Breathe, Scan, Wean

The RT's Guide to Point-of-Care Ultrasound

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The planner and speaker for this session have no relevant financial relationships with ineligible companies to disclose.

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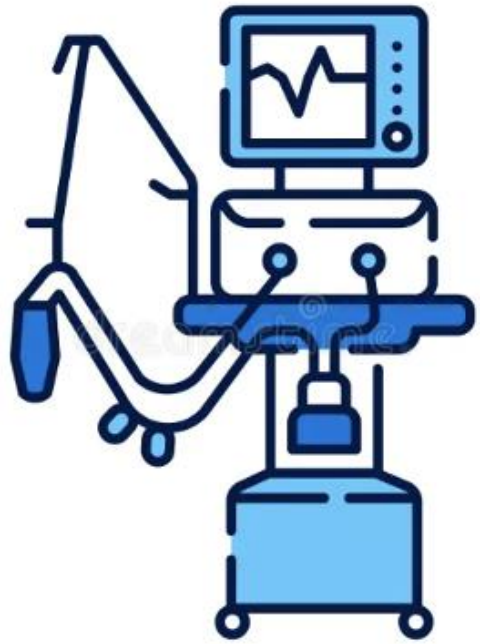
My disclaimers

- This will be Engaging…
- I will call on the audience
- You cannot hide ..

Objectives

- Identify key ultrasound views used in respiratory therapy, including diaphragm, lung, and airway views.
- Explain how diaphragm ultrasound can assess weaning readiness.
- Use ultrasound clips to distinguish between common pulmonary conditions and diaphragm performance.



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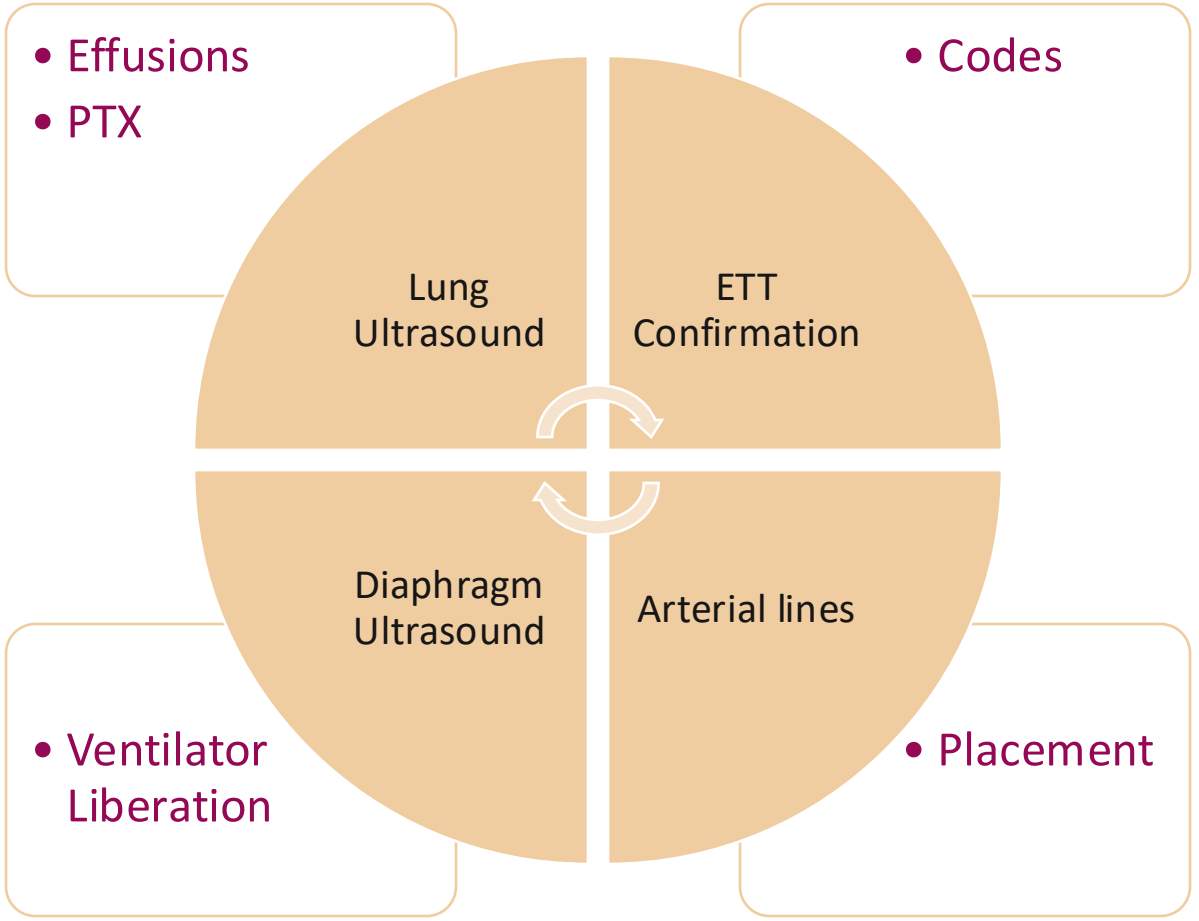
How many have used ultrasound before, and if so what did you use it for?

I. Why Ultrasound for RTs?

- RT's at the front life of ventilator care
- Real-time, bedside, no radiation
- Guides vent management, extubation, troubleshooting
- Expands RT autonomy & decision-making
- Short training (2–16 hrs; 20–80 scans) can achieve competency
- Evidence: Auscultation sensitivity only 37% vs higher accuracy with LUS (Arts et al., 2020)

Key Applications of POCUS in Respiratory Care



Case: Mr. Al Veoli 68-year-old man with severe COPD (GOLD D)

- Intubated with hypercapnic respiratory failure 48h.
- **Sedation:** off; following commands.
- **Hemodynamics:** HR 92, BP 128/72, no vasopressors
- **Secretions:** moderate, cough weak
- **CXR:** hyperinflation, basilar atelectasis; no clear pneumonia

- **SBT (PS 8 / PEEP 5 / FiO_2 0.35):**
  - RR 32/min, VT ≈ 320 mL (IBW 65 kg → 4.9 mL/kg)
  - **RSBI** ≈ 100
  - **NIF** −18 cmH_2O
  - **VC** ≈ 9 mL/kg
  - SpO_2 94%
  - **ABG (end of 30-min SBT):** 7.38 / 52 / 82 on FiO_2 0.35

Would you Extubate?

II. Ultrasound 101 for RTs

Phased/Linear Probe

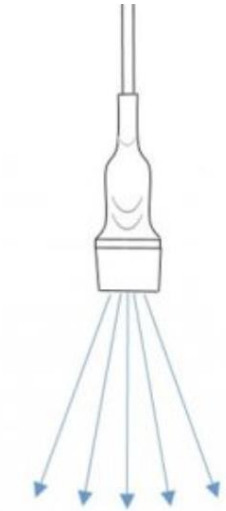
Vascular Access

- Superficial
- High Frequencies (7.5Mhz)
- Low Depth
- Large Surface Area

Curvilinear Probe

Abdominal

- Superficial
- Low -Medium Frequencies (2-5Mhz)
- High Depth
- Large Surface Area

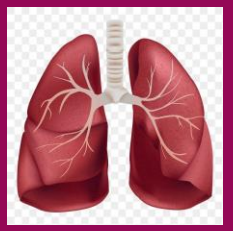


Phased Probe

Echo

- Low Frequencies (1-5Mhz)
- HIGH Depth
- SMALL Surface Area

LIVE DEMO CUE!

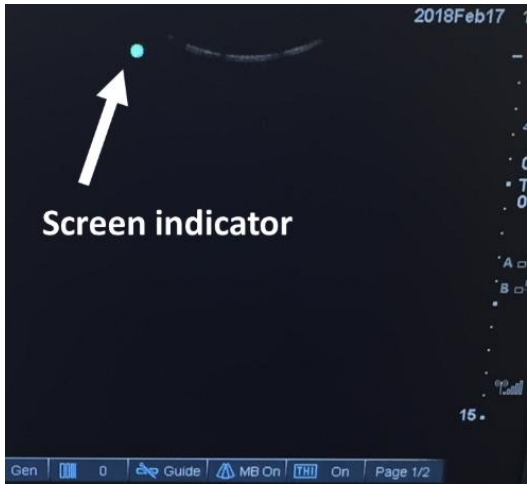


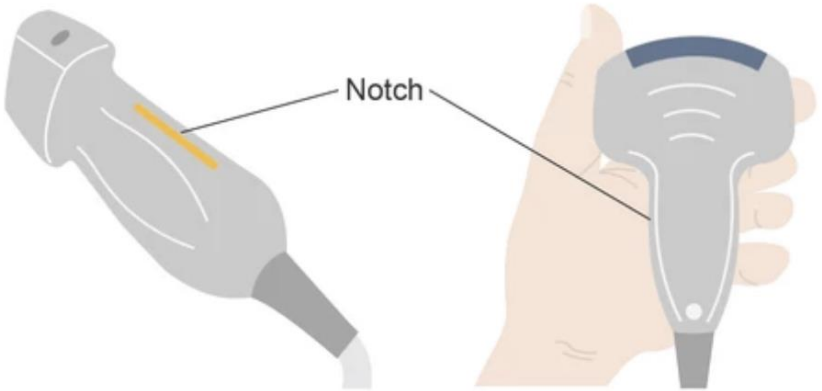
Who is brave enough to Volunteer?

