



LUNG & DIAPHRAGM US

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Resuscitative
急救復甦

Diagnostic
臨床診斷

Procedural
Guidance
處置導引

Symptom- or
Sign-Based
症狀導引

Therapeutic
輔助治療



Core Applications (2023 ACEP Emergency Ultrasound Guidelines)
15項急診超音波核心應用

陳國智醫師

Aorta

DVT

Trauma

Thoracic/Airway

Cardia/HD assessment

Procedural Guidance

US-guided NB

Testicular

Ocular

Skin & Soft tissue

Hepatobiliary

Urinary tract

Pregnancy

Bowel

MSK

Lung Ultrasound: The Essentials

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From the Departments of Imaging Sciences (T.J.M., D.J.R., Y.T.Z., K.A.K.J.), Medicine (J.W., W.H.N.), and Emergency Medicine (T.P.O.), University of Rochester Medical Center, School of Medicine and Dentistry, 601 Elmwood Ave, Box 655, Rochester, NY 14642. Received October 24, 2020; revision requested January 5; revision received January 16; accepted February 5. Address correspondence to T.M. (e-mail: RochesterRadiology2021@gmail.com).

Conflicts of interest are listed at the end of this article.

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Sensitivity and Specificity of Lung US versus Chest Radiography

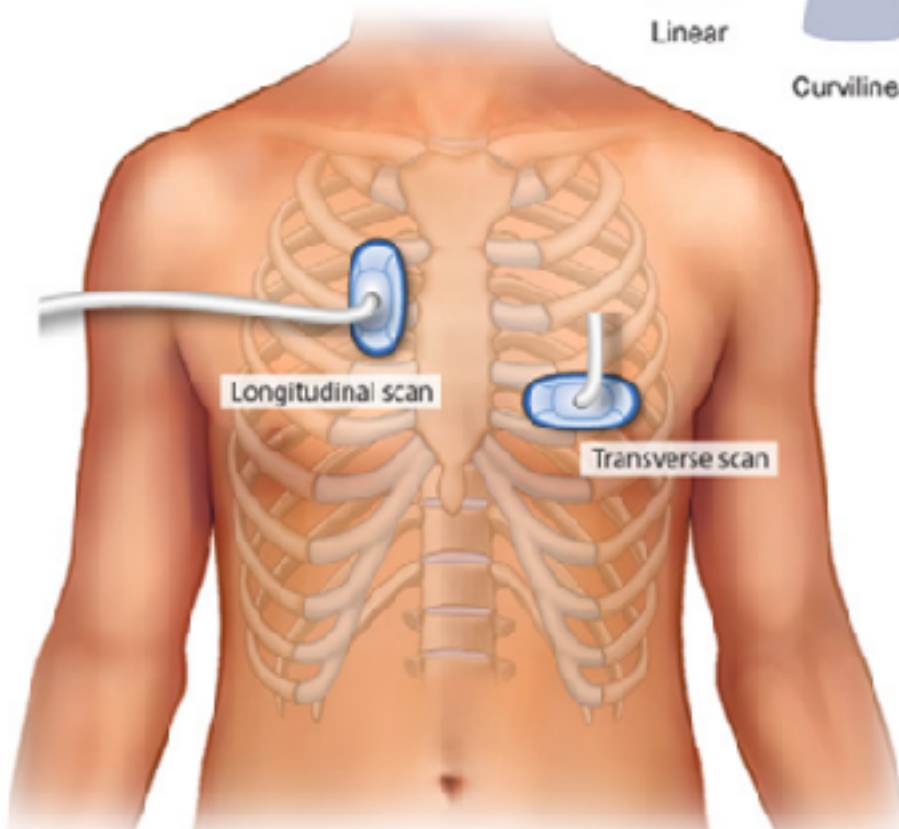
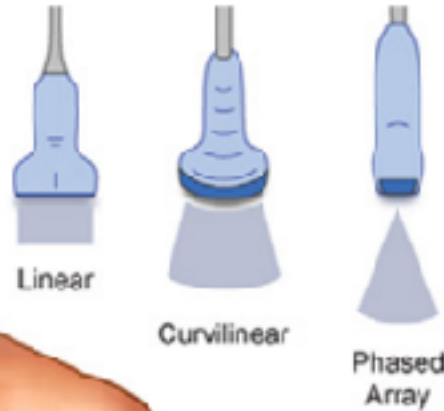
Indication	Study Type	No. of Patients	Lung US		Chest Radiography	
			Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
Pleural effusion (5)	Prospective	32	92	93	39	85
Pneumonia (7)	Systematic review with meta-analysis	742	95	90	77	91
Pneumothorax (4)	Systematic review with meta-analysis	5314	87	99	46	100
Pulmonary edema (6)	Systematic review with meta-analysis	1827	88	90	73	90

