

You are cordially invited to attend the  
**Echocardiography  
in the Intensive Care Unit**

Friday, 8 February 2019  
Bayt Al Dhiyafah, Hamad bin Khalifa Medical City  
Saturday, 9 February 2019  
Hajar Auditorium, HMC Medical Education Center

This course is in collaboration with the European  
Association of Cardiovascular Imaging (EACVI).

# Lung Ultrasound

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“Speaker disclosure - I do not have an affiliation (financial or otherwise) with a pharmaceutical, medical device, or communication and event planning company.”



# OBJECTIVES

- 1.- To show the diagnostic capabilities of Lung UltraSound in Critical Care.
- 2.- To illustrate the diagnostic modalities needed.
- 3.- To highlight the fields of application.
- 4.- To encourage the use of standardized protocols and terminology.

# Lung Approach in Critical Care

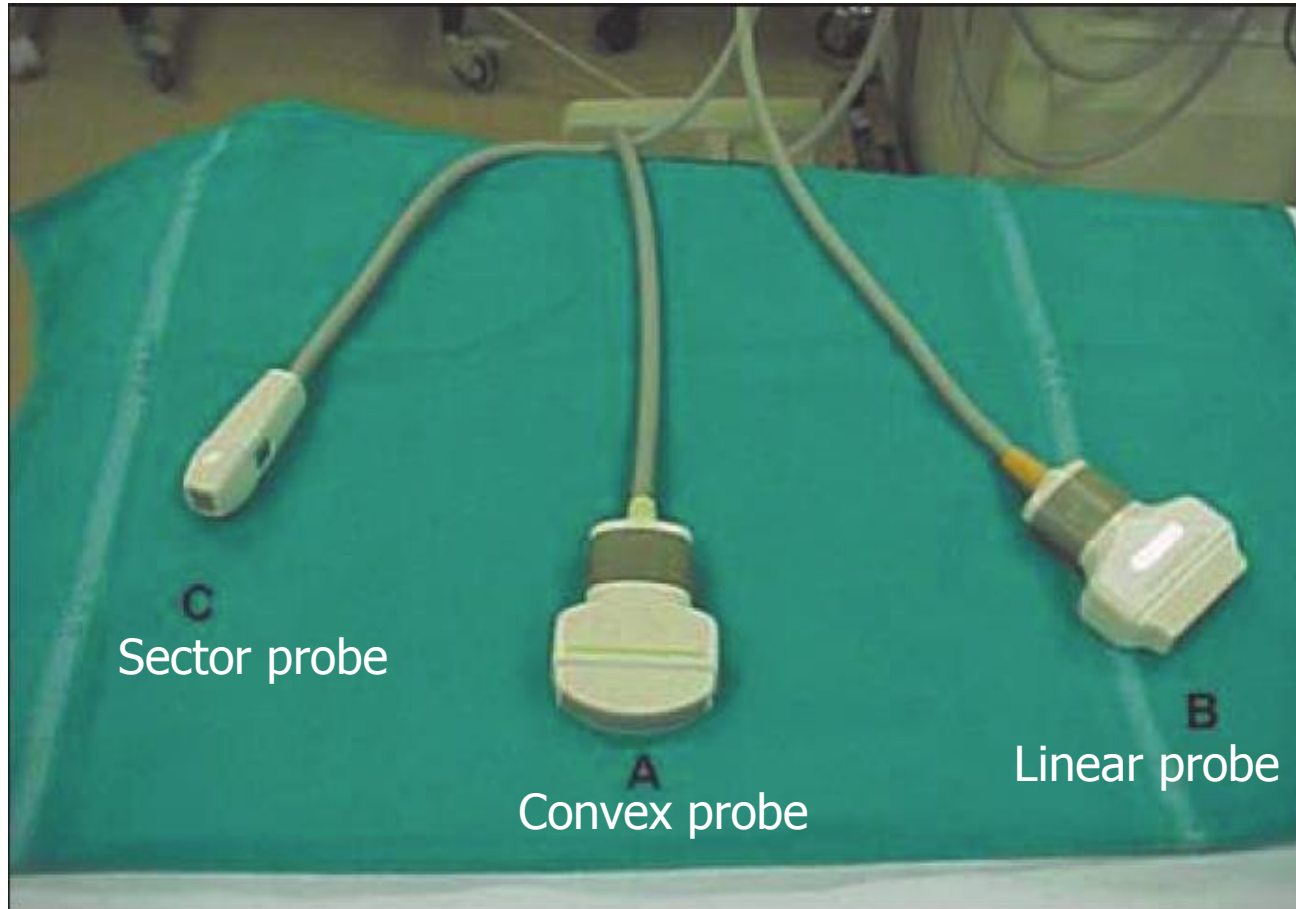
- **Physical examination**: insufficient for fine diagnosis
- **Bedside chest radiography**: limited accuracy
- **Chest computed tomography**: risk of transportation and limited availability
- **Lung UltraSound (LUS)**: Easy available, Low cost

# Lung Ultrasound (LUS) In Emergency

When LUS can be useful in ER:

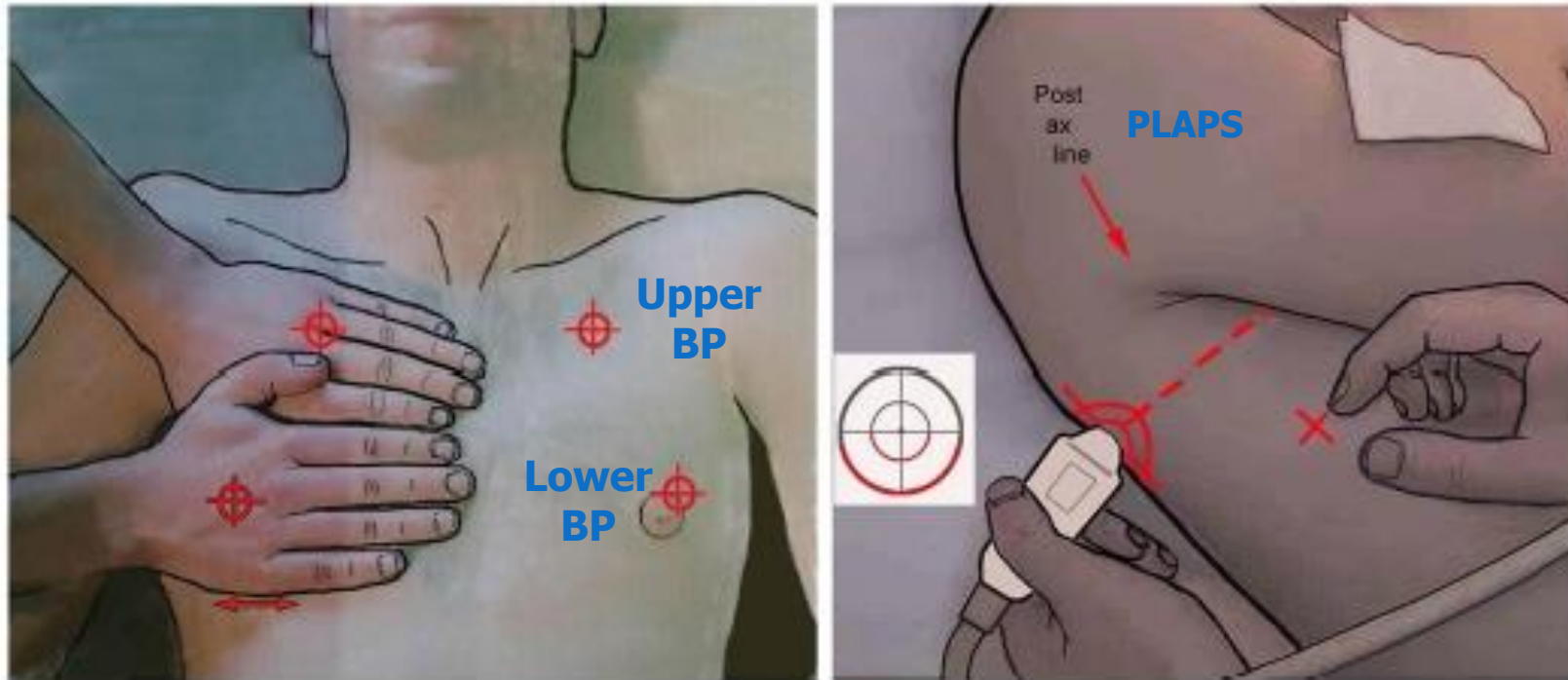
- Pleural pathology
- Pericardial pathology
- Shortness of breath
- Cyanosis
- Cough
- Shock

