Practical POCUS for Respiratory Therapists: Everyday Lung Ultrasound Made Easy

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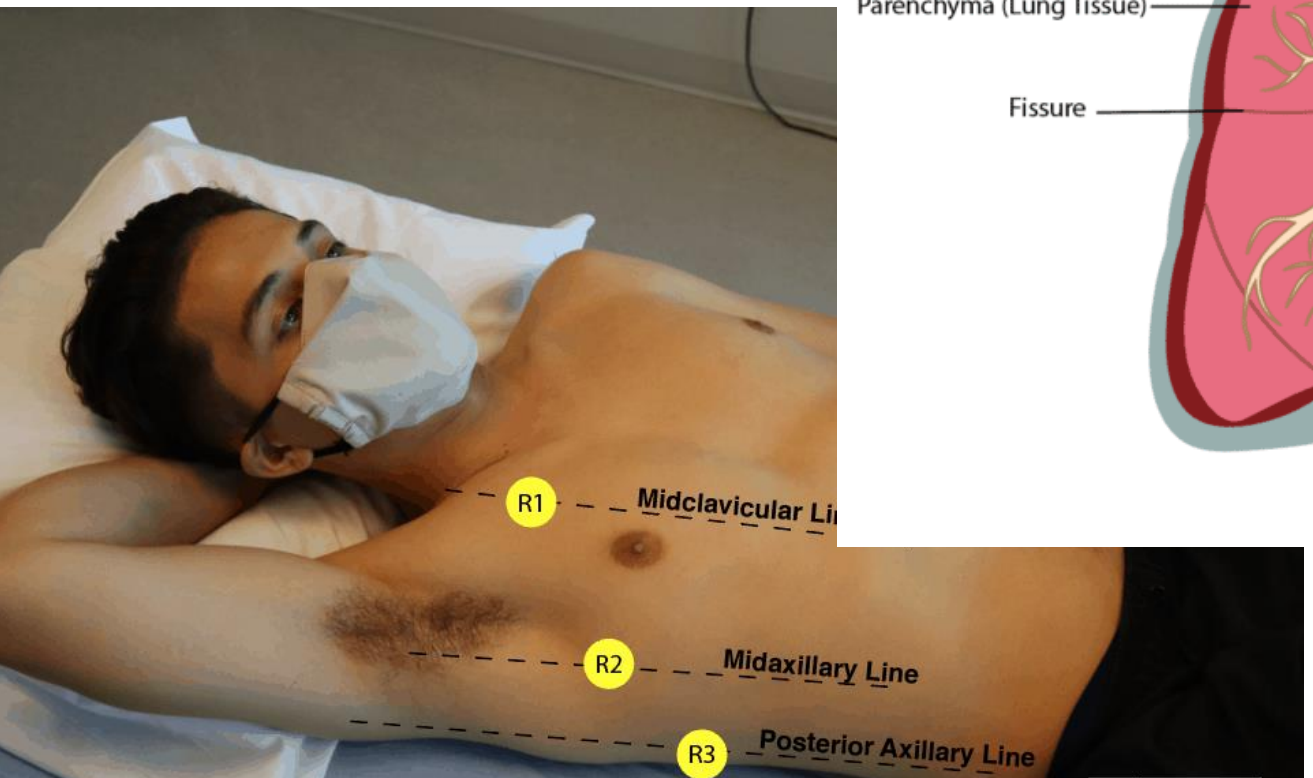
By the end of this session, participants will be able to:

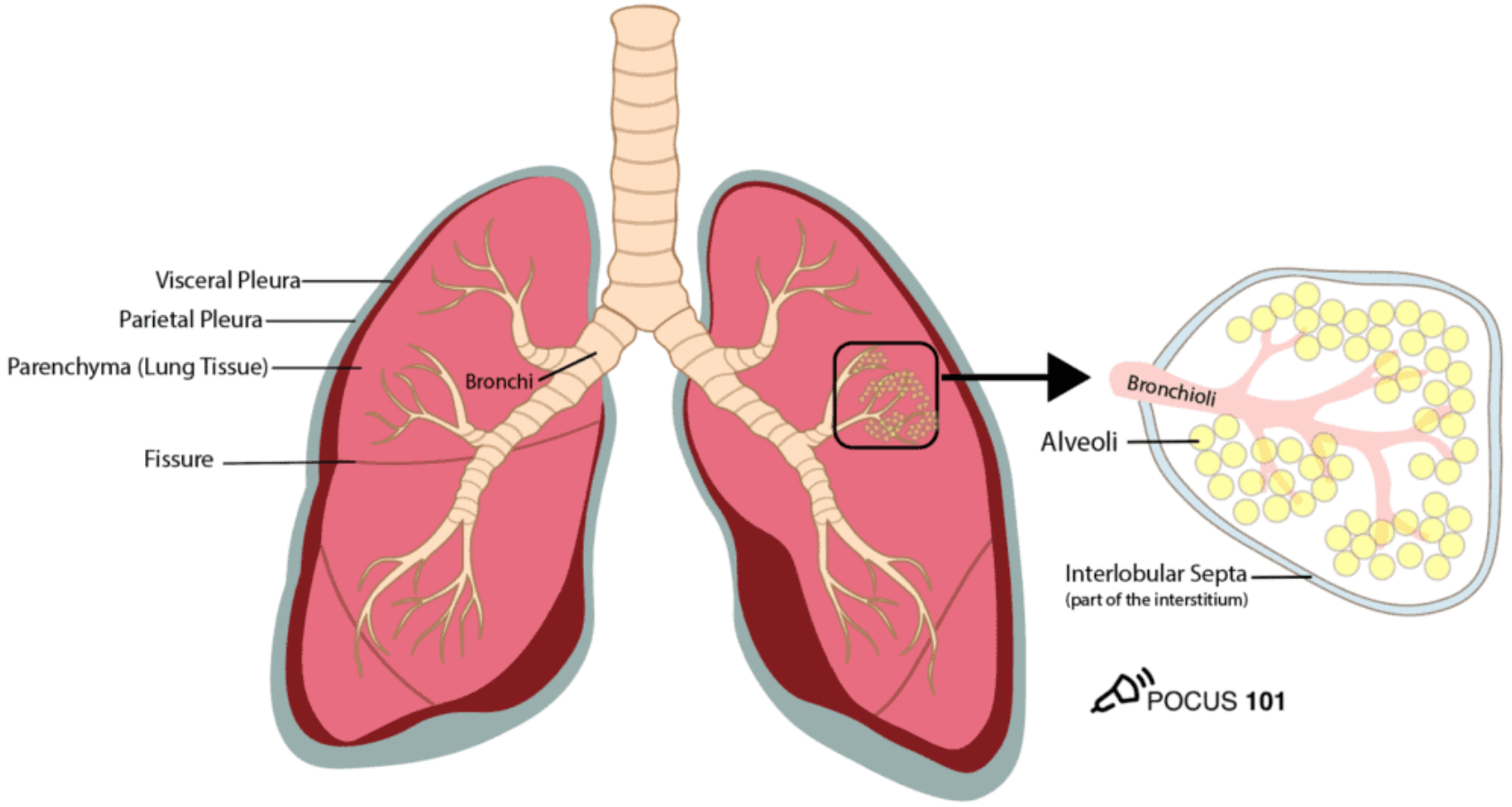
1. Identify the advantages and limitations of lung ultrasound (LUS) with respect to X-ray and CT imaging.

2. Recognize the appearance of normal lung anatomy as well as common respiratory pathologies on LUS

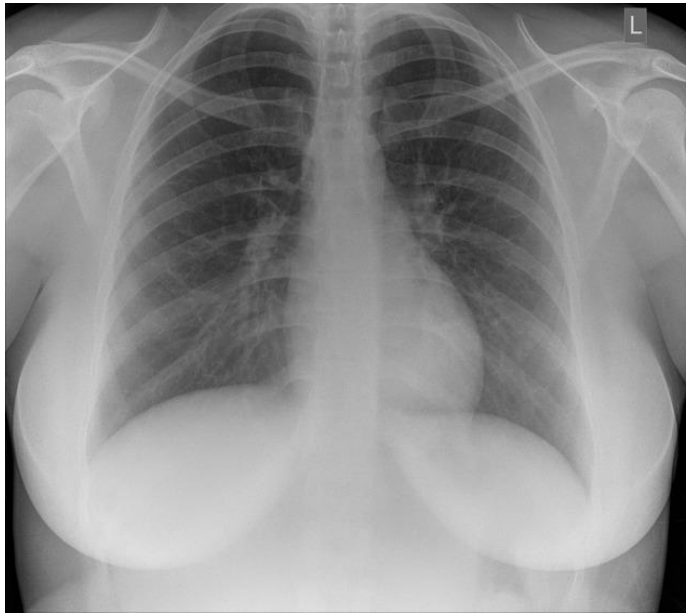
3. Demonstrate an understanding of how LUS can guide respiratory therapy interventions

Anatomy





Routine Chest Imaging



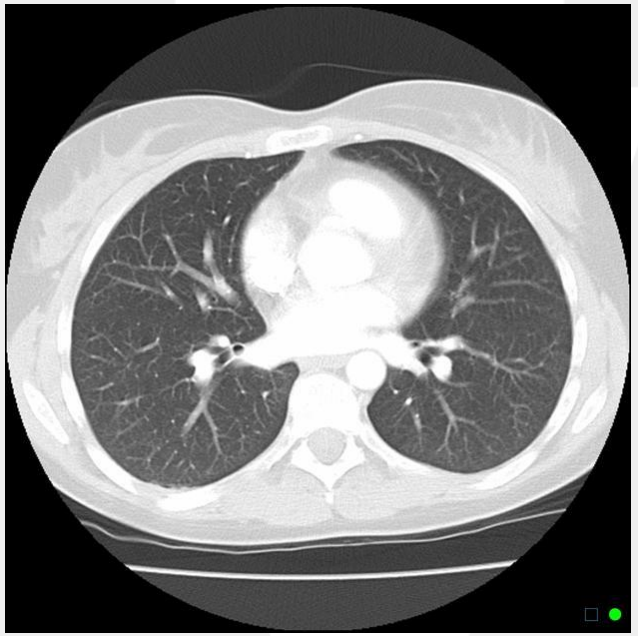
CXR

Pros

- Quick & widely available
- Low $
- Good for gross abnormalities

Cons

- Limited sensitivity for subtle abnormalities
- Can miss pathology behind structures
- Radiation



