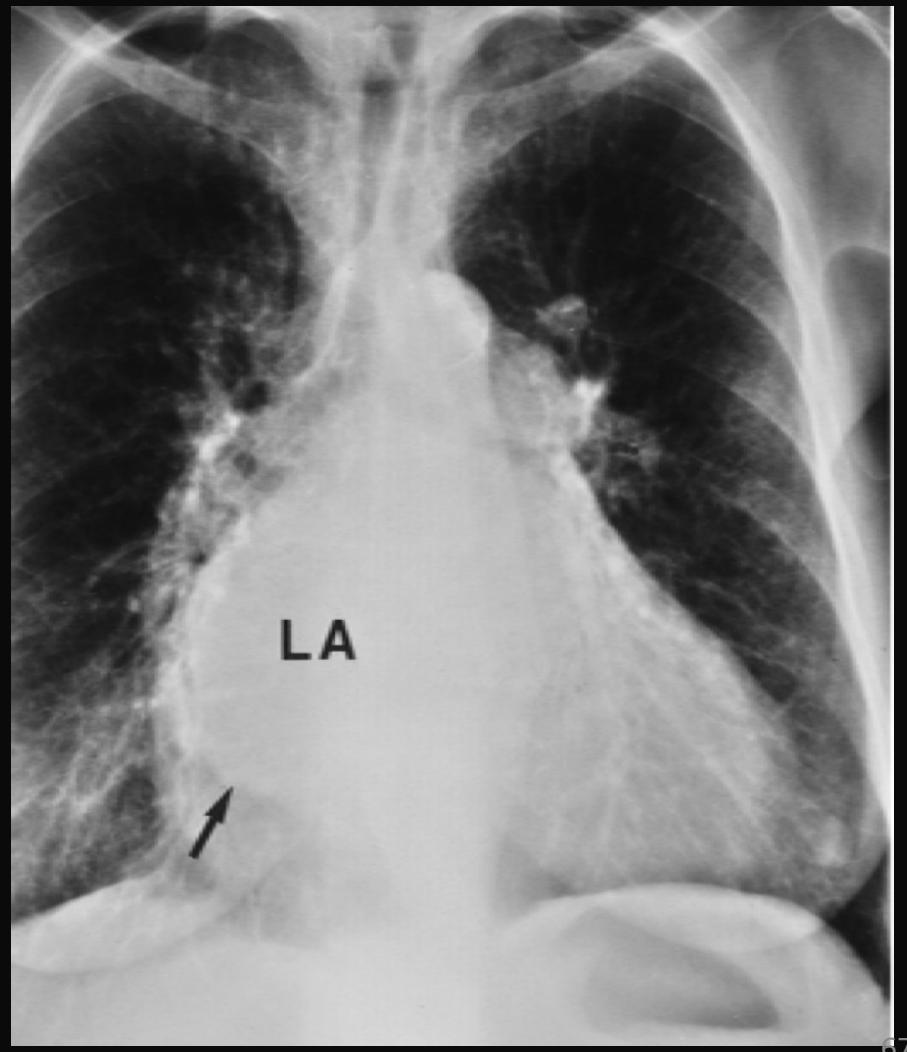
Left atrium enlargement: mitral valve disease