# Probes for Lung Ultrasound (LUS)



# LUS approach standardization

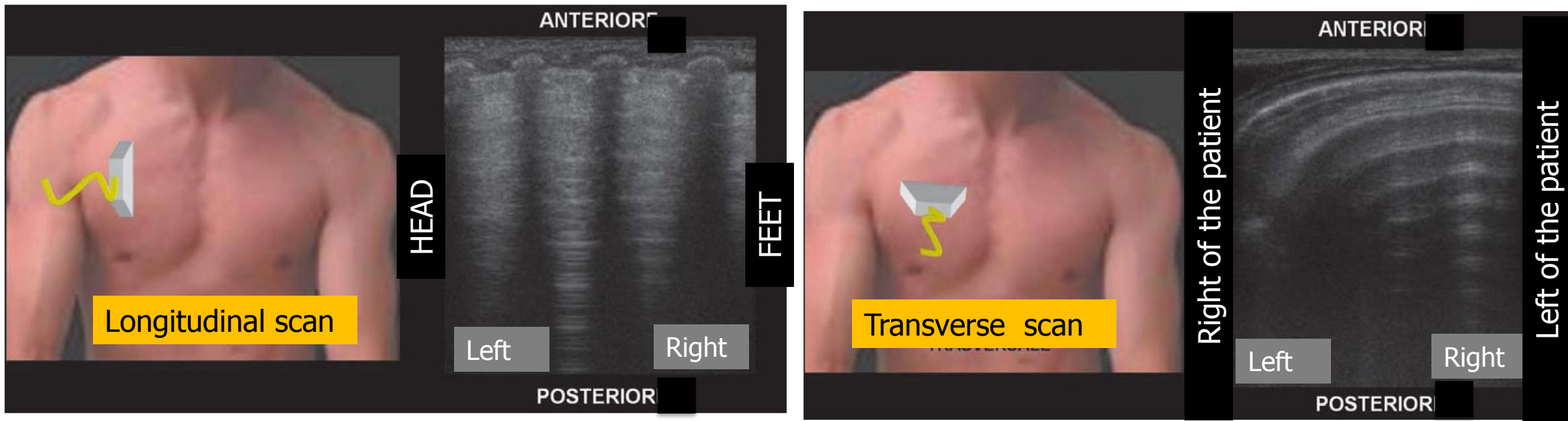
## The blue points



Each point shows a standardized area for a given disorder

Lichtenstein D, *Curr Opin Crit Care* 2014;20:315-322

# Longitudinal or Transversal Approach

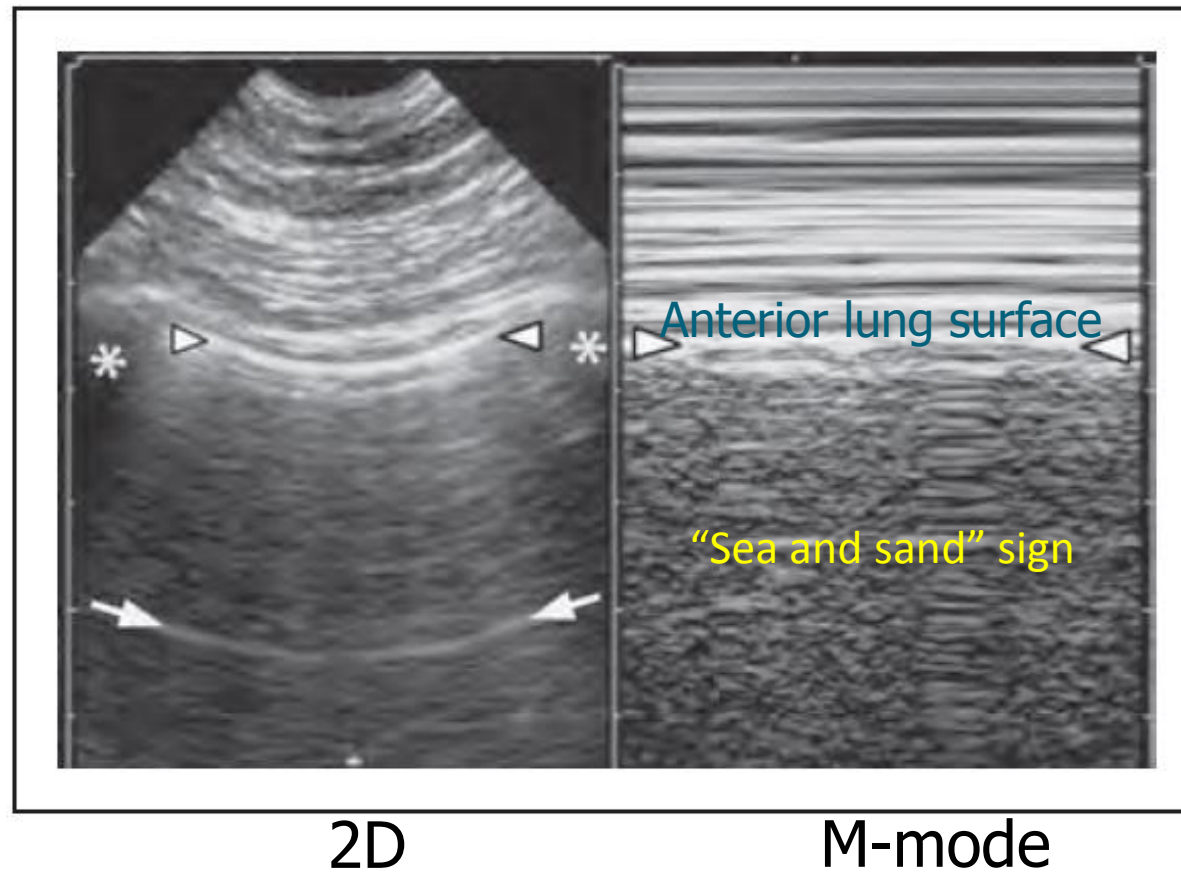


The longitudinal approach has the advantages of locating the pleural line in all circumstances.