Note.—Sensitivity and specificity values vary slightly from study to study. The pleural effusion statistics are drawn from a sample of critically ill patients.

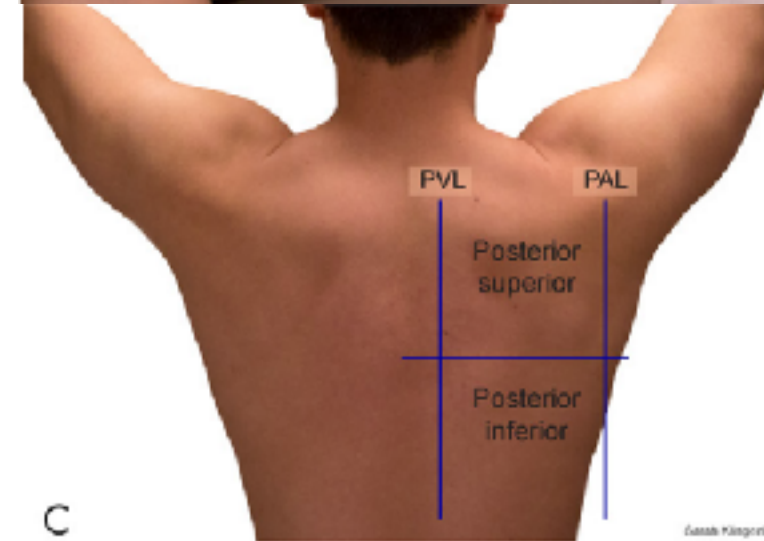
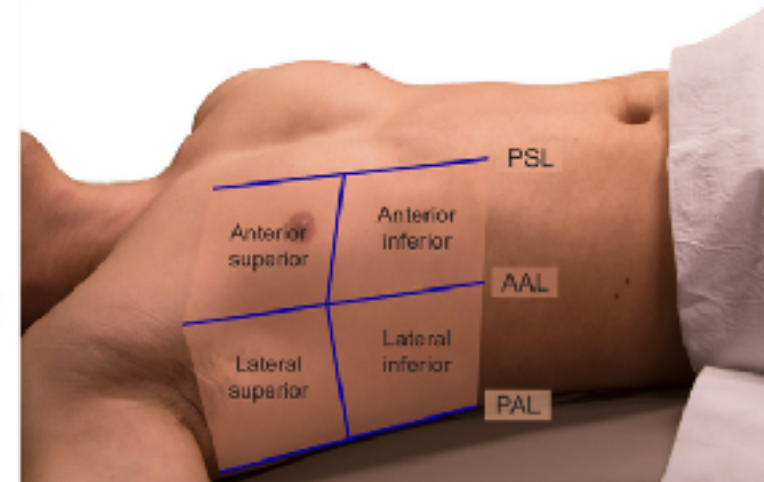
PROBE & POSITION