CT

Pros

- High Resolution/Gold standard

Cons

- ↑↑Radiation
- High $$
- Requires transport
- Not widely available

Lung Ultrasound

A useful adjunct & at times replacement for CXR or CT

Pros

No Radiation

Performed real-time at the bedside
- Great for unstable patients

Excellent for:
- Pleural Effusions
- PTX
- Pulmonary Edema
- Consolidation

Cons

Operator Dependent

Limited ability to visualize deep parenchyma

Limited penetration in obese patients

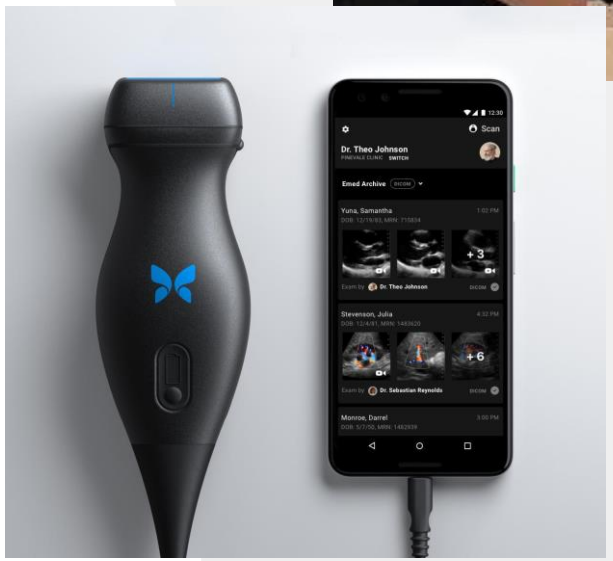
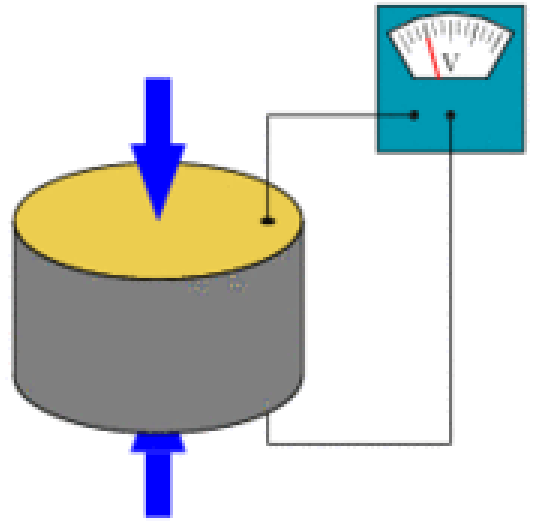
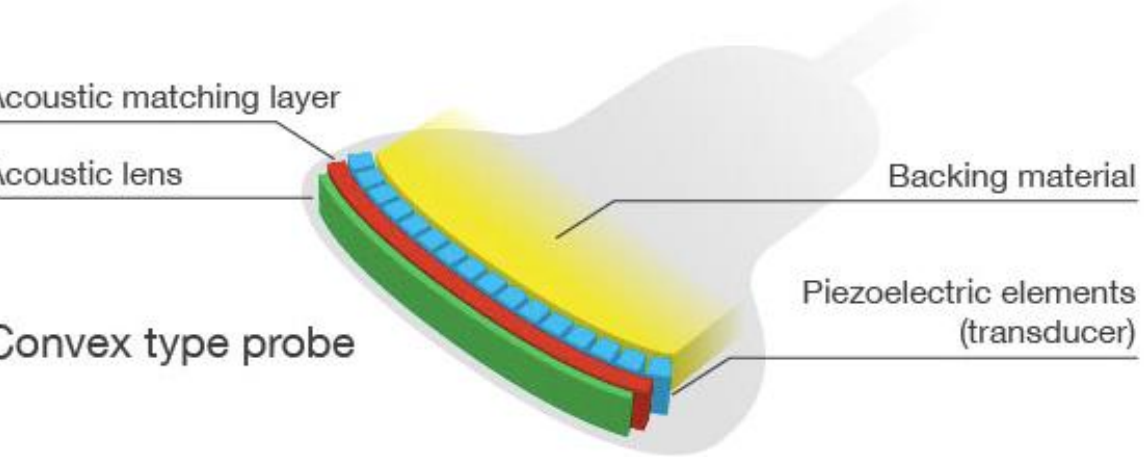


Image Formation



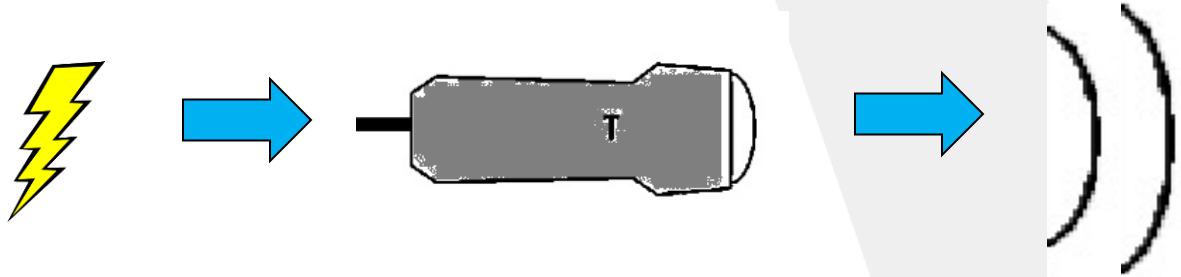


Piezoelectric Element (Quartz)

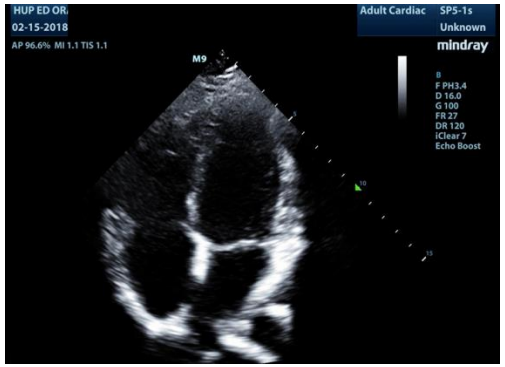
Image Formation

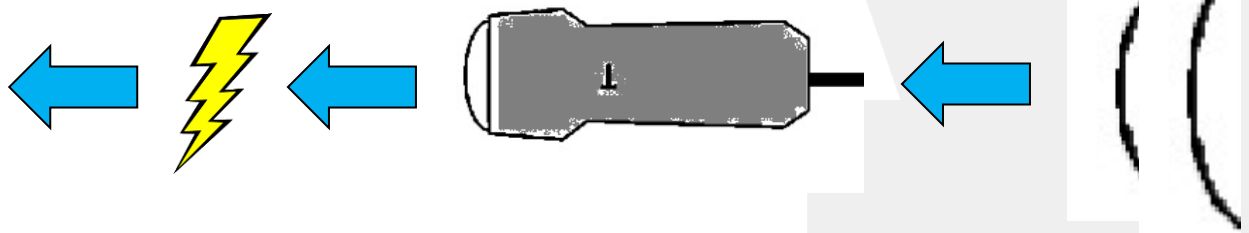
US Probe Acts Transducer:

Oscillating voltage →Crystal vibration → Pressure waves (sound)



PAUSE *(to Listen)*





Voltage Oscillation ← crystal vibration ← Pressure waves (echoes)

Cranial

Caudal

ULTRASOUND

Great for visualizing many solid or fluid filled structures

NOT for air filled Structures!

So how can US help us evaluate Lung??

LUNG ULTRASOUND

Interpretation relies heavily on the presence/absence of artifacts at the Pleural Interface

Getting Started

Ultrasound Probe Selection

Phased Array

Curvilinear

Linear

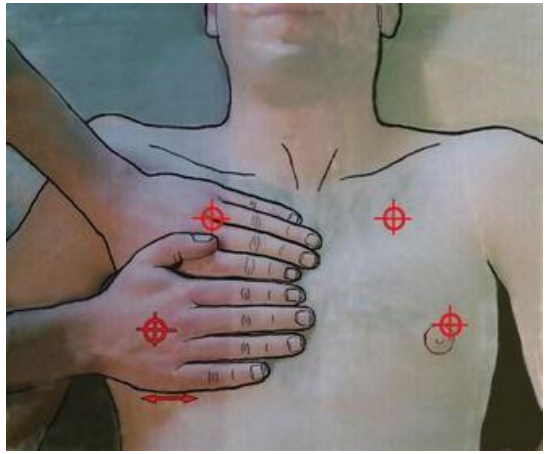
Best for detection of :

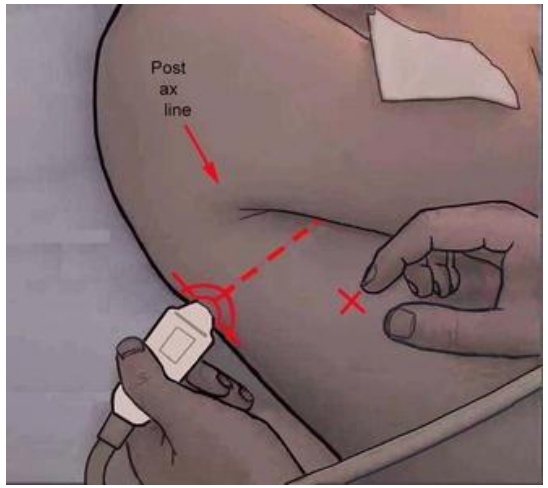
Effusion
Consolidation
Pneumonia

Best for detection of :

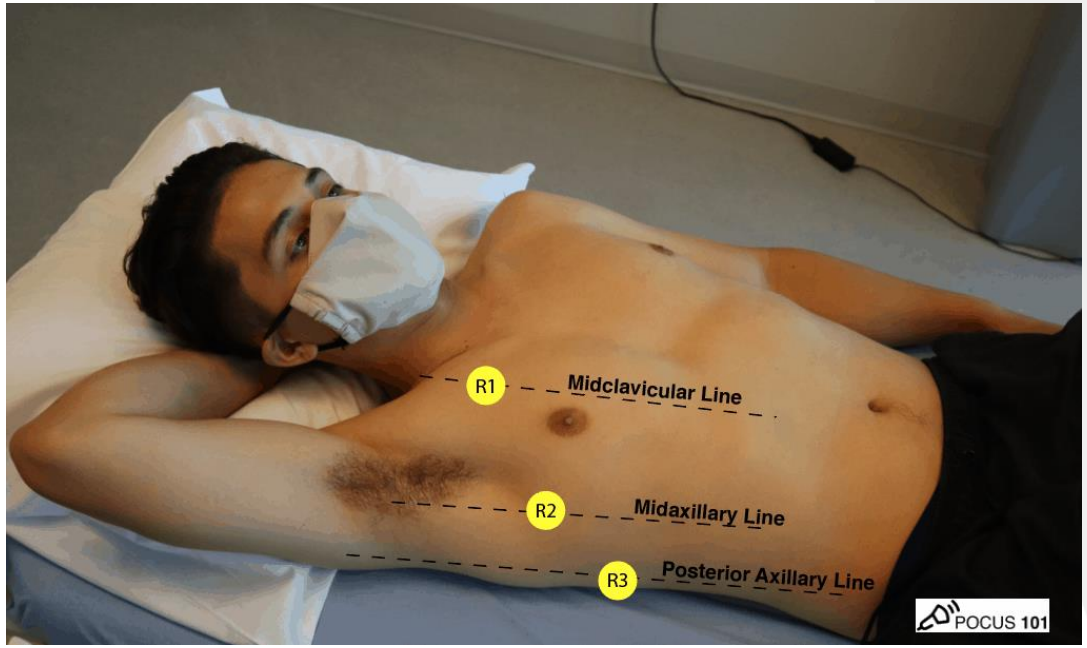
Pneumothorax

How to Scan





BLUE Protocol



My Approach:

RIGHT:
Evaluate Anterior Lung (Mid clavicular line)

Evaluate lateral/posterolateral Lung (Mid-Ax to Mid post line)

LEFT:
Evaluate Anterior Lung (Mid clavicular line)

Evaluate lateral/posterolateral Lung (Mid-Ax to Mid post line)

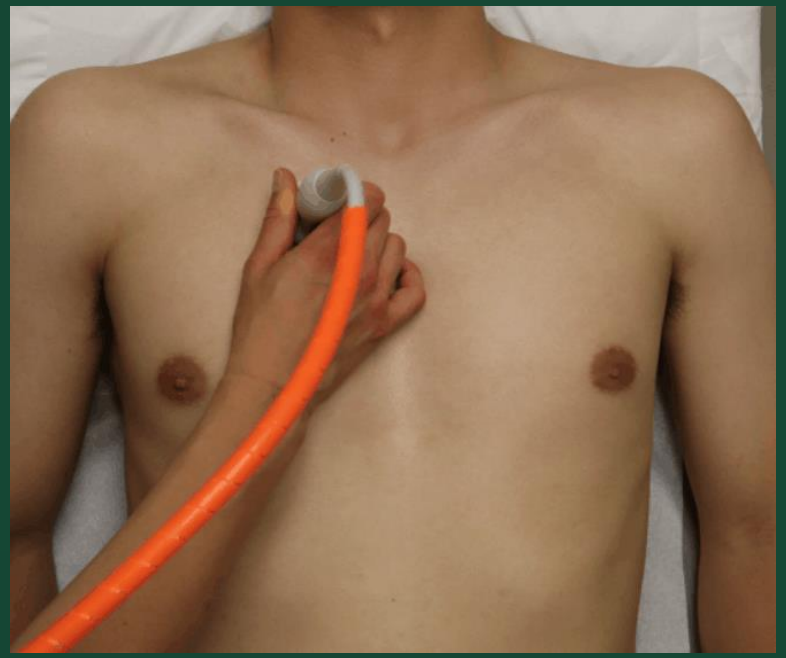
Obtain additional views if clinical picture remains unclear