# Mastery of the LUS Blue Protocol (<3 min)

## Normal lung



Ribs

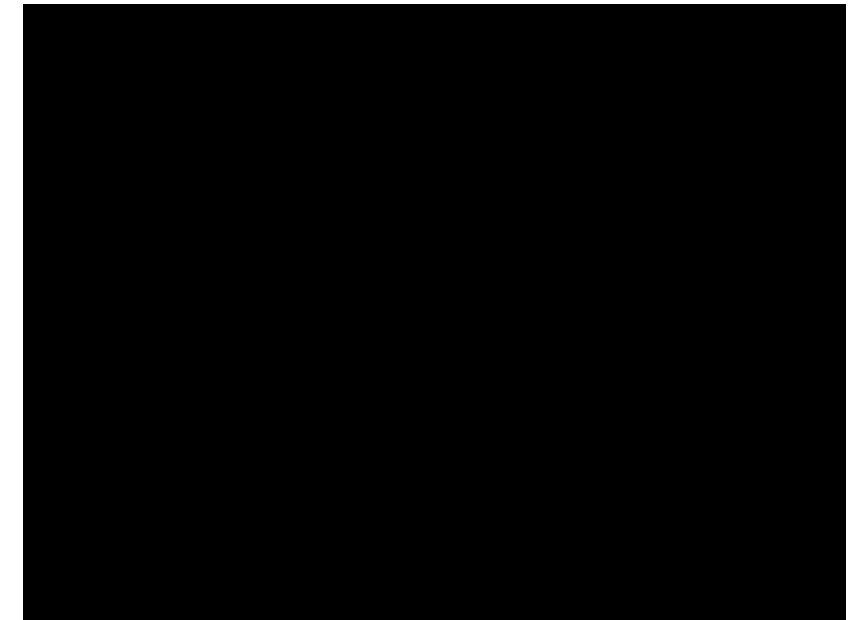
Anterior lung surface

"Sea and sand" sign

**Bat sign** Pleural line

2D

M-mode

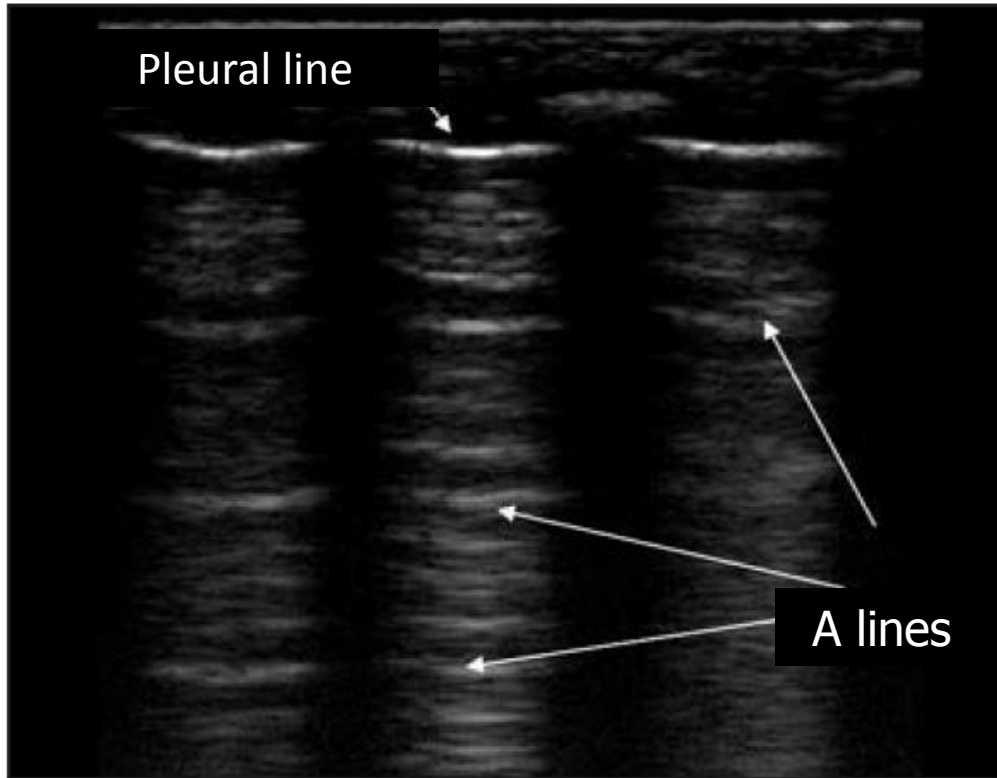


Sector probe



# 1. Lung Ultrasound (LUS): The A lines

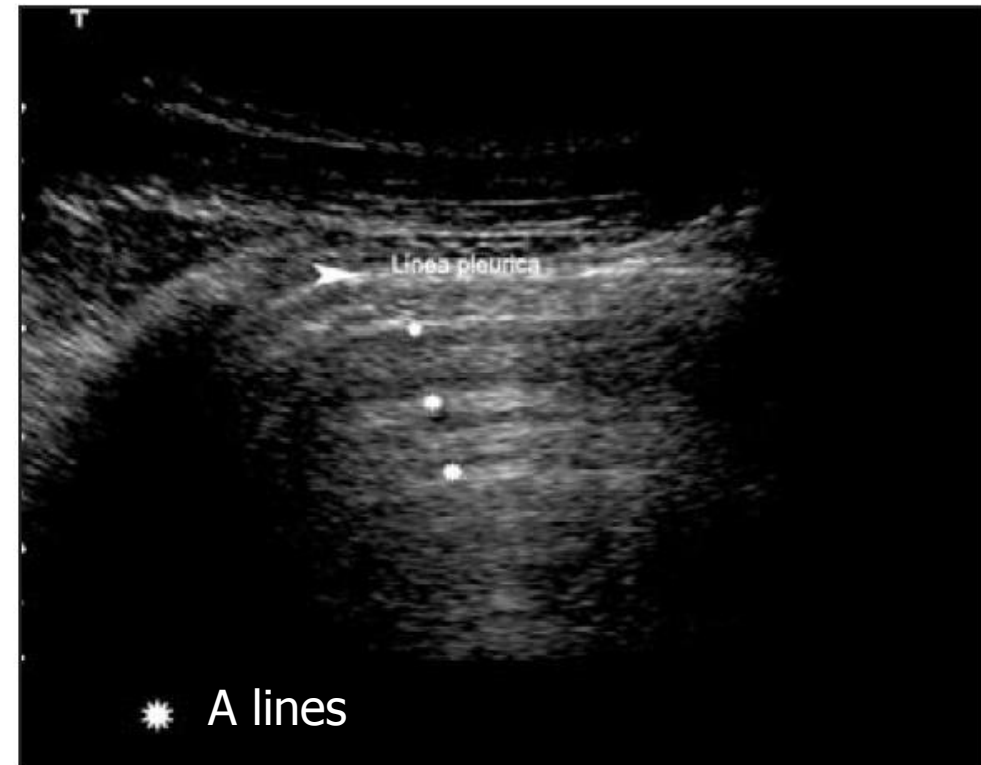
Linear probe



Normal lung

Convex probe

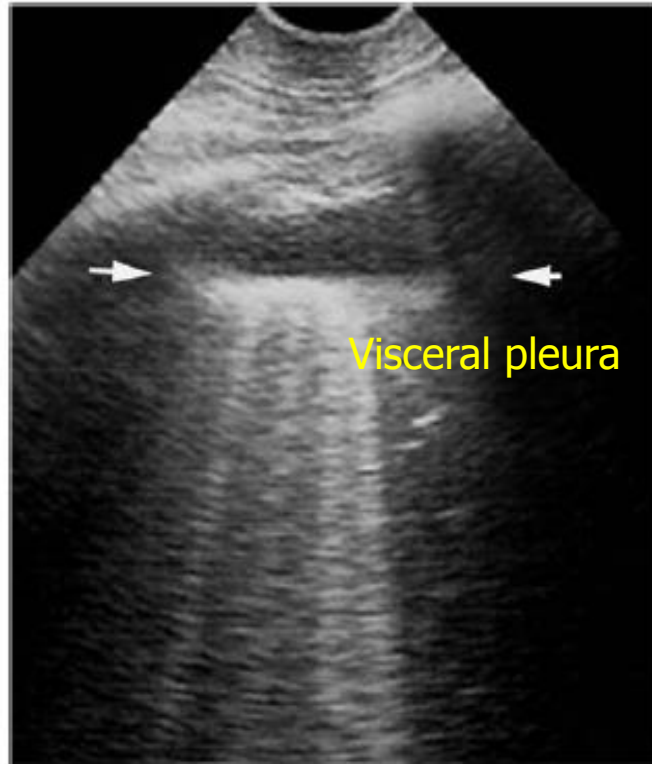
The A profile



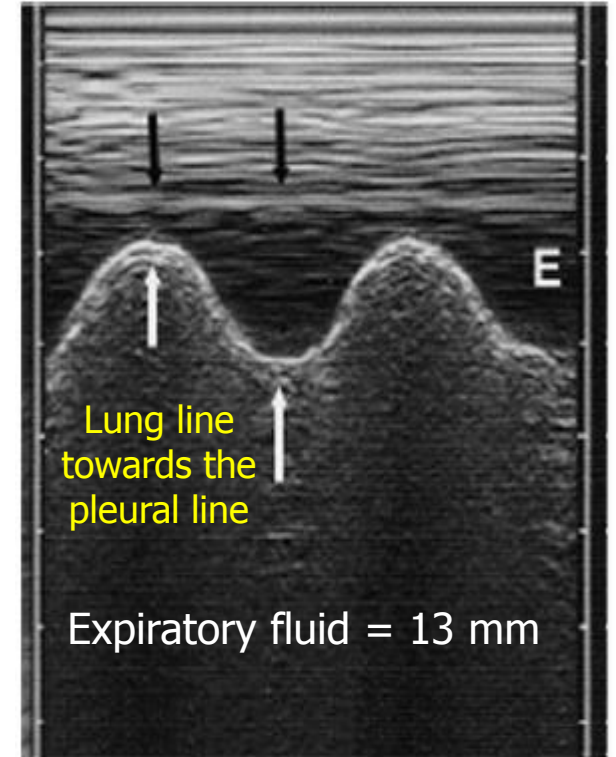