Probe Positions

A



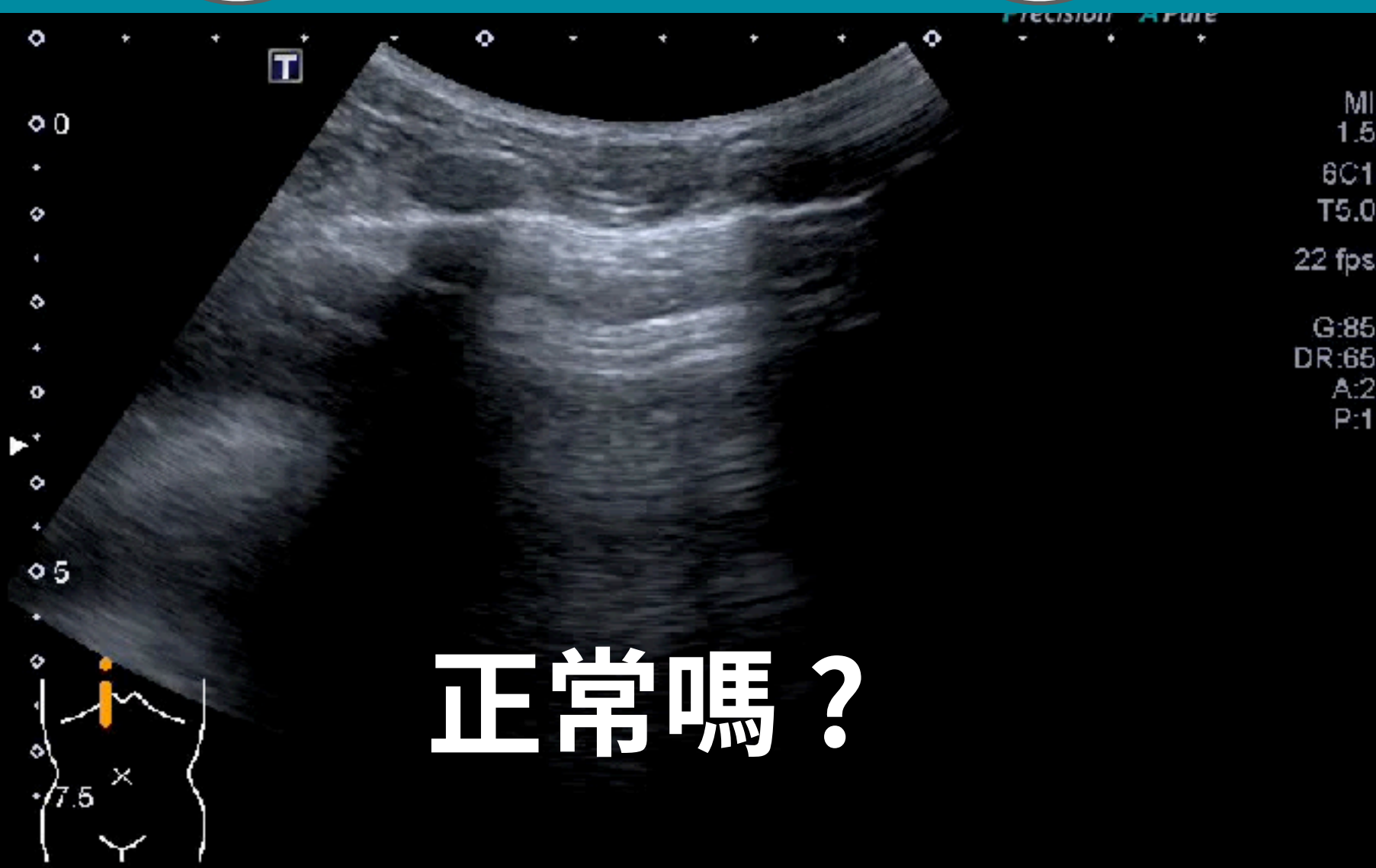
B



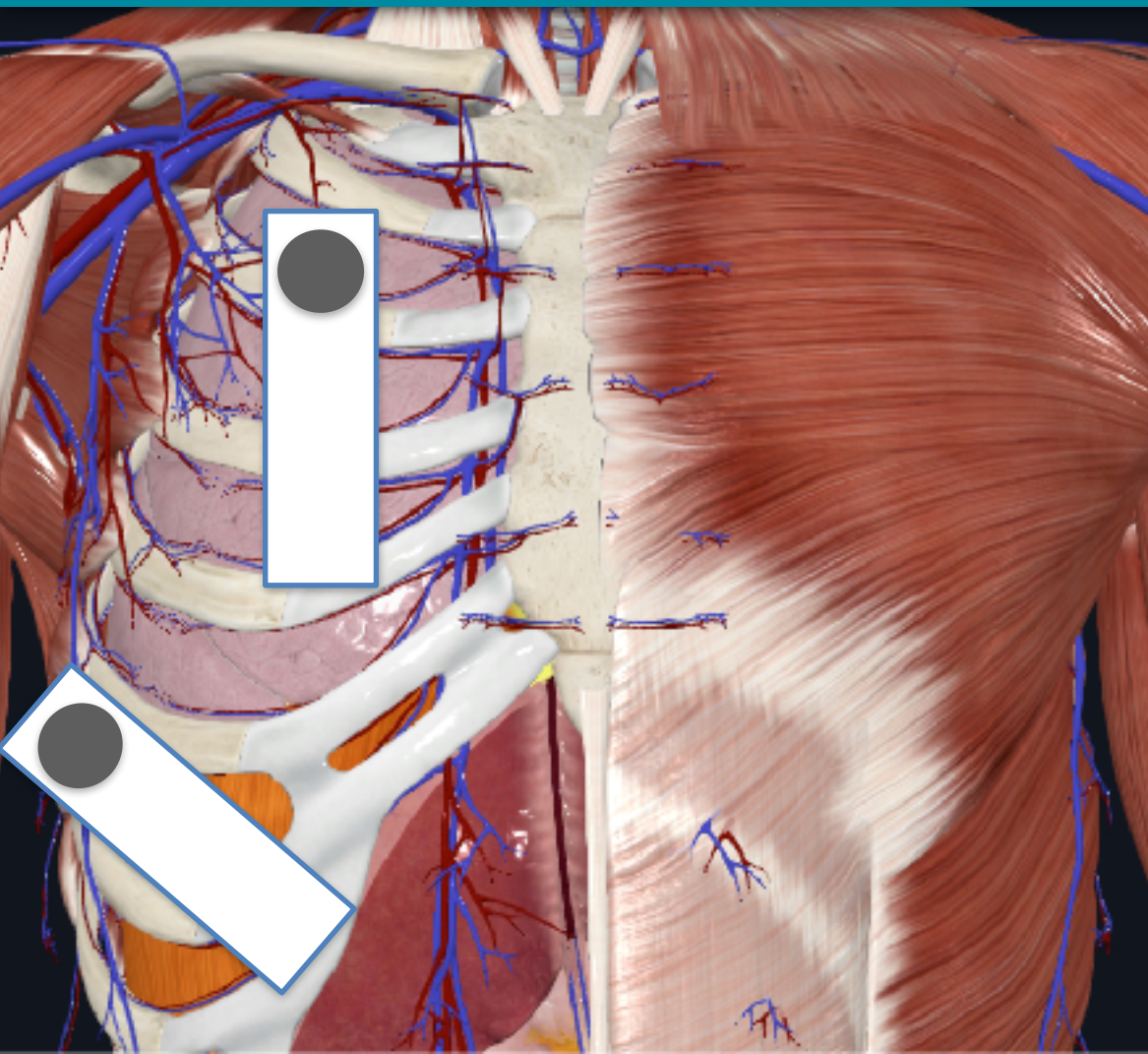
C



LUNG



