

Lung & thorax basics

Justin Bowra

Critical Care Ultrasound Course

Summary

1. Is there a pneumothorax?
1. Is there stuff in the pleural space?
1. Is the lung wet/ dry/ chunky?
1. What's the overall pattern?

Why scan the lung & thorax?

Pleural pathology

- Air: PTX
- Fluid
- Pleural thickening
- Malignancy:
mesothelioma

Lung pathology

- Fluid in lung eg
APO
- Consolidated
lung eg
pneumonia /
contusion

Procedural guidance

Why bother?

- **More accurate** than CXR:
 - PTX (>95% v 50%)
 - Pleural fluid (20ml v 200ml)
 - APO sens 97%, spec 94%, acc 95%
 - PE?? Sens 74% ... 81% if add DVT
- It's also
 - **Faster** (2 min versus 19 min)
 - **Safer**
 - **Repeatable**

The theory

Normal lung ≠ disease processes*

Normal lung

- Air in lung reflects the sound
- You don't really see normal lung at all
- Pleural line = sliding 'twinkling curtain'
- Sparkle = scatter from air
- Bright horizontal lines = reverberation

Pathology (that reaches the pleura)

- PTX: air but no sliding
- Pleural fluid: 'gap' between chest wall & lung
- Pleural disease: thickened / irregular
- Wet / fibrosed lung: bright vertical lines
- Consolidated / infarcted lung: hypoechoic 'chunks'

Normal dry lung

Only air

Scatter

May see horizontal static lines (reverberation artefacts from the pleura) = **A lines**

Lung sliding

Ribs / costal cartilages



Ribs / costal cartilages



Pleural line



Pleural line



TOSHIBA

EM76:EMERGENCY76
Liverpool Hospital Emergency

ABDOMEN

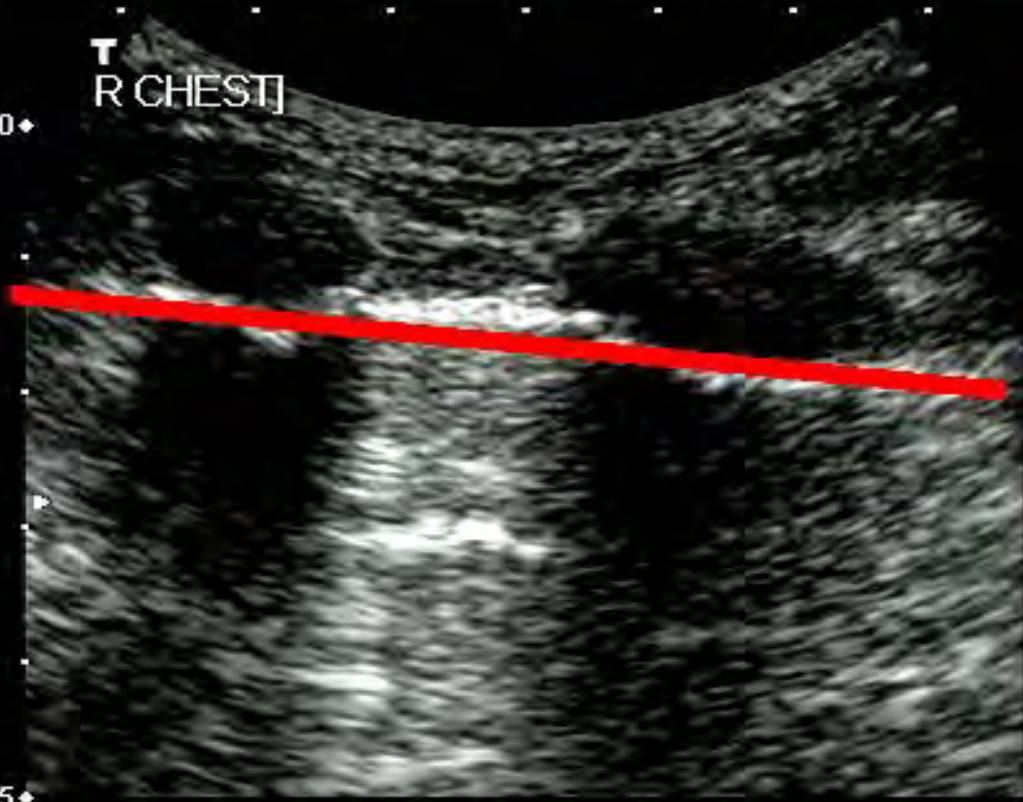
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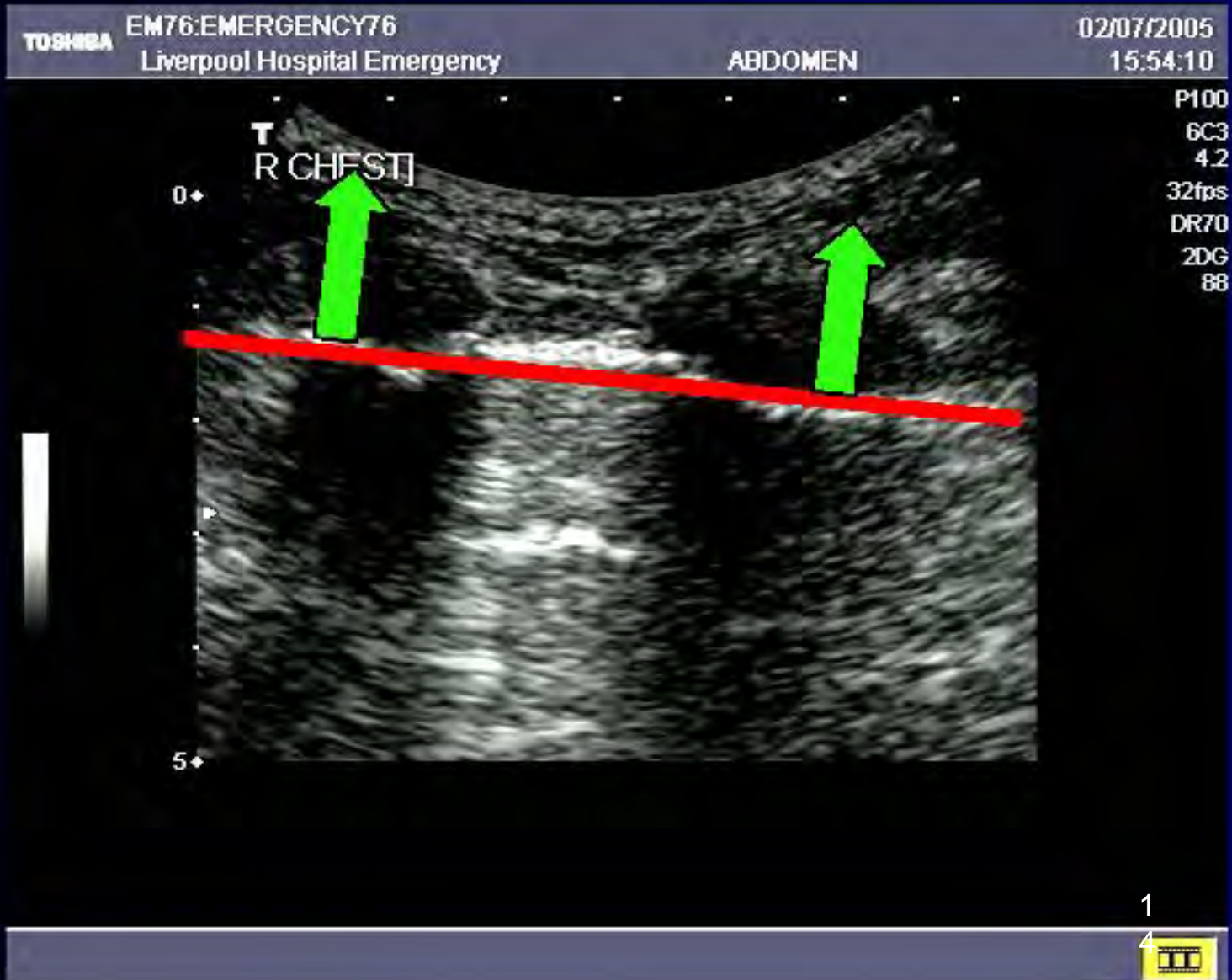