The **A lines** are horizontal artifactual repetitions of the pleural line displayed at regular intervals.

# 2. Lung UltraSound (LUS): Pleural Effusion

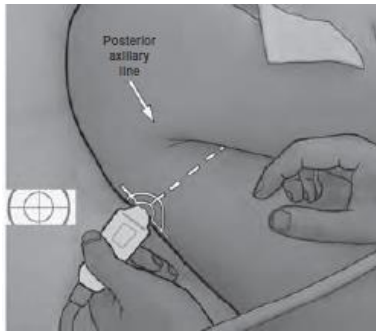
Quoad sign (2D LUS)



Sinusoid sign (M-mode)



PLAPS profile

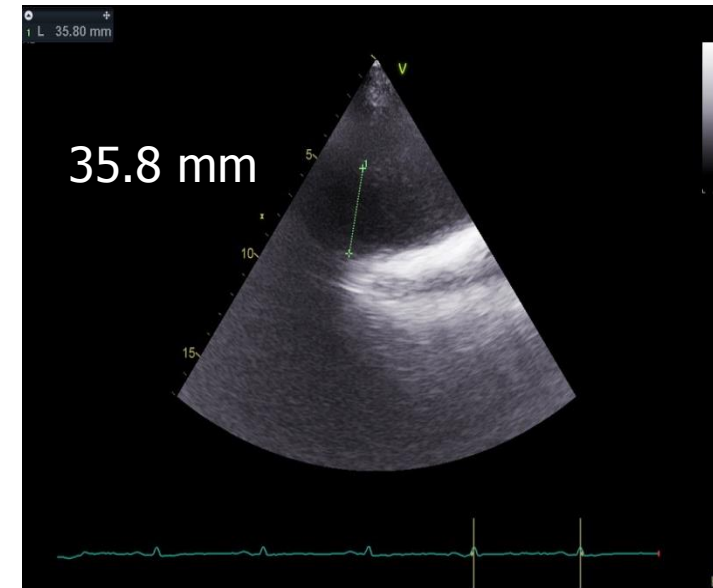
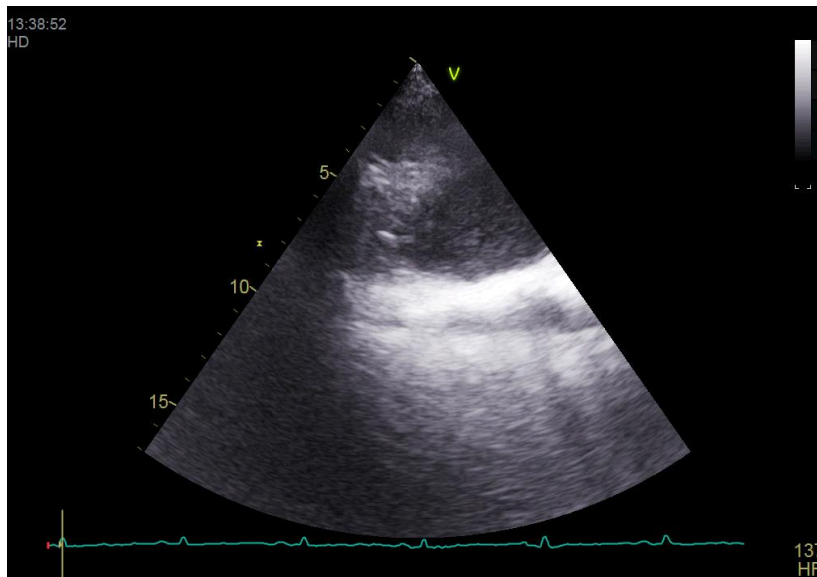
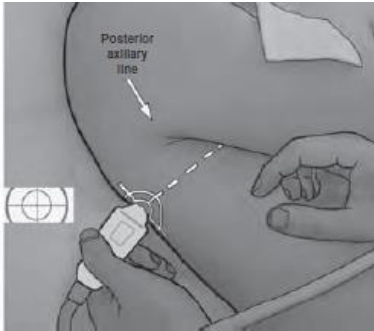


A 15-mm distance is our minimum required for safe diagnostic or therapeutic puncture,