Lung



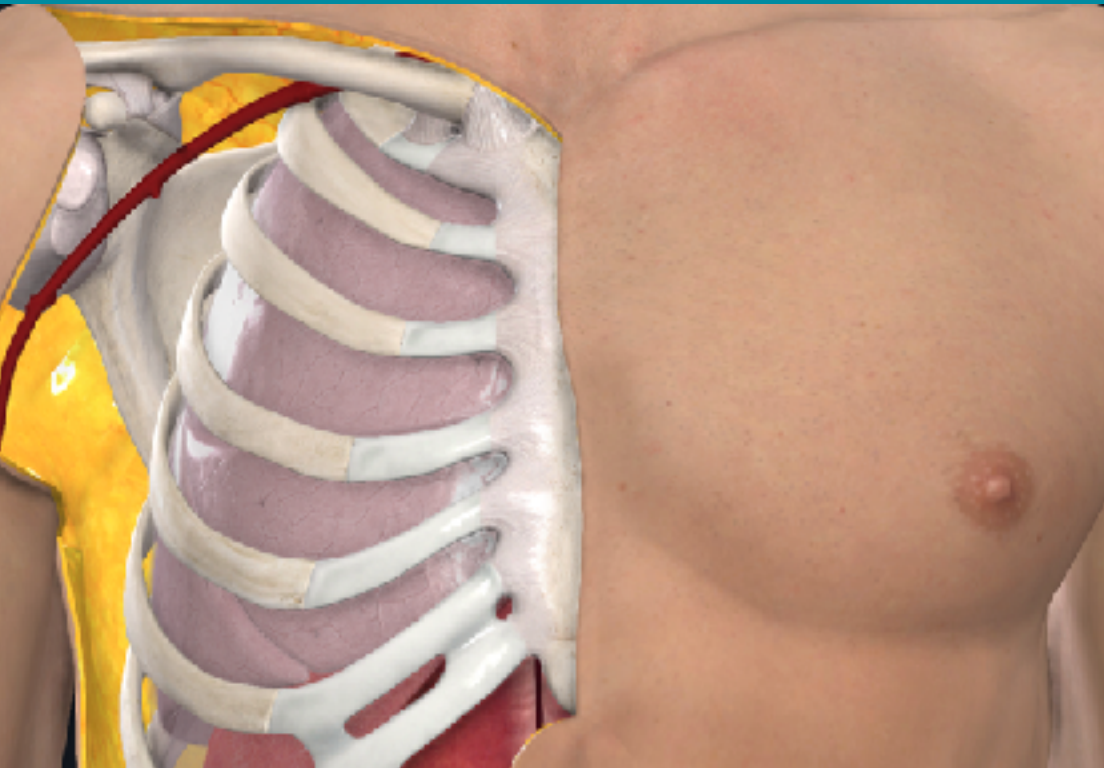
肋膜

高回音
有滑動
縱向掃描
鎖骨中線之最高點

橫膈膜

高回音
有移動
肋間掃描
劍突腋前/後線交界

LUNG USG APPLICATIONS