Orientation and Positioning

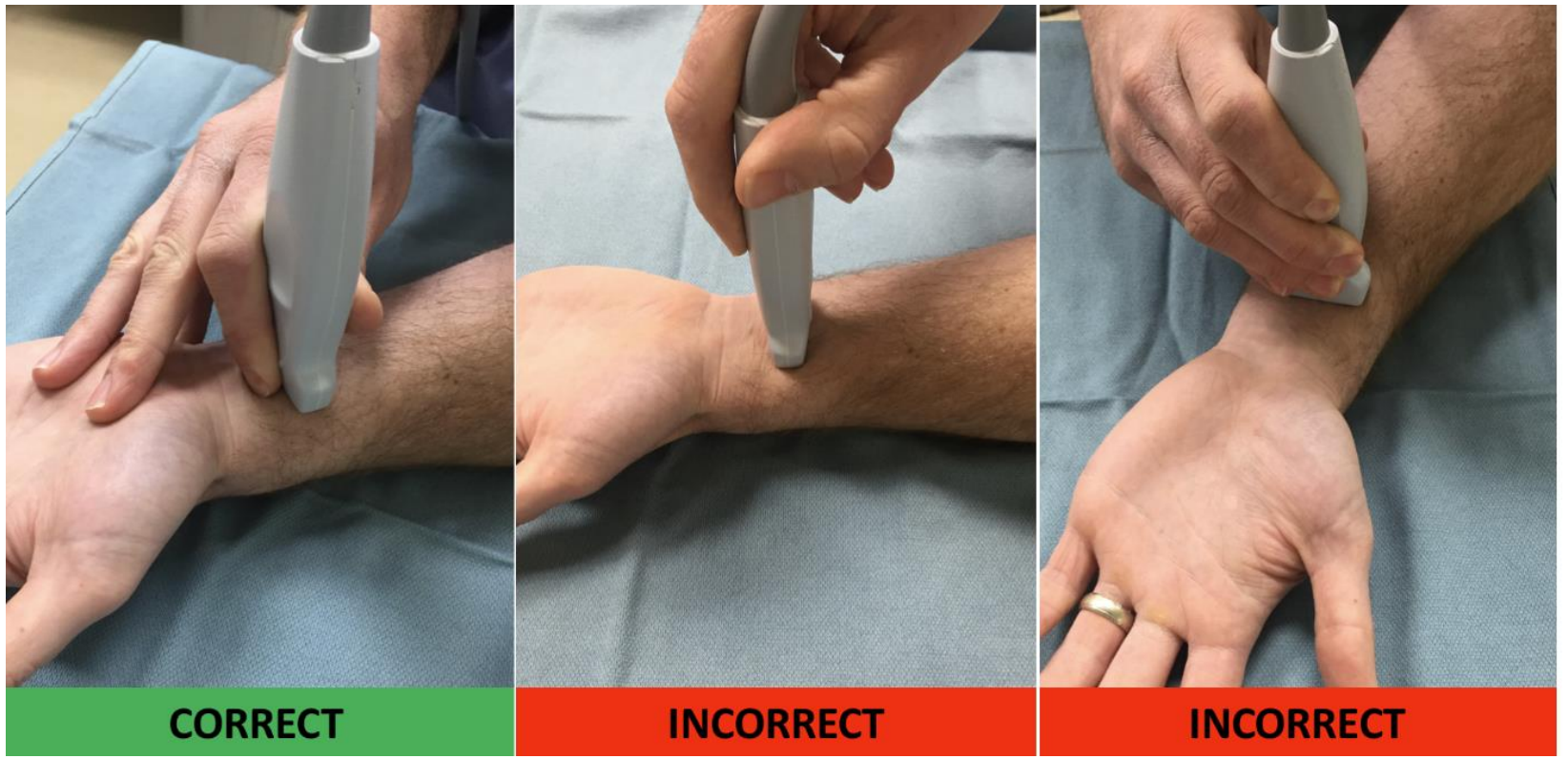
Longitudinal

Transverse

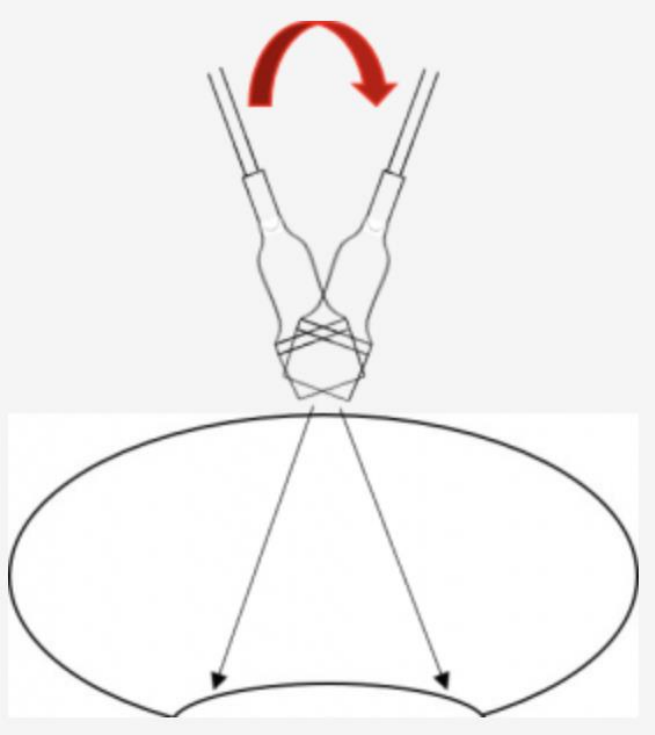




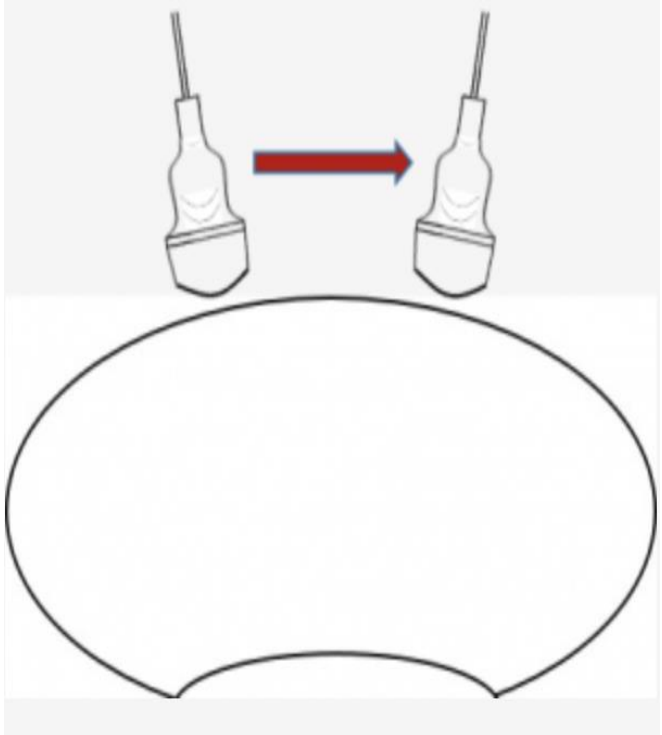
Stabilization



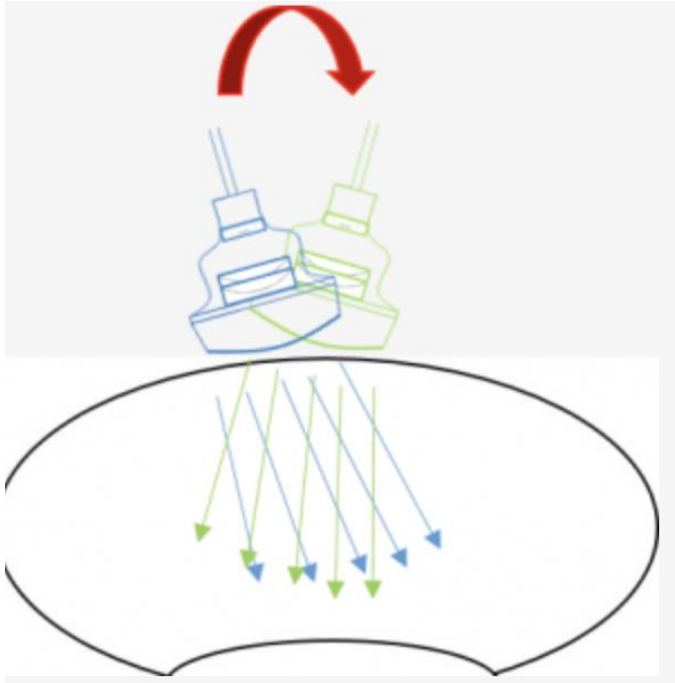
Mobility



Tilting
(short axis of curvilinear probe)



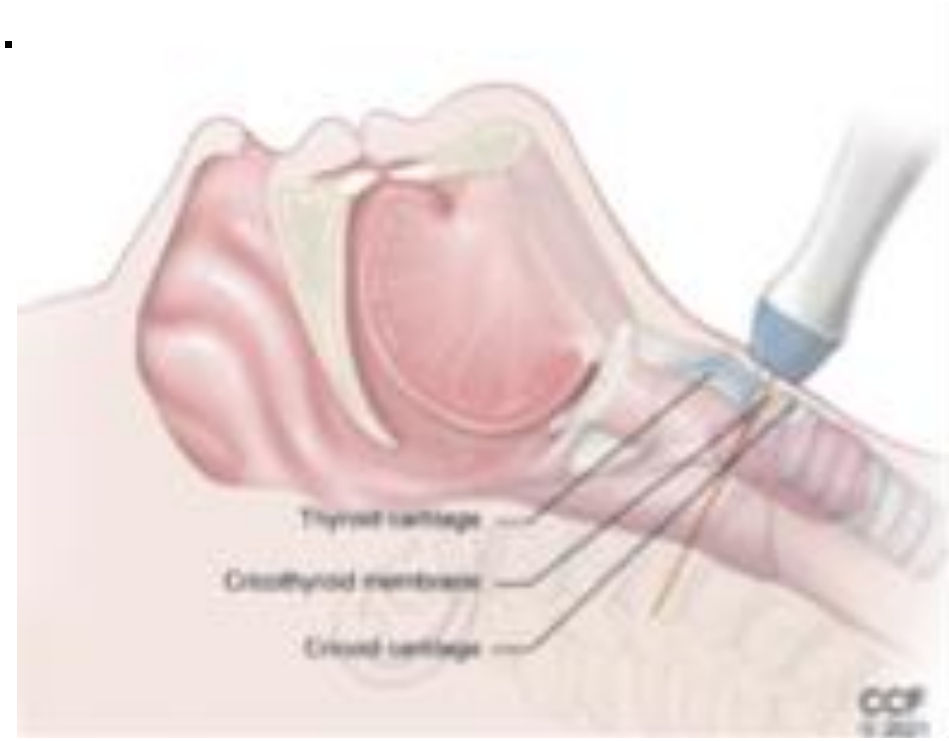
Sliding



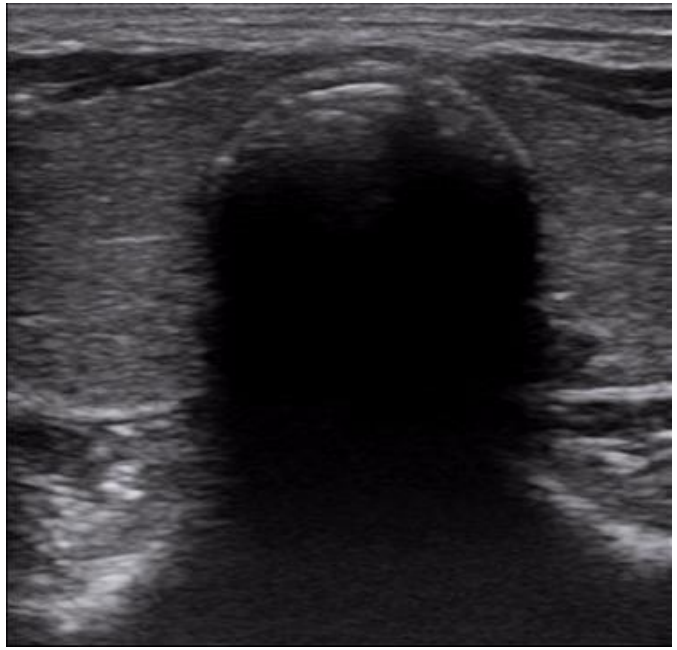
Rocking
(long axis of curvilinear probe)