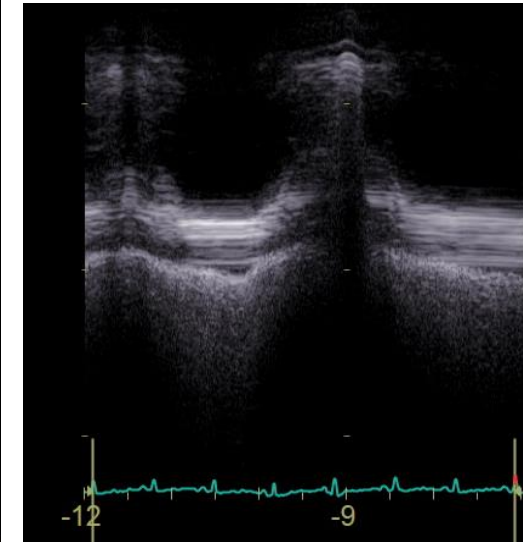
# Pleural Effusion

Sector probe

PLAPS profile



Sinusoid sign

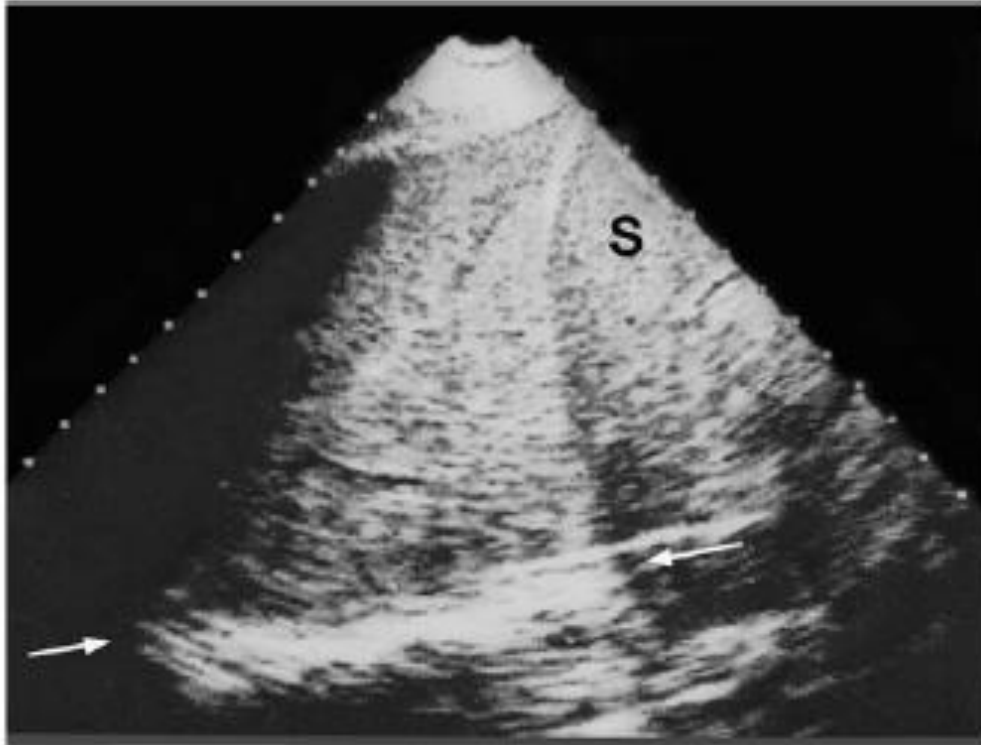
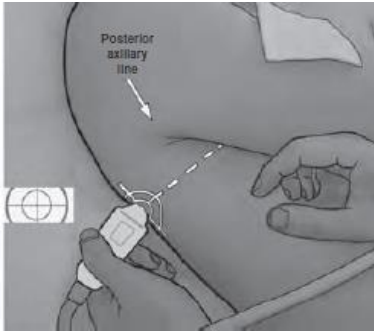


M-mode

# 3. Lung UltraSound (LUS): Lung consolidation

## The C profile

PLAPS profile



**Massive consolidation** of the whole lower lobe without aerated lung tissue and no fractal sign

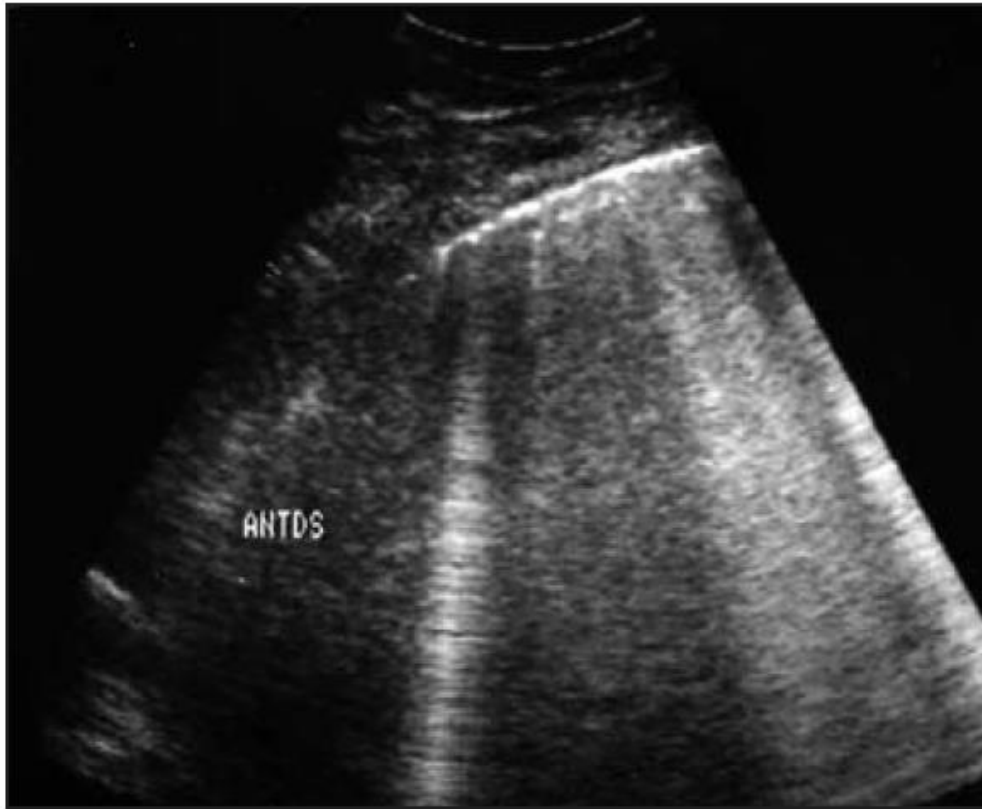


**Middle lobe consolidation** not invading the whole lobe, with **fractal border** with aerated lung

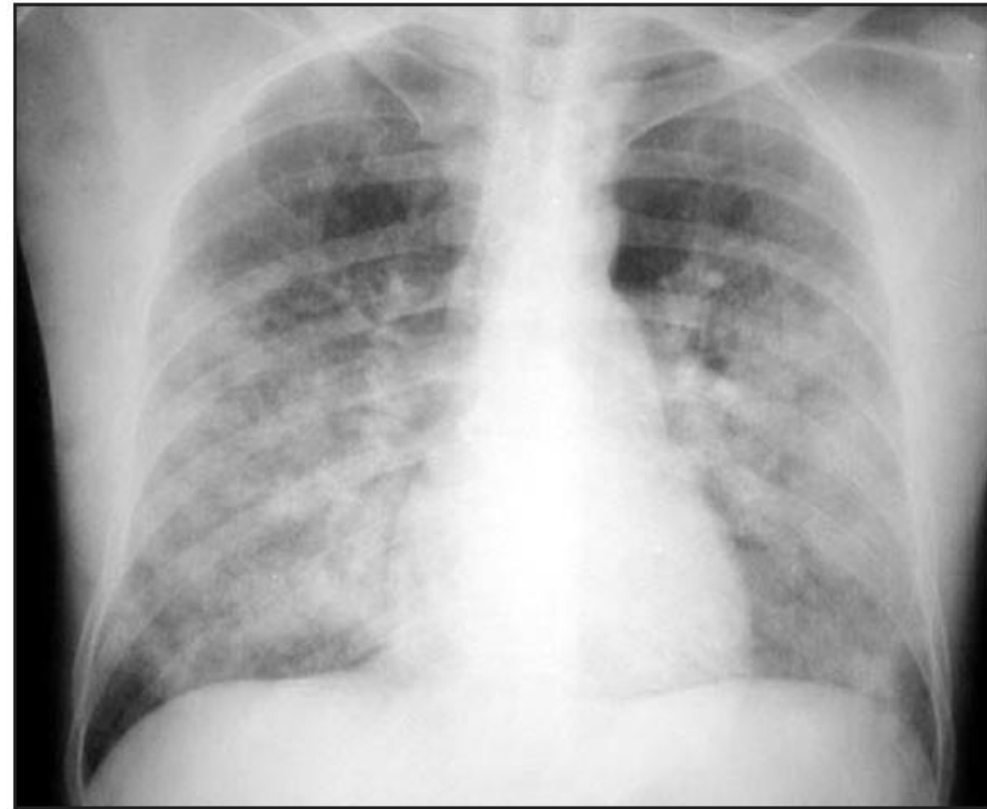
# 4. Lung Ultrasound: Interstitial syndrome