Dyspnea
Chest pain
Infections

PTX
AIS
PLE

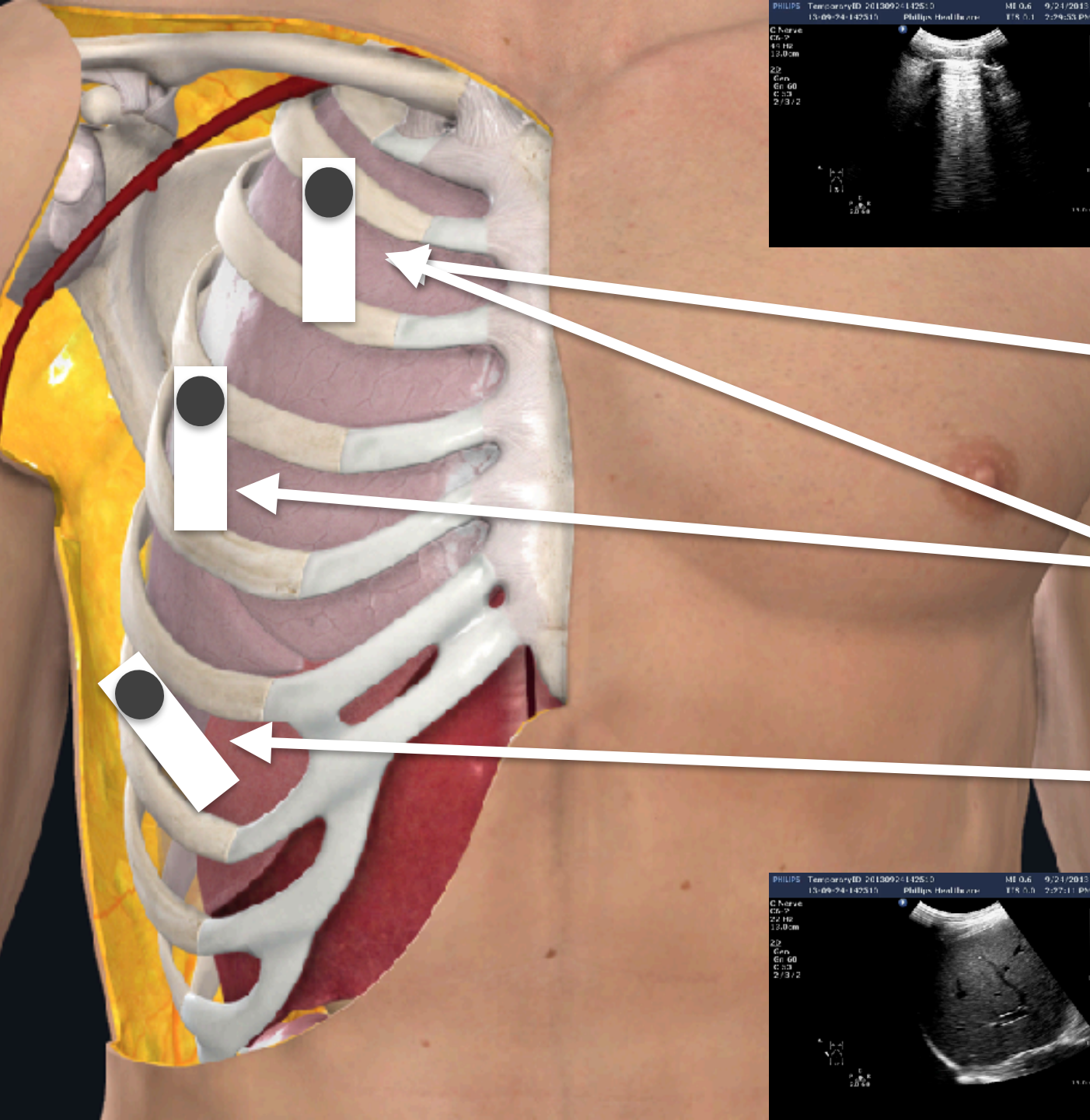
Consolidation

7