Case

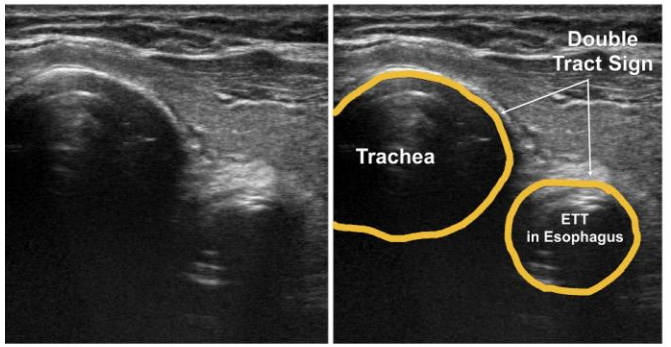
- 60 M with pmh HTN, DM, COPD, smoking history, presents with SoB and productive cough.
- He arrives in moderate respiratory distress with retractions, speaking in 3 word sentences.
- Patient gets intubated.
- Portable xray is delayed.
- How can we confirm ETT placement on ultrasound?

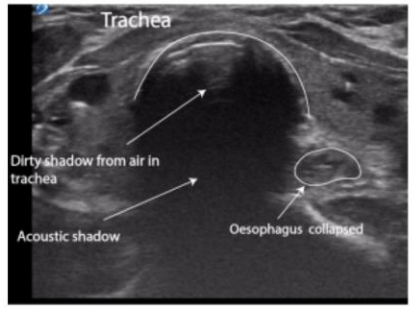


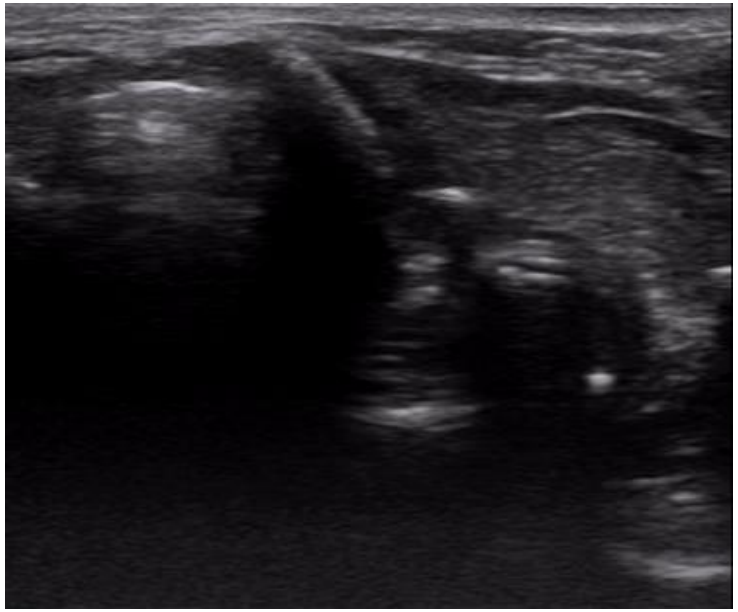
III. Key Applications
ETT Confirmation



Tracheal intubation: **"Bullet SIGN"** ✅







Esophageal intubation:
"Double tract sign" 🚨

- Transverse at suprasternal notch
- Confirm bilateral lung sliding for tube depth

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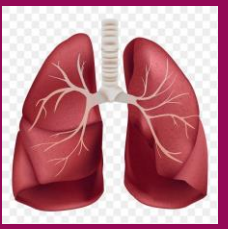
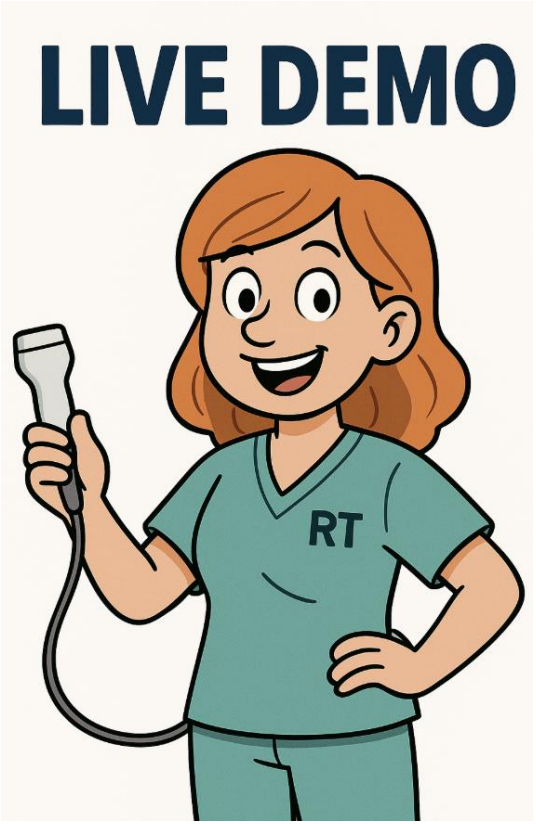


Who is brave enough to Volunteer?



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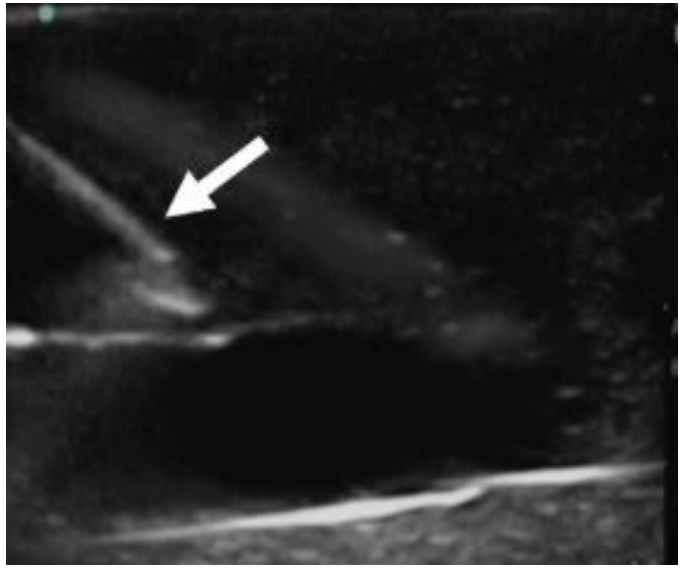
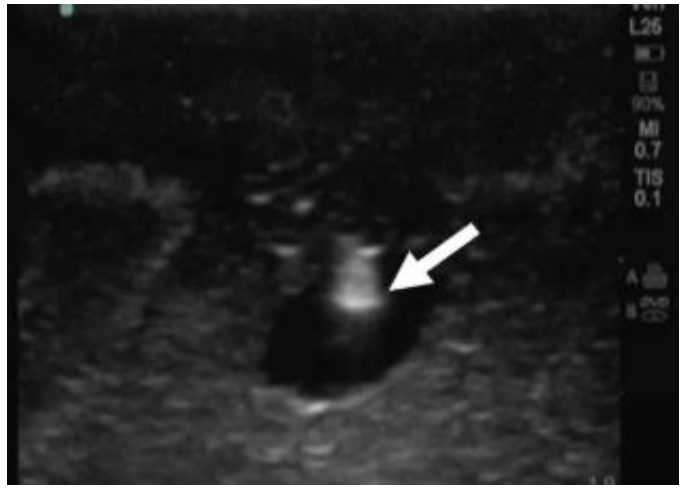
III. Key Applications
Arterial Lines

- Increases **first-pass success** and reduces complications (hematoma, posterior wall puncture)
- Helpful in **hypotensive, edematous, obese, or pediatrics.**
- **Probe:** High-frequency linear probe (10–15 MHz)
- **Transverse (Short-Axis):**
  - Perpendicular
- **Longitudinal (Long-Axis):**
  - Parallel