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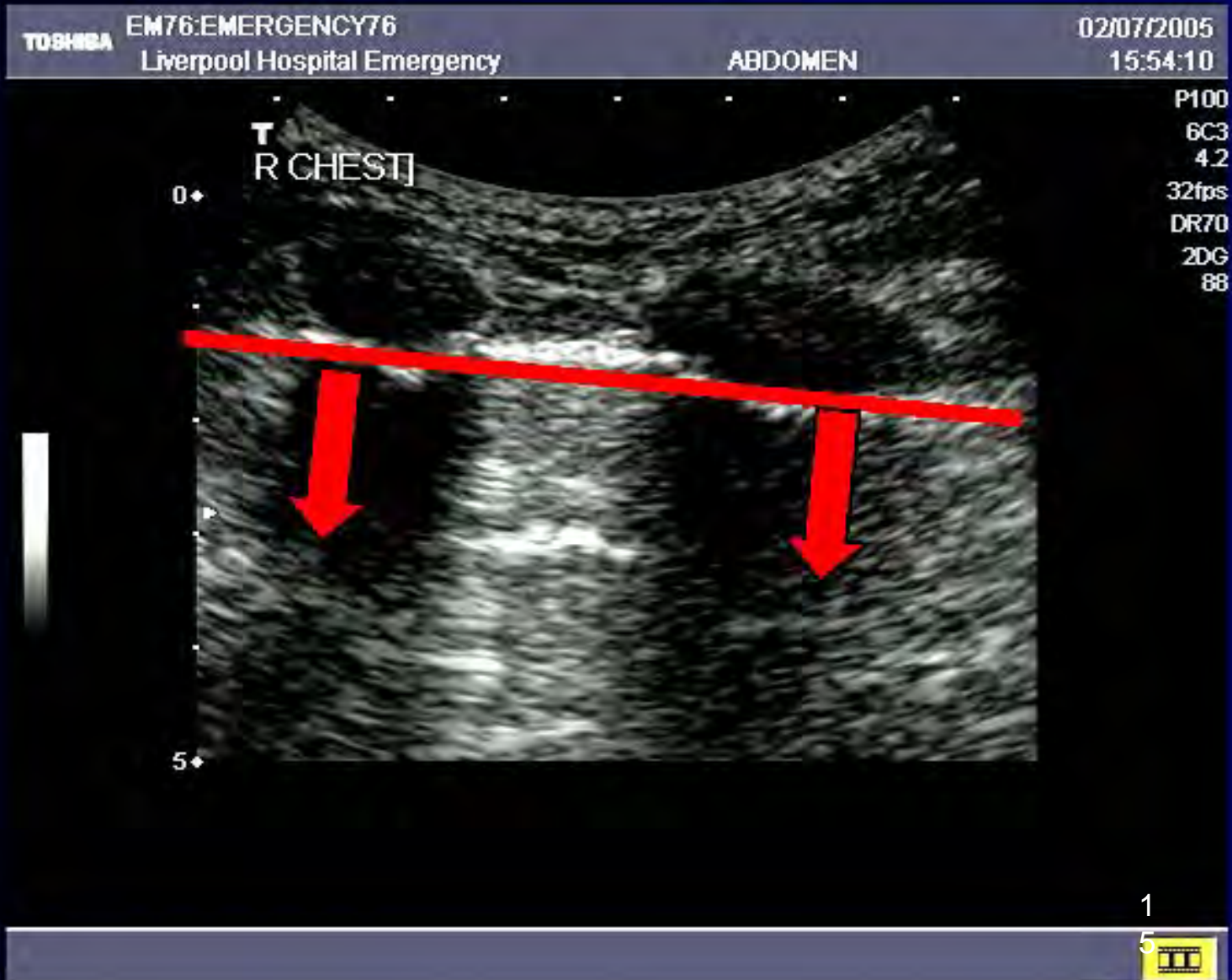
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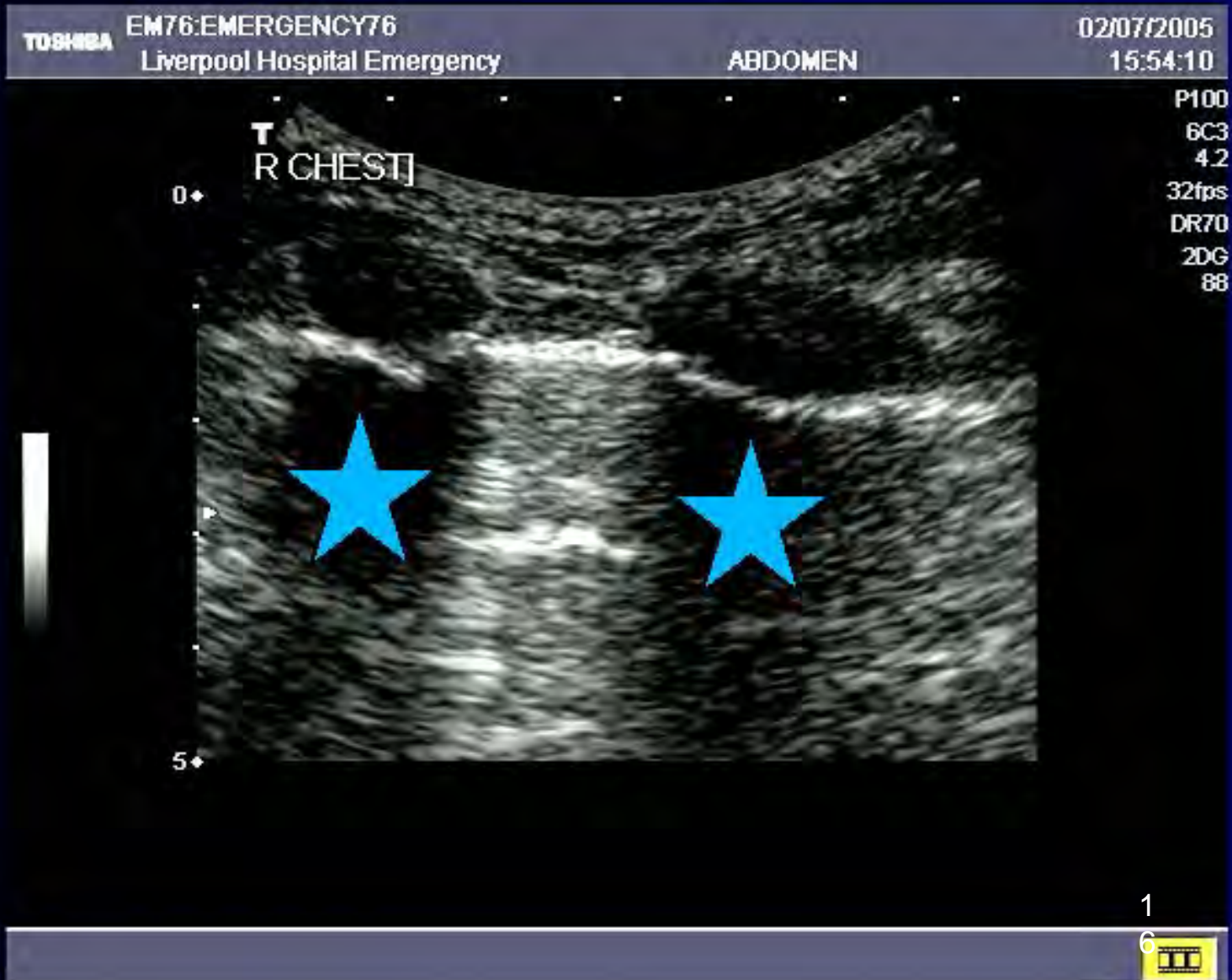
Real



Not real

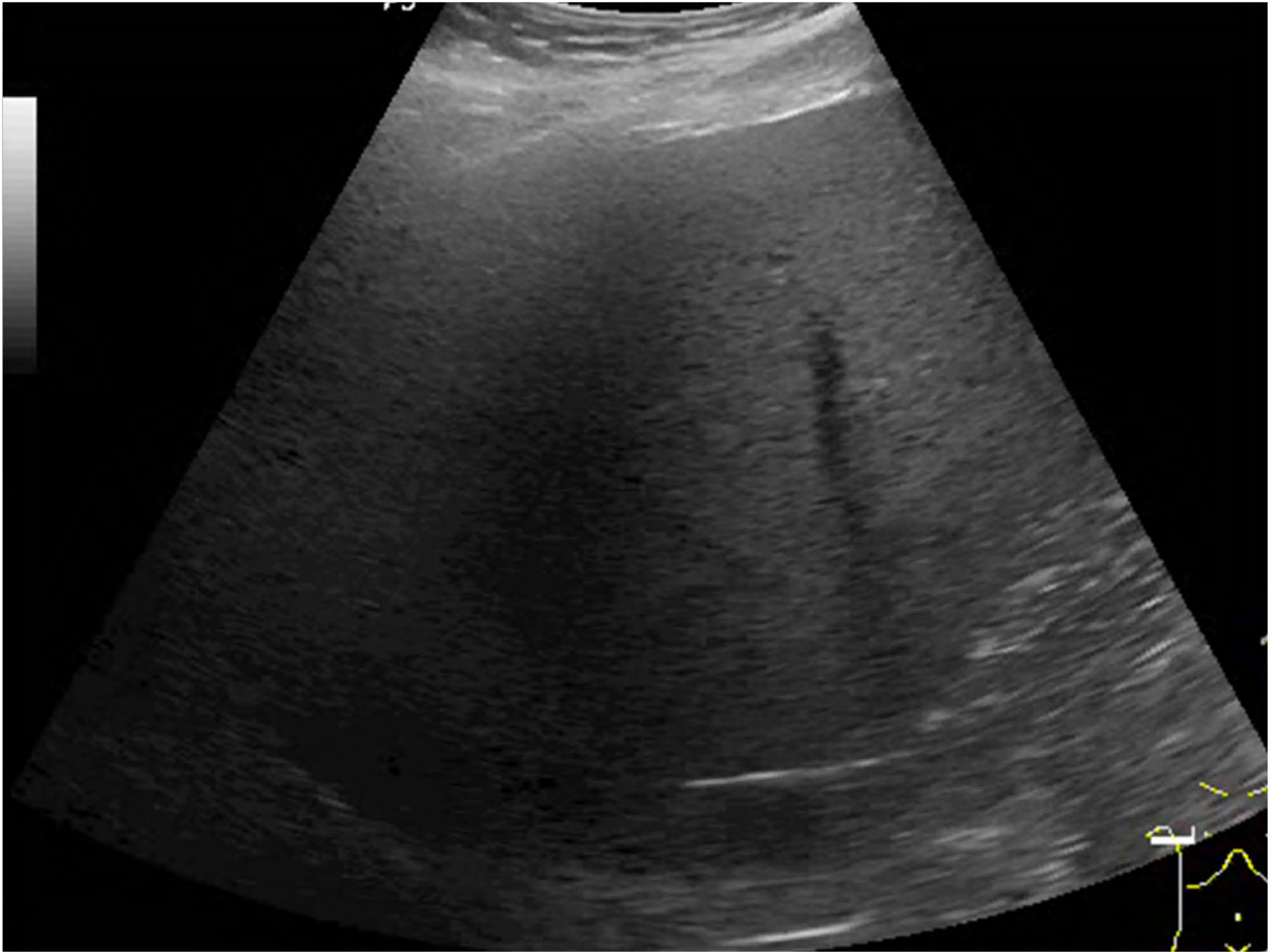


Shadowing



Scatter





A lines



A lines & pleural sliding





Slightly wetter (but still normal) lung

Lung sliding

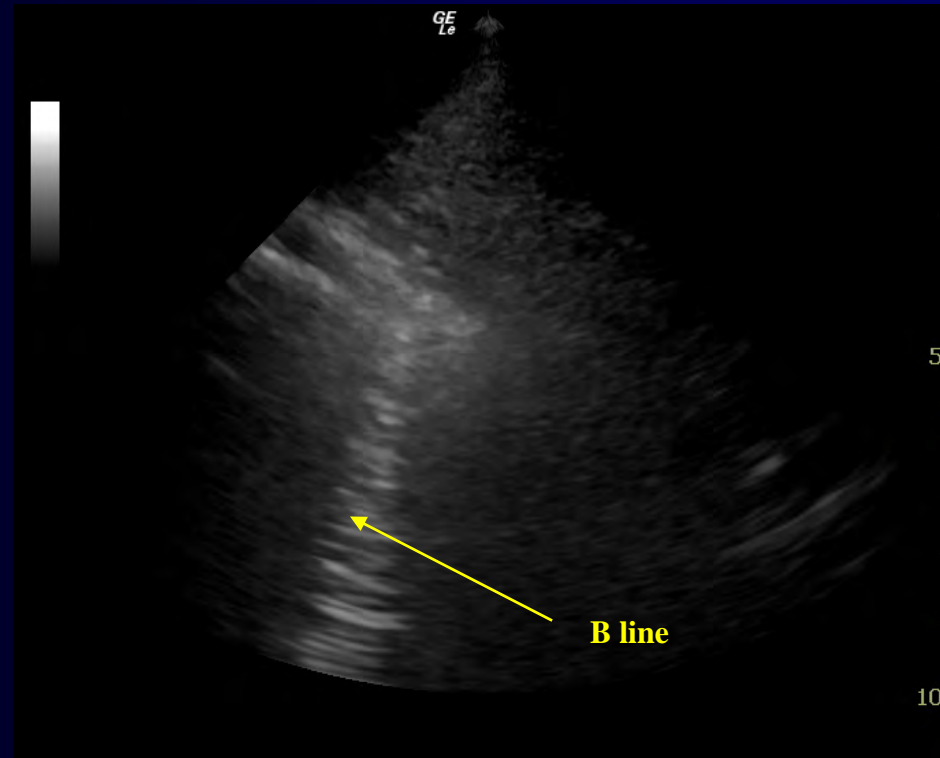
Some 'B lines'

Reverberation artifact

Microbubbles of air/ water in interlobular septa

Vertical & move with resps = thick / bright / vertical lines
which reach to edge of screen & obliterate A lines

