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# Bedside Ultrasonography in Acute Respiratory Failure

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# A Brief Case Presentation

- A 72-year-old male with a past medical history of congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and end-stage renal disease is admitted to the ER of your hospital because of acute dyspnea from 12 hours ago.
- His vital signs are:
  - BP=190/110 mm Hg
  - PR=115/minute
  - RR= 32/minute
  - So2= 82% while breathing room air
- Examination of the lungs demonstrates bilateral expiratory wheezing and basilar fine crackle. His oxygenation moderately improves with supplemental oxygen, but his work of breathing is considerable.

## Differential diagnoses?

- Acute Pulmonary Edema
- Pulmonary Embolism
- COPD or Asthma Attack
- Pneumonia
- Pneumothorax

## What imaging Study?

- Plain Chest X Ray
- CT Scan
- **Ultrasonographic Study**



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# Ultrasonographic Study

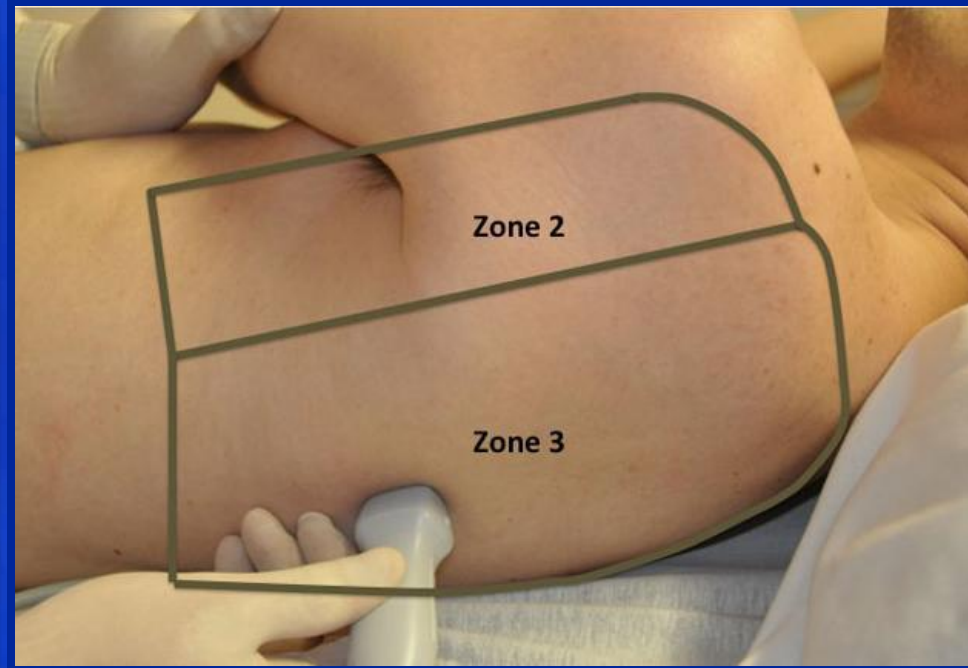
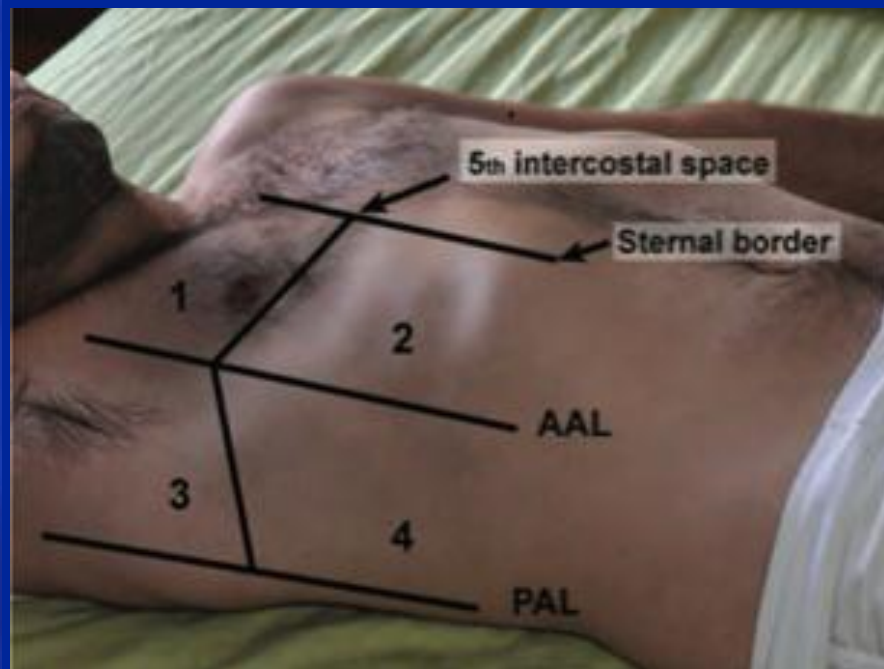
- Lung ultrasound is a holistic discipline and:
  - Multifaceted tool:
    - Emergency Medicine Specialists
    - Surgeons
    - Pulmonologists
    - Intensivists
  - Attractive tool:
    - Sliding and Normal artifacts
  - Solution to the issue of growing irradiation
  - Limitations:
    - Subcutaneous Emphysema
    - Dressing
    - Inter-observer disagreement