Pulmonary Interstitial Edema is diagnosed by diffuse lung rockets  
**Lung rockets are defined as at least 3 B lines between two ribs**

**B lines**



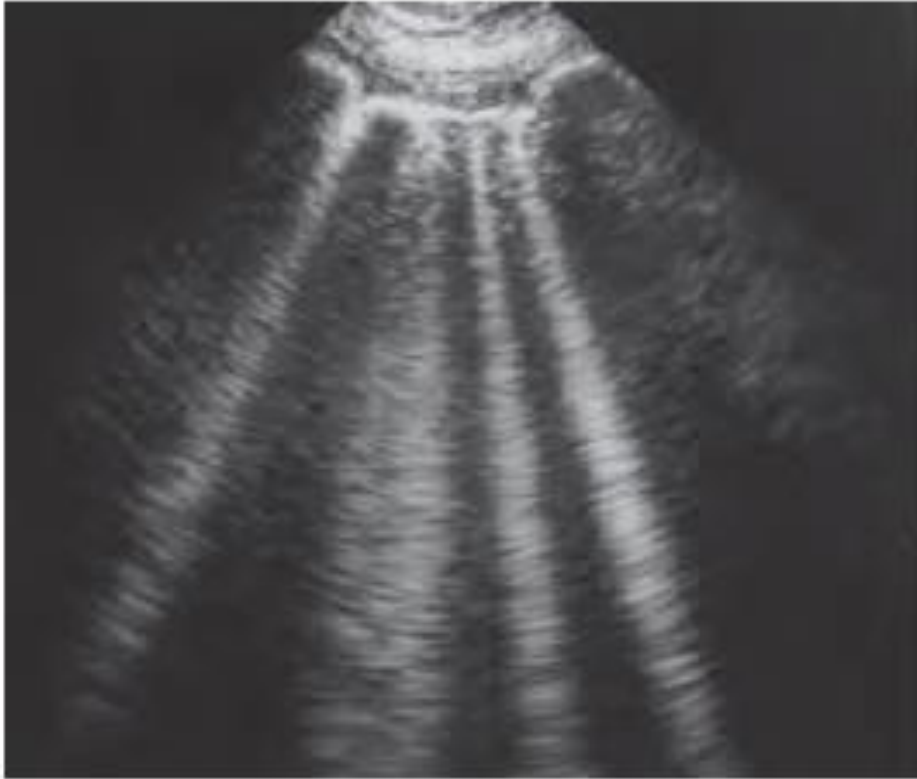
LUS



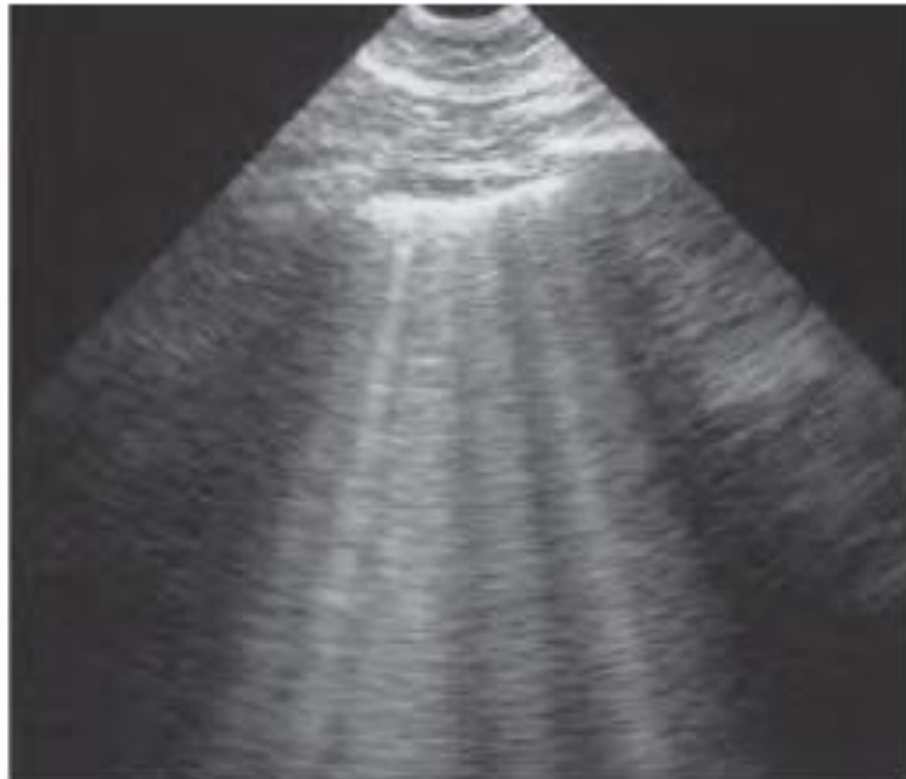
Chest x-ray

# Lung interstitial syndrome

## B lines



Septal lung rockets correlating with edematous subpleural interlobular septa



Ground glass rockets correlating with ground-glass areas

# Interstitial syndrome: Multiple B lines

Lung rockets



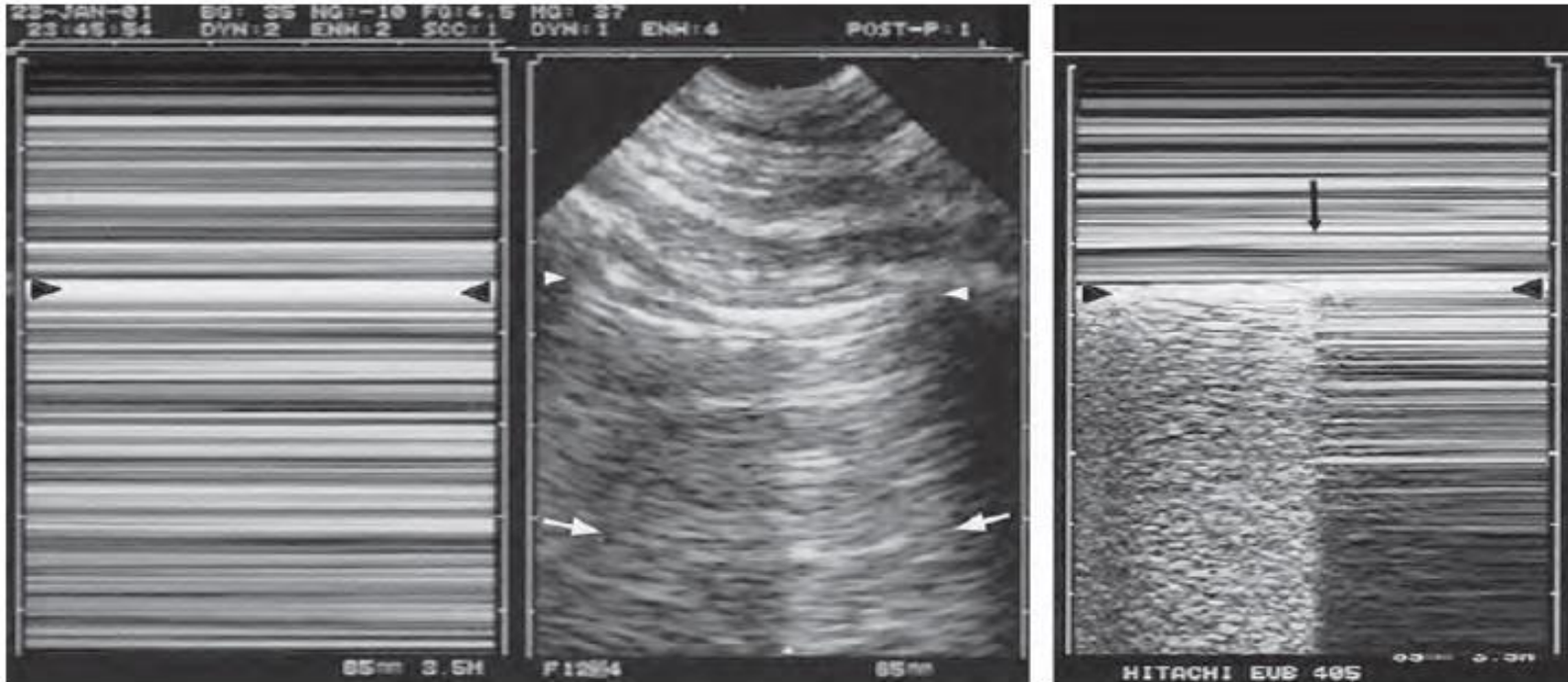
Glass rockets





# 5. Lung UltraSound (LUS): Pneumothorax

## The A' profile



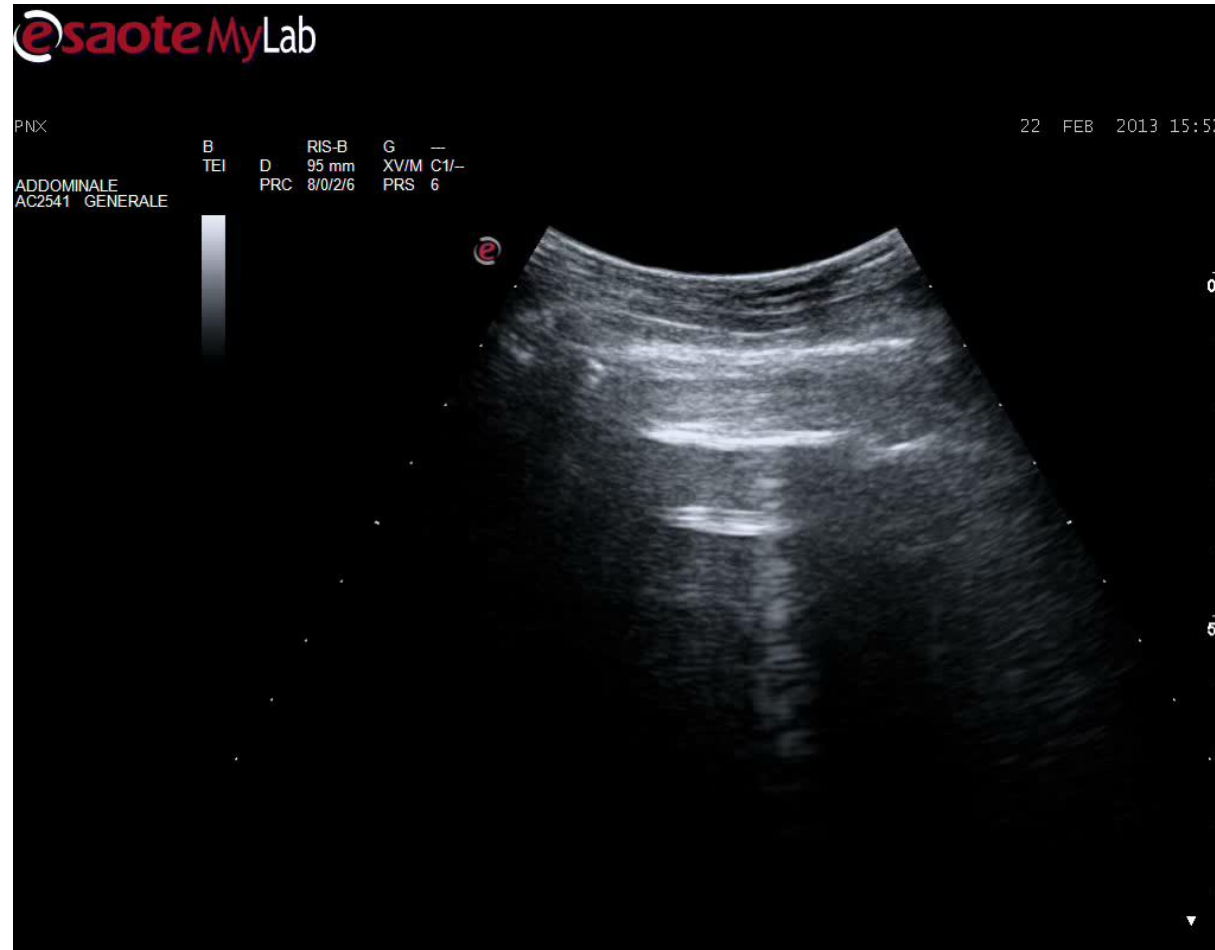
Abolished lung sliding  
"Stratosphere sign"