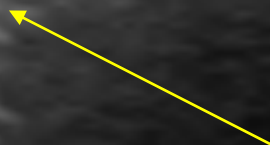
B-line



GE
Le

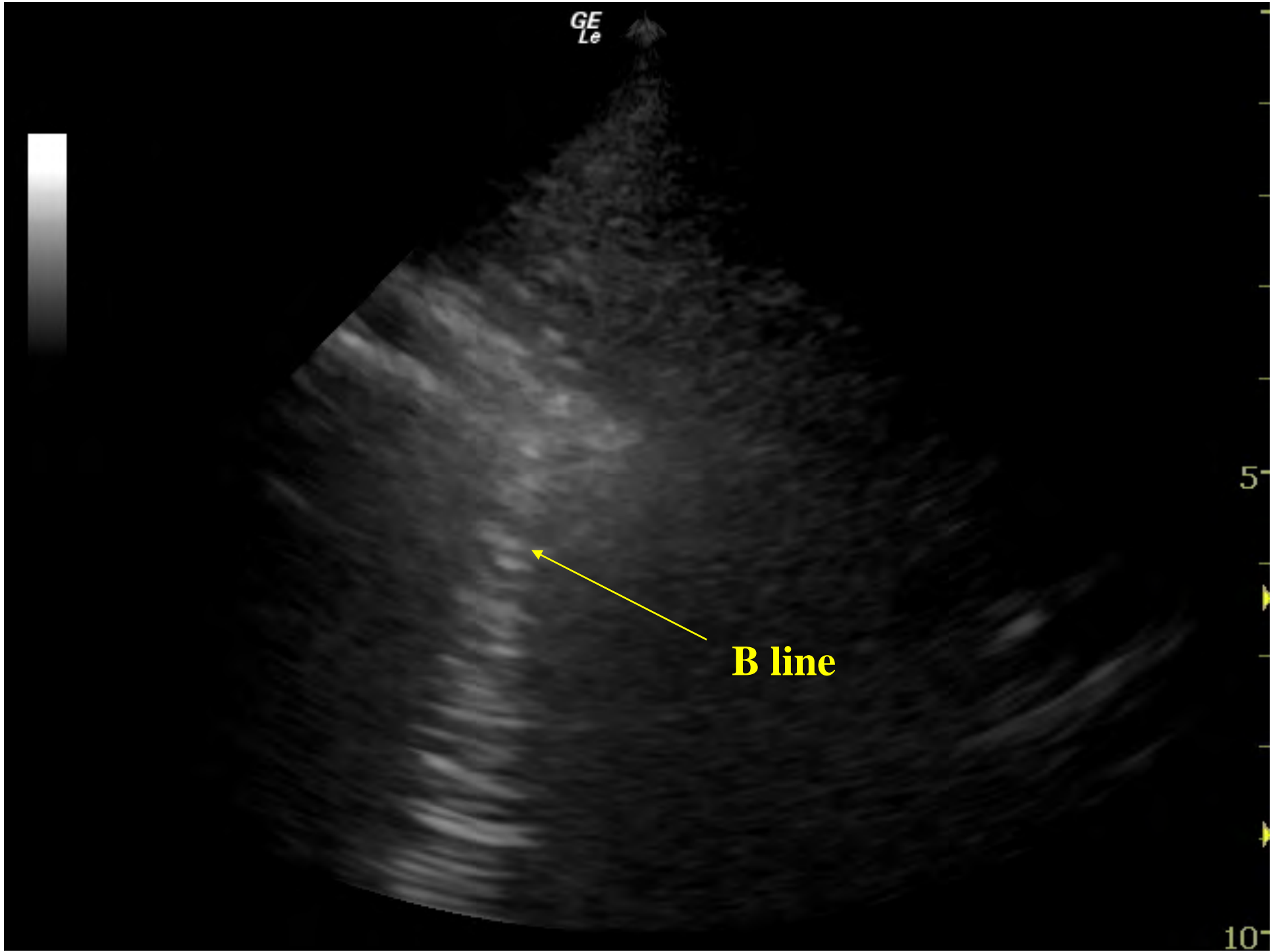


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B line

10



4 questions

1. Is there a pneumothorax?
1. Is there stuff in the pleural space?
1. Is the lung wet/ dry/ chunky?
1. What's the overall pattern?

Is there a pneumothorax?

Normal dry lung VS PTX

Normal dry lung VS PTX

Normal dry lung

- Only air is present (scatter)

Pneumothorax (PTX)

- Only air is present (scatter)

Normal dry lung VS PTX

Normal dry lung

- Only air is present (scatter)
- You may see A lines

Pneumothorax (PTX)

- Only air is present (scatter)
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Normal dry lung VS PTX

Normal dry lung

- Only air is present (scatter)
- You may see A lines
- And the occasional B line

Pneumothorax (PTX)

- Only air is present (scatter)
- You may see A lines
- You will **NOT** see B lines

Normal dry lung VS PTX

Normal dry lung

- Only air is present (scatter)
- You may see A lines
- And the occasional B line
- You will also see lung sliding

Pneumothorax (PTX)

- Only air is present (scatter)
- You may see A lines
- You will **NOT** see B lines
- You will **NOT** see lung sliding

Pneumothorax

Lung



It can be tricky

Top tip: compare sides

Pneumothorax

Lung



The explanation

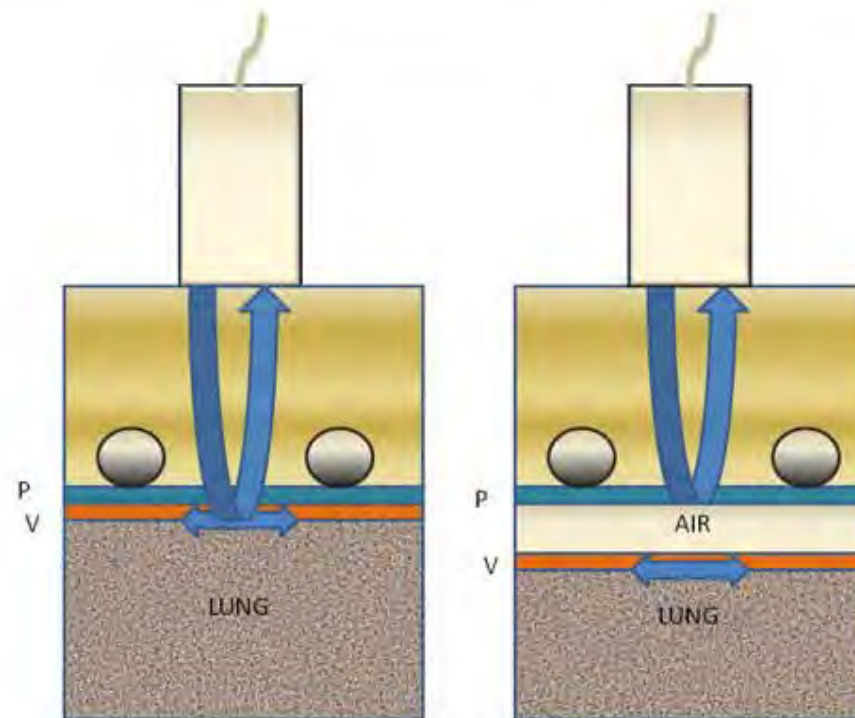


Figure 5. Ultrasound waves are reflected back at the visceral pleura-lung interface – pleural sliding can be seen (a). In the presence of a pneumothorax, ultrasound waves are reflected at the parietal pleura – air interface and no sliding is seen (b).

Caveat:

Lots of other things can prevent lung sliding

COPD

Bullae

Apices

Failure to ventilate

eg R main stem intubation (L lung doesn't move)

Eg pain (chest splinting)

Pneumonia & ARDS (pleura gummed up)

Top tip.

Be a doctor.

Clinical context can usually fill in the gaps.

Tip: M-mode can help

Sliding = seashore sign

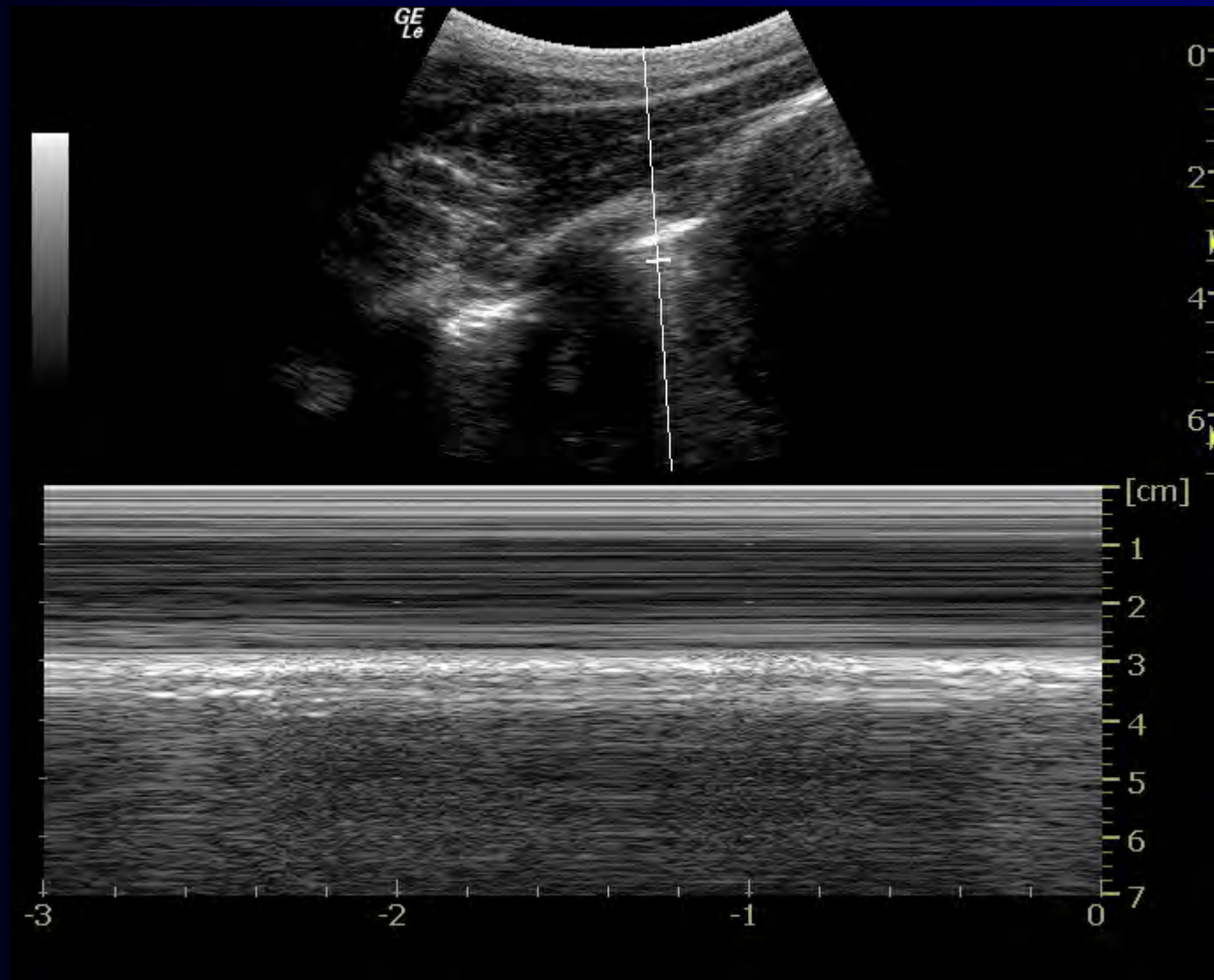
No sliding = stratosphere sign

But beware 'false seashore' with chest wall movement!