# Principles of Lung Ultrasound

1. Being performed by simple equipment
2. The lung is the most voluminous organ and standardized areas can be defined
3. In the thorax, gas and fluids have opposite locations and generating artifacts
4. All signs arise from the pleural line
5. The lung is a vital organ. The signs arising from the pleural line are foremost dynamic
6. Almost all acute life-threatening disorders are about the pleural line
7. Static signs are mainly artifactual

# Bedside Lung Ultrasonography in Emergency; Ultrasound Areas



- Each wall is divided into upper and lower halves, resulting in six areas of scanning



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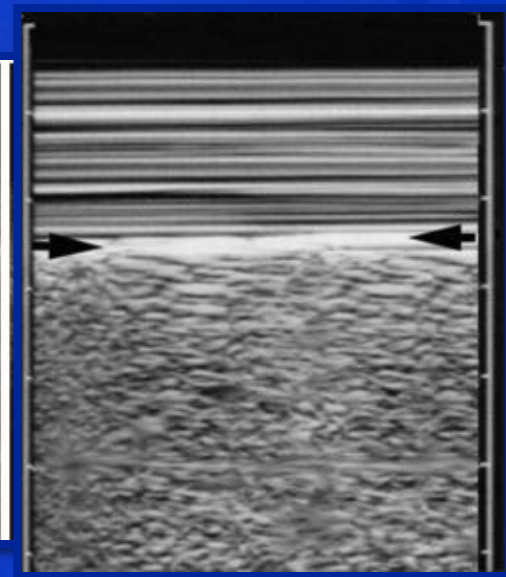
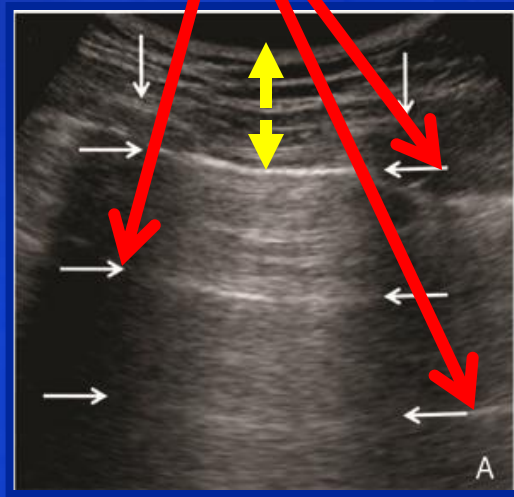
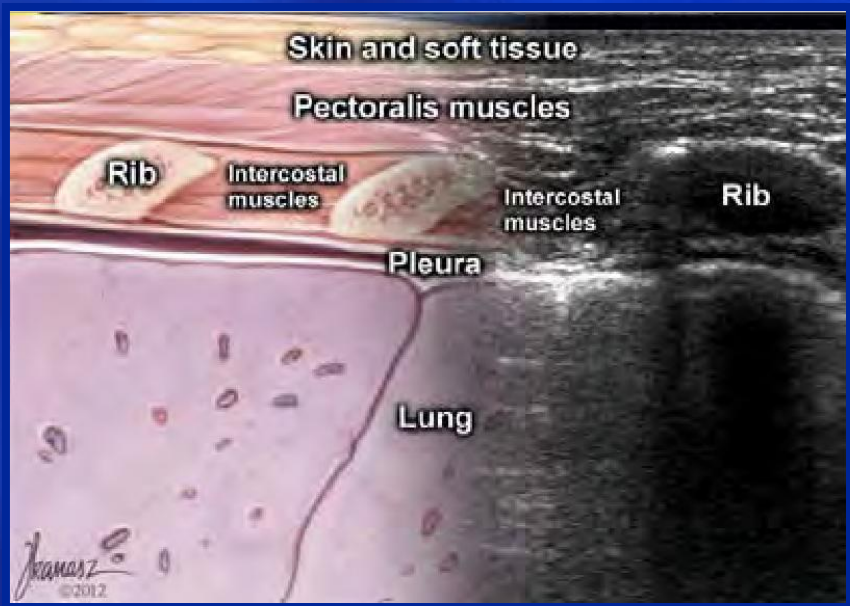