Anterior abolished  
lung sliding  
+  
A lines

Lung point at the area at the  
junction between dead air  
(pneumothax) and living air  
(inflating lung)

# Pneumotorax

Sector probe



**Lung point**

# LUS 10 signs

1. Bat sign (pleural line)
2. Lung sliding
3. A-line (horizontal artifact)
4. Quoad sign
5. Sinusoid sign
6. Fractal and Tissue-like sign
7. B-line (vertical artifact)
8. Lung rockets
9. Abolished lung sliding with Stratosphere sign
10. Lung point

NORMAL

EFFUSION

CONSOLIDATION

INTERSTITIAL

PNEUMOTORAX

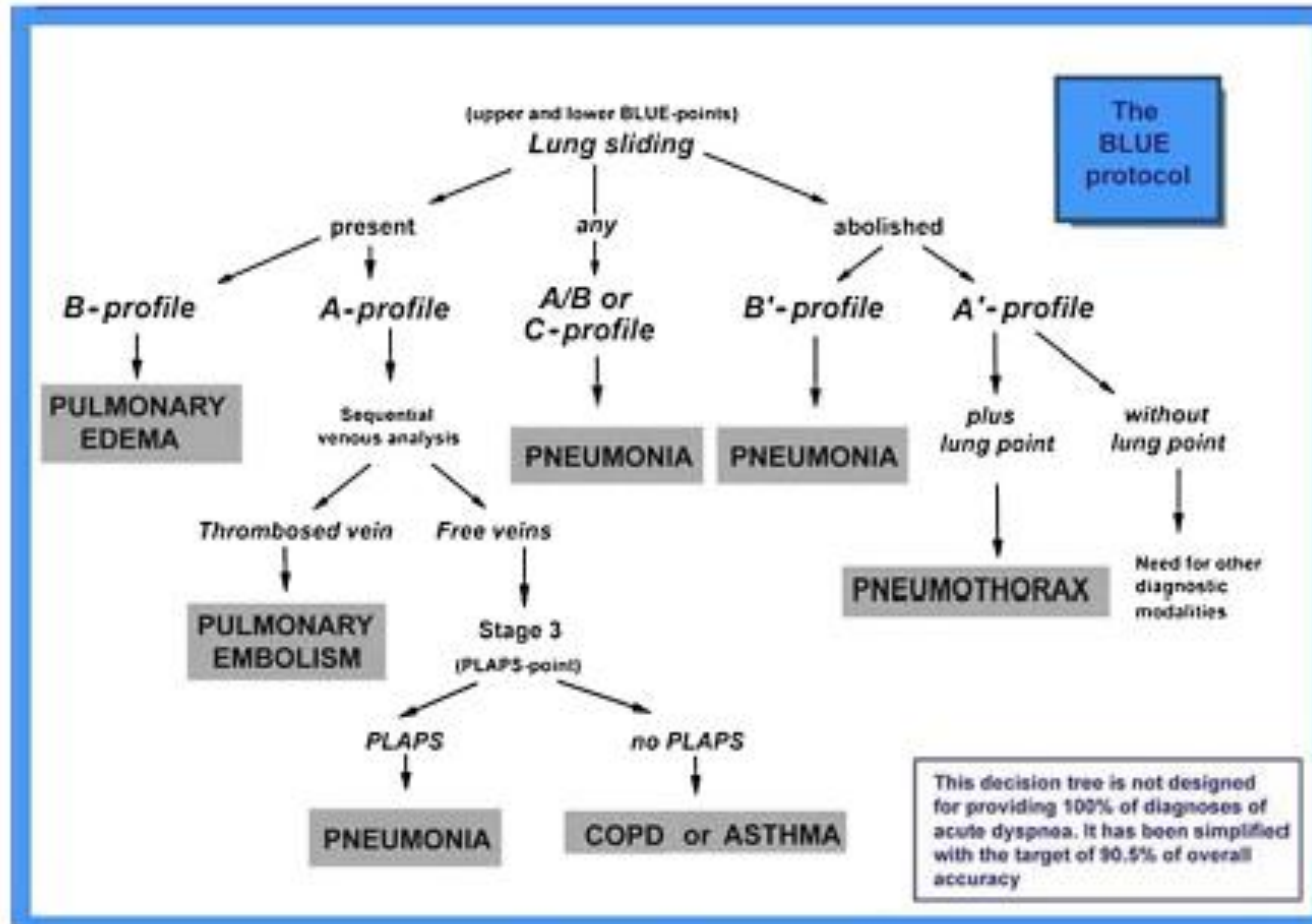
Two more signs, the lung pulse and the dynamic air bronchogram, are used to distinguish atelectasias from pneumonia