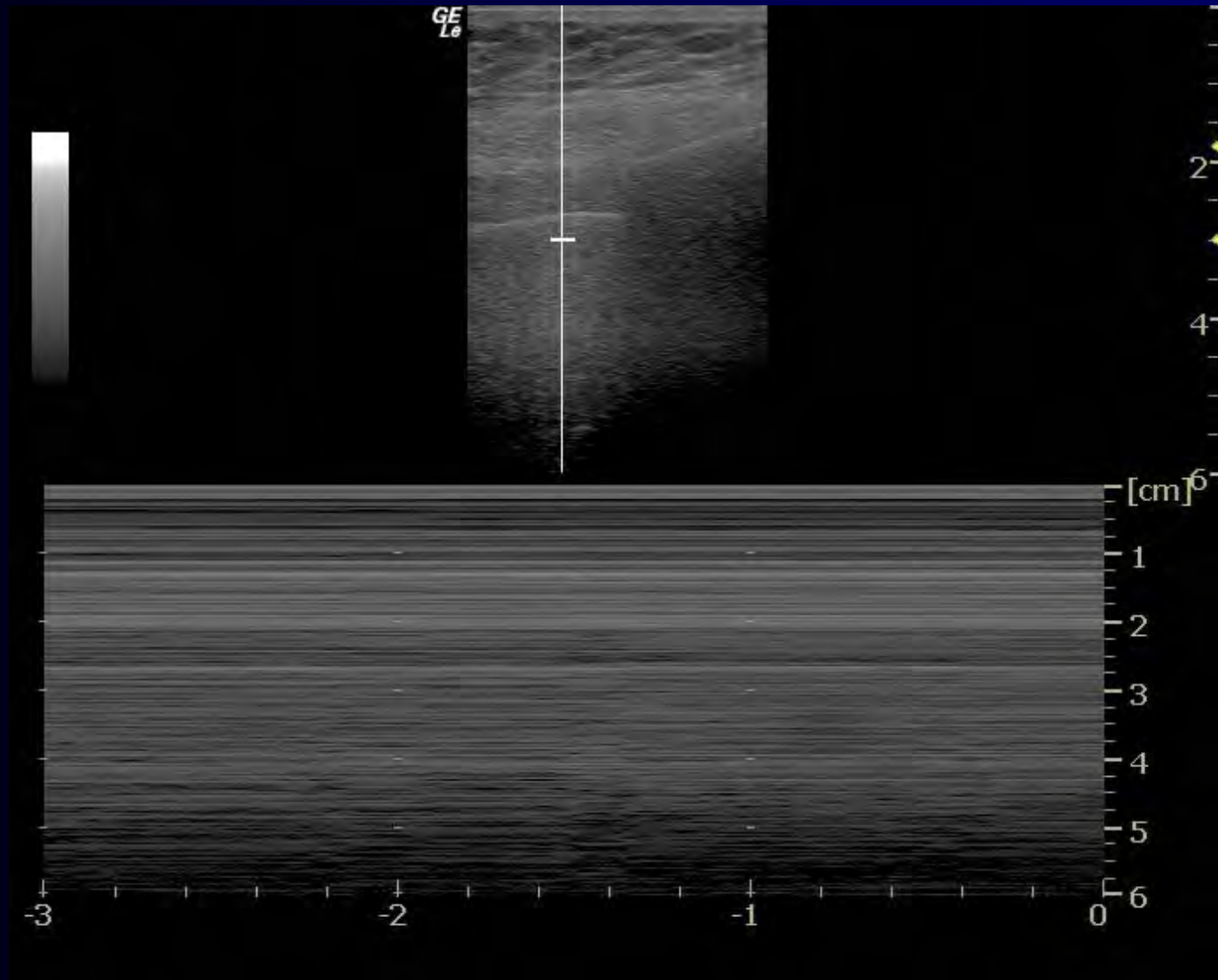
Stratosphere sign

- M-mode = motion mode
- If something isn't moving, it's a straight line

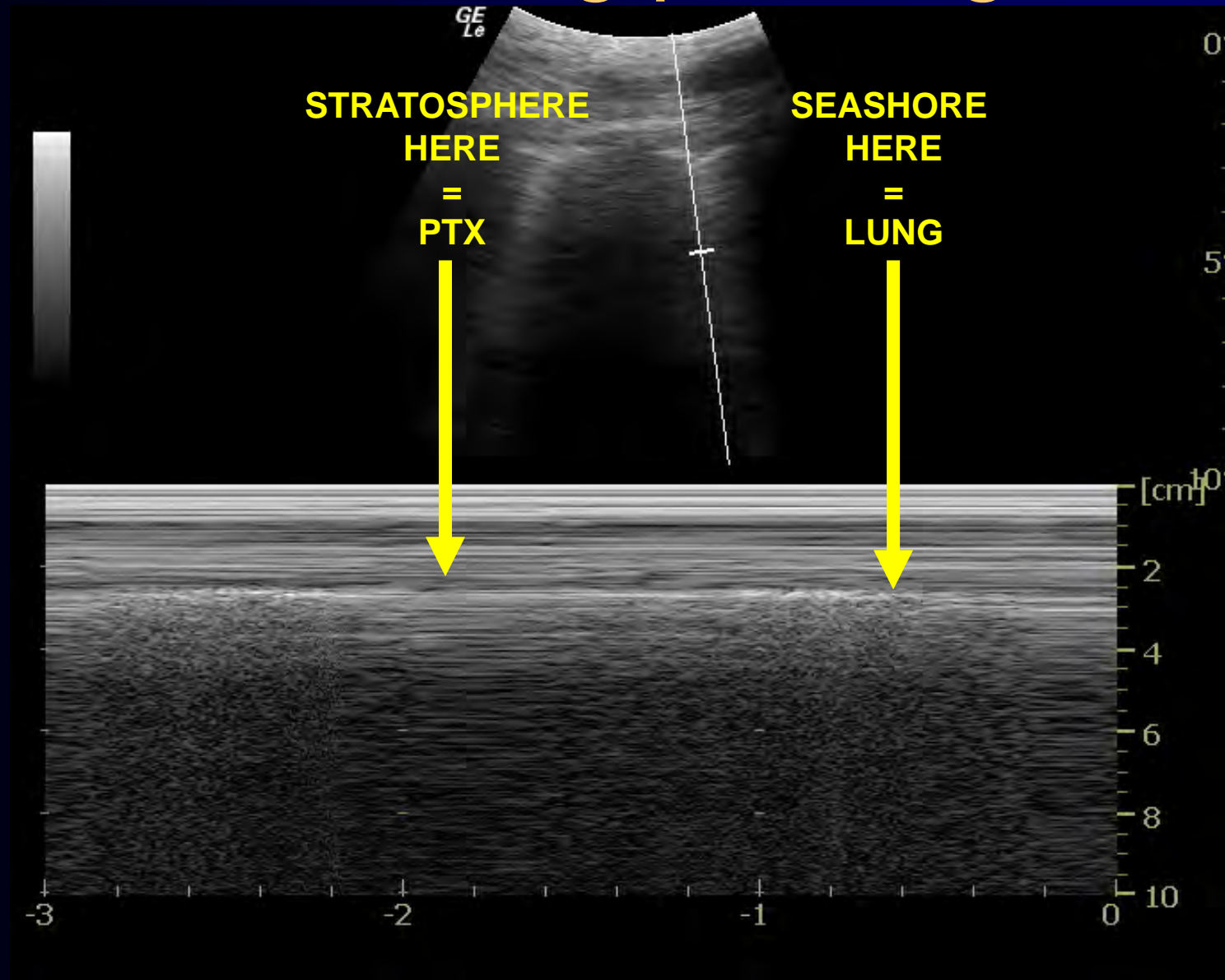
Normal: seashore sign



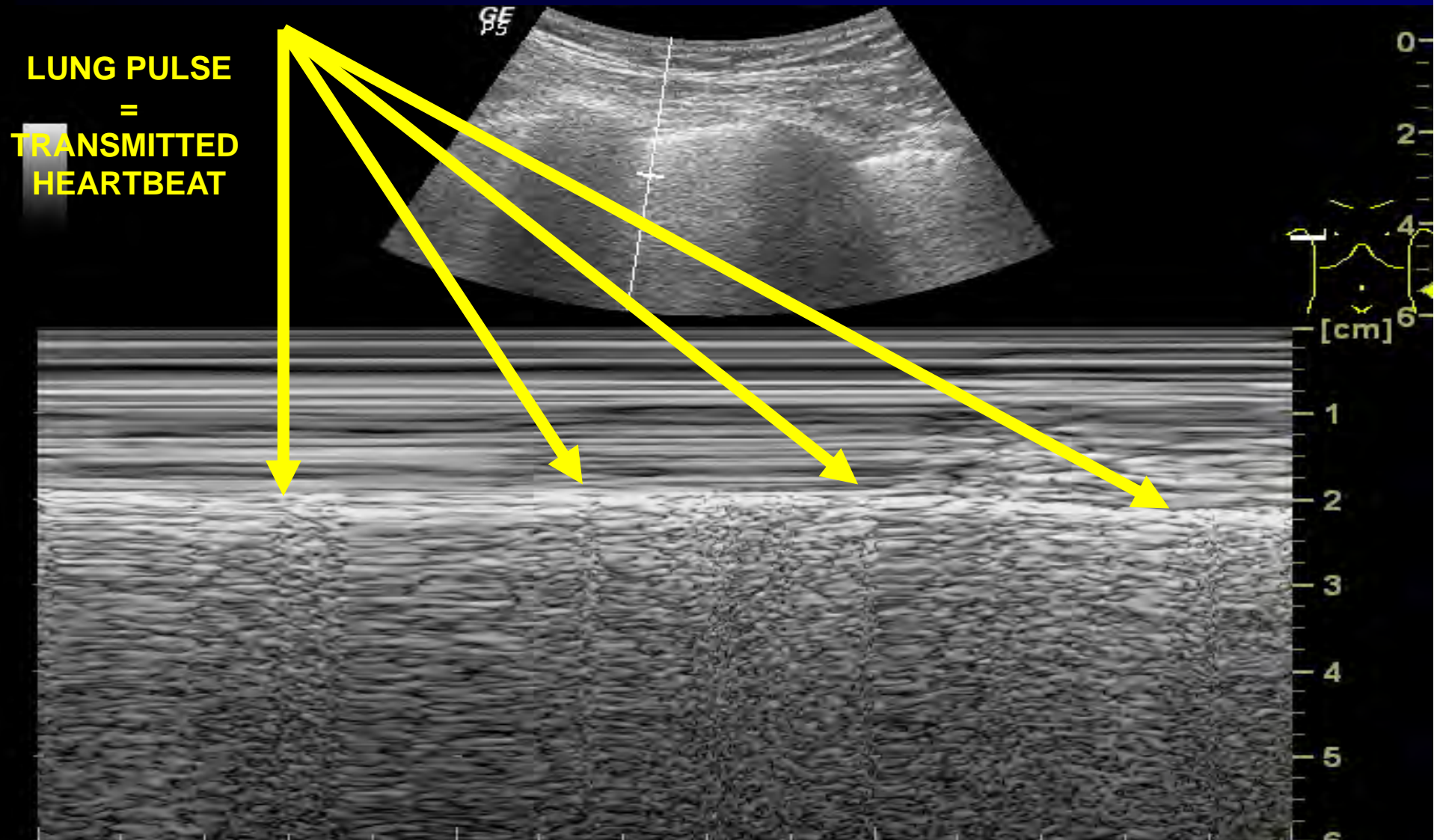
PTX: stratosphere sign



PTX: lung point sign



Normal: lung pulse sign



Just to recap: Normal dry lung VS PTX

Normal dry lung

- Only air is present (scatter)
- You may see A lines
- And the occasional B line
- You will also see lung sliding
- **You should see a lung pulse**

Pneumothorax (PTX)

- Only air is present (scatter)
- You may see A lines
- You will NOT see B lines
- You will NOT see lung sliding
- **You will NOT see a lung pulse**

Is there stuff in the pleural
space?