Double contour sign





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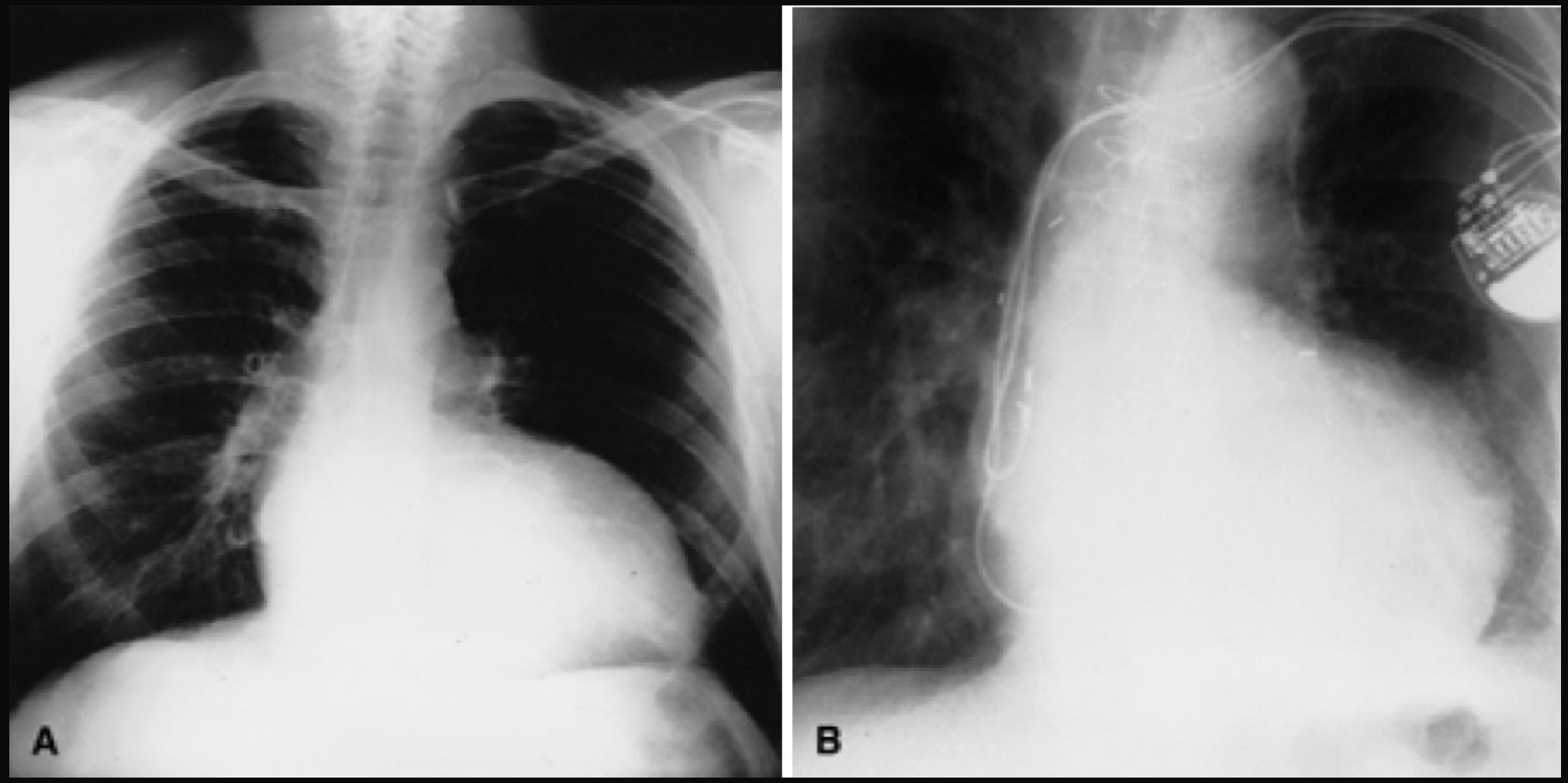
Left ventricular dilatation

Sometimes mimicks RV dilatation with elevated apex



Baron, Murray G. M.D. The Cardiac Silhouette, Journal of Thoracic Imaging: October 2000 - Volume 15 - Issue 4 - p 230-242