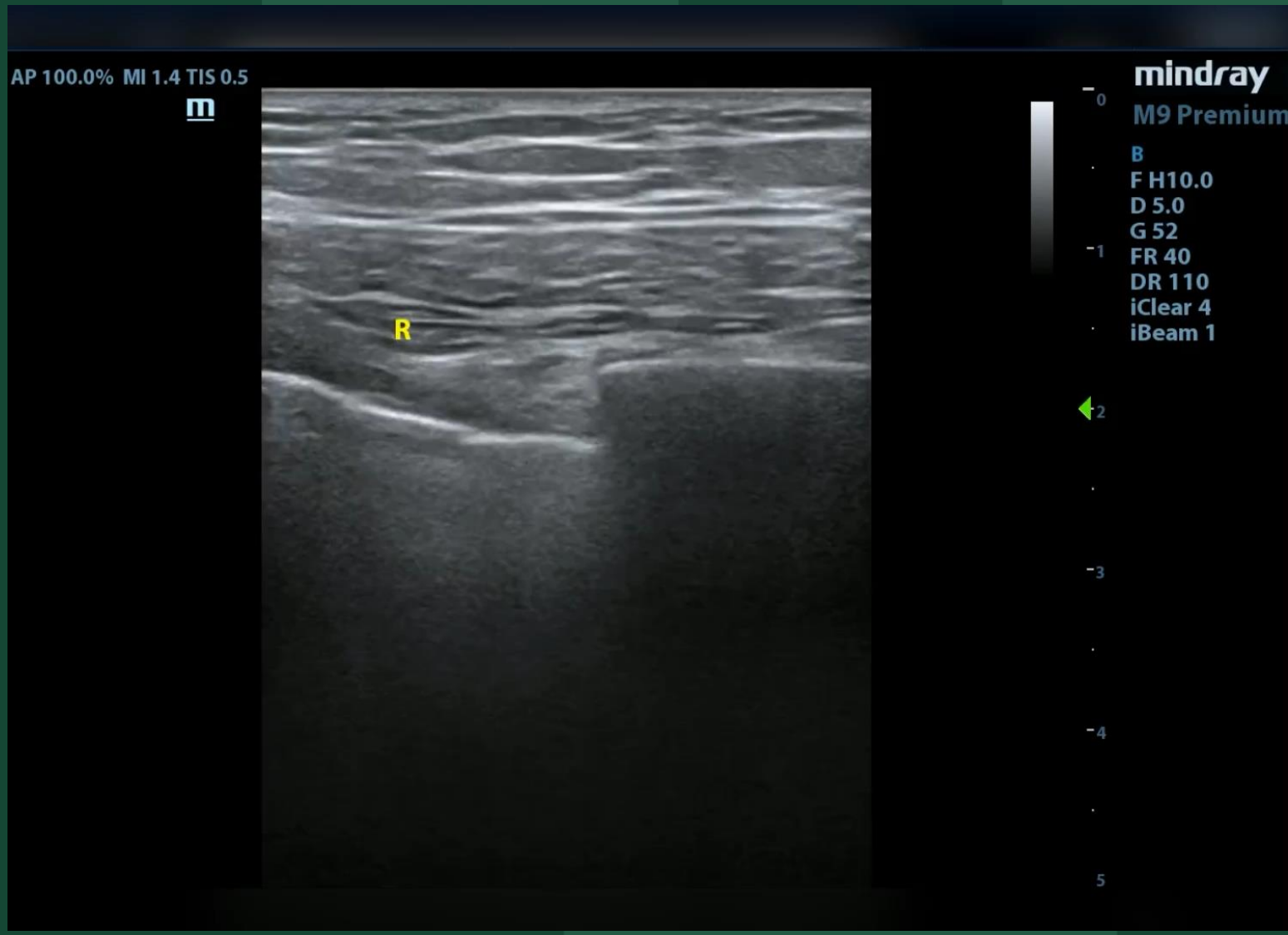
Anterior Views

Place Probe along mid clavicular line

Probe marker should face towards head

Inspect individual intercostal spaces from superior to inferior





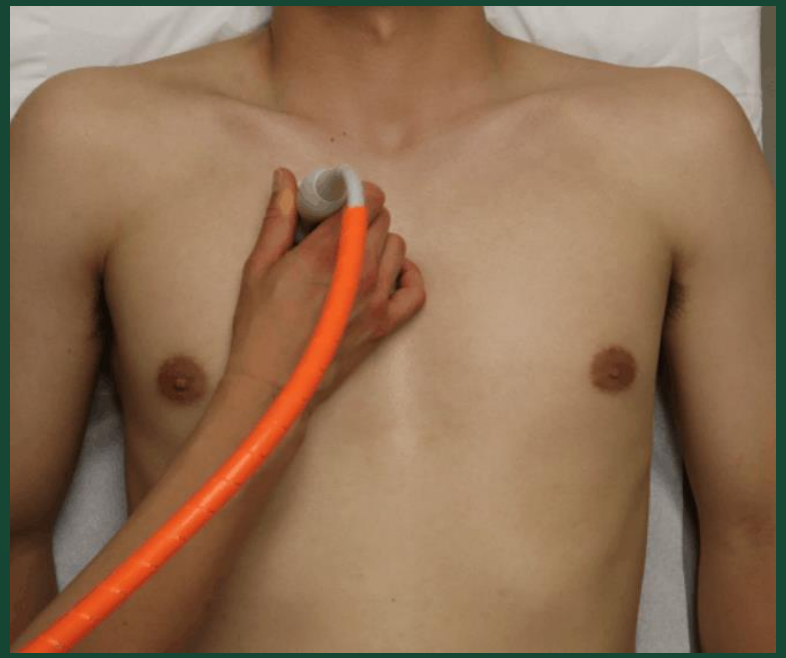
Linear Probe- Normal Lung

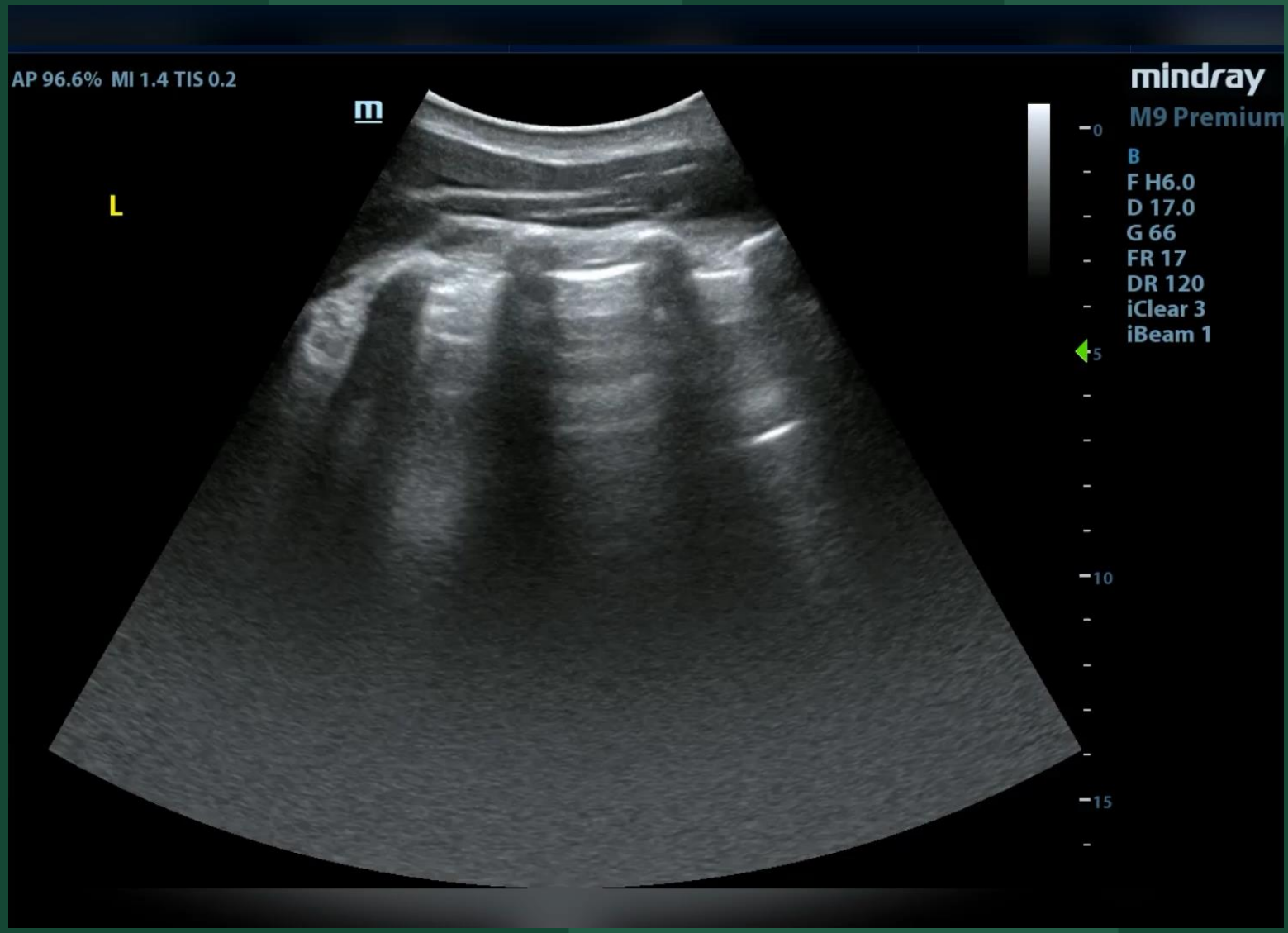
Anterior Views

Place Probe along mid clavicular line

Probe marker should face towards head

Inspect individual intercostal spaces from superior to inferior





Curvilinear Probe- Normal Lung

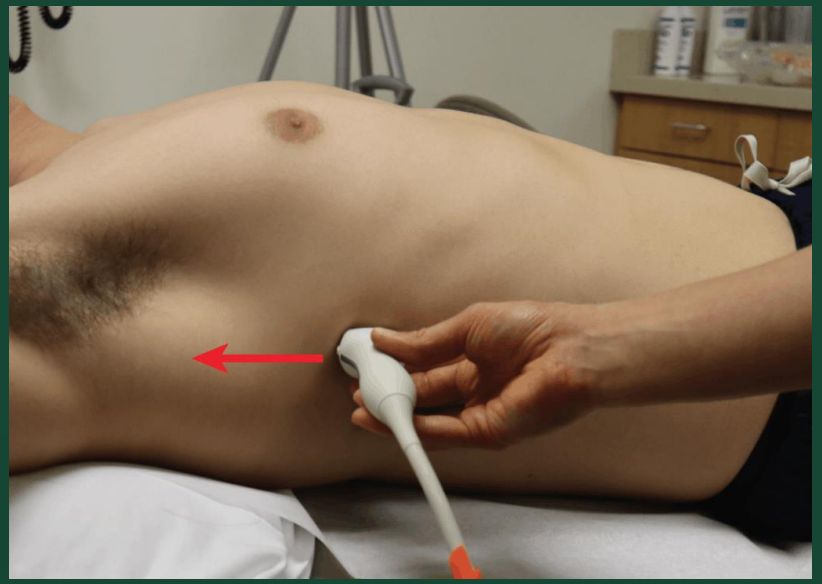
Lateral/Posterolateral Views

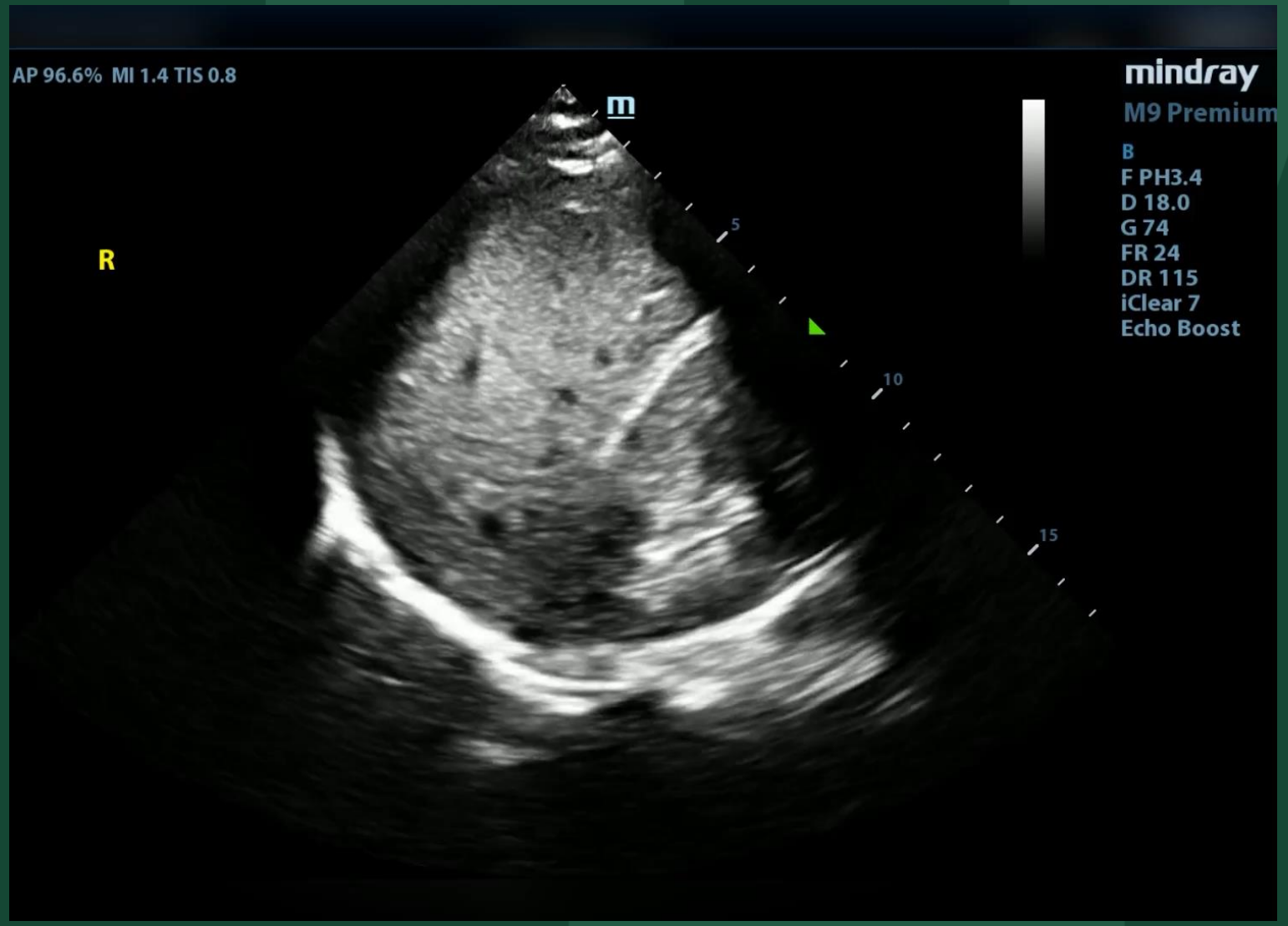
Place Probe between mid to posterior axillary line