Pleural fluid

Pleural fluid

- A 'gap' between chest wall & pleura
- Dependent regions
- Appearance:
 - Black / anechoic: fresh blood, transudate
 - echogenic / stuff: clotted blood, exudate
- >20ml
- Sensitivity >97%, specificity 99-100% (Sisley et al, J Trauma 1998)

Pleural fluid: large



Pleural fluid: small



Pleural fluid: loculated



R



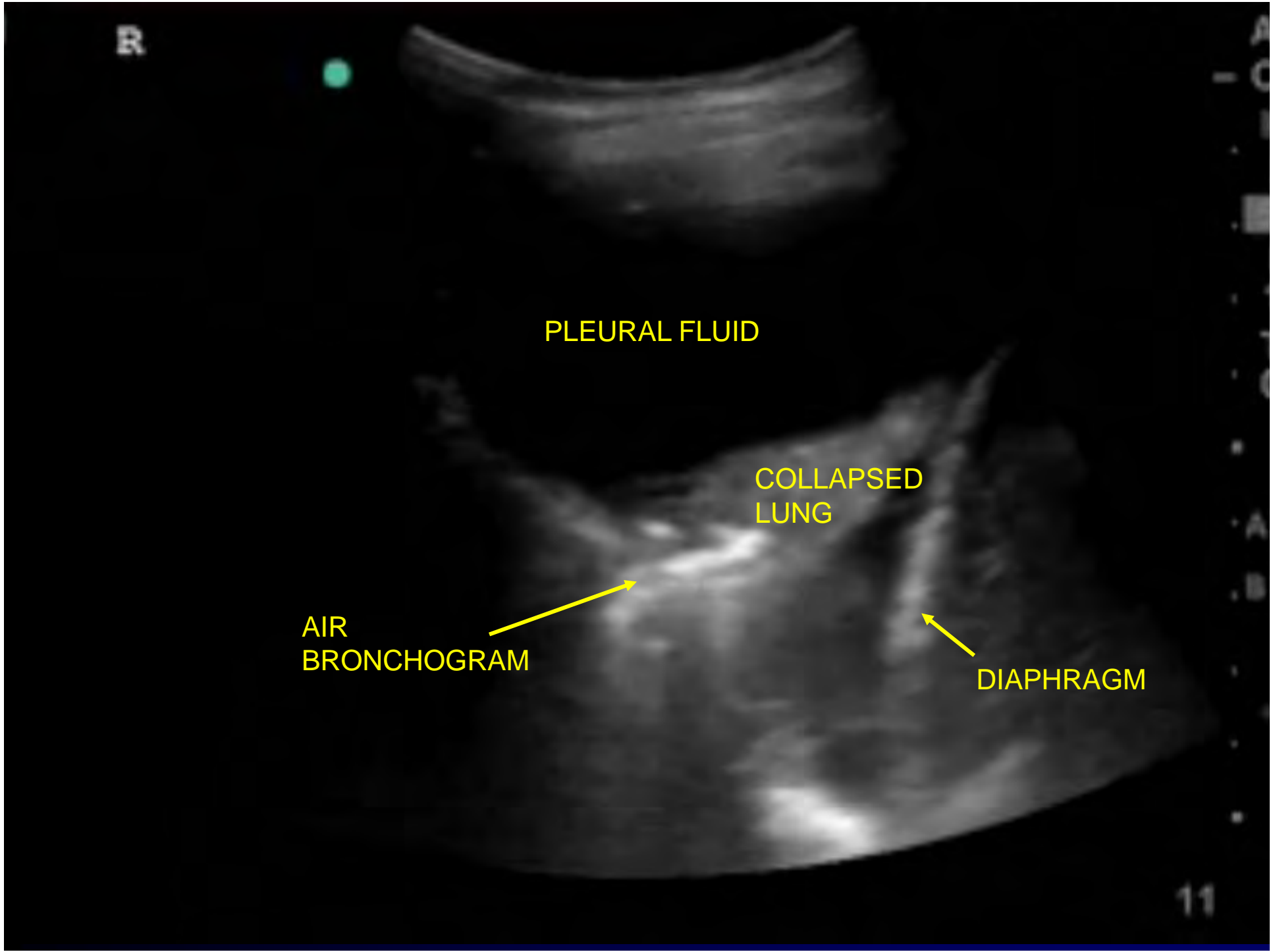
PLEURAL FLUID

COLLAPSED LUNG

AIR
BRONCHOGRAM



DIAPHRAGM



Is the lung wet / dry / chunky?

Wet lung

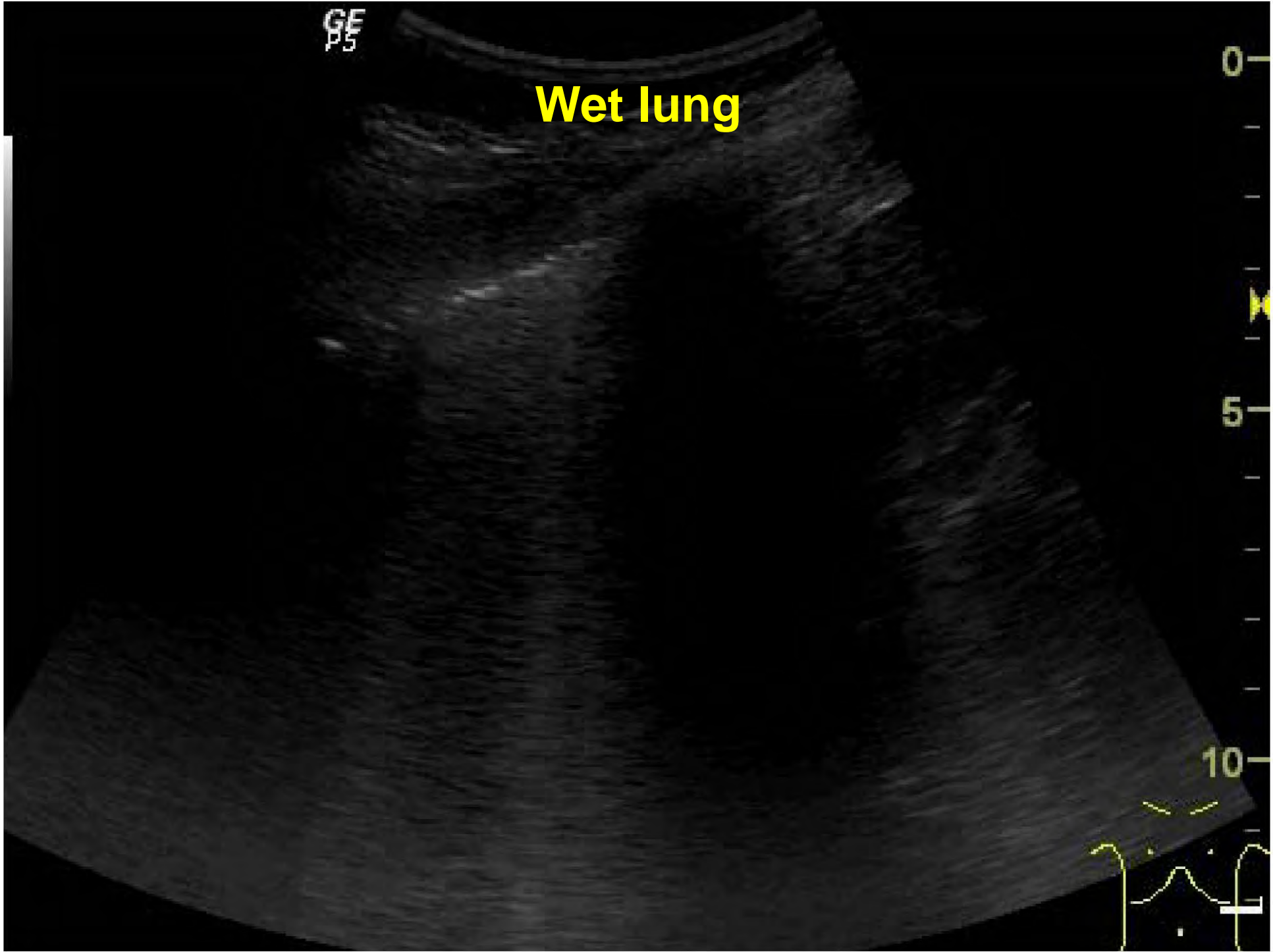
GE
P5

Wet lung

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Wet lung

Many B lines (3 or more per field)

Previously called 'rockets' or 'comets'

Bases = OK (25% of 'normal people')

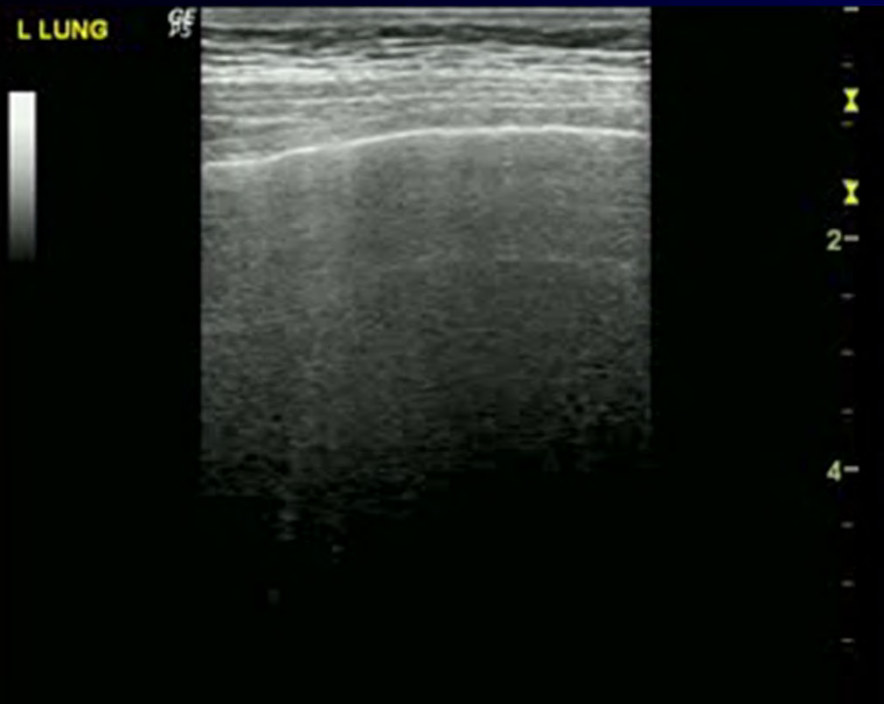
Cardiogenic = symmetrical / sliding preserved

Inflammatory / ARDS = asymmetrical / reduced sliding

Caveat: Fibrosed lung

- Lung fibrosis also generates B-lines
- There are subtle differences
- But even experienced practitioners can be fooled