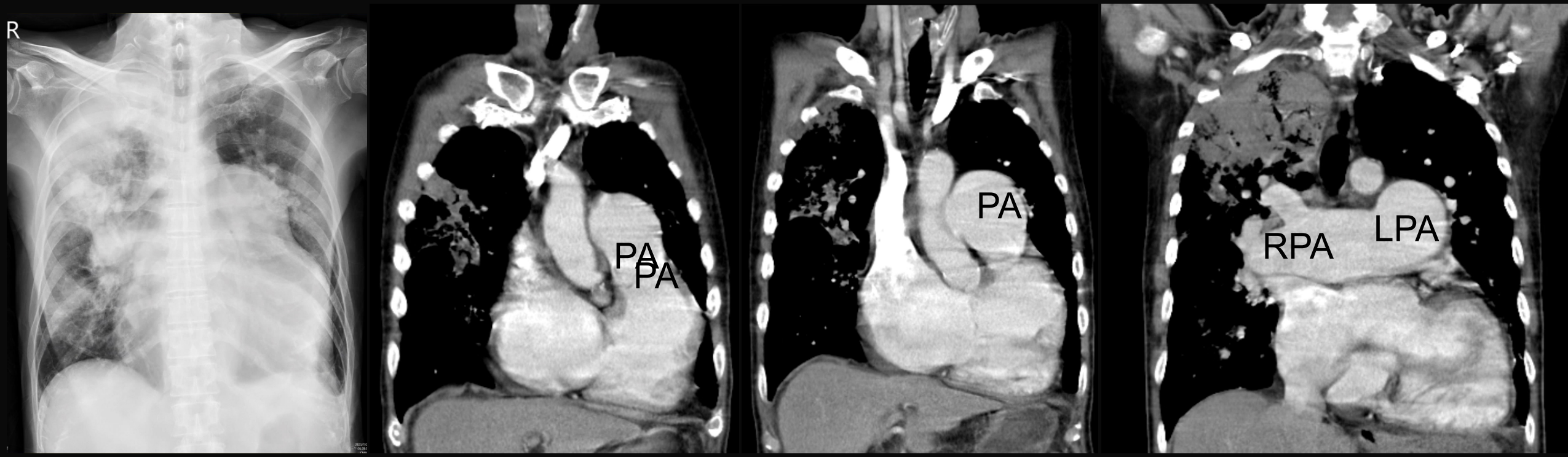
ASD with secondary pulmonary hypertension

2011

2019

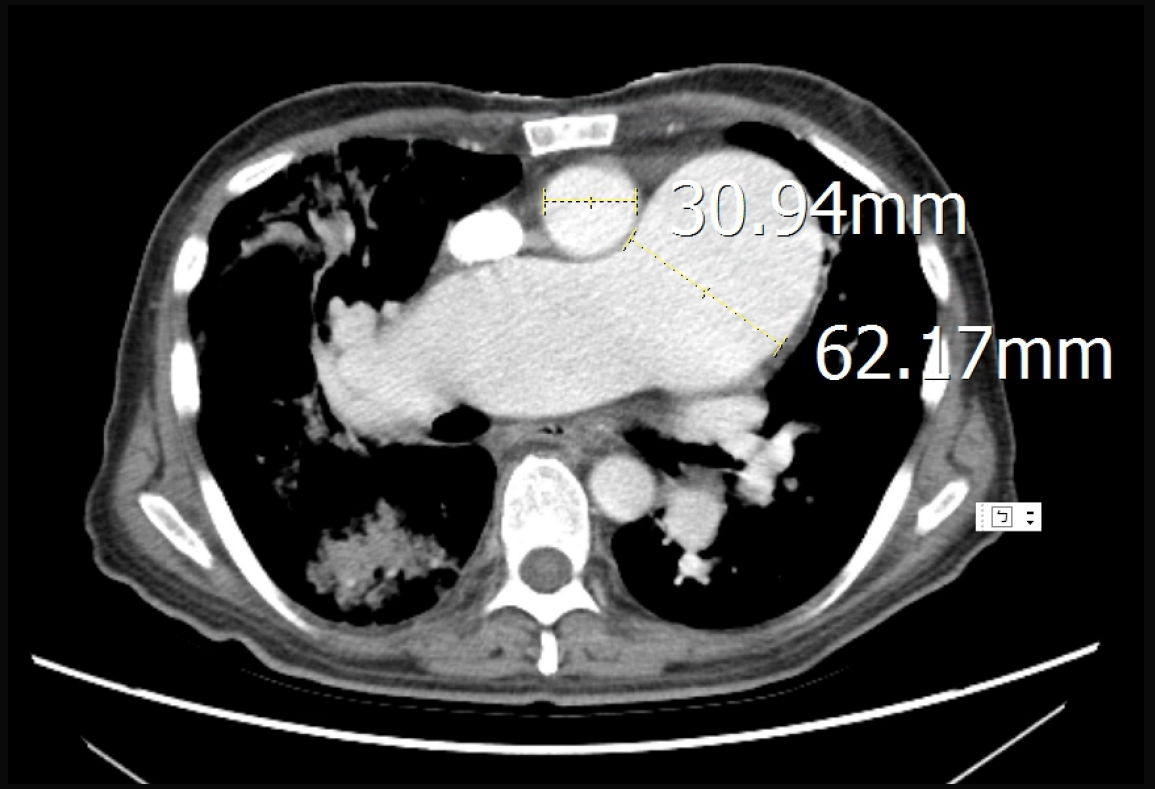
ASD with secondary pulmonary hypertension