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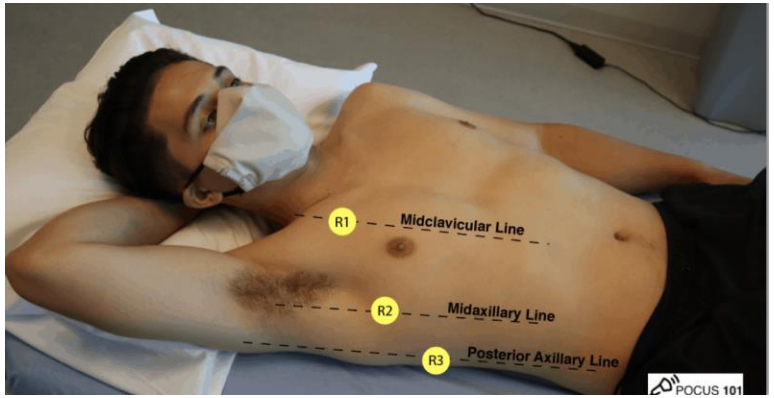
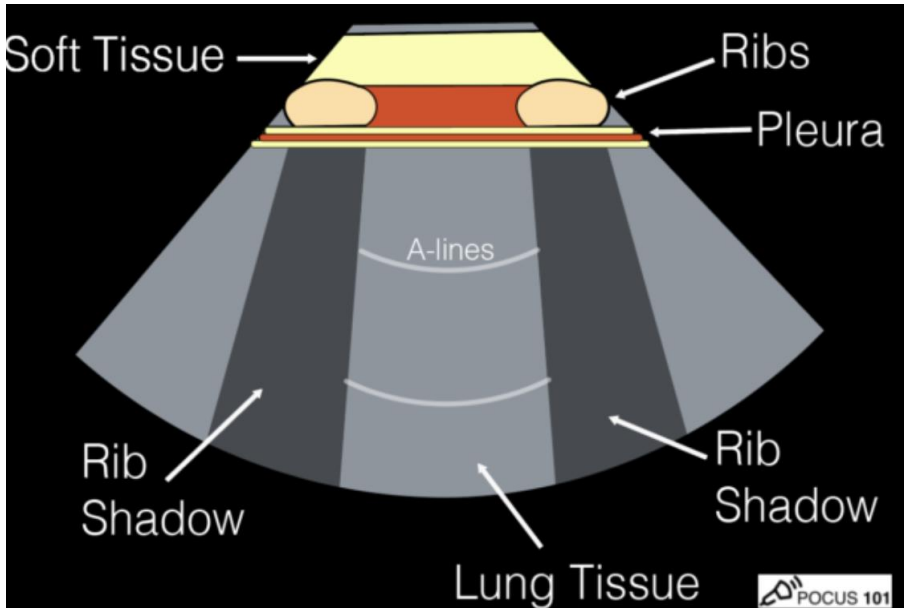
III. Key Applications
Lung US

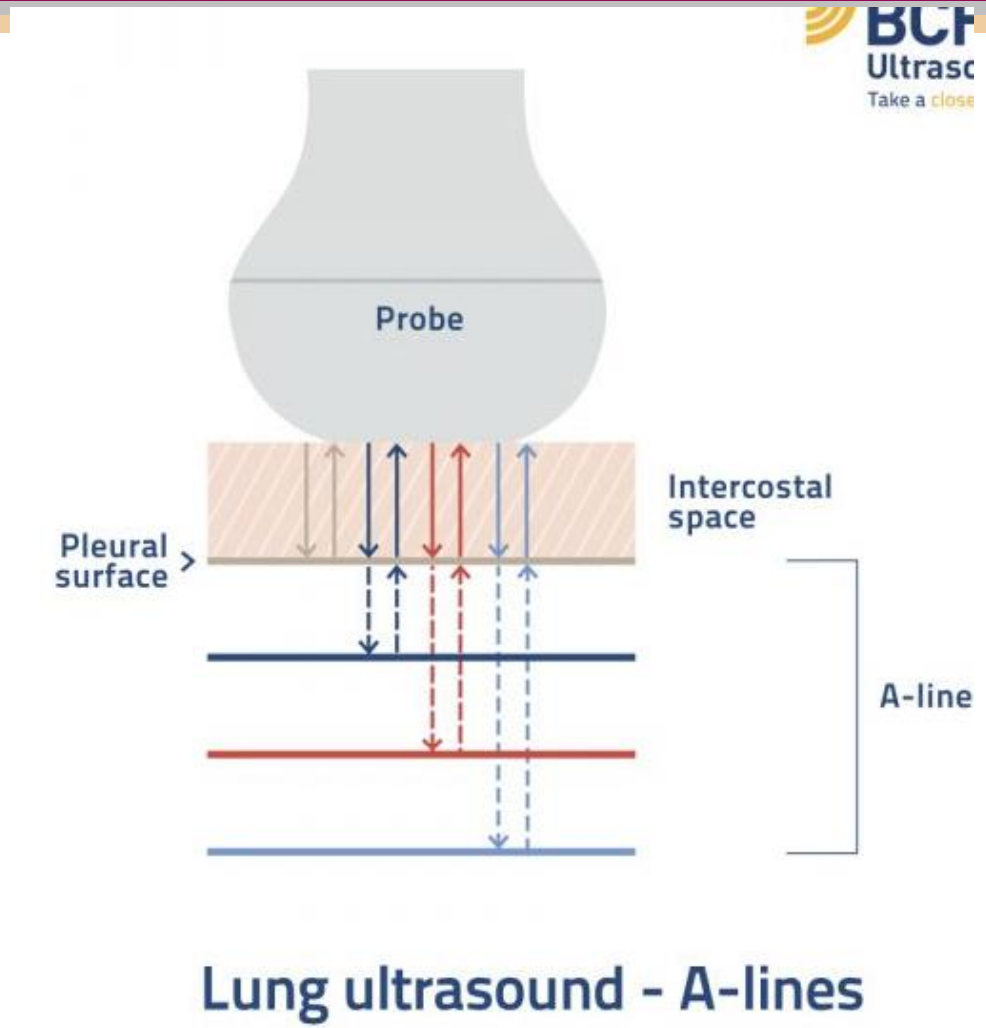
A-lines:	B-lines:	Consolidation	Pleural effusion:	Pneumothorax:
horizontal, normal aeration	vertical, comet-tail → edema	Tissue-like, bronchograms	anechoic, spine sign	absent sliding, barcode sign



A-lines

- Horizontal reverberation artifacts parallel to pleural line – indicates normal aeration.

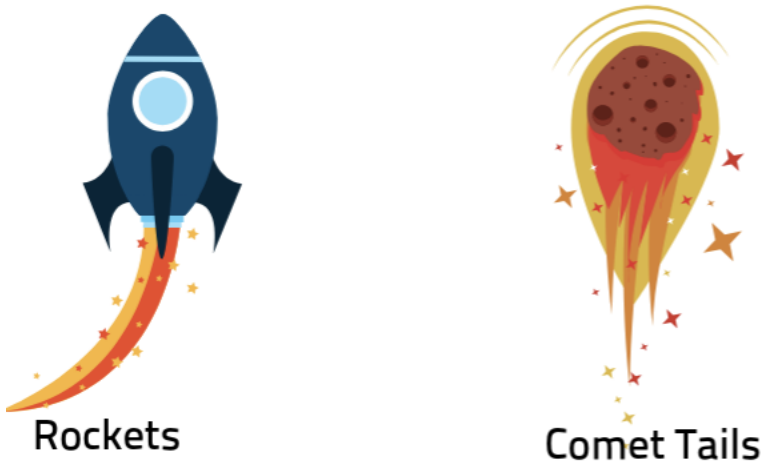


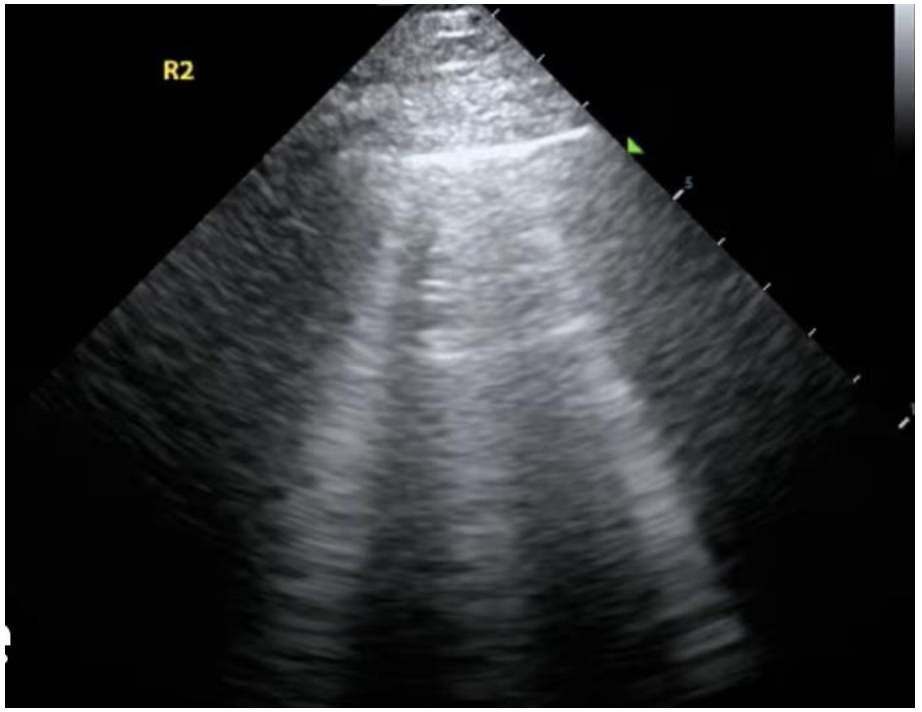


Ref: Lichtenstein DA. Lung ultrasound in the critically ill. Ann Intensive Care. 2014;4:1–12.

B-lines (Interstitial Syndrome)

- Vertical comet-tail artifacts arising from pleura, erasing A-lines – seen in edema, ARDS, pneumonia.



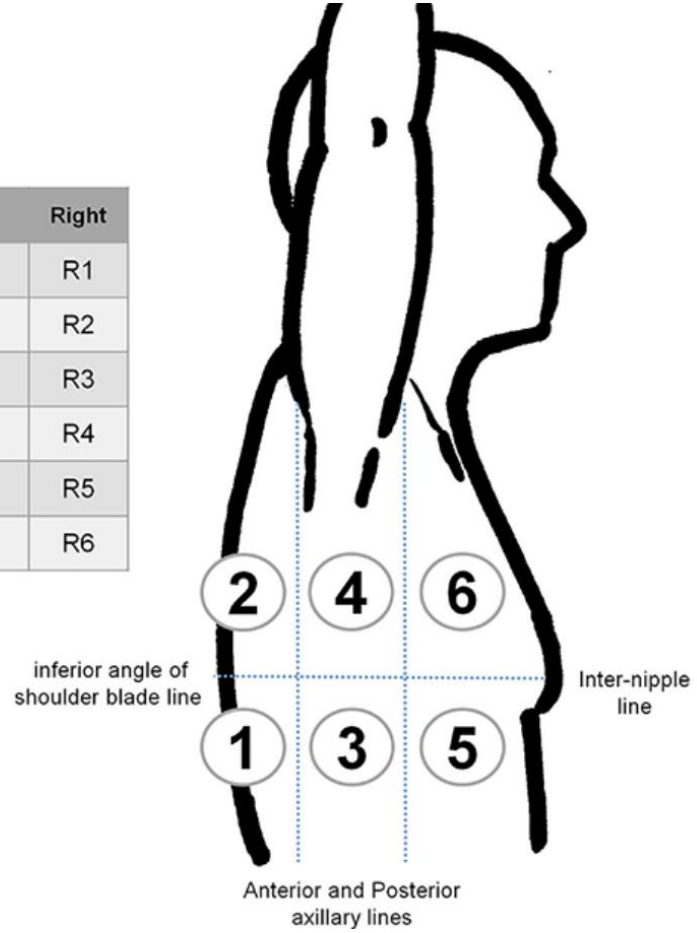


Ref: Volpicelli G, et al. Int Care Med. 2012;38(4):577–591.