Probe marker should face towards head

Identify anchoring anatomy (e.g. diaphragm, liver, spleen)

Inspect individual intercostal spaces from inferior to superior

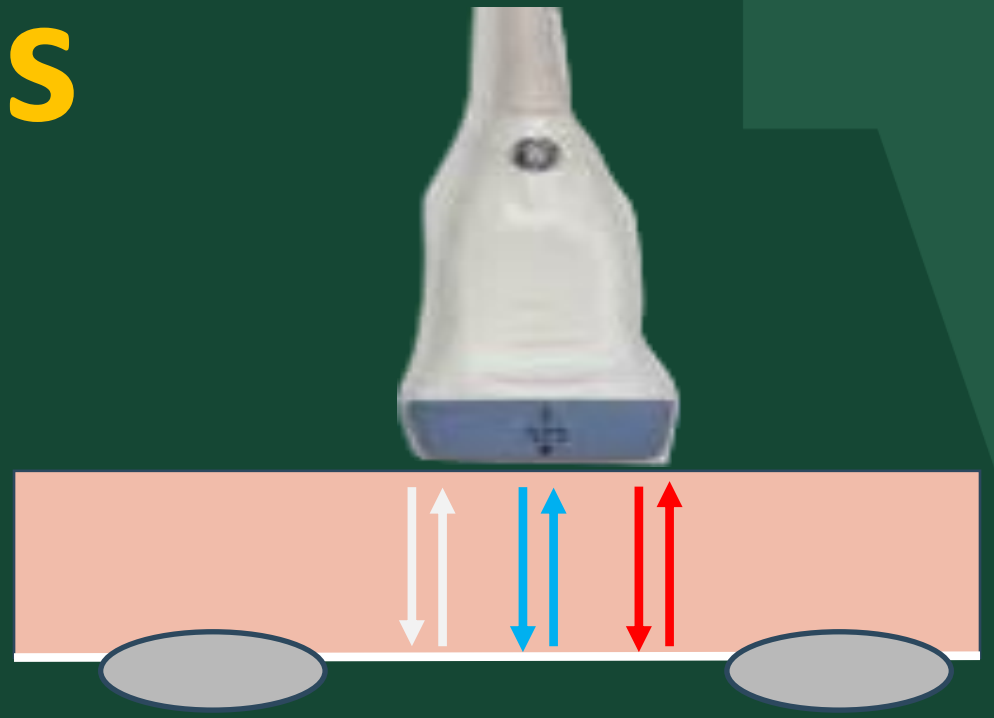




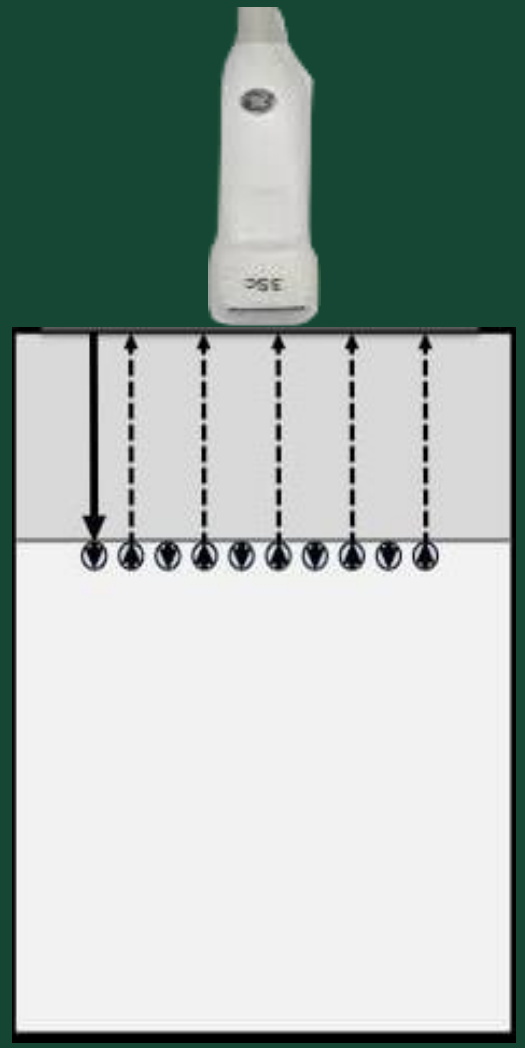
Phased Array Probe- Normal Lung

Artifacts

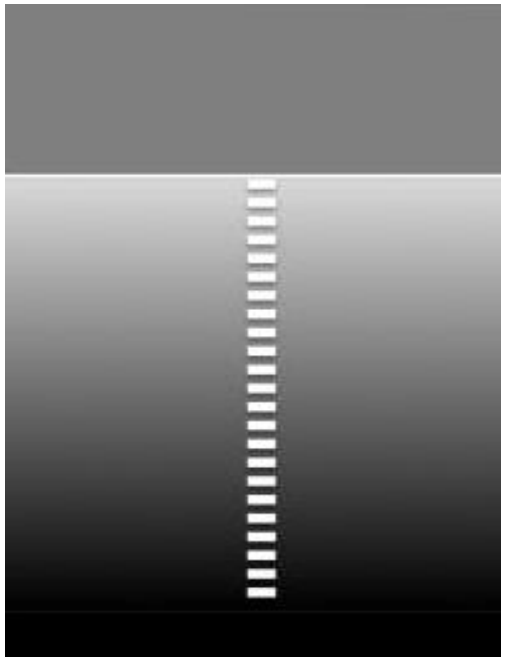
A-Lines



B-Lines



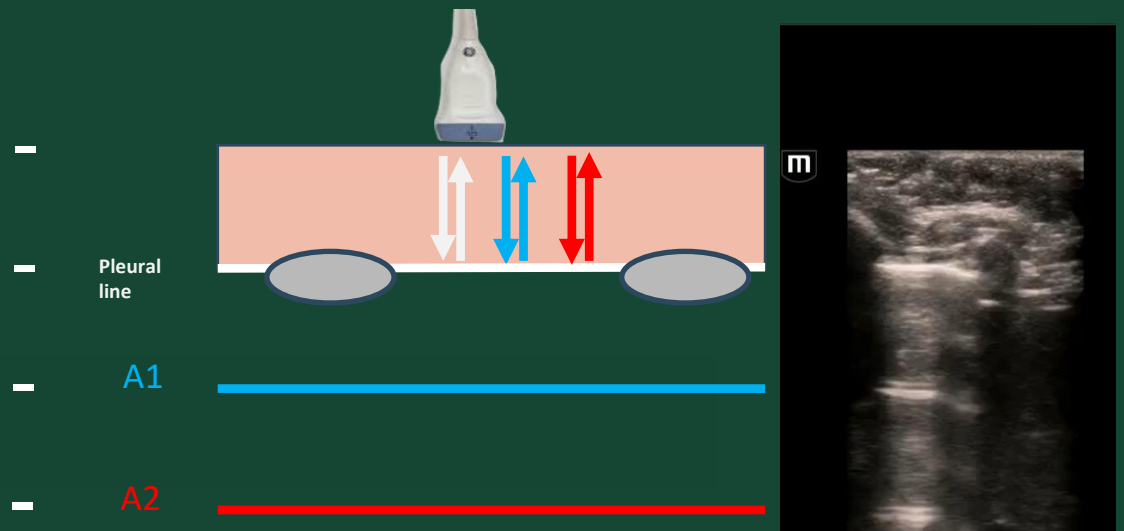
US Monitor



https://litfl.com/short-path-reverberation-artefact/

A-Lines

- A reverberation artifact between the probe and parietal pleura
- LUNG SLIDE (+)
  Indicative of aerated lung
- LUNG SLIDE (-)
  Most commonly Indicative of pneumothorax



B-Lines

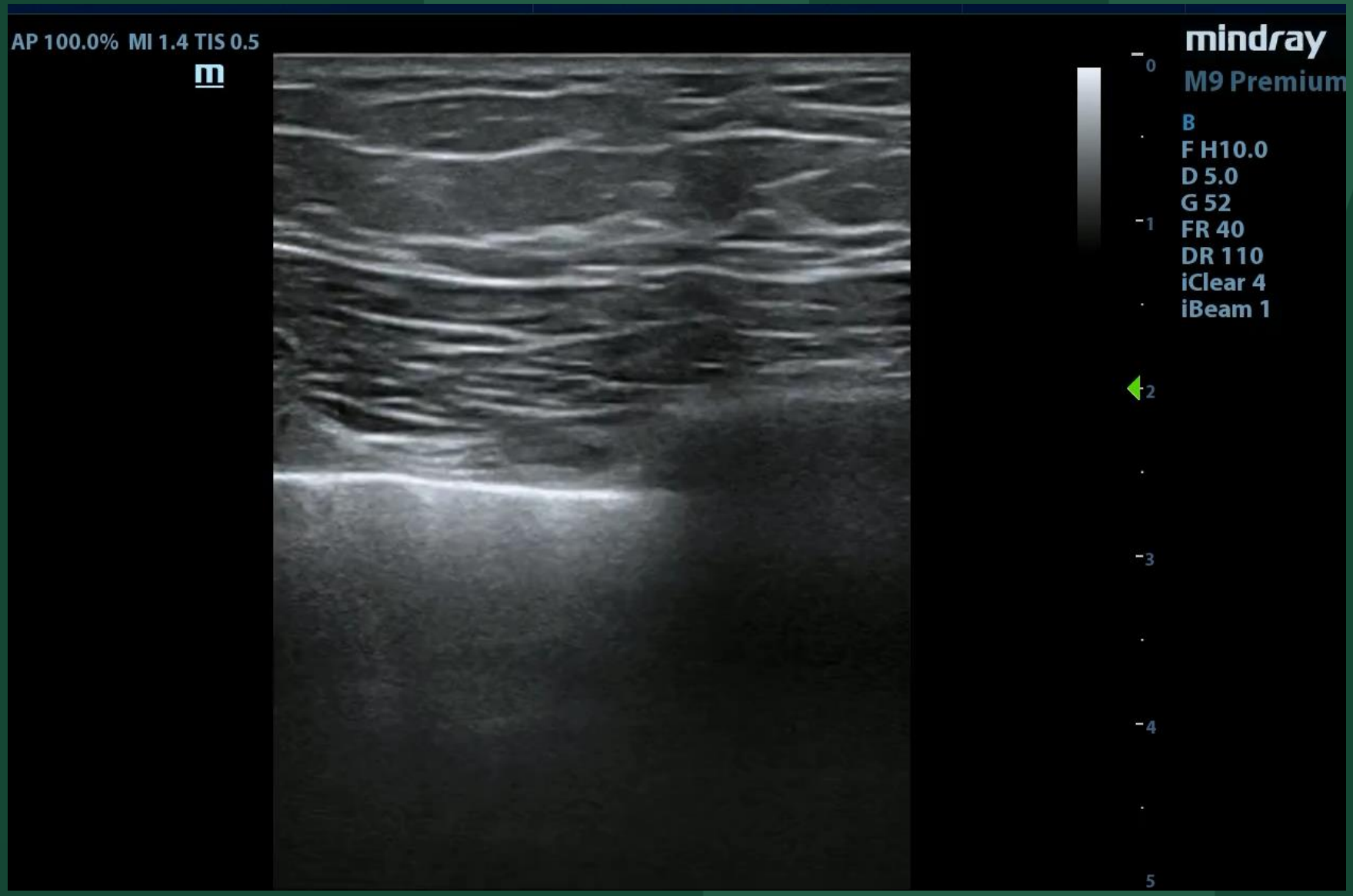
- Aka *Comet-tail* OR *ring-down* artifact
- Arise from the visceral pleura; extends to edge of image
- ≥3/rib space indicative of interstitial process
  Most commonly pulmonary edema