Oedema



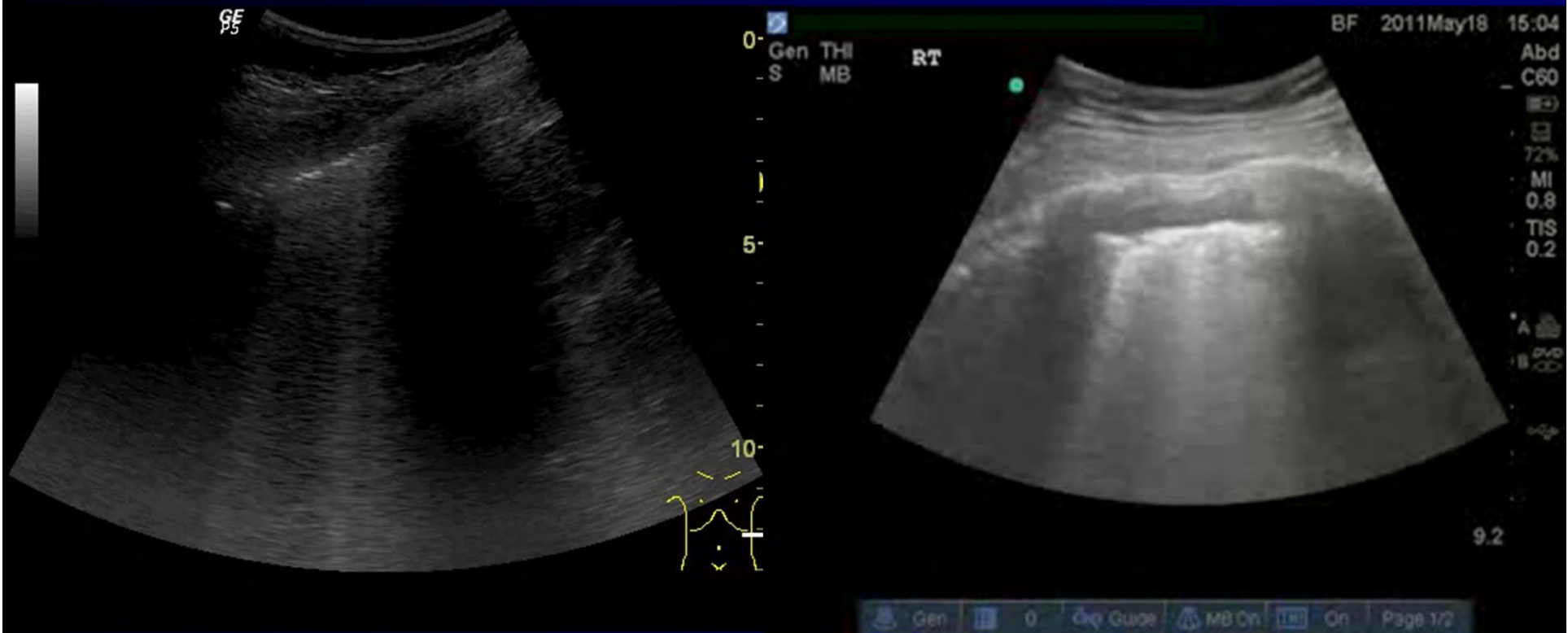
Fibrosis



Compare the lung sliding

Cardiogenic oedema

Oedema in pneumonia



Chunky lung

Consolidation

a.k.a. Lichtenstein's *C profile*

Alveolar consolidation

- If you can see lung **tissue**, it ain't normal!
- It ain't aerated
 - Collapse
 - Consolidation
 - Atelectasis
 - Contusion
 - Infarction (PE)

Alveolar consolidation



Alveolar consolidation

- Can you differentiate collapse, consolidation, tumour etc?
- Clinicians should stick to clinical features
- But for advanced scanners:
- Air bronchograms, normal Doppler flow = consolidation
- No flow on Doppler = infarction (e.g. PE)
- Bizarre flow = neovascularisation = malignancy

Finally...
what is the overall pattern?

Pattern

Wet all over = cardiogenic / fluid overload

Just 1 lung = pneumonia

Just in 1 spot = inflammation / infection

Patchy = ARDS / ALI

Technique for scanning lungs

Patient position

No need to sit patient up (eg trauma)

In fact, accuracy for PTX is **improved** if lying flat...
just harder to get round the back for pleural fluid

Air rises

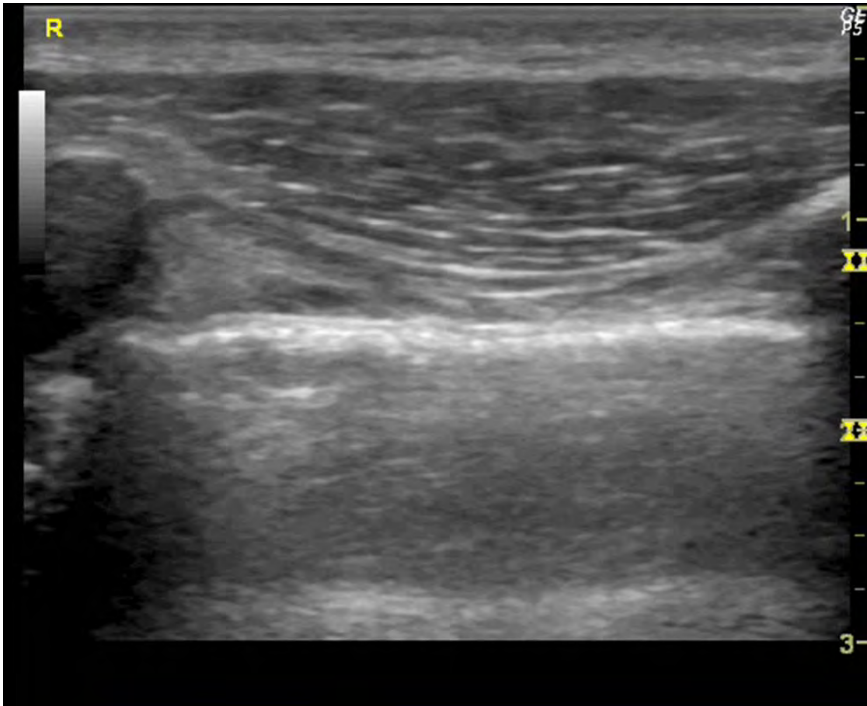
Fluid sinks

Probe

Linear = best for close-up detail eg small PTX, but poor for wet lung & no anatomical info

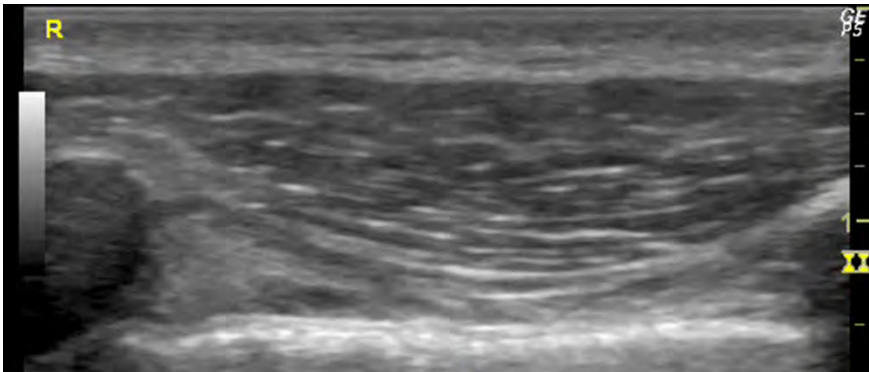
Sector (cardiac) probe: poor image quality but gets between the ribs

Curved probe = good compromise

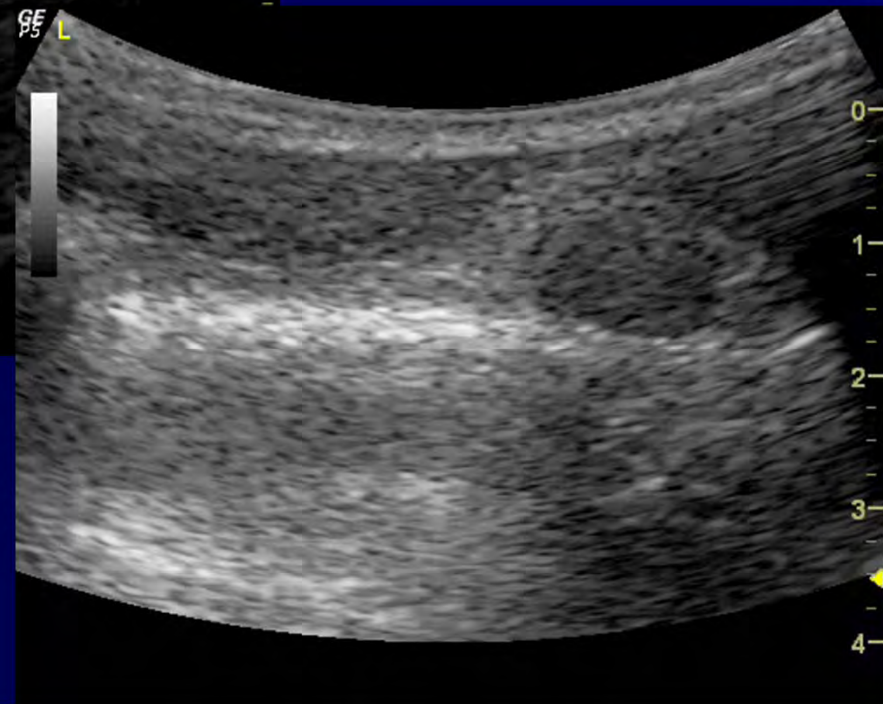
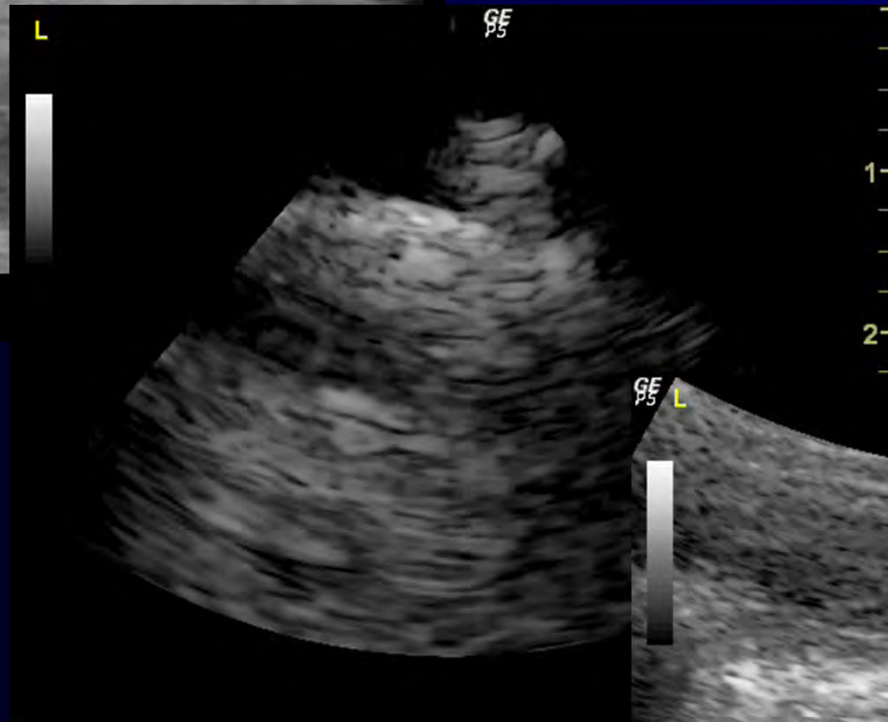
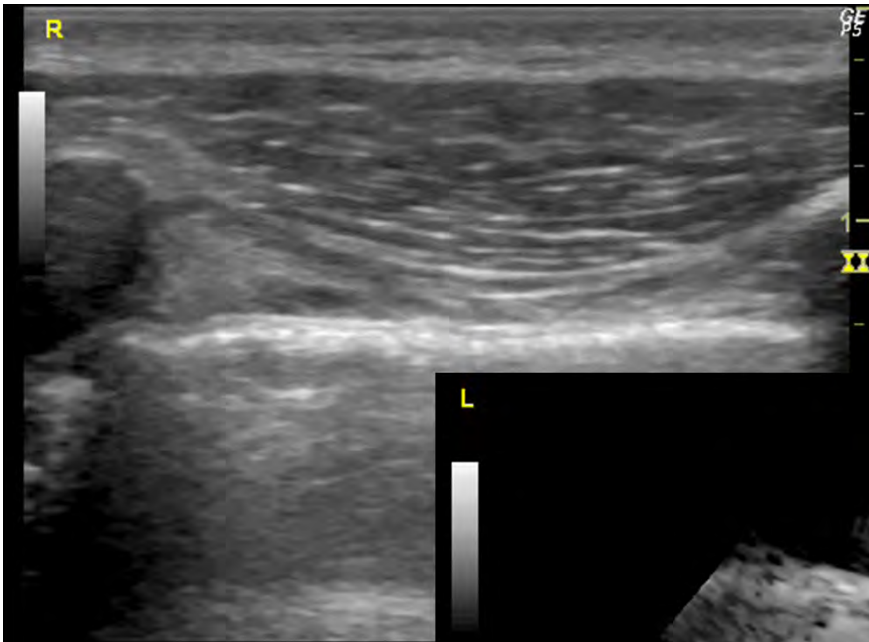