Lung Ultrasound Score

- **Studied in COVID patients**
- **Correlates with clinical severity/resp failure.**

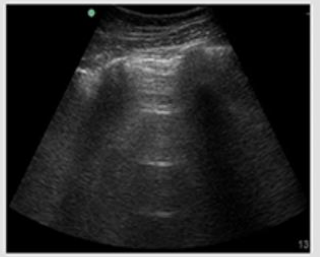
Left	Thoracic Areas	Right
L1	Posterior Inferior	R1
L2	Posterior Superior	R2
L3	Lateral Inferior	R3
L4	Lateral Superior	R4
L5	Anterior Inferior	R5
L6	Anterior Superior	R6



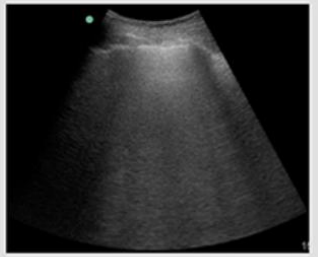
LUS B-line Score

The total score is the sum of points obtained by the evaluation of each area (range 0-12).

0 points for each area with normal A line pattern



1 point for each area with pathological B-lines



Scoring per Zone:
0 = A-lines / ≤2 B-lines (Normal)
1 = ≥3 B-lines (Moderate loss)
2 = Coalescent B-lines (Severe loss)
3 = Consolidation (Complete loss)

Total Score: 0–36
Extubation readiness:
≤12 → Higher success
>13 → Higher risk of failure

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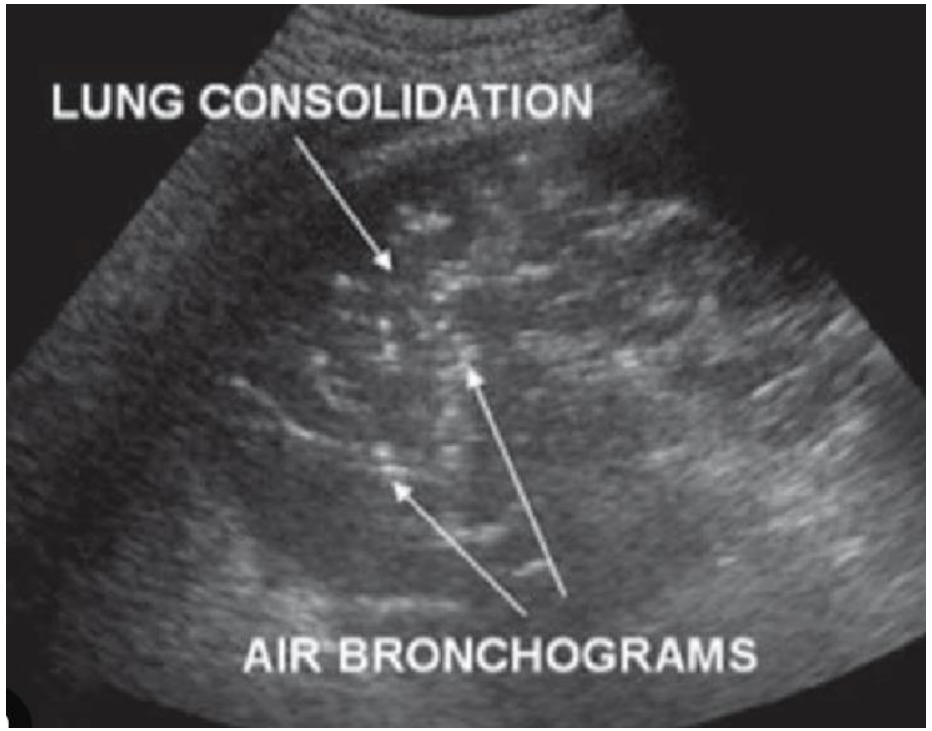
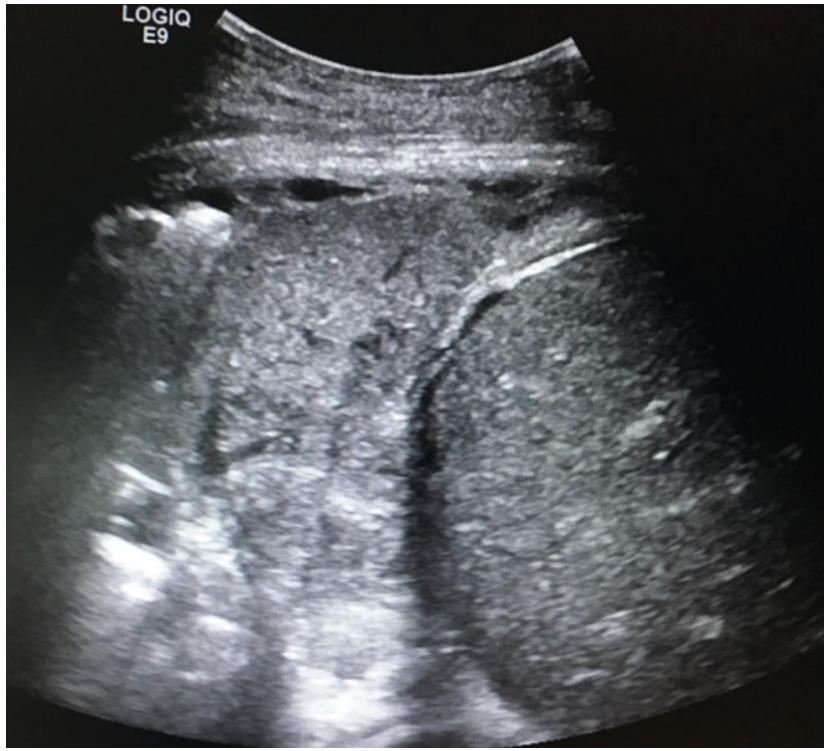
*Bouhemad, B.; Mongodi, S.; Via, G.; Rouquette, I. Ultrasound for "lung monitoring" of ventilated patients. Anesthesiology **2015**, 122, 437–447.*