Lung Slide

Gliding movement of lung against parietal pleura

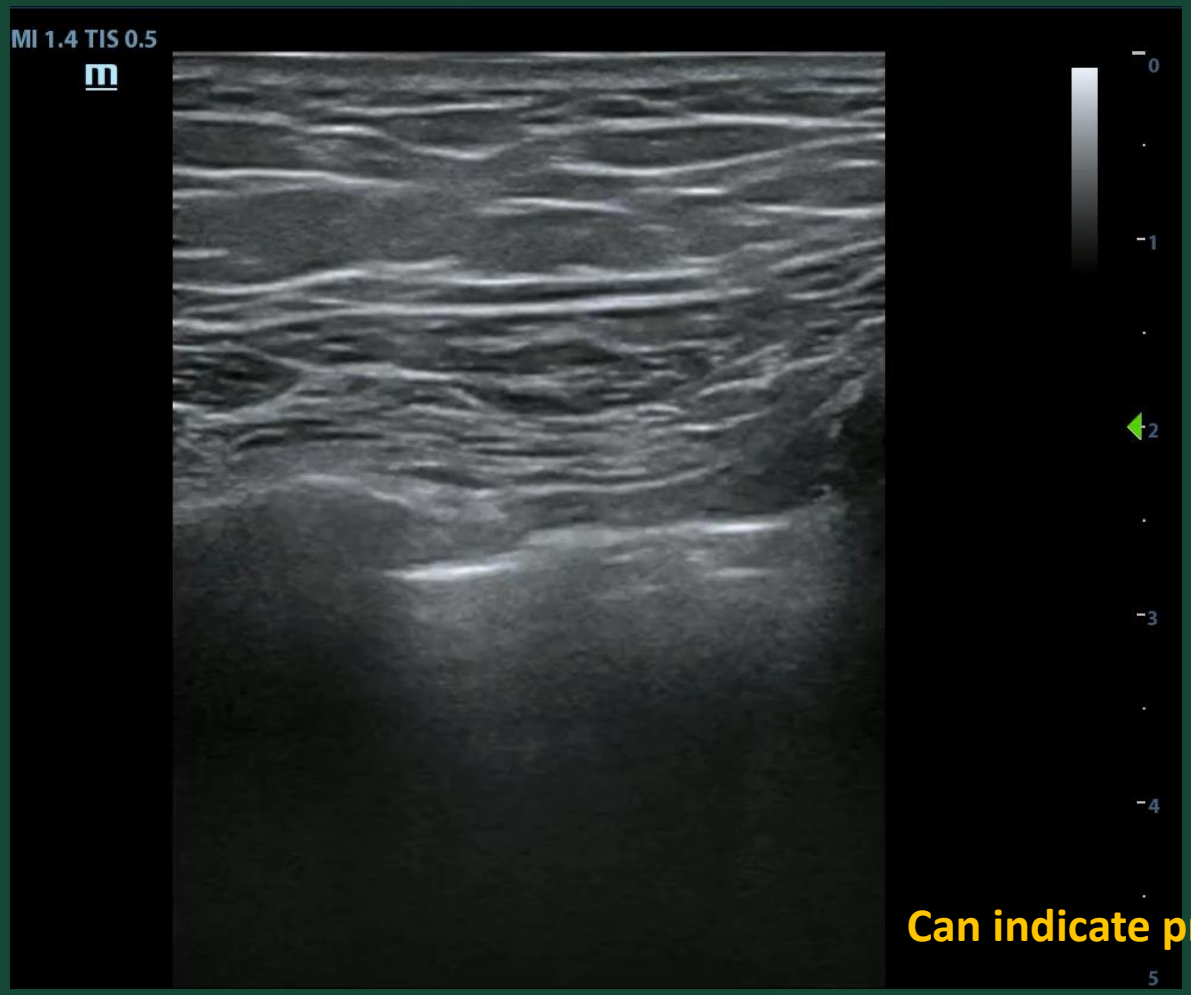
Indicative of aerated lung

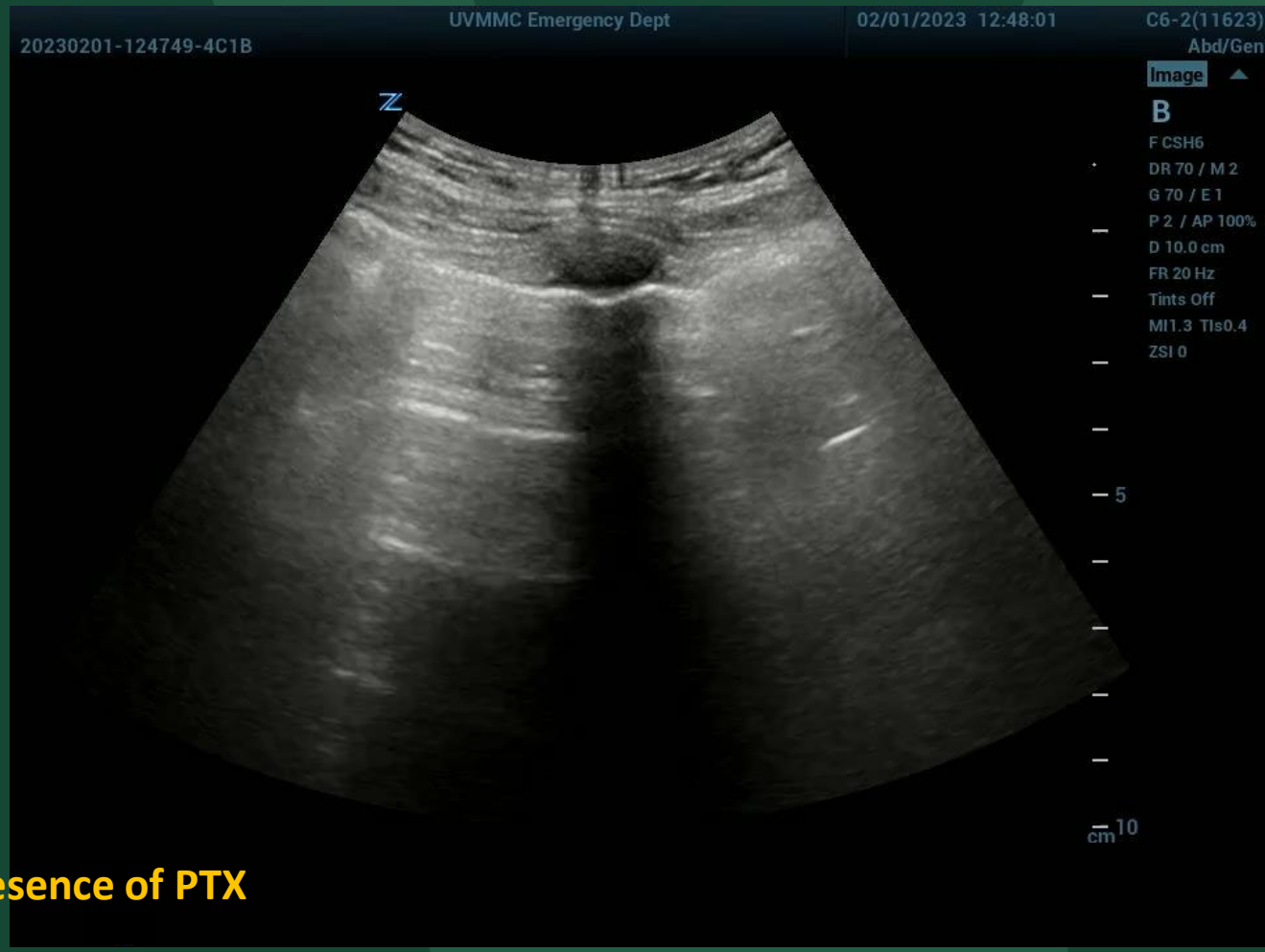
Rules out PTX at the visualized intercostal space