# Bedside Lung Ultrasonography in Emergency; cont'

- Transducer Selection
  1. High frequency linear
  2. Low-frequency curvilinear
  3. Low-frequency Sector
  4. Low-frequency micro-convex



# Normal Lung Sliding & A Line

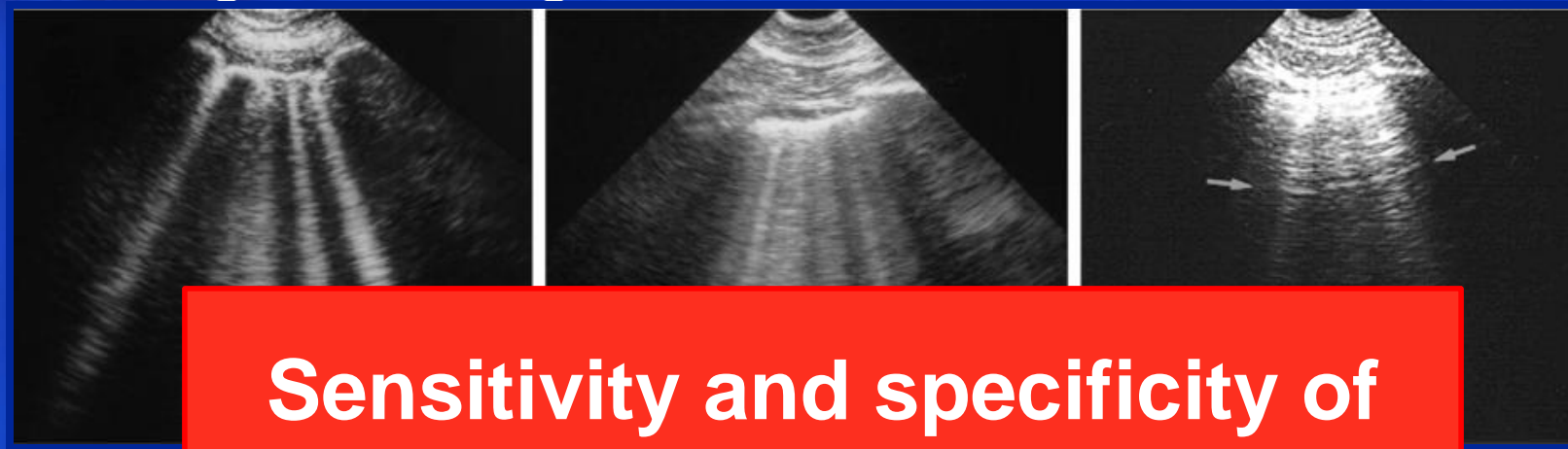


# Normal Lung Sliding

- Abolition occurs when the visceral pleura
  - 1. does not slide against parietal pleura**
    1. inflammatory adhesences
    2. Loss of lung expansion
    3. Atelectasis
    4. Apnea
    5. Chronic adhesion
  - 2. is separated**
    1. Pneumothorax
    2. Pneumonectomy



# Pathologic findings: B Line; Cont'



**Sensitivity and specificity of 93-98% and 85-93%, respectively, in