Sensitivity and Specificity of Lung US versus Chest Radiography

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AIR

PTX

AIS

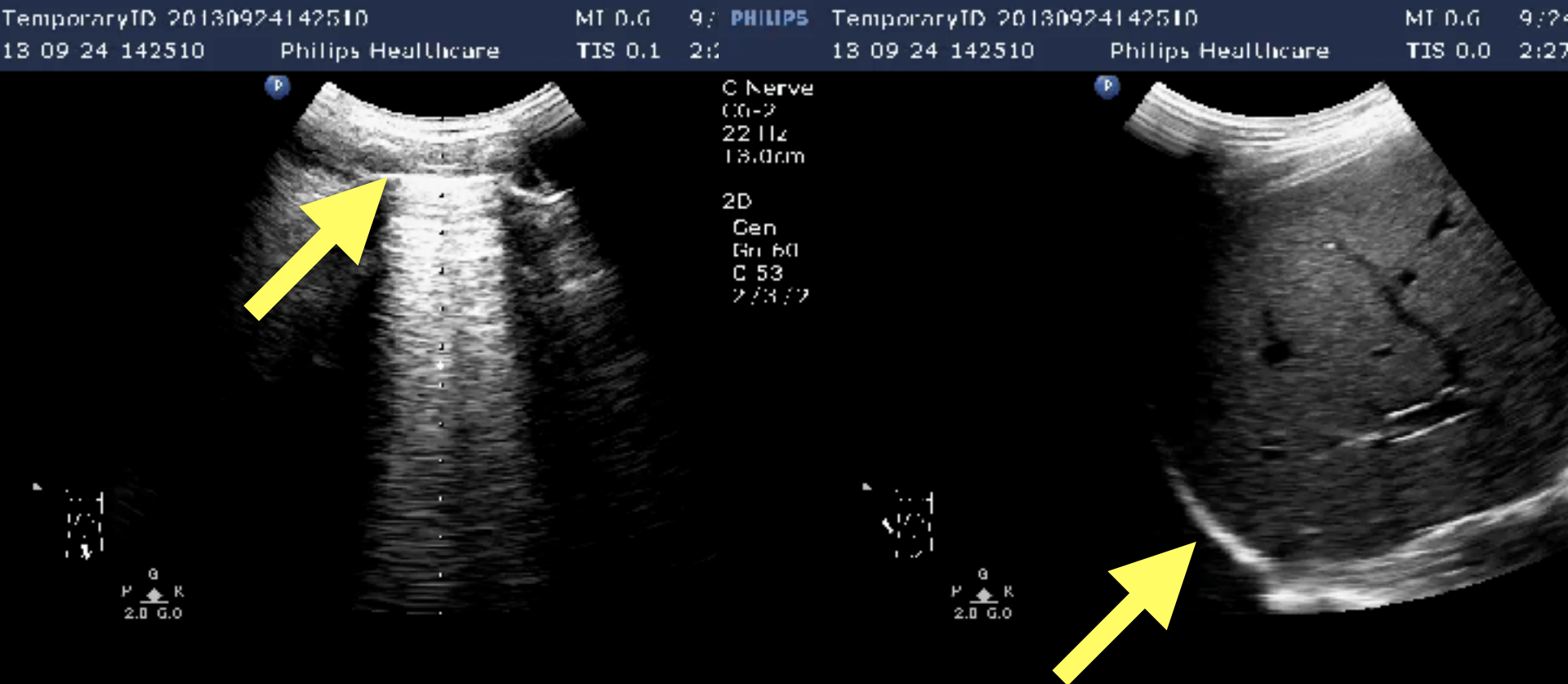
PLE

FLUID

NORMAL LUNG

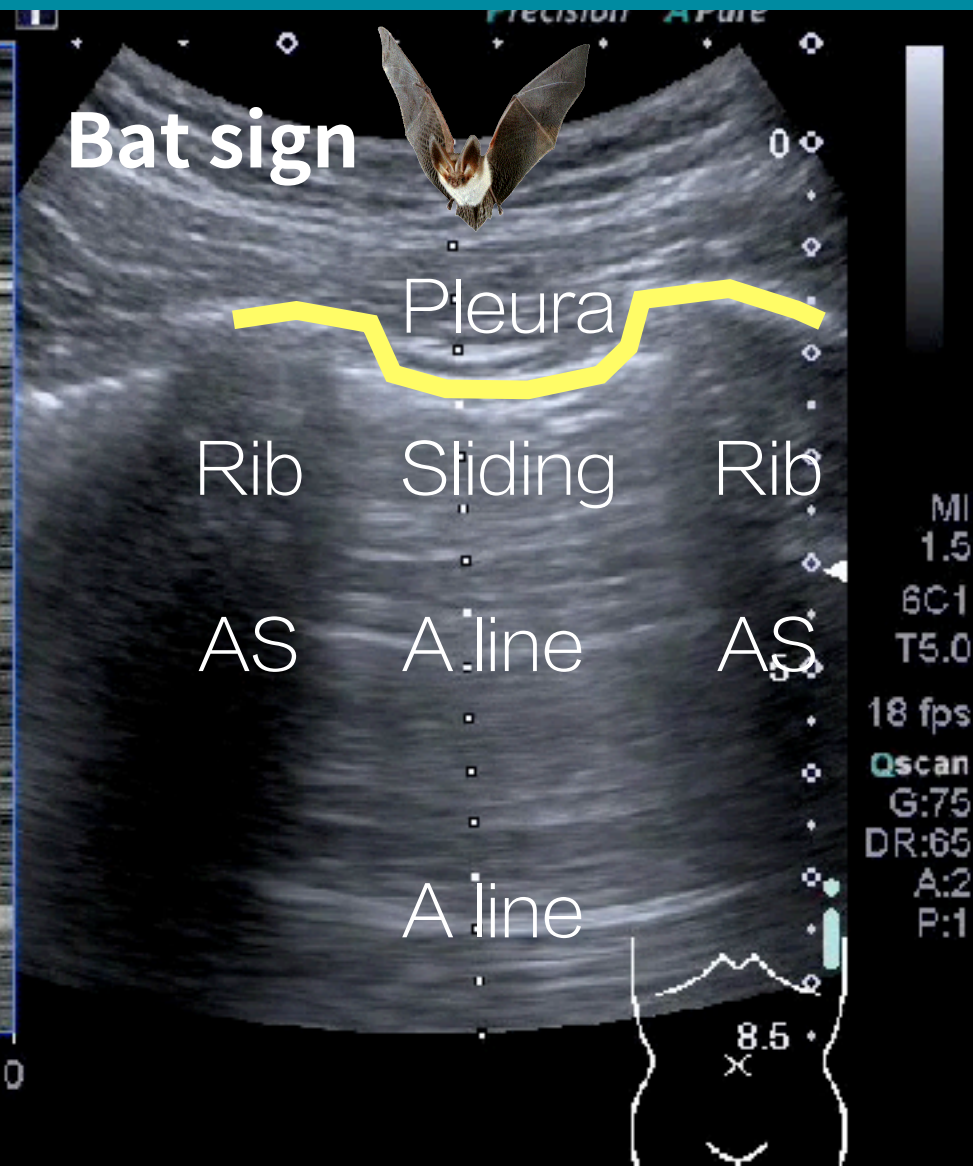