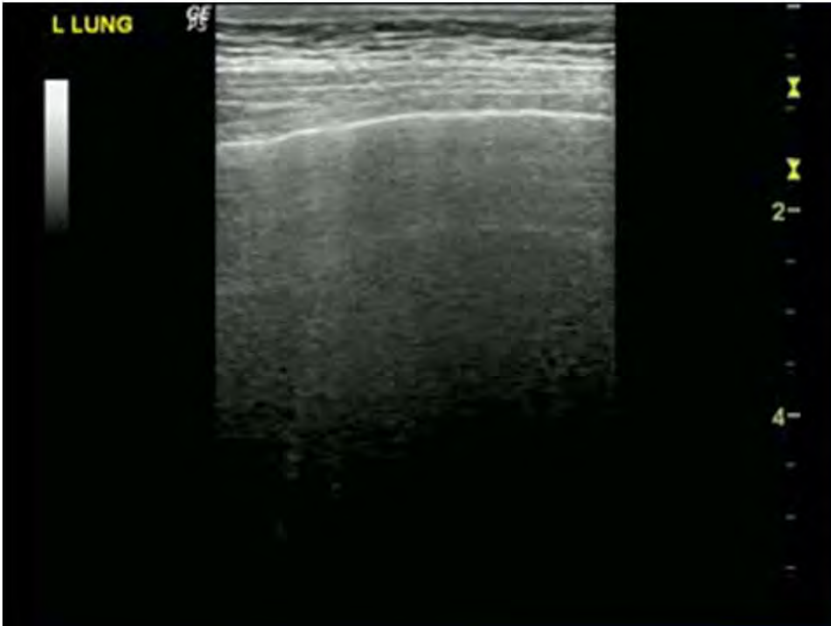
Tiny pneumothorax
(lung point)

Tiny pneumothorax (lung point)



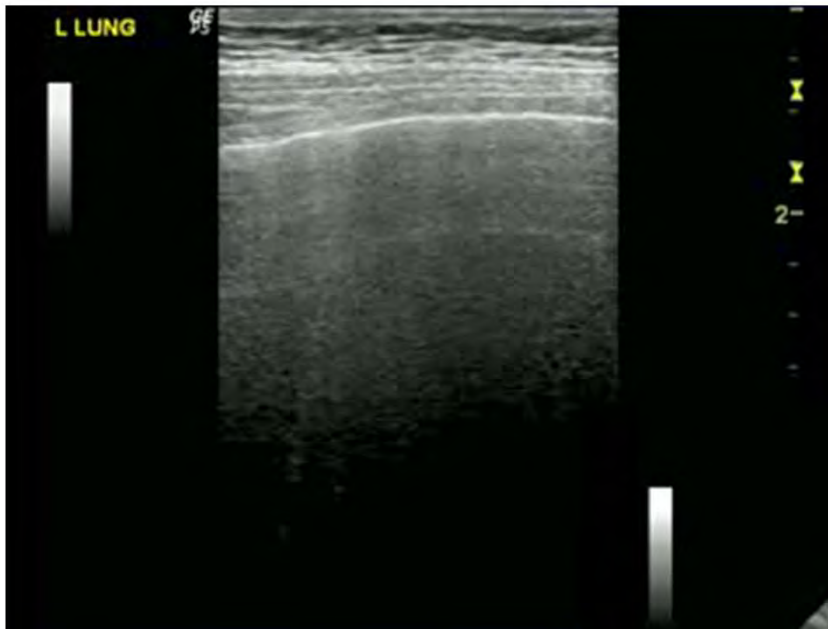
Tiny pneumothorax (lung point)



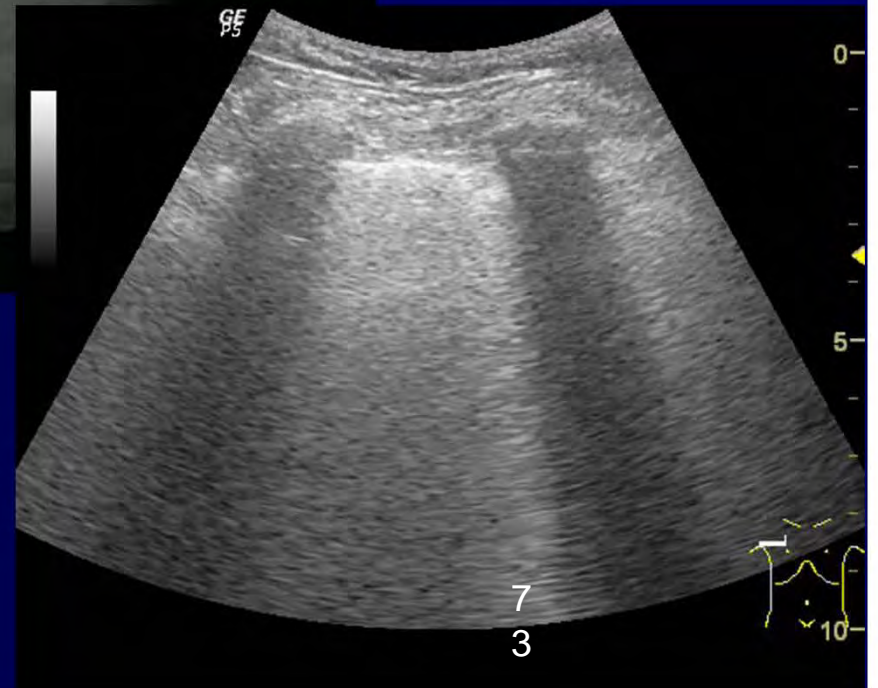
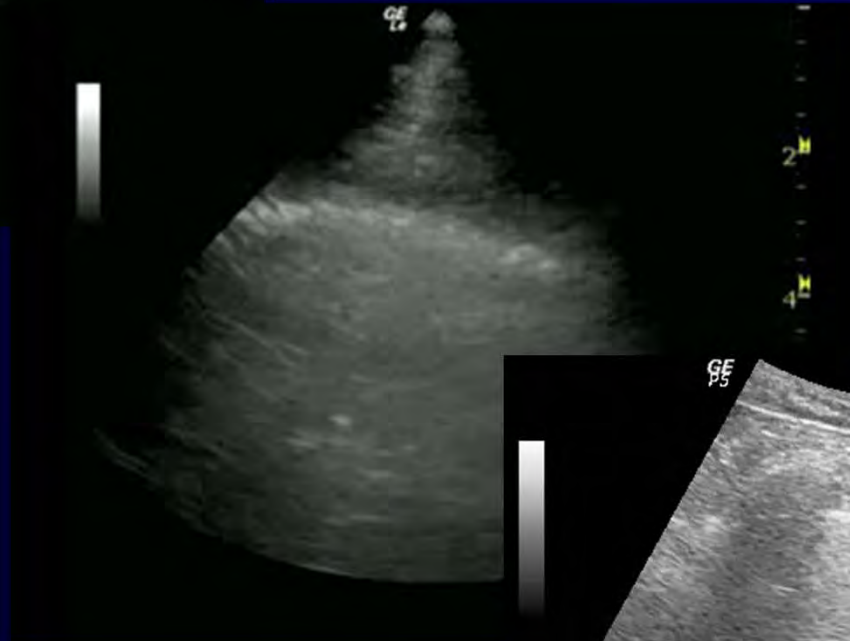


Wet lung

Wet lung



Wet lung



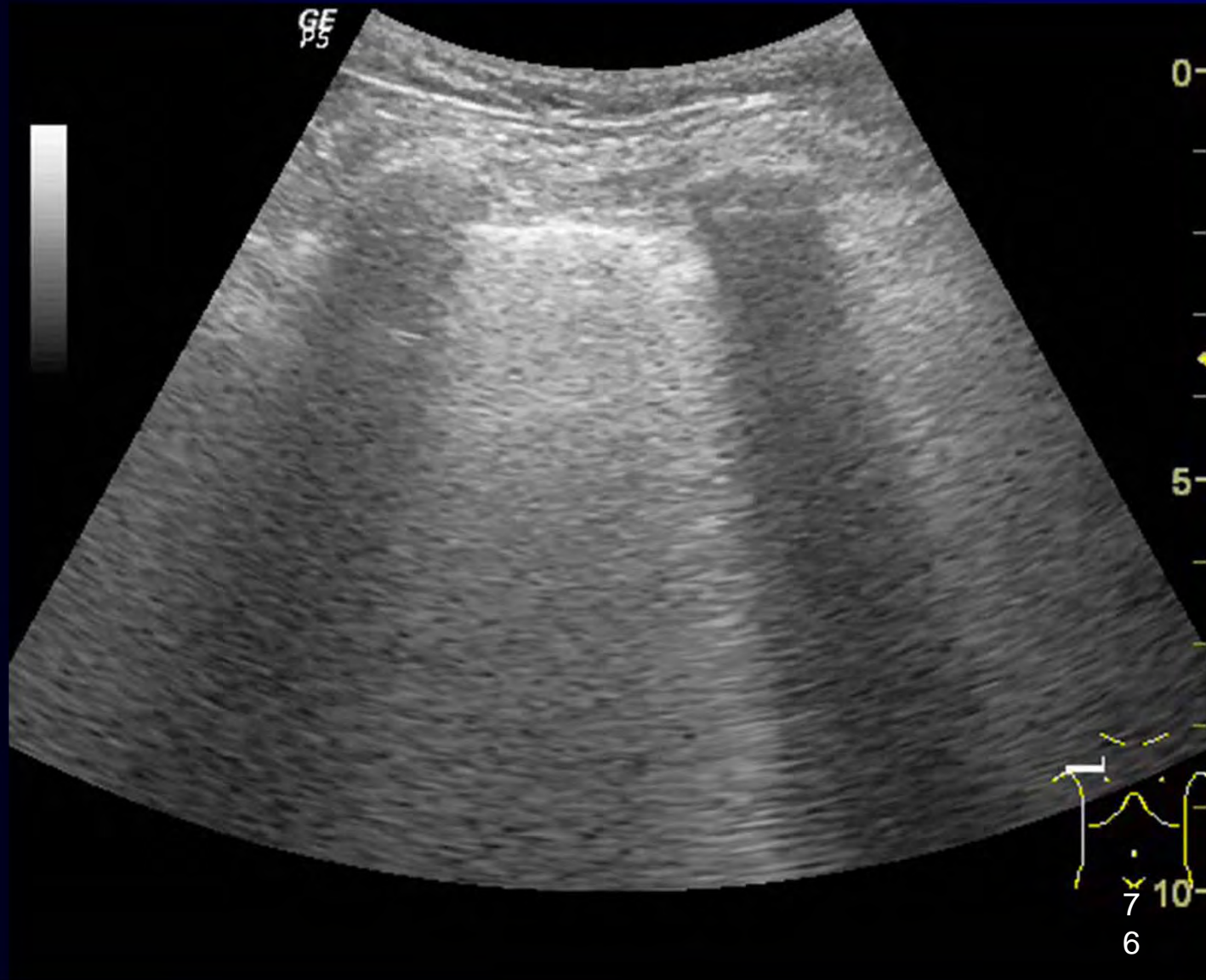
Preset

- There are commercial 'lung' settings
- But abdo / FAST preset suffices
- The key: **turn off filters**
 - Multibeam / compounding
 - Tissue harmonics
- Why? **You are looking for artifacts**

Cardiogenic oedema with THI & MB on.