~~Lung Slide~~

Loss of gliding movement of lung against parietal pleura





Can indicate presence of PTX

Blebs, Mainstem intubation, Adhesed lung can cause similar appearance

Lung Point

Point where opposition of visceral/parietal pleura is lost

Confirms PTX

100% Specific

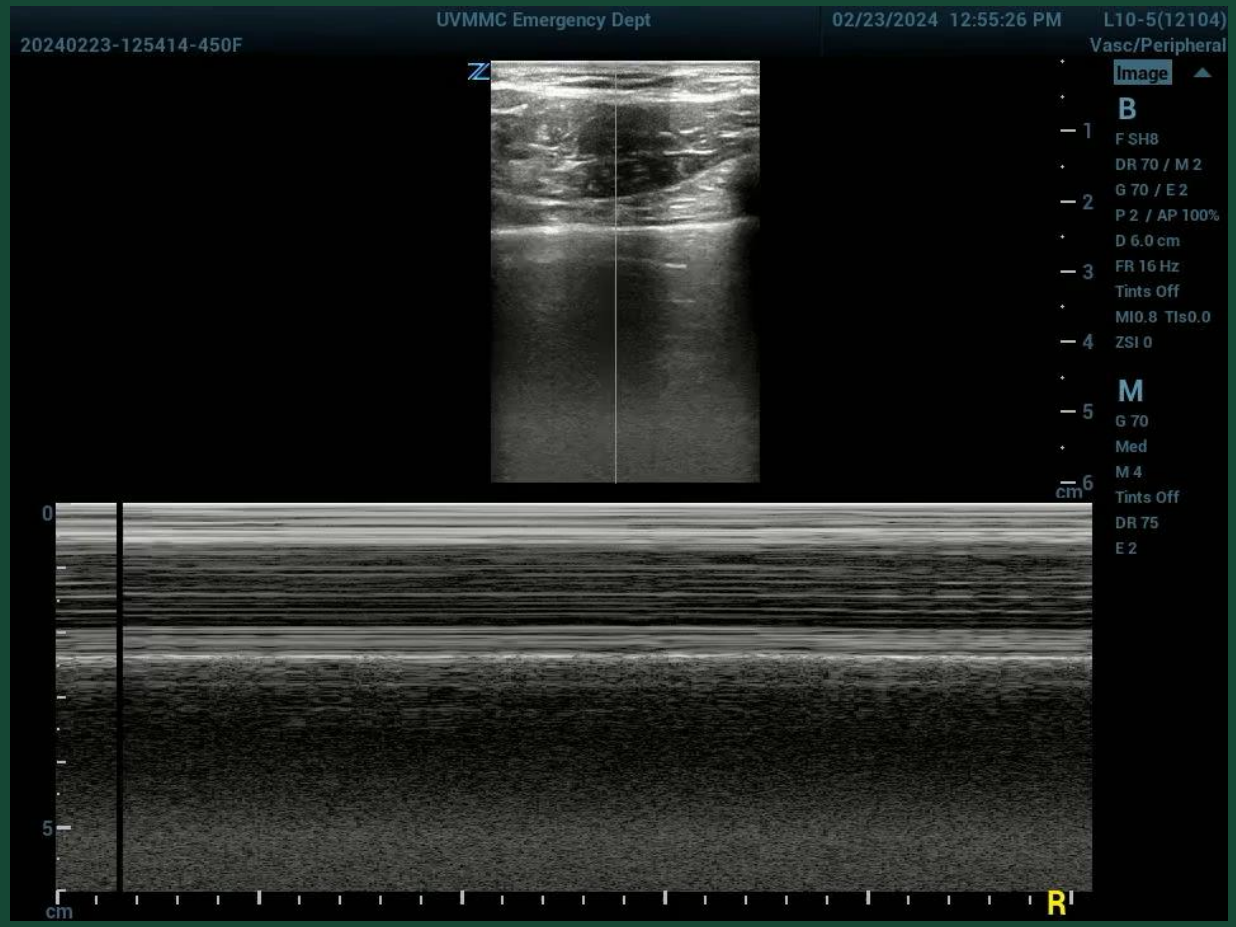
Lung Point

Point where opposition of visceral/parietal pleura is lost

Confirms PTX

100% Specific

Sea Shore Sign



Normal Lung

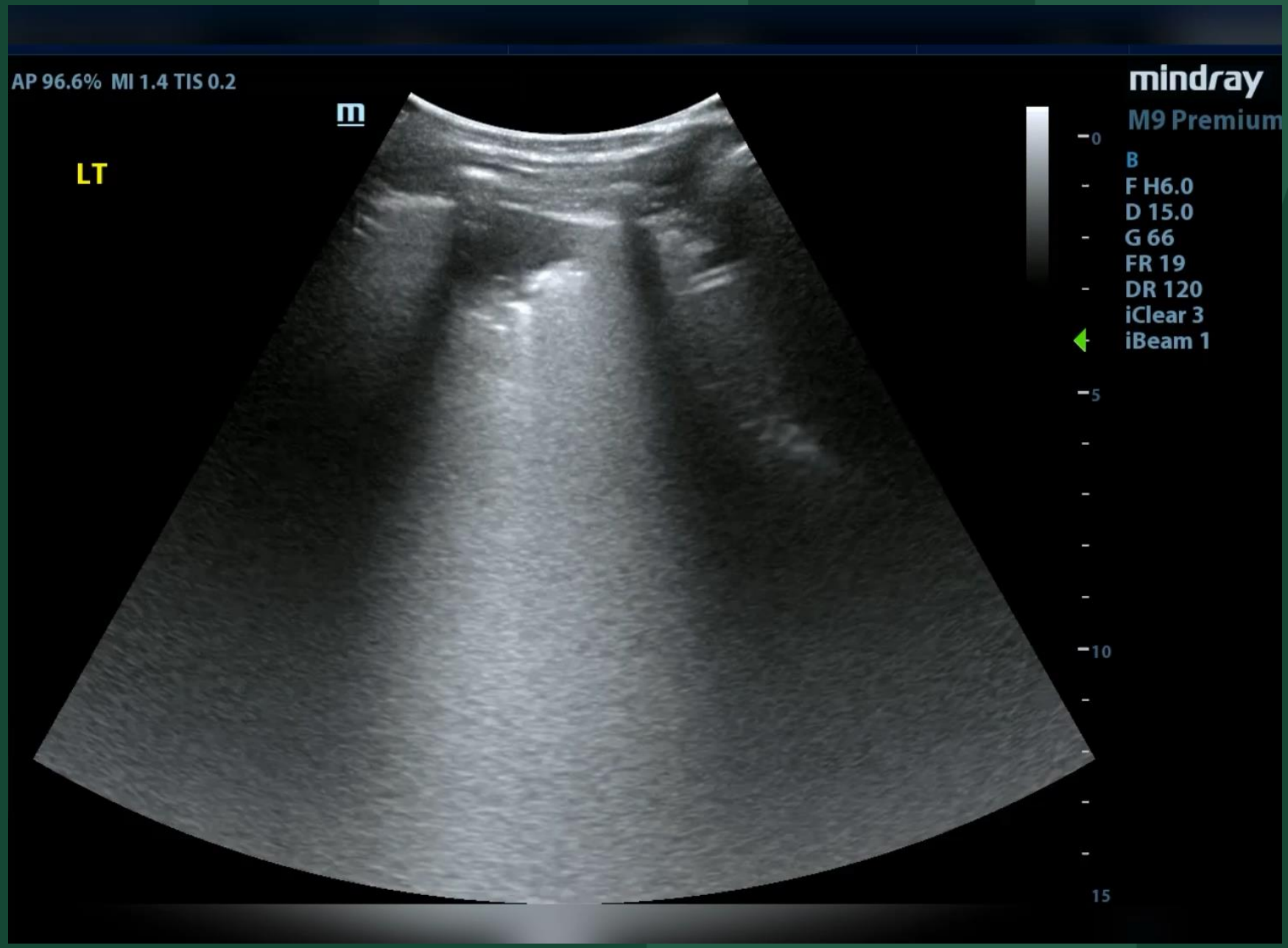
Bar Code Sign

Pneumothorax

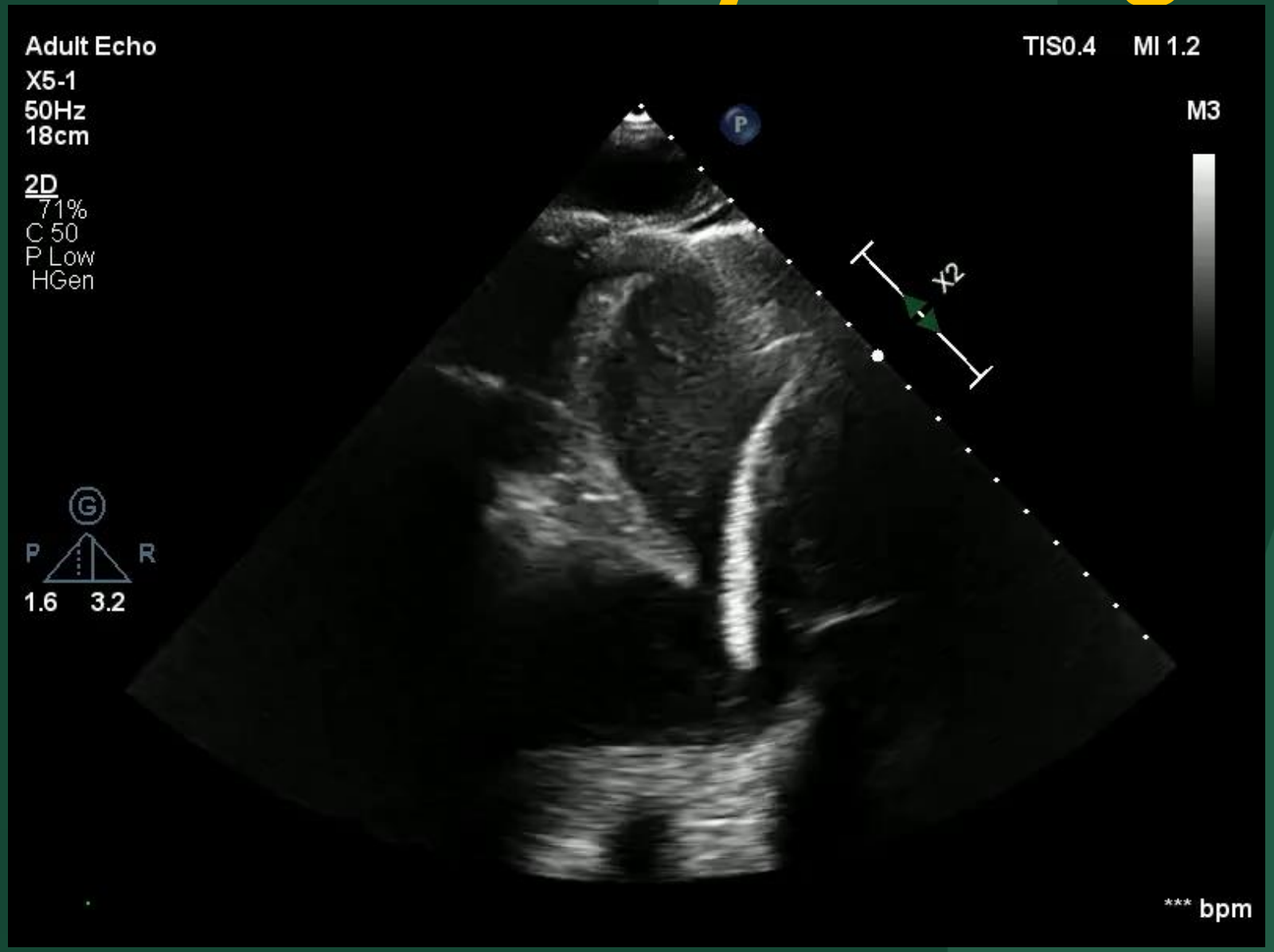
Shred Sign

Irregularity in the smooth border of the parietal interface

Commonly indicative of pneumonia

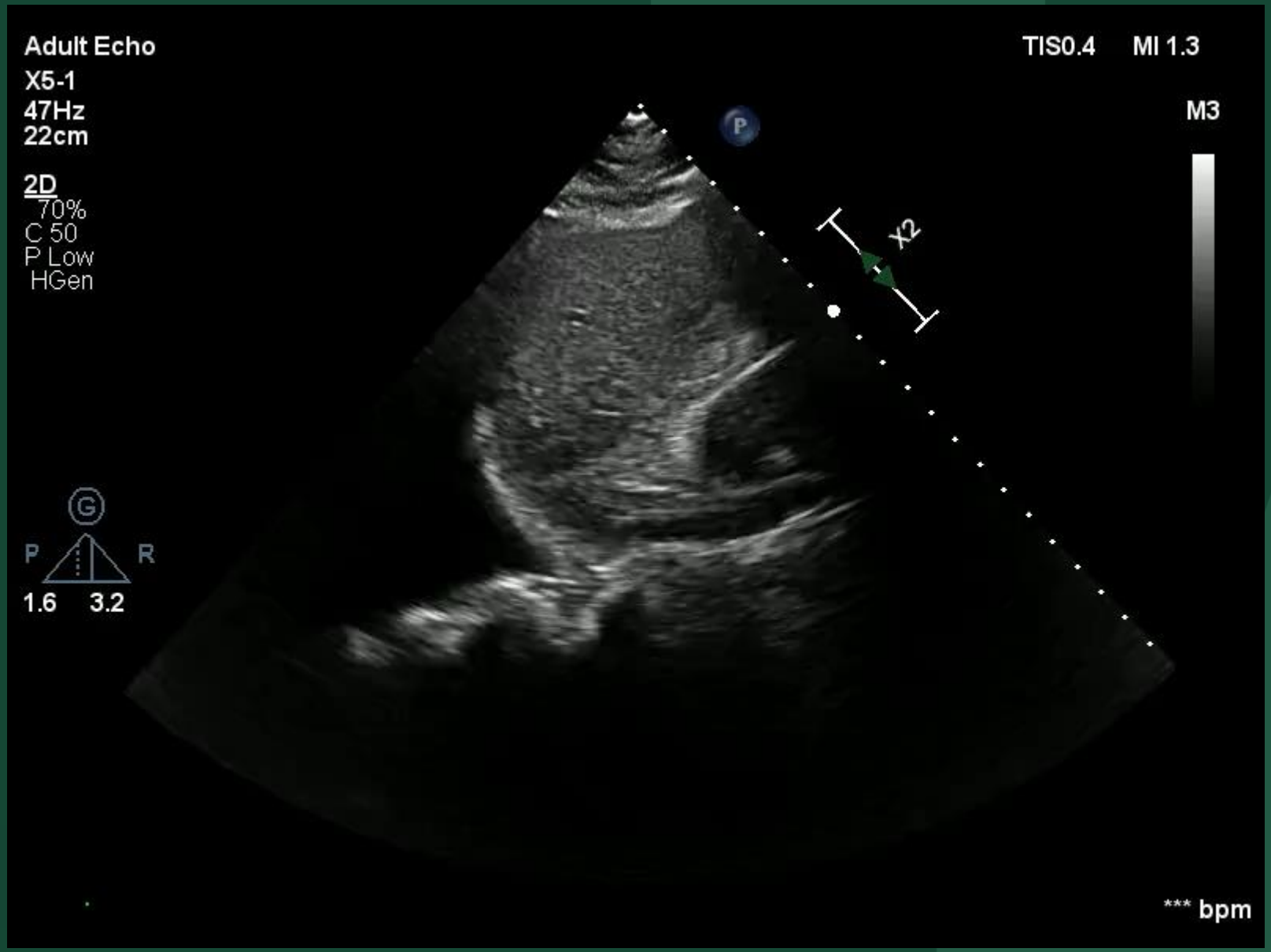


Pleural Effusion- Jelly Fish Sign

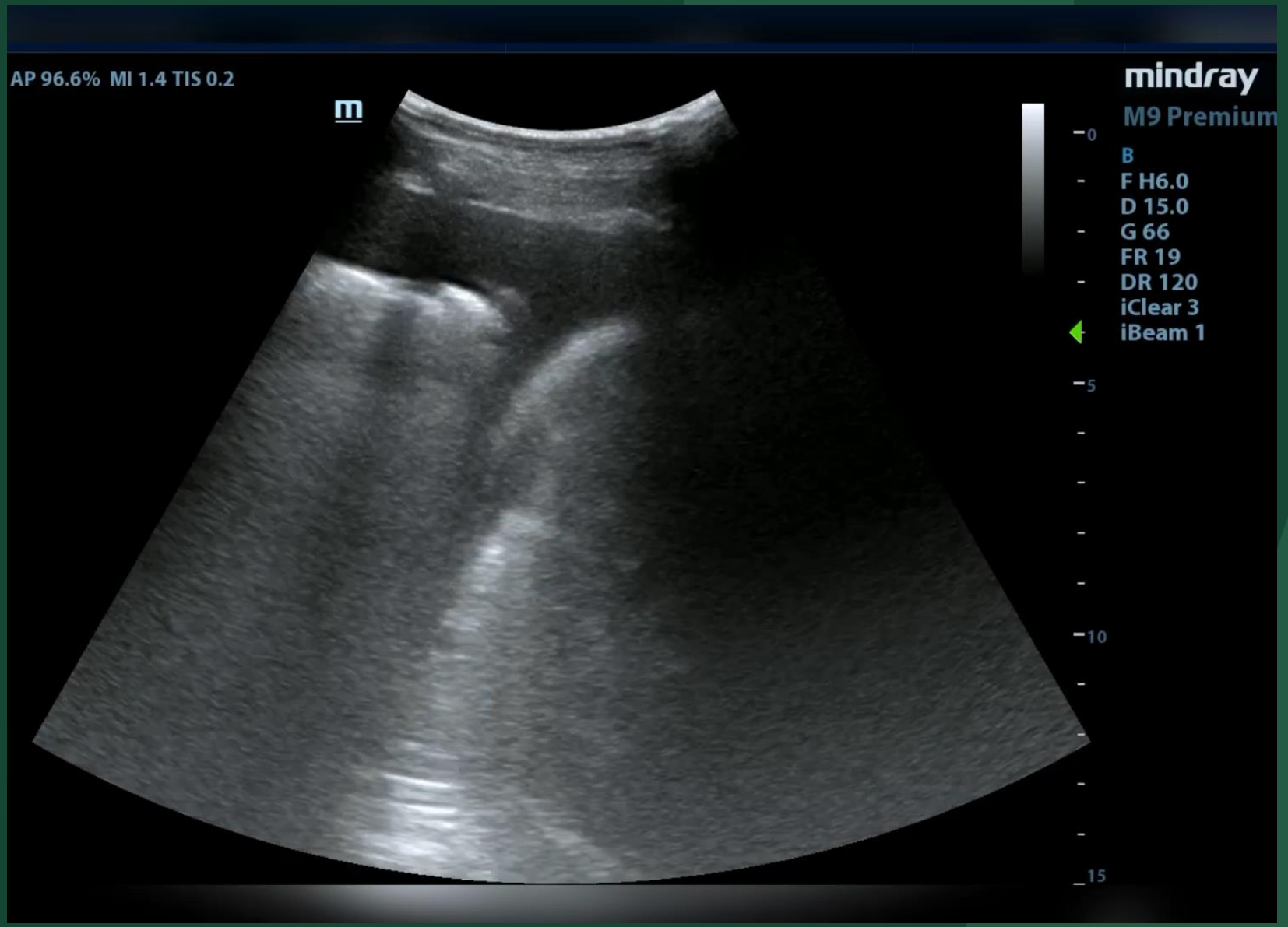


Pleural Effusion

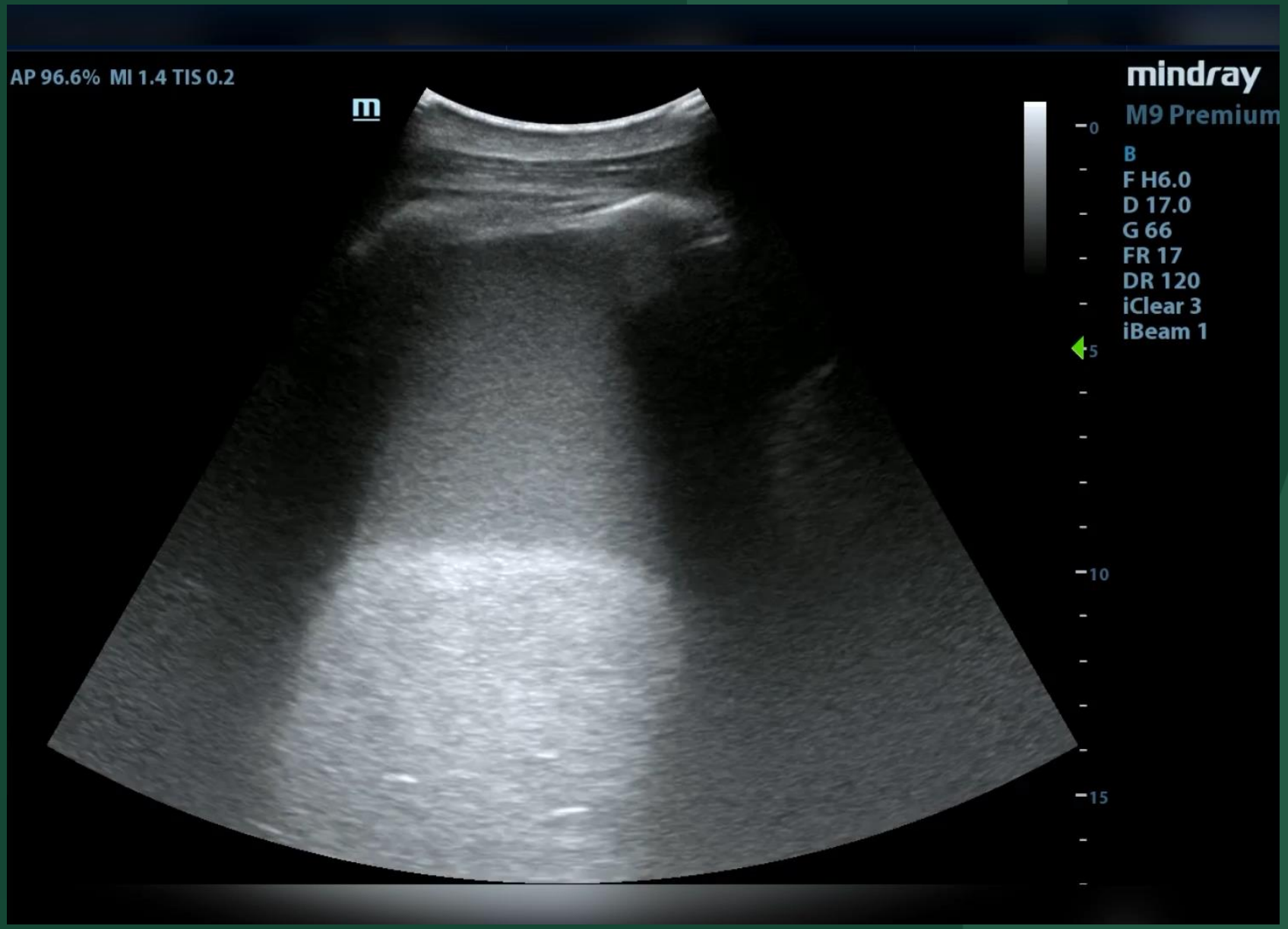
1) Spine Sign
2) Jellyfish Sign



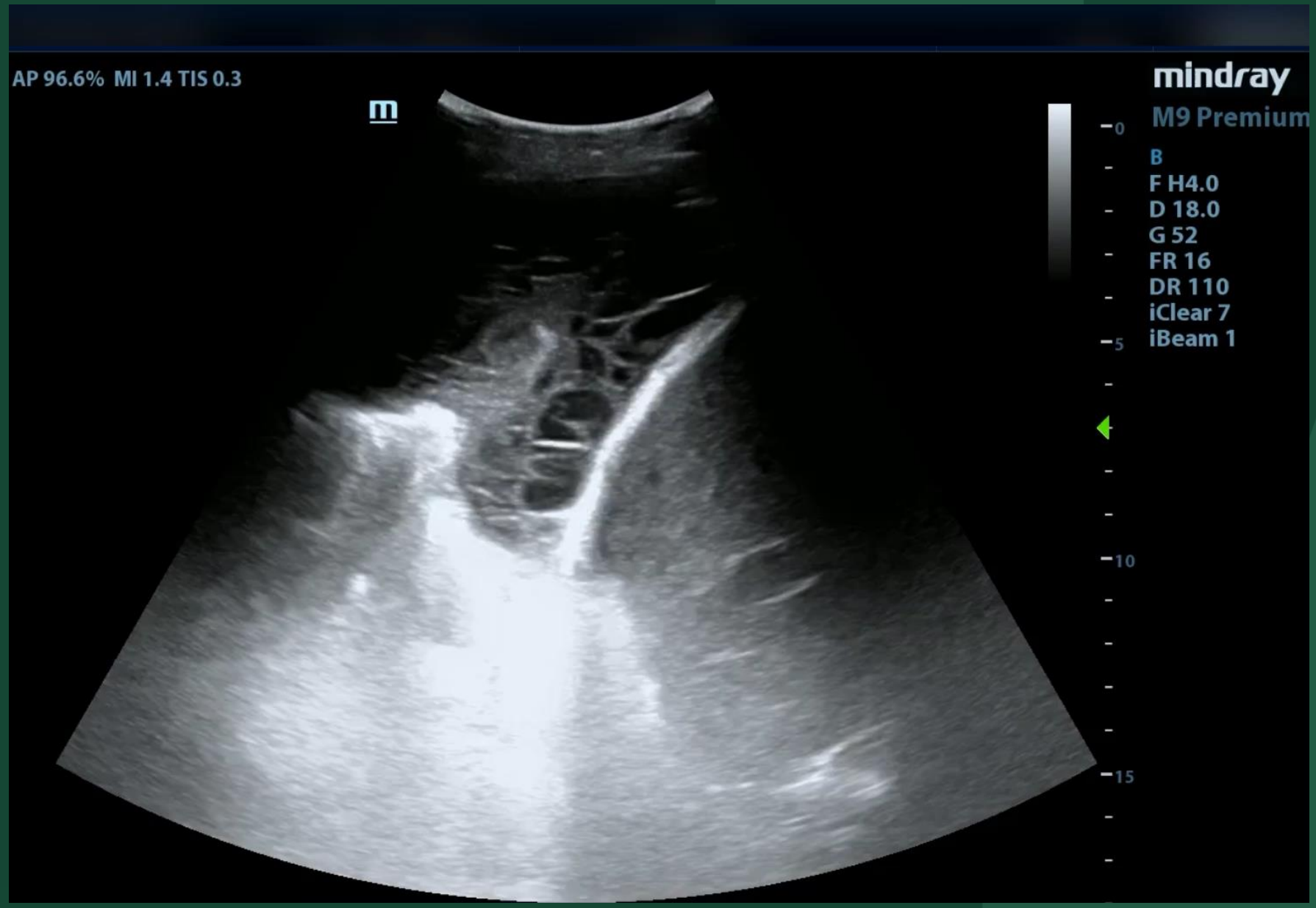
Pleural Effusion- Small