Consolidation

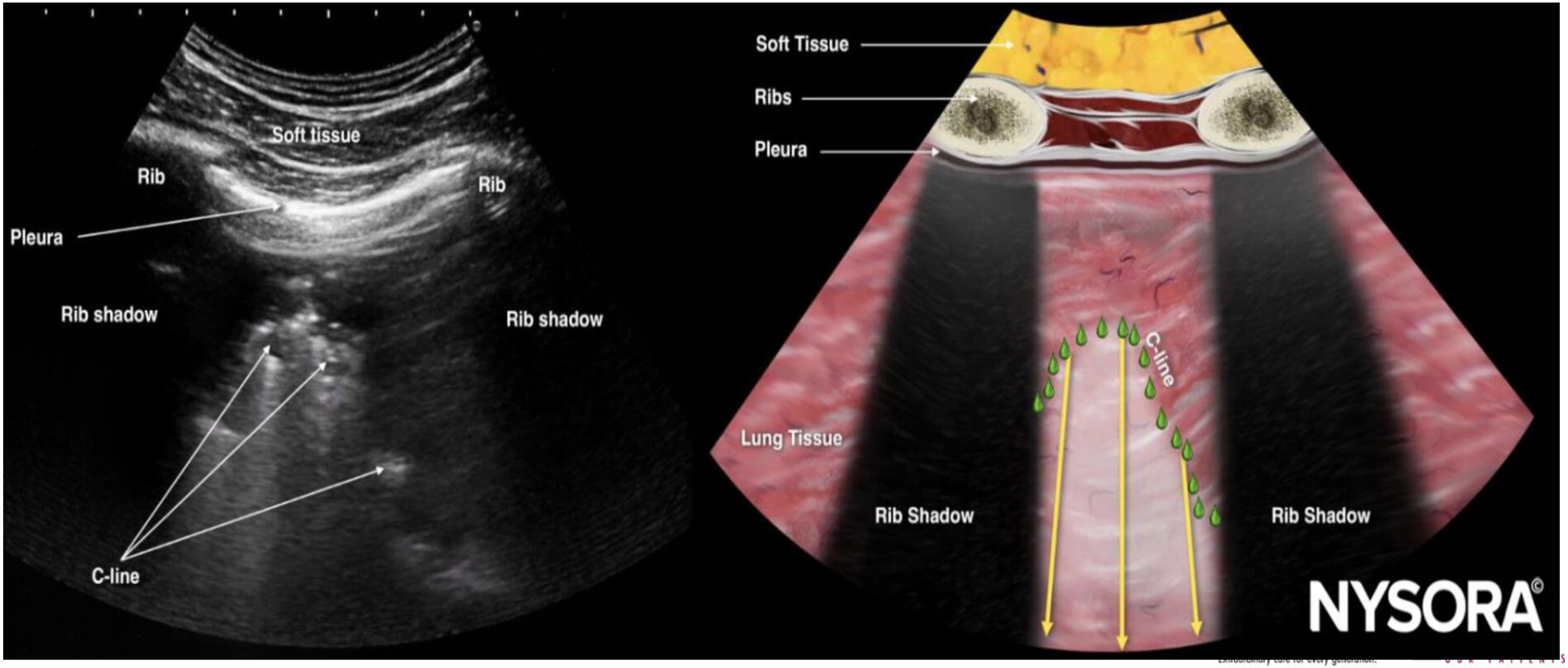




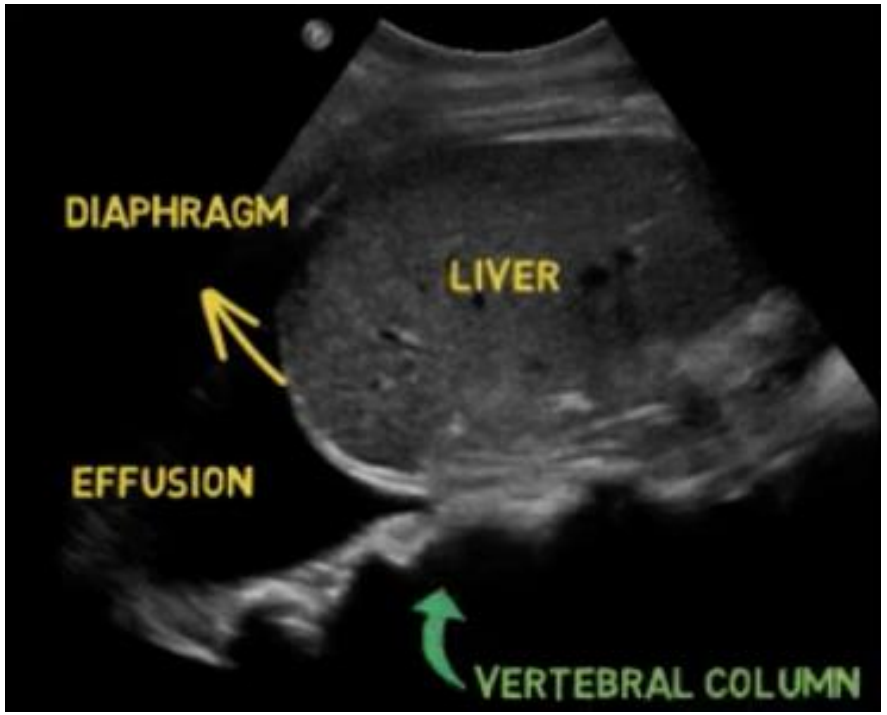
- Tissue-like (hepatization), with hyperechoic punctate dynamic air bronchograms.

Ref: Bouhemad B, et al. Int Care Med. 2011;37:1368–1376.

Shred, “C”-Line


Soft tissue
Rib
Rib
Pleura
Rib shadow
Rib shadow
C-line
Soft Tissue
Ribs
Pleura
C-line
Lung Tissue
Rib Shadow
Rib Shadow
NYSORA©

Pleural Effusion



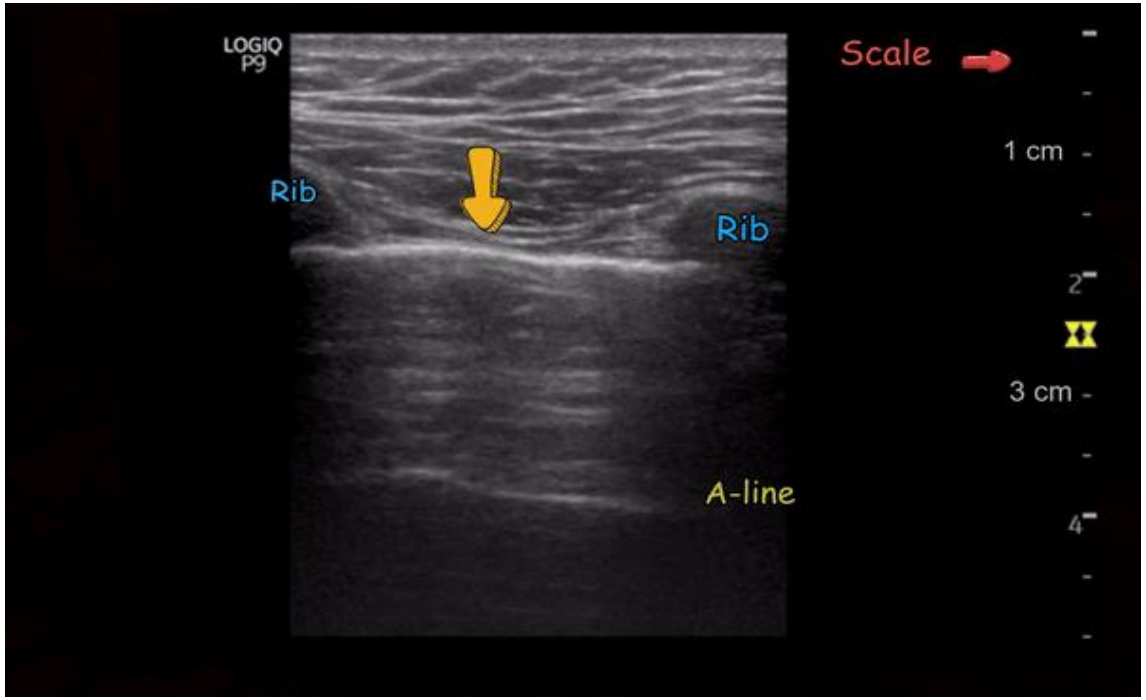
'Spine Sign'

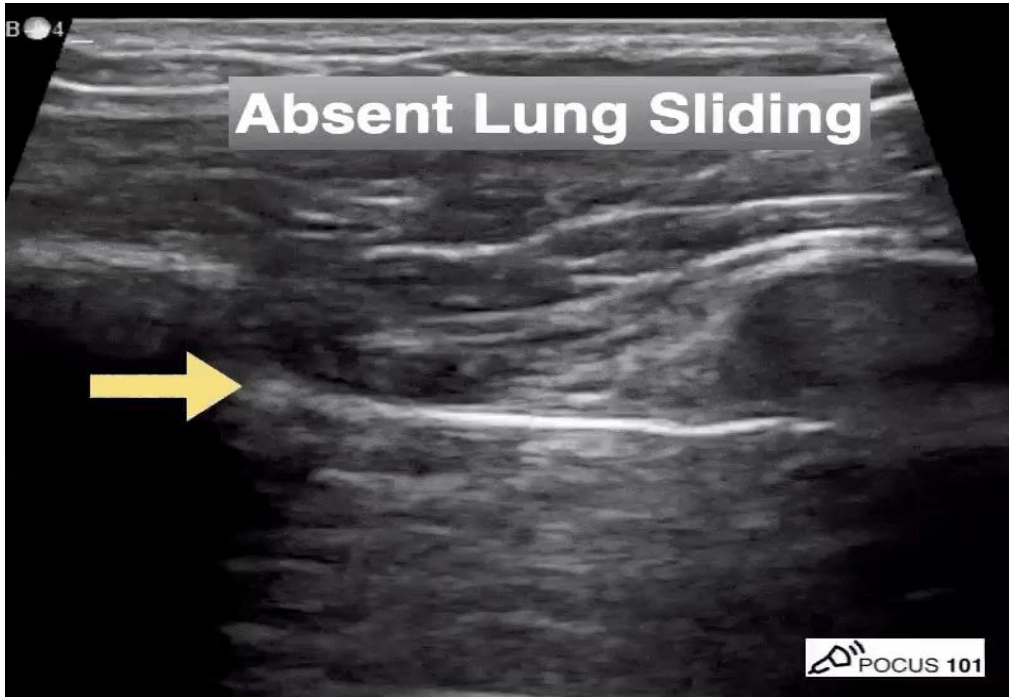
“Mirror Artefact”

Ref: Xirouchaki N, et al. Int Care Med. 2011;37:1488–1493.

Pneumothorax

- Absent sliding, barcode sign (M-mode horizontal lines).

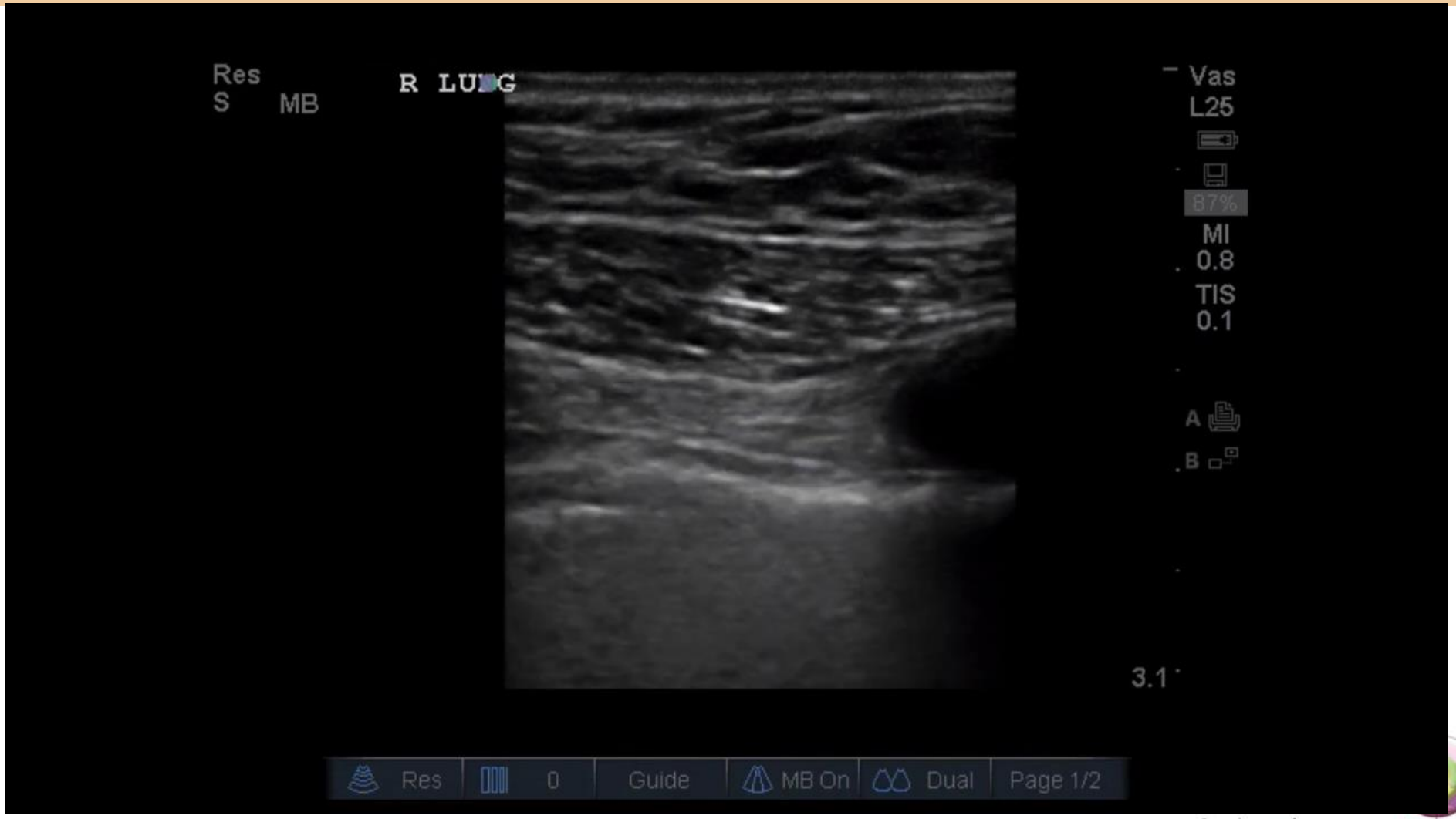




Video Resource: https://www.ultrasoundvillage.com.au/education/normal-seashore-sign-vs-pneumothorax-barcode-sign/

Ref: Al Deeb M, et al. Chest. 2014;145(4):725–734.