Cardiogenic oedema with THI & MB off.



Depth

- For fine detail: **close up**
- E.g. Microconsolidation, pleural disease

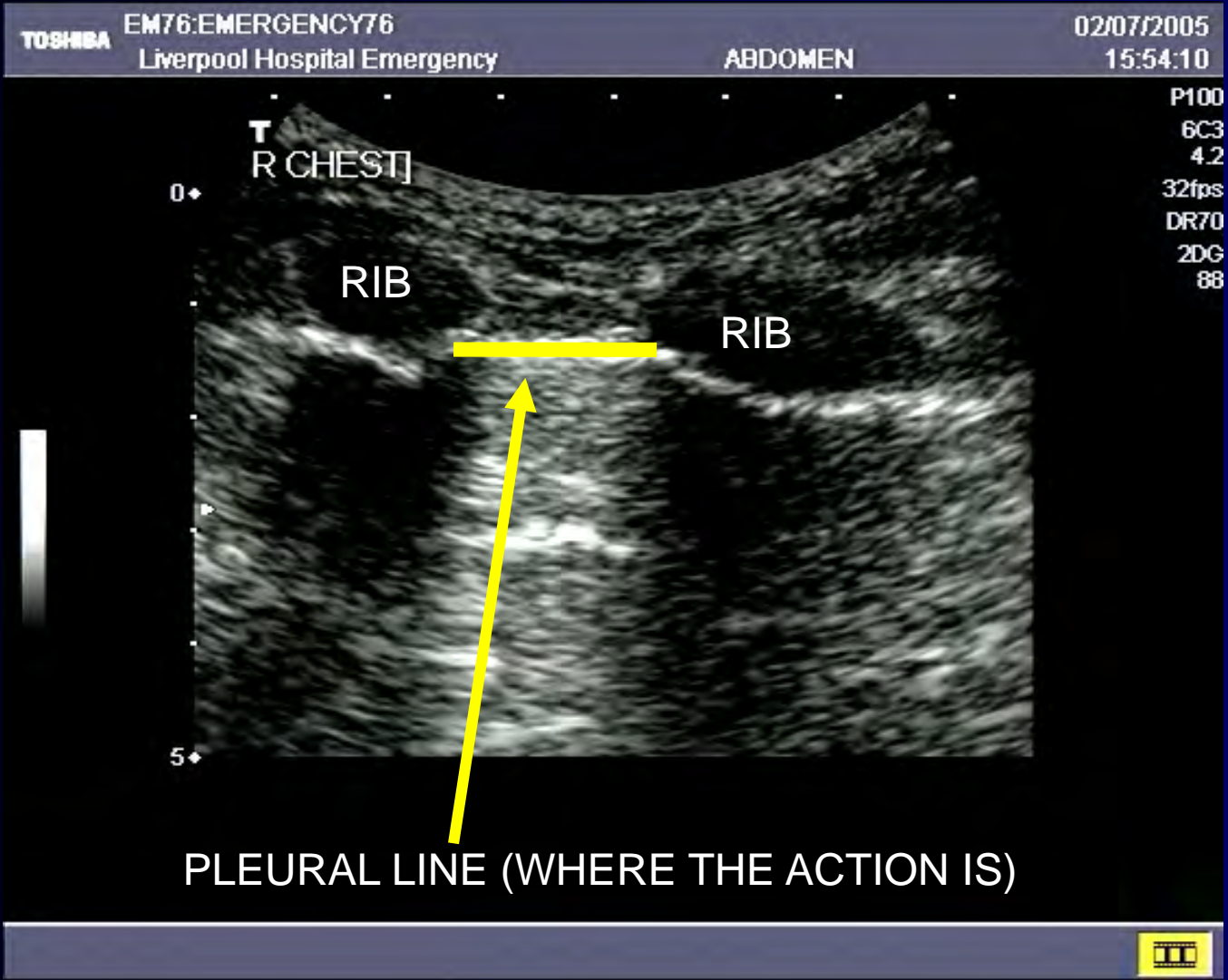
- For everything else: **add depth** eg 15cm
- E.g. wet lung (do the 'B lines' reach to the end of the screen?)
- Anatomical landmarks (e.g. diaphragm)

Probe position

- Up to personal preference
- Long axis of patient (**right angles** to the ribs) keeps the landmarks (rib shadows) in view



Look between the ribs



Where will I scan?

Depends on clinical context

The basic principles

Air rises → scan **highest** point of the chest for
PTX

Fluid sinks → scan **lowest** point for pleural fluid

Patchy diseases? (e.g. pneumonia, ARDS)

Cardiogenic versus inflammatory oedema?

→ scan **as much lung as possible** (at least each
lobe)

Let's keep it simple

Upper anterior: that's where you'll find PTX

Around the back: that's where you'll find pleural fluid



Tip: watch out for the abdomen!

If you scan the liver / spleen & think you're still above the diaphragm, it will resemble consolidation.

ESP if you are using linear probe

Putting it all together

Normal lungs

Dry(-ish) air

Scatter, often with A-lines

Up to 2 B lines per window are OK

No chunkiness

No pleural fluid

Pneumothorax

Very dry air

Usually see A-lines

No sliding

No B lines

No lung pulse

See a lung point unless lung is completely collapsed

Acute cardiogenic pulmonary oedema (APO)

B profile =

Plenty of B lines in all windows

lung sliding preserved

Often see effusions

ARDS or pneumonia

- *Lungs might look wet*
- lung rockets in all windows
- lung sliding **reduced / absent**
- And pleural line may be irregular

- *Lungs might look patchy (wet / dry areas)*
 - *Lungs might look chunky*

Asthma / COPD

Lungs usually look dry.

Pulmonary embolus

Lungs usually look dry.

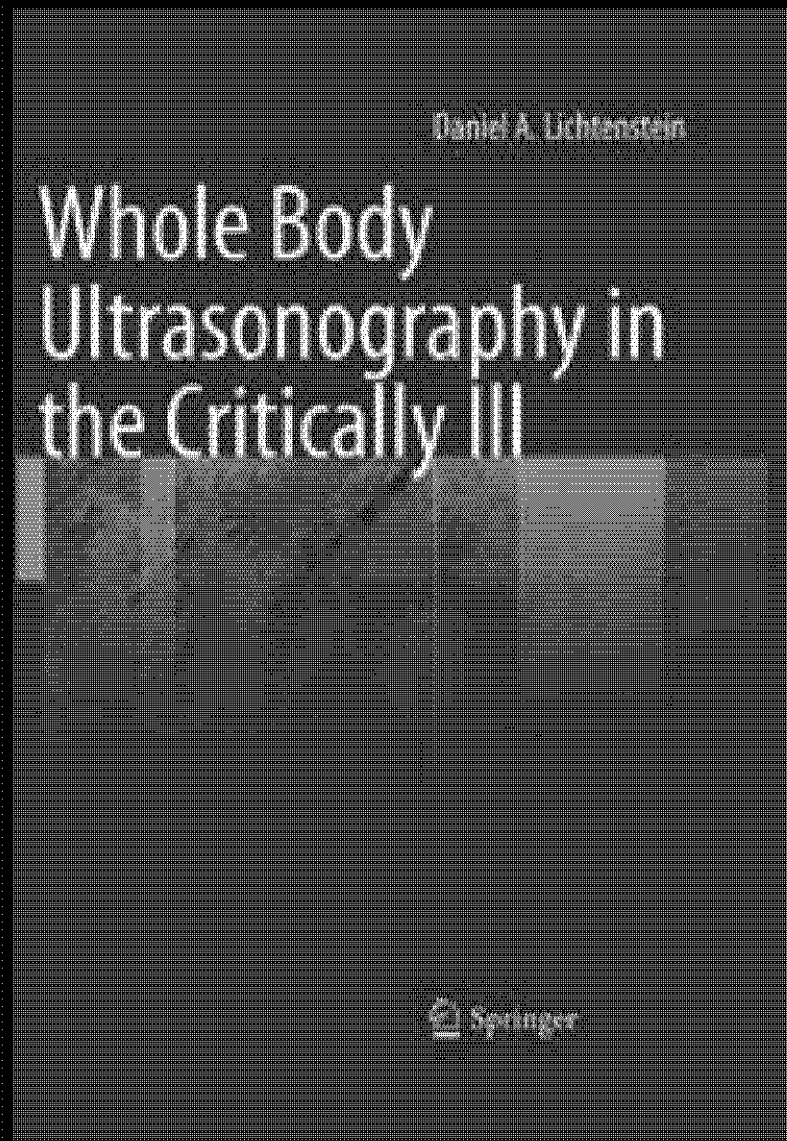
Sometimes you see chunks.

Sticking needles in thorax

Chest drains/ thoracocentesis

- Same rationale as central line placement
- Ensures you don't stick ICC in the liver
- Tricks:
 - Get patient to take maximal inspiration & expiration
 - Scan in 2 planes
 - Scan in same position you'll insert ICC
 - NB Use real time US??

Confused? Read this.



Or this.

Intensive Care Med
DOI 10.1007/s00134-012-2513-4

CONFERENCE REPORTS AND EXPERT PANEL

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**International evidence-based
recommendations for point-of-care
lung ultrasound**

Let's wrap this up

Lung US basics

Curved probe / FAST preset

At right angles to the ribs

4 simple Qs...

The 4 questions

1. Is there a pneumothorax?
1. Is there stuff in the pleural space?
1. Is the lung wet/ dry/ chunky?
1. What's the **overall pattern**?

Any questions?

Thanks to:

Dr Paul Atkinson
Dr Juan Chiang
Dr Maggie Chung
Dr Bishr Faheem
Dr Daniel Lichtenstein

References

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- San Critical Care Ultrasound Seminars <http://www.sah.org.au/critical-care-ultrasound-library>
- Volpicelli G et al. International evidence-based recommendations for point-of-care lung ultrasound. Intens care med 2012.