Pleural Effusion- Large

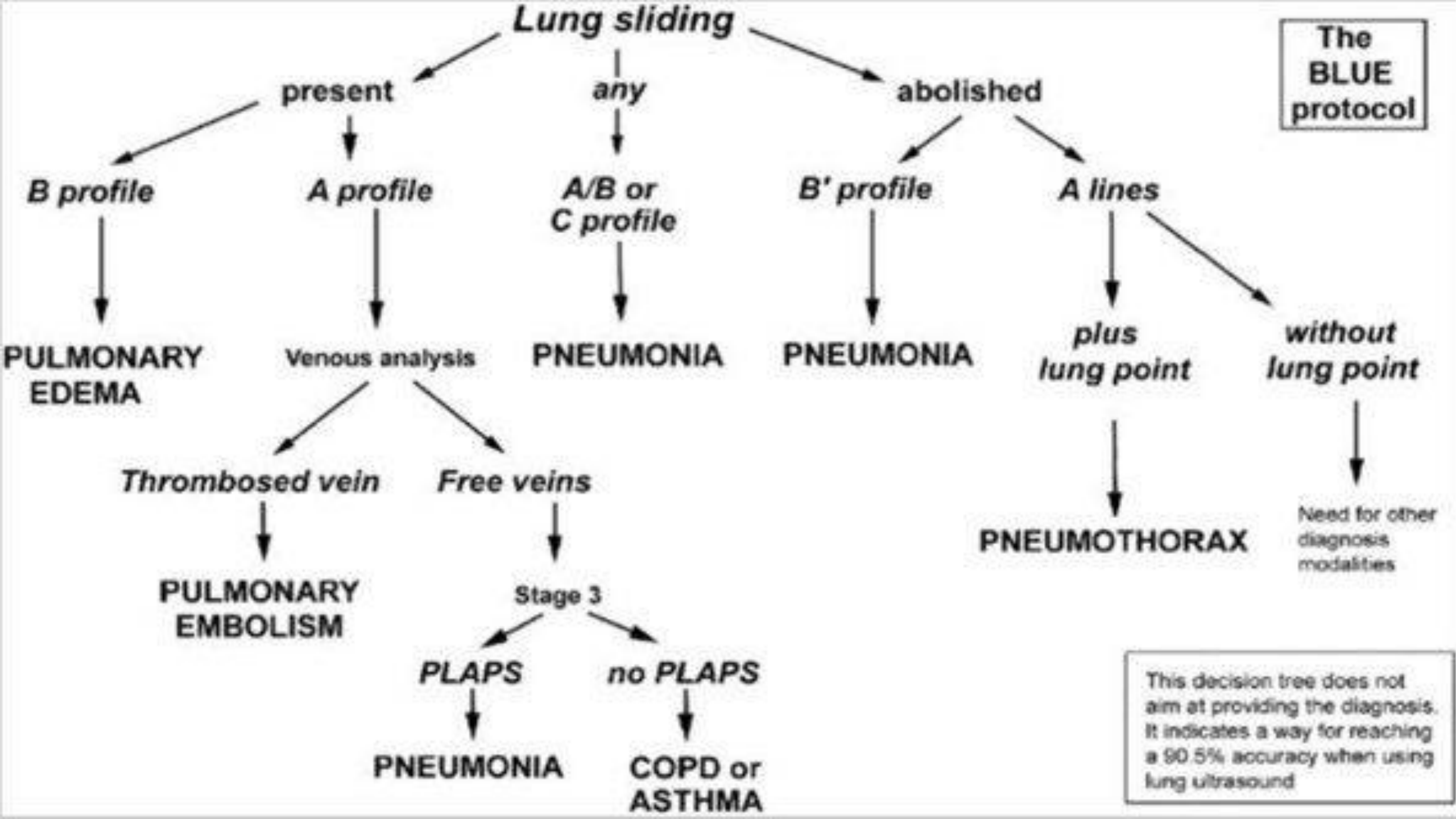


Pleural Effusion- Loculated



Hepatization

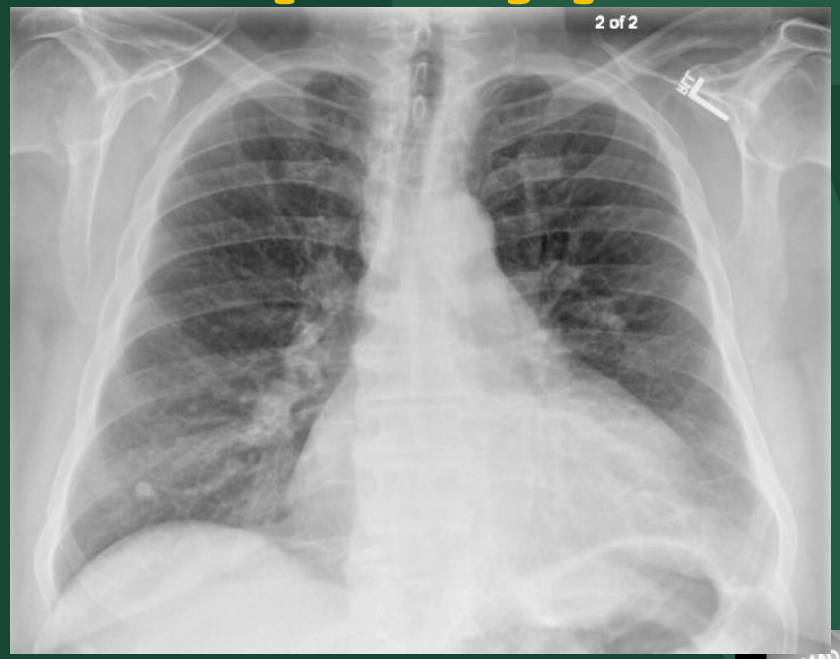
Putting It All Together


Lung sliding
present
any
abolished
The BLUE protocol
B profile
A profile
A/B or C profile
B' profile
A lines
PULMONARY EDEMA
Venous analysis
PNEUMONIA
PNEUMONIA
plus lung point
without lung point
Thrombosed vein
Free veins
PNEUMOTHORAX
Need for other diagnosis modalities
PULMONARY EMBOLISM
Stage 3
PLAPS
no PLAPS
PNEUMONIA
COPD or ASTHMA
This decision tree does not aim at providing the diagnosis. It indicates a way for reaching a 90.5% accuracy when using lung ultrasound

A Case of Post-op Hypoxia

62 y/o male POD4 s/p Aortic valve replacement is unable to wean from HFNC. FiO2-60%, at 40 L/min, despite pulm toilet, percussive therapy, cough assist, inspiratory spirometry.

A Chest XR is obtained.



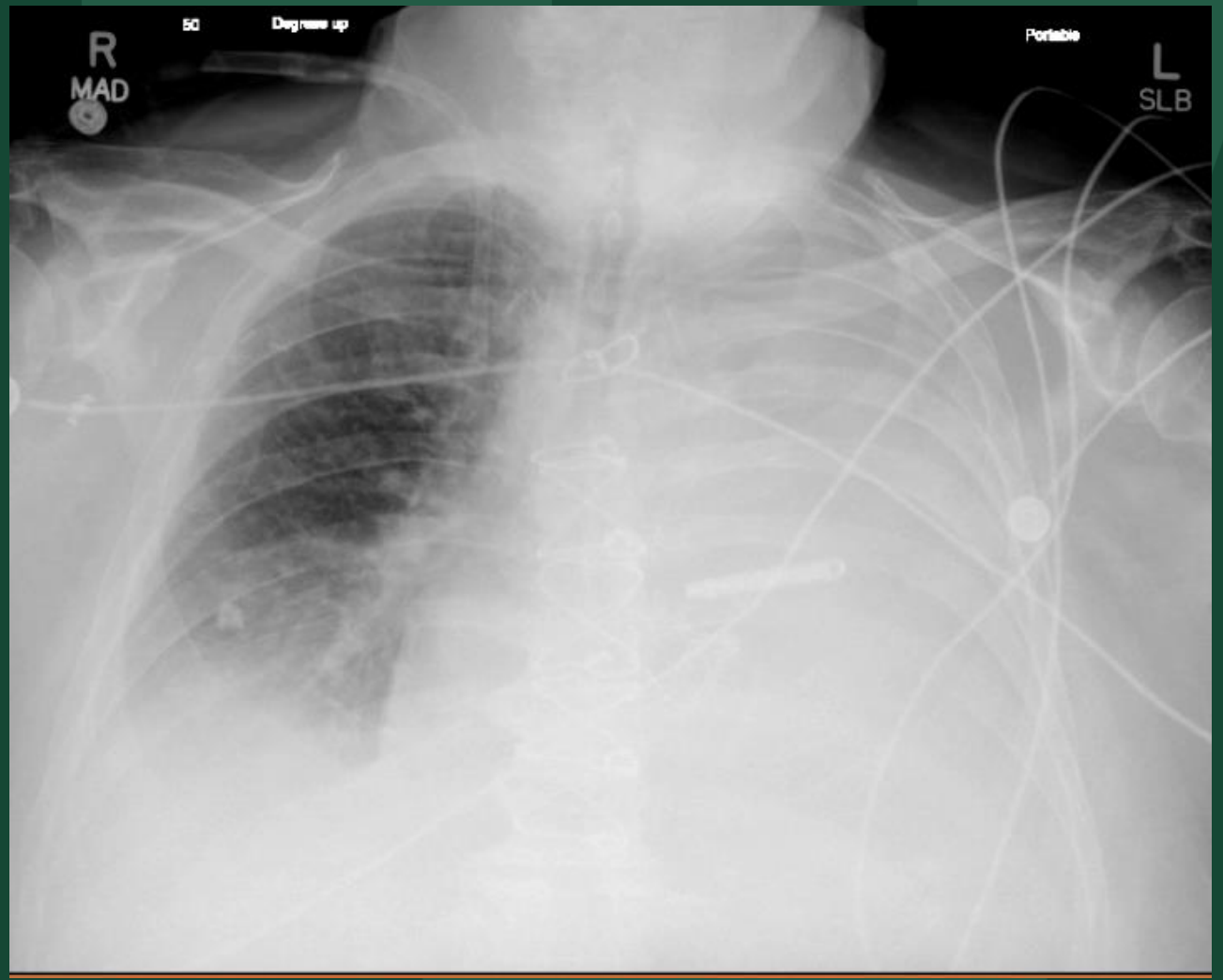
CXR (Pre-op)