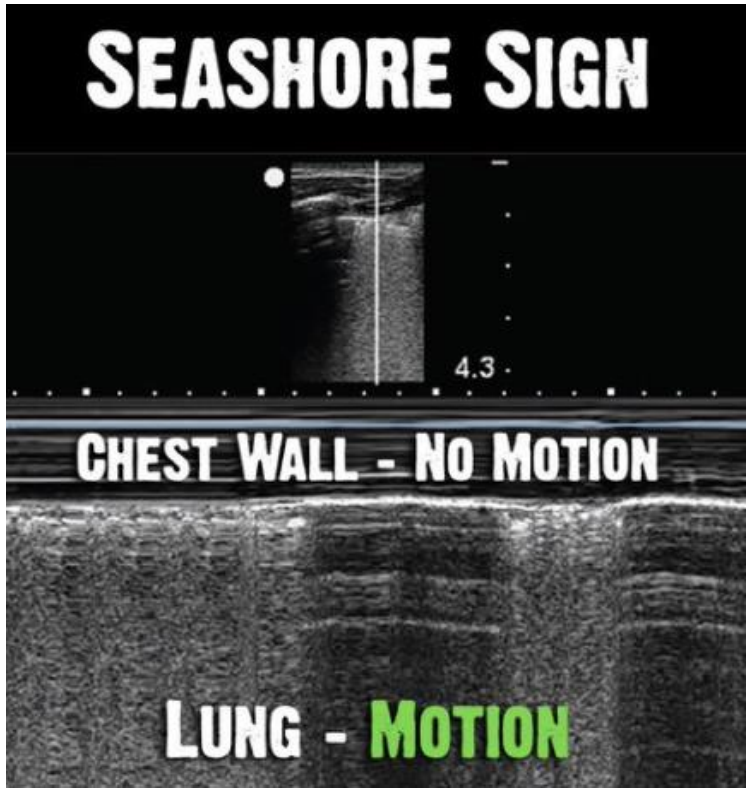
Lung Sliding and Lung Point

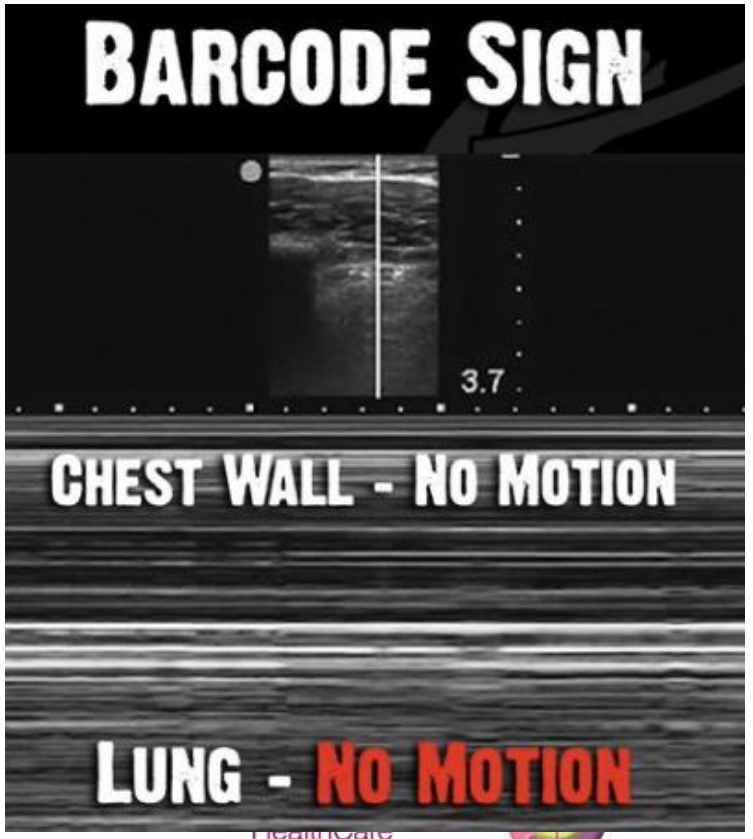


https://www.youtube.com/watch?v=rnLwPhidvZA&t=173s

Seashore Sign

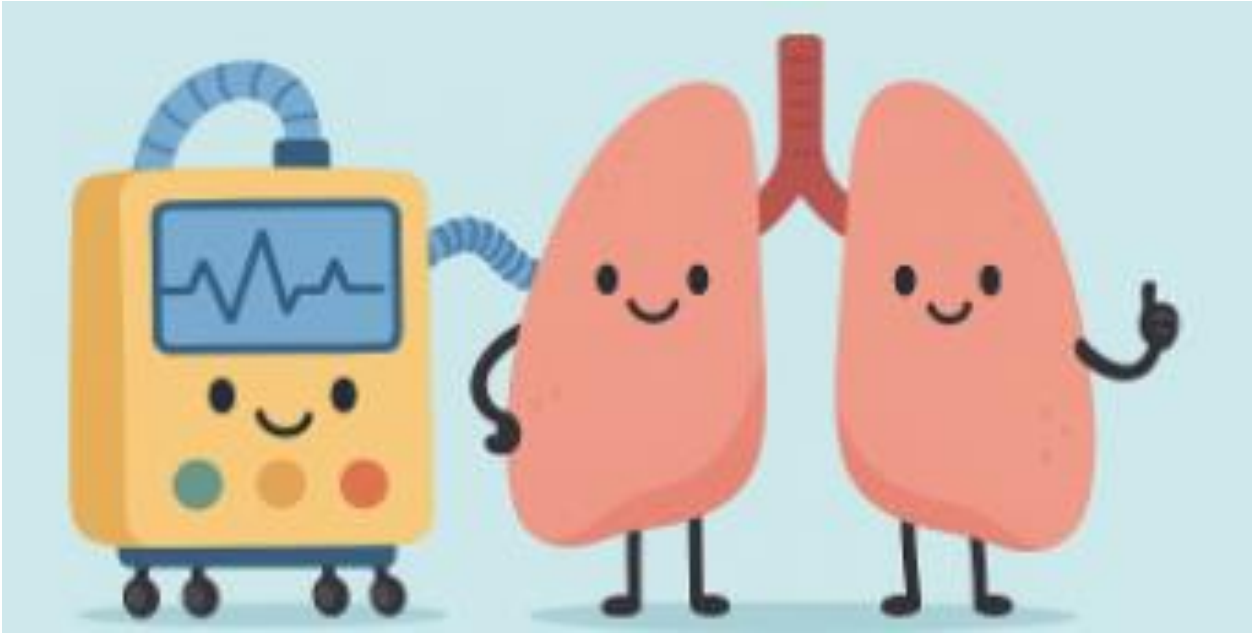
- M-Mode at the pleura





III. Key Applications
Diaphgram US

- Linear probe (zone of apposition):
  - thickness + thickening fraction (TFdi)
- Curvilinear probe (subcostal):
  - Excursion measured in M-mode



Ventilator Liberation Framework

Daily Screen

- SAT/SBT
- Gas exchange
- Airway Protection

Measure Mechanics

- RSBI
- NIF/VC
- Diaphragm Ultrasound

Optimize the 4 P's

- Pulmonary Mechanics
- Pain
- Psychology
- Power

Choose SBT

- Phenotype

Post Extubation Support

- HFNC
- NIV

Diaphragm Ultrasound: Thickening Fraction (DTF) vs Excursion (DE)

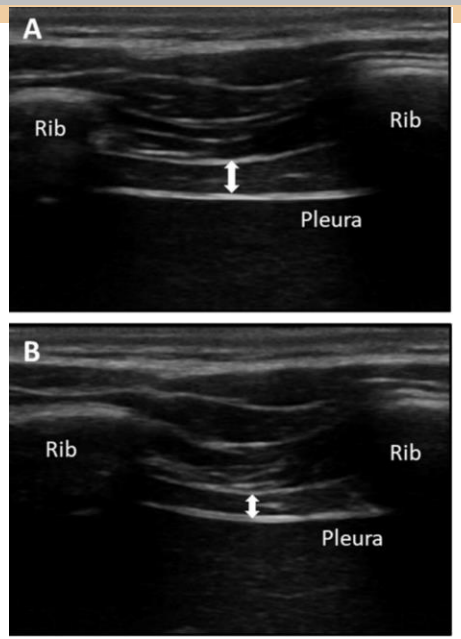
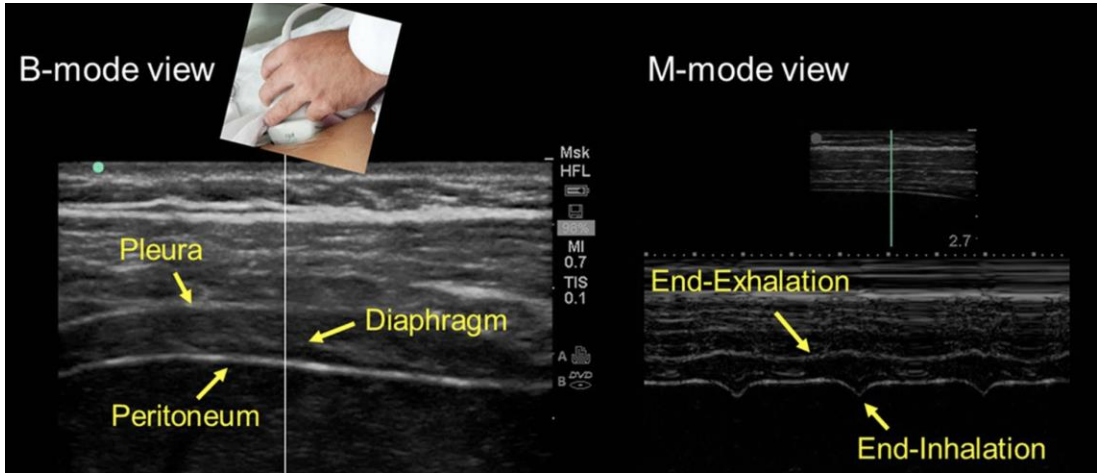


Image: B-mode ultrasound of diaphragm thickness at end-inspiration vs end-expiration (labeled with a double-headed arrow marking thickness change)



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DTF = (Thickness at Insp – Thickness at Exp) / Thickness at Exp × 100%

DE = Excursion distance (cm) of diaphragm dome during inspiration

DTF values under **20–30%** and DE below **10 mm** are strong predictors of weaning or extubation failure.