# Diagnosis of Pulmonary Embolism

The association of A profile with venous thrombosis (venous scan) favours the diagnosis of pulmonary embolism

- 81% sensitivity
- 99% specificity

# The BLUE Protocol Decision Tree



Lichtenstein D, *Chest* 2008;134:117-125

# Performance of LUS in the critical care

Accuracy of LUS in the critical ill compared with Computed Tomography

Ultrasound	Sensitivity	Specificity
Pleural effusion [9]	94%	97%
Alveolar consolidation [10]	90%	98%
Interstitial syndrome [11]	93%	93%
Pneumothorax [12]	95%	94%
Complete pneumothorax [13]	100%	96%
Occult pneumothorax [14]	79%	100%

CT, computed tomography.

Lichtenstein D, *Curr Opin Crit Care* 2014;20:315-322

# The BLUE Protocol combined with simple Echo

The BLUE Protocol applies LUS and venous ultrasound for drawing profiles.

A simplified echocardiography without Doppler can be associated with the BLUE protocol.

The BLUE protocol can be adapted to multiple clinical settings:

Trauma

Neonate

Acute Respiratory Distress Syndrome (ARDS)



# Fluid Administration limited by LUS Protocol

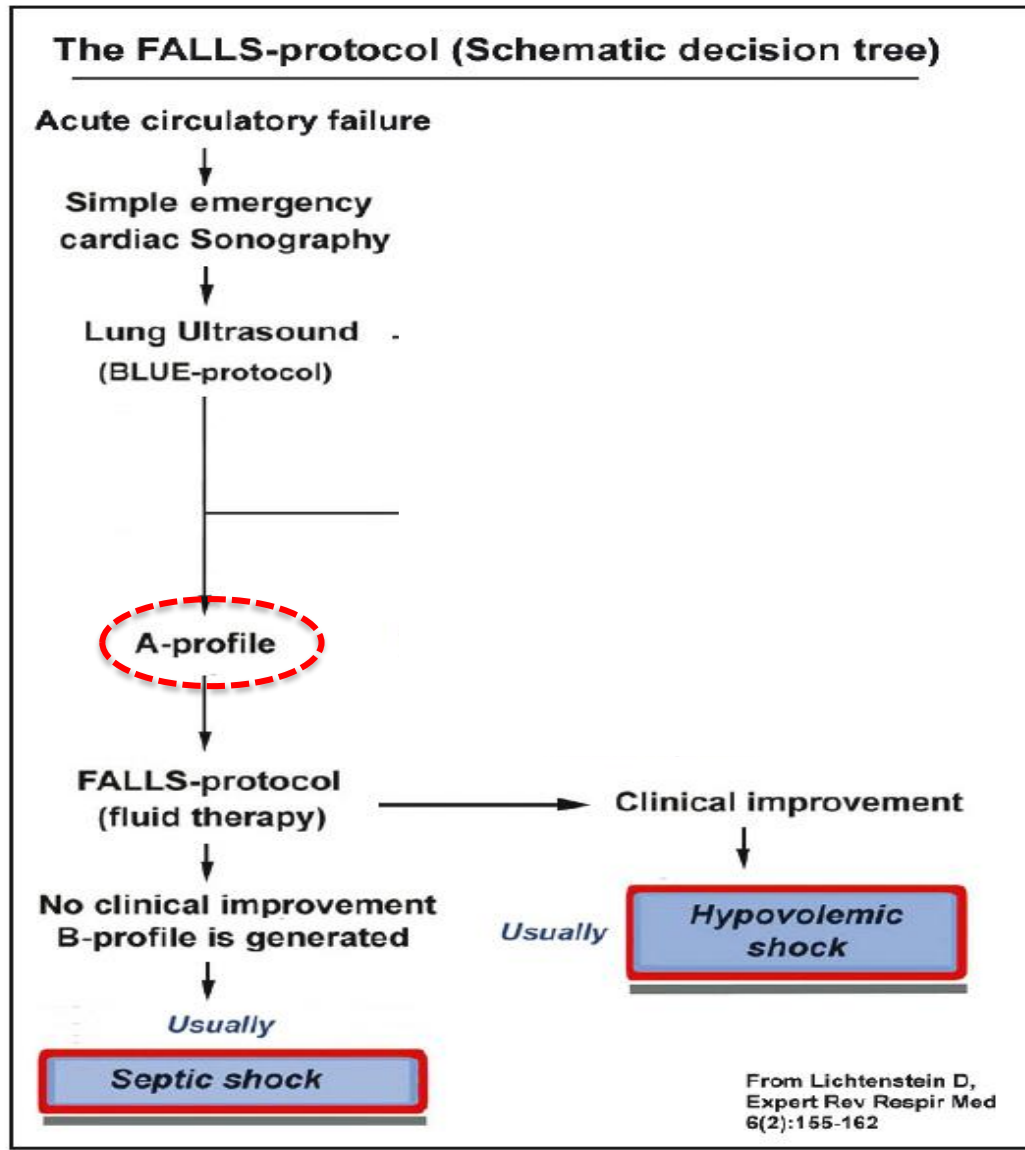
LUS can be used for answering two basic questions

1. Will the given patient benefit from fluid therapy ?
2. If administered, when stop fluid ?





# FALLS protocol



Lichtenstein D, *Heart Lung Vessels* 2013;5:142-147

# Take home message

Lung UltraSound signs, either alone or combined to other point-of-care ultrasound techniques, are helpful in the diagnostic approach to patients with acute respiratory failure, circulatory shock or cardiac arrest.

Lung UltraSound is a useful diagnostic and monitoring tool that might become in the next future part of the basic knowledge of physicians taking care of the critically ill patient.

Lung ultrasound can be used for early detection and management of respiratory complications under mechanical ventilation, such as pneumothorax, ventilator-associated pneumonia, atelectasis and pleural effusions.