2021

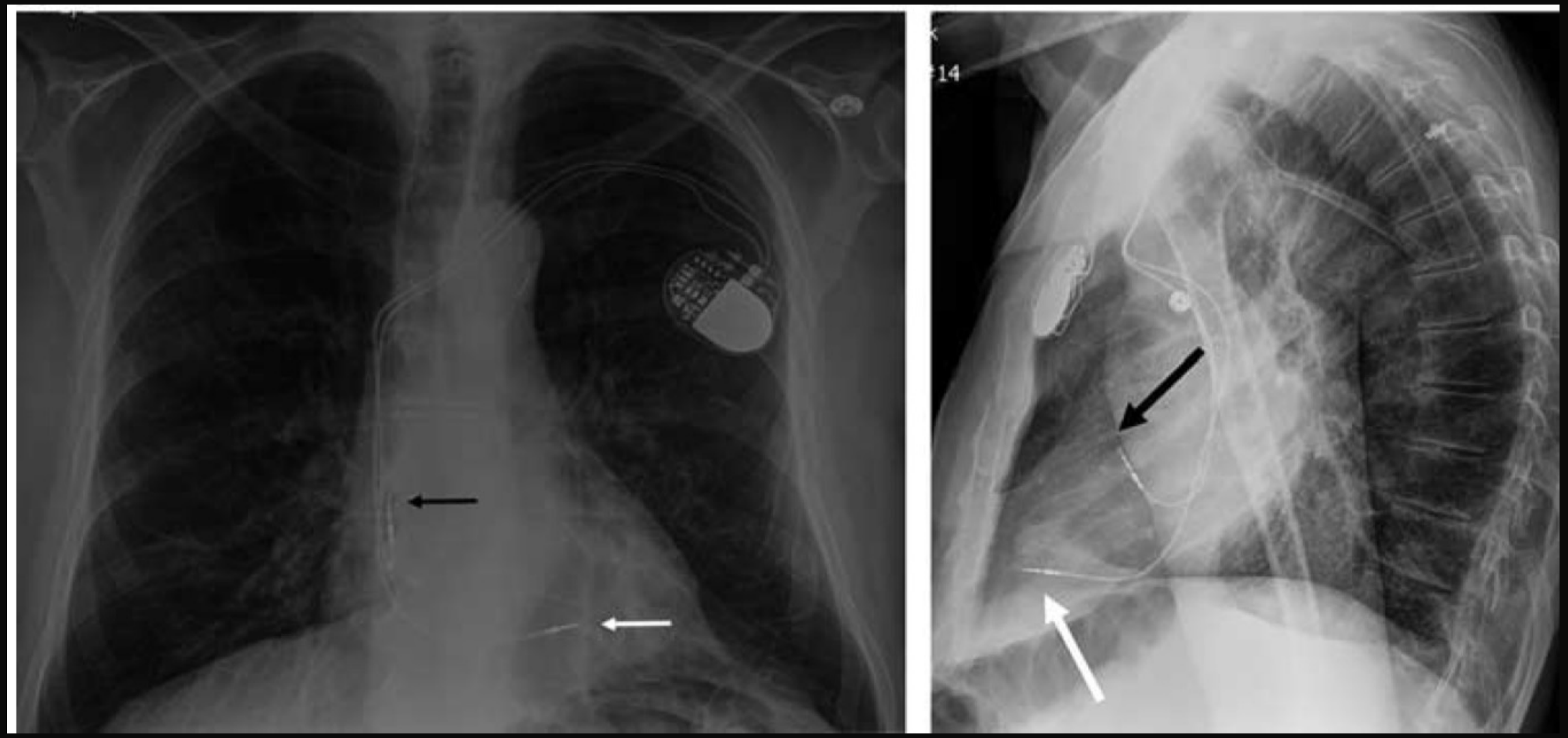


ASD with secondary pulmonary hypertension

2021

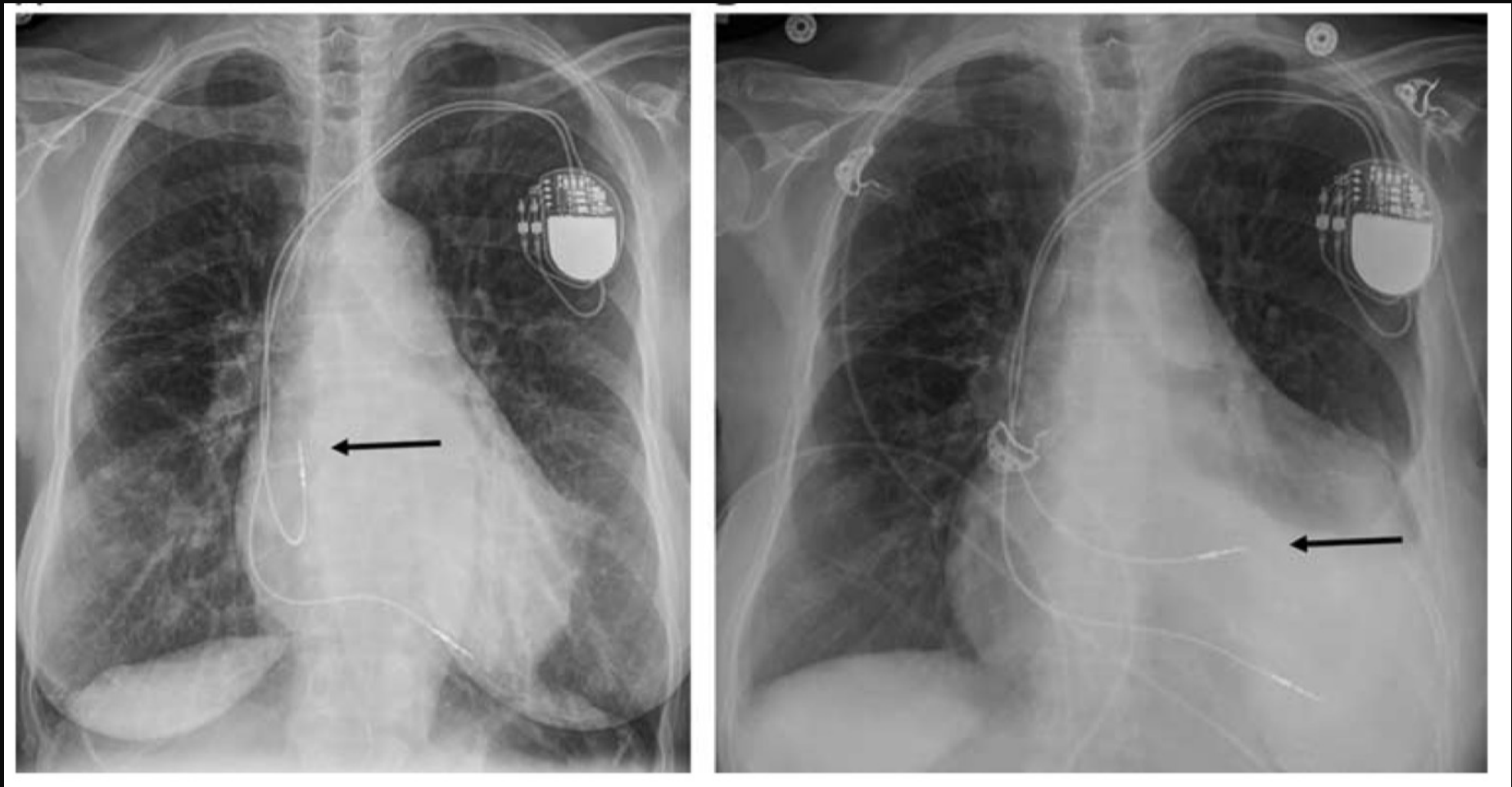


Pacemaker



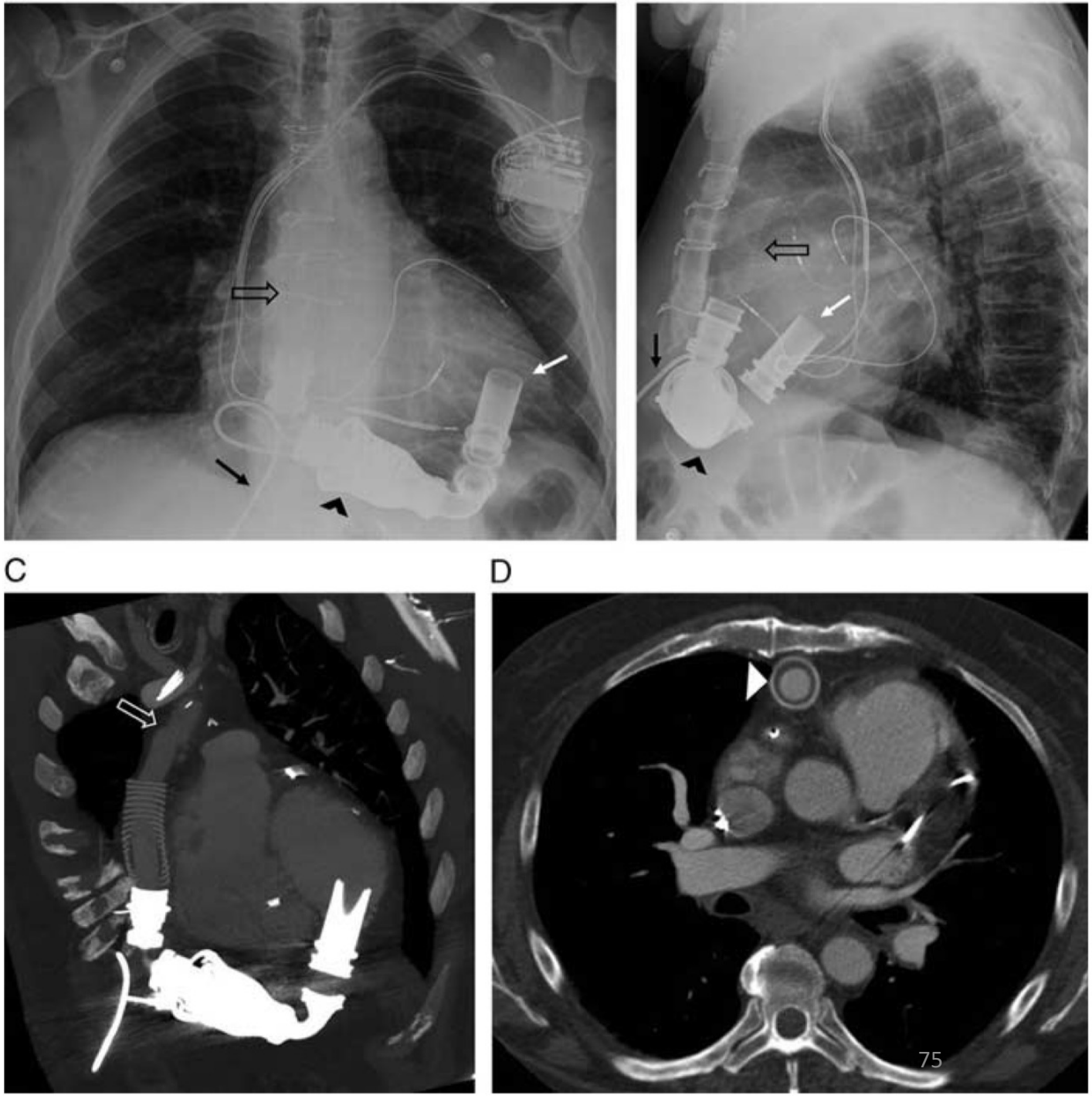
Brixey, et al. J Thorac Imaging 2017;32:343–357

Disslodged atrial lead (black arrow) and the enlarged cardiac silhouette on follow-up radiograph, consistent with myocardial perforation and resultant hemopericardium.



Brixey, et al. J Thorac Imaging 2017;32:343–357

Left ventricular assist device (LVAD)



Brixey, et al. J Thorac Imaging 2017;32:343–357

急重症與心血管影像判讀

管路位置與併發症
急症疾病
心血管影像

中國附醫胸腔內科暨重症系 陳韋成醫師