early detection of pulmonary edema**

6. Moving with lung sliding when lung sliding is present
7. Like a laser beam to the (lower) margin of the screen
  - $\geq 3$  lines and less than  $7 \pm 1$  mm apart in a single view is called: B + lines

# B Line

- B + line

**Interstitial  
Syndrome**

- Multiple B lines in:

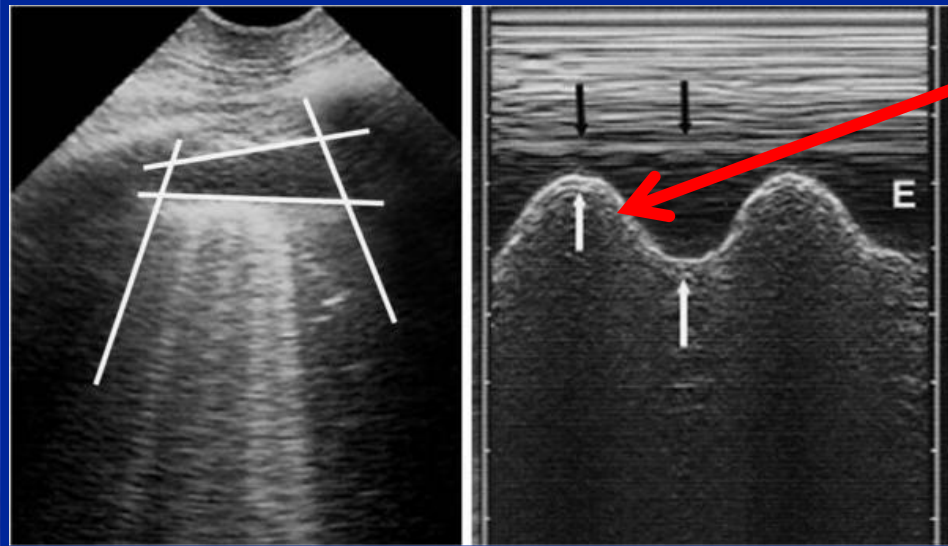
1. Pneumogenic lesions, e.g. alveolar consolidations like pneumonia

- Sensitivity of about 64-66% and a specificity of around 63%

2. In the baso-lateral regions of healthy individuals

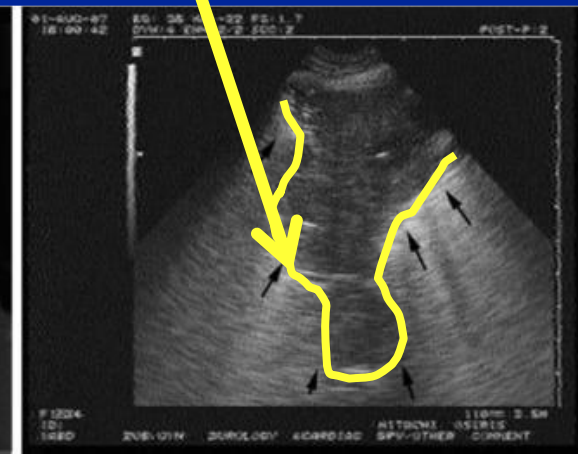
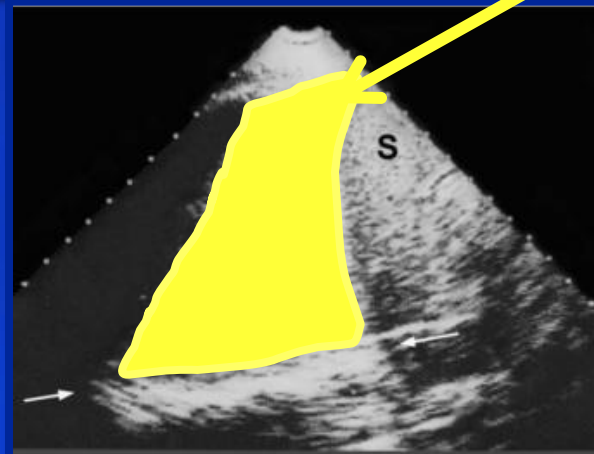
- Frequency is around 20-28%