Mucolytics are added in addition to performing the above measures more frequently

CXR POD#4

A Case of Post-op Hypoxia

Despite escalation in supportive respiratory care, pt remains on HFNC now requiring FiO2-70%, at 50 L/min



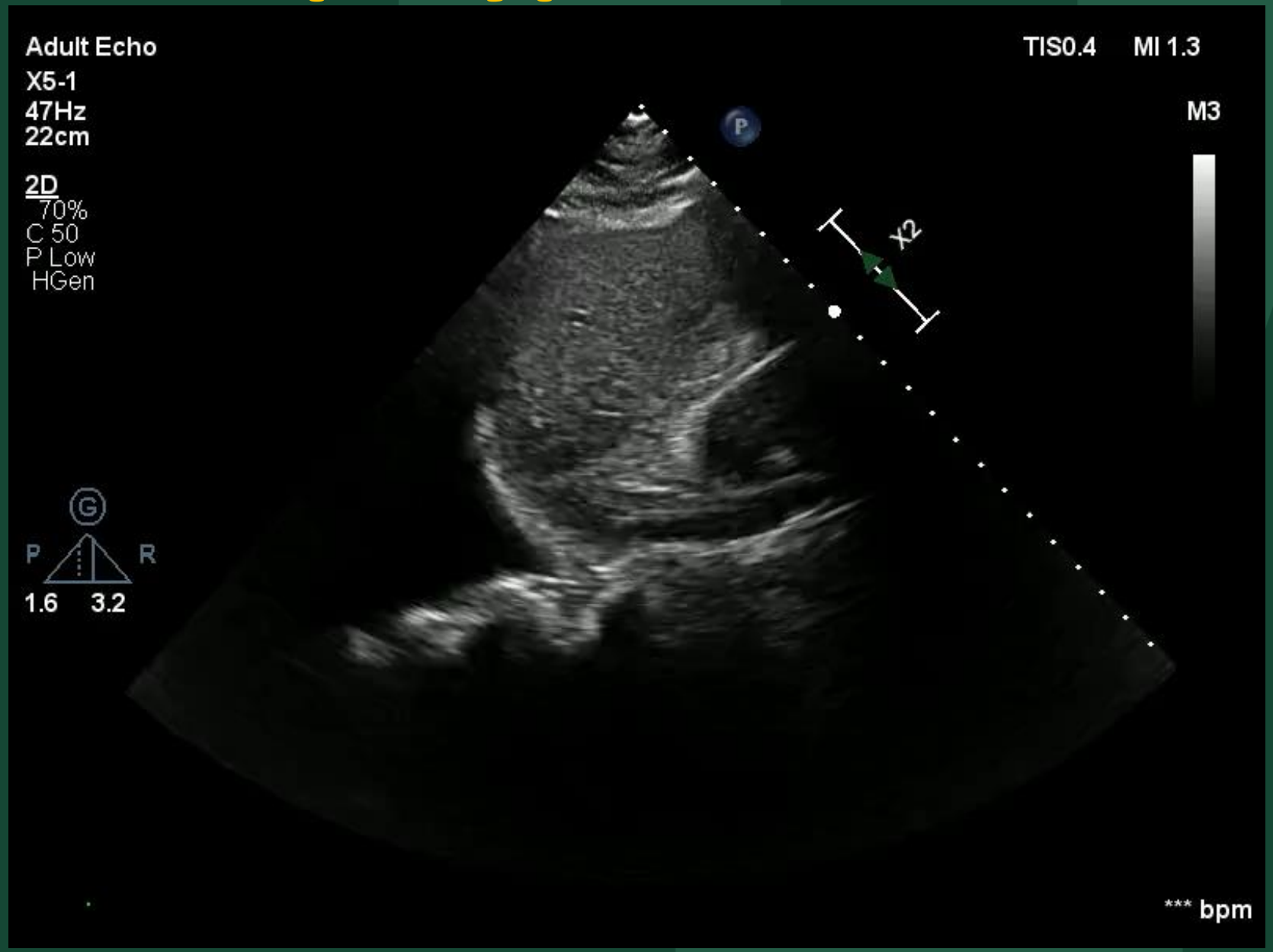
A repeat CXR is taken

You ponder which intervention may be the most helpful:

A) Diuresis alone
B) Diuresis and Therapeutic Thoracentesis
C) Diuresis and Chest Tube insertion
D) Diuresis and Therapeutic Bronchoscopy
E) Start Broad Spectrum Antibiotics for Pneumonia

A Case of Post-op Hypoxia

POCUS is performed to help guide management



A Case of Post-op Hypoxia

A small effusion and atelectasis is noted.

The decision is made to perform therapeutic bronchoscopy in addition to diuresis.

A repeat CXR is taken post-bronchoscopy

Over the next 3 days, the patient is weaned to NC @ 1L/min with the ongoing support of the patient's respiratory therapists

Thank You