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Why is this Important for RTs?

- Guides vent management, extubation, troubleshooting
- Expands RT autonomy & decision-making

- Saudi survey: 18% use LUS, but 81% believe it's promising; 60% cite lack of training (Sreedharan et al., 2022)
- U.S. study: 97% of RTs agree LUS should be part of scope (Ireland et al., 2024)
- Global survey: 83.7% RTs support adding LUS (Alismail et al., 2022)

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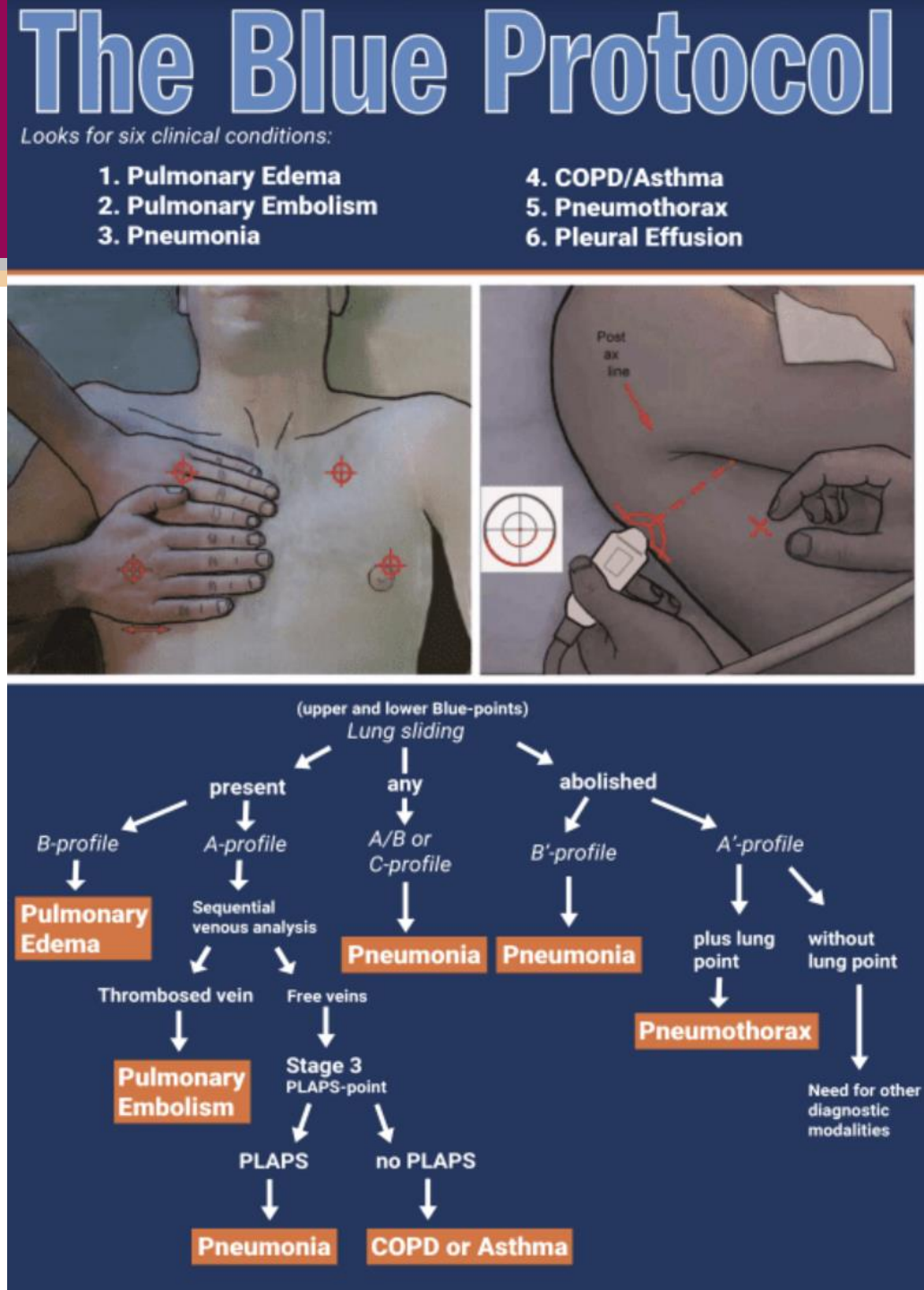
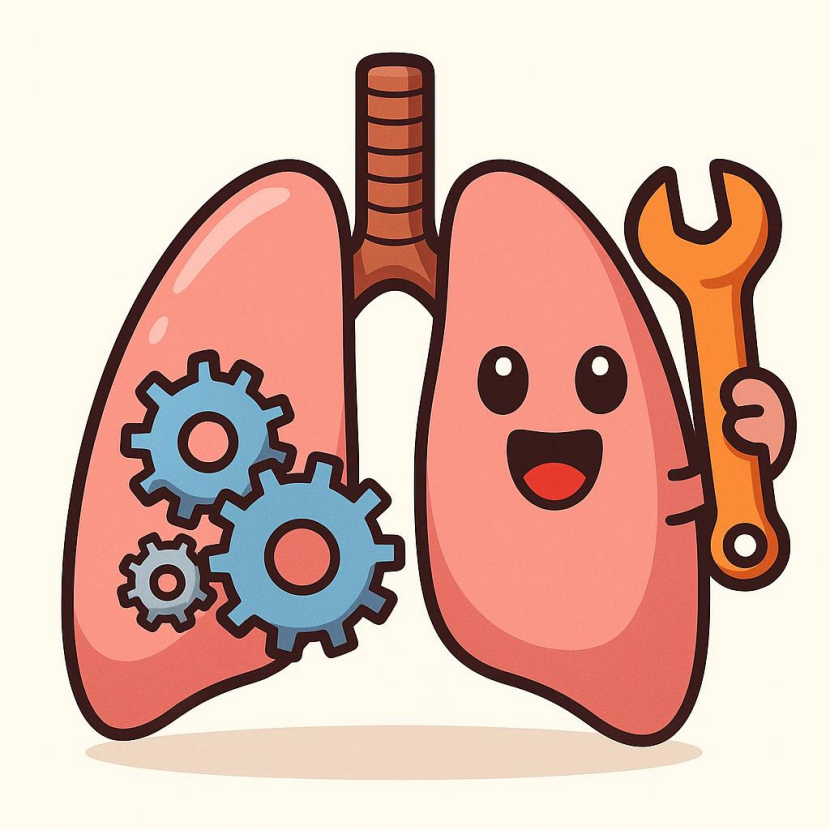
RT Protocols

- BLUE Protocol: lung profiles for acute dyspnea
- Diaphragm Protocol: TFdi + excursion for weaning
- Use alongside RSBI, NIF, cuff leak tests

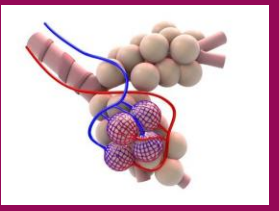


Pearls & Pitfalls

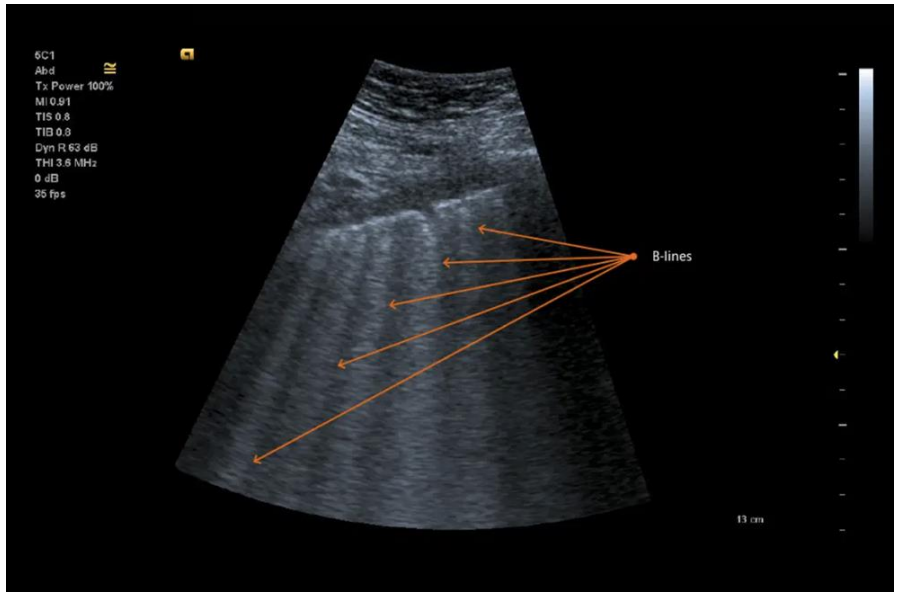
- Pitfalls: obesity, dressings, subcutaneous air, operator learning curve
- Pearls: always scan bilaterally, repeat if unclear
- Learning curve improves after ~20–30 supervised scans



Back to our case: Mr. Al Veoli



- **Lung US**
  - Bilateral pleural effusions
  - **LUS score: 14/24** (moderate interstitial syndrome)
- **Diaphragm US:**
  - Right thickening fraction **(TFdi)**: **18%**
  - Left TFdi**: 22%**
  - **Excursion: 6–7 mm**



DTF values under **20–30%** and DE below **10 mm** are strong predictors of weaning or extubation failure.

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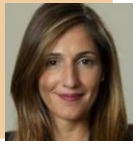
Would you extubate?

Take home pearls

Ultrasound is FAST	Ultrasound is Bedside	Ultrasound is Radiation-Free	Weaning Success predictor
Used to Troubleshoot	RT can lead POCUS Integration	Expand RT role	Phone a friendly Intensivist



Thank you!!

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