# Pathologic findings: Consolidation $\pm$ Pleural Effusion



**Sinusoid sign**

**Consolidation**



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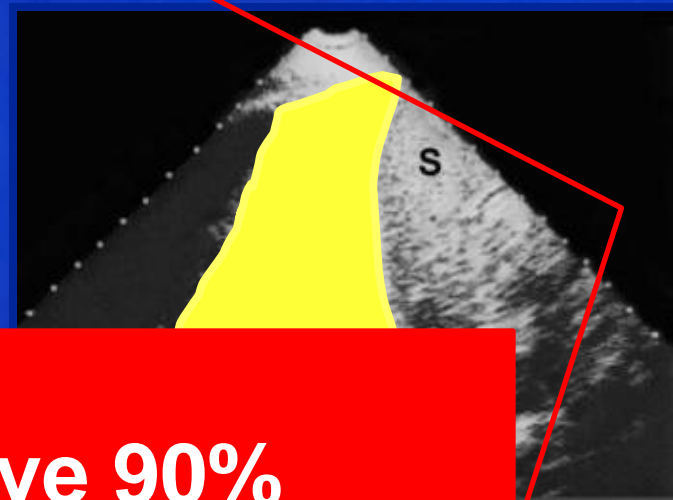
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# Consolidation

## Shred sign:

- Irregular line
- Opposed to

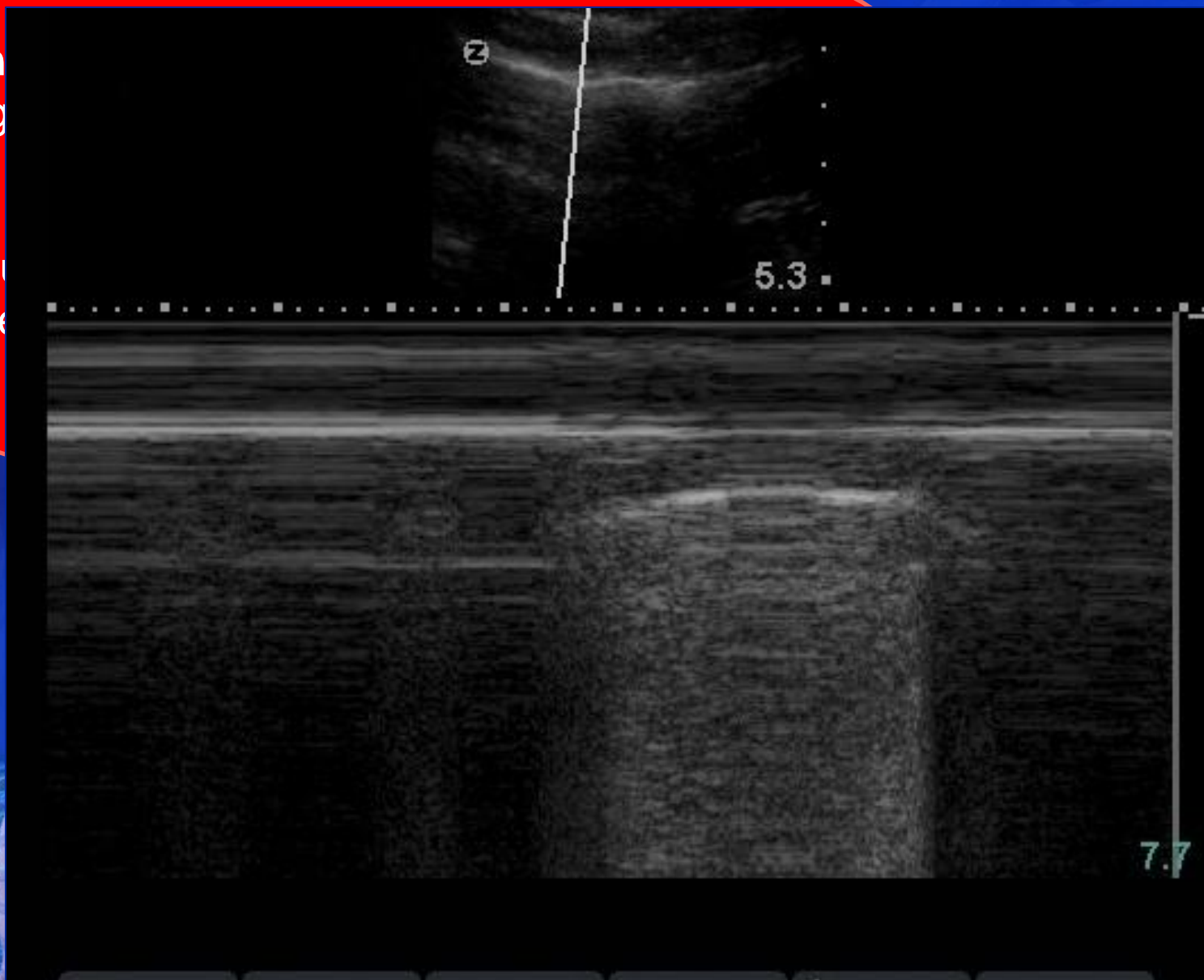


**Both signs have 90% sensitivity and 98% specificity**

# BLUE-Protocol; cont'

- A Combination of signs and associates them with a location, resulting in seven profiles:
  1. **A-profile:** Anterior lung-sliding with A-lines
  2. **A'-profile :** A-profile with abolished lung-sliding
  3. **B-profile:** Anterior lung-sliding with lung-rockets
  4. **B'-profile:** B-profile with abolished lung-sliding
  5. **C-profile:** Anterior lung consolidation, regardless of size and number. A thickened, irregular pleural line is an equivalent.
  6. **A/B profile:** A half A-profile at one lung, a half B-profile at another
  7. **PLAPS Profile:** A posterior and/or lateral alveolar and/or pleural syndrome. All these definitions are based on the patient being supine or semi-recumbent.

Lung  
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# Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure \* : The BLUE Protocol

Mechanism of dyspnea	Profiles of BLUE-protocol	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Acute hemodynamic pulmonary edema	B-profile	97%	95%	87%	99%
			(187/196)	(62/71)	(187/189)
COPD in exacerbation or severe acute asthma	Nude p			93%	95%
					(172/181)
Pulmonary embolism					98%
					(238/242)
Pneumothorax					99%
					(251/252)
Pneumonia	B				70%
				(9/9)	(177/251)
	A/B profile		100%	100%	71.5%
		(12/83)	(177/177)	(12/12)	(177/248)
	C-profile	21.5%	99%	90%	73%
		(18/83)	(175/177)	(18/20)	(175/240)
	A-V-PLAPS profile	42%	96%	83%	78%
		(35/83)	(170/177)	(35/42)	(170/218)
	The four profiles	89%	94%	88%	95%
		(74/83)	(167/177)	(74/84)	(167/176)

**The diagnostic accuracy is 90.5%**

# What about the case?

Lung Sliding & B+  
Lines = B Profile

Pulmonary Edema



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