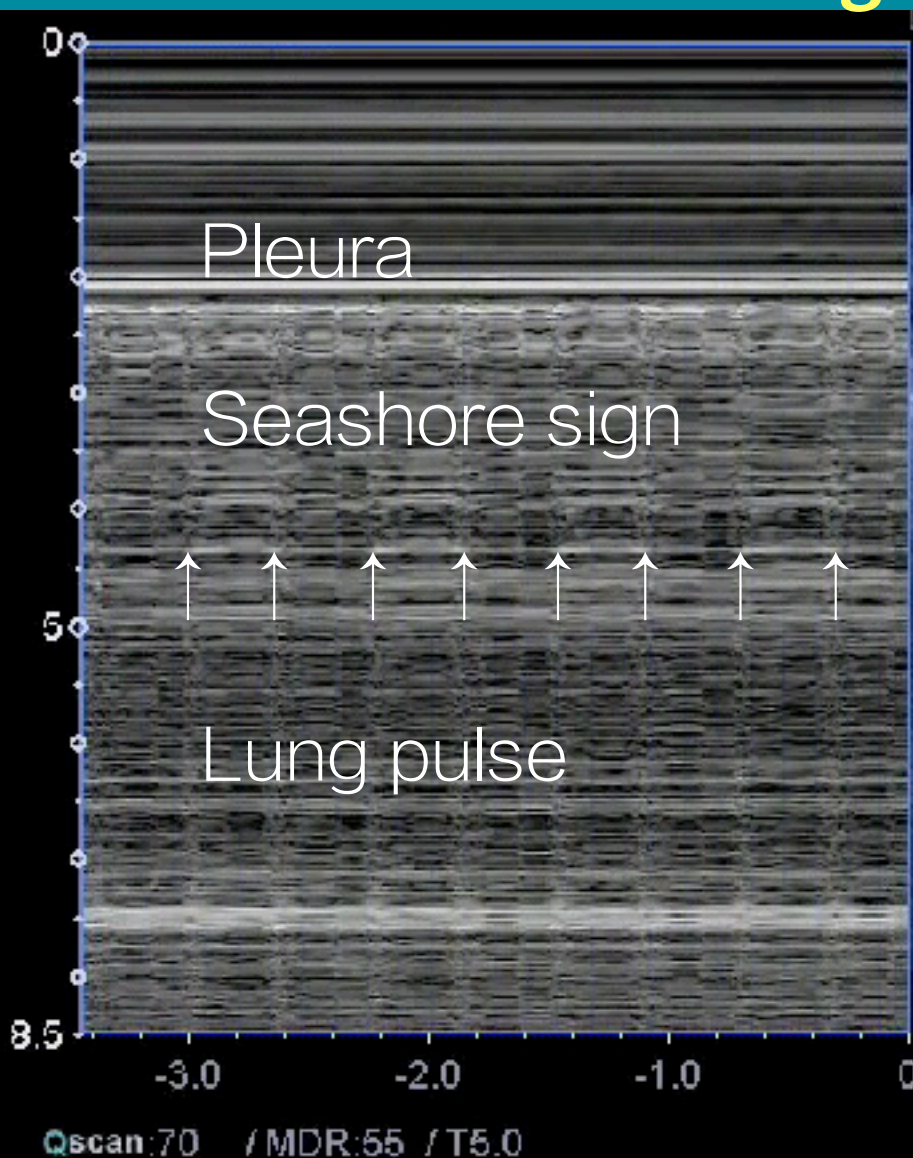
肋膜/滑動

橫膈膜/移動



NORMAL LUNG

Sliding + A lines



SLIDING FIRST



A line

肋膜下
水平線
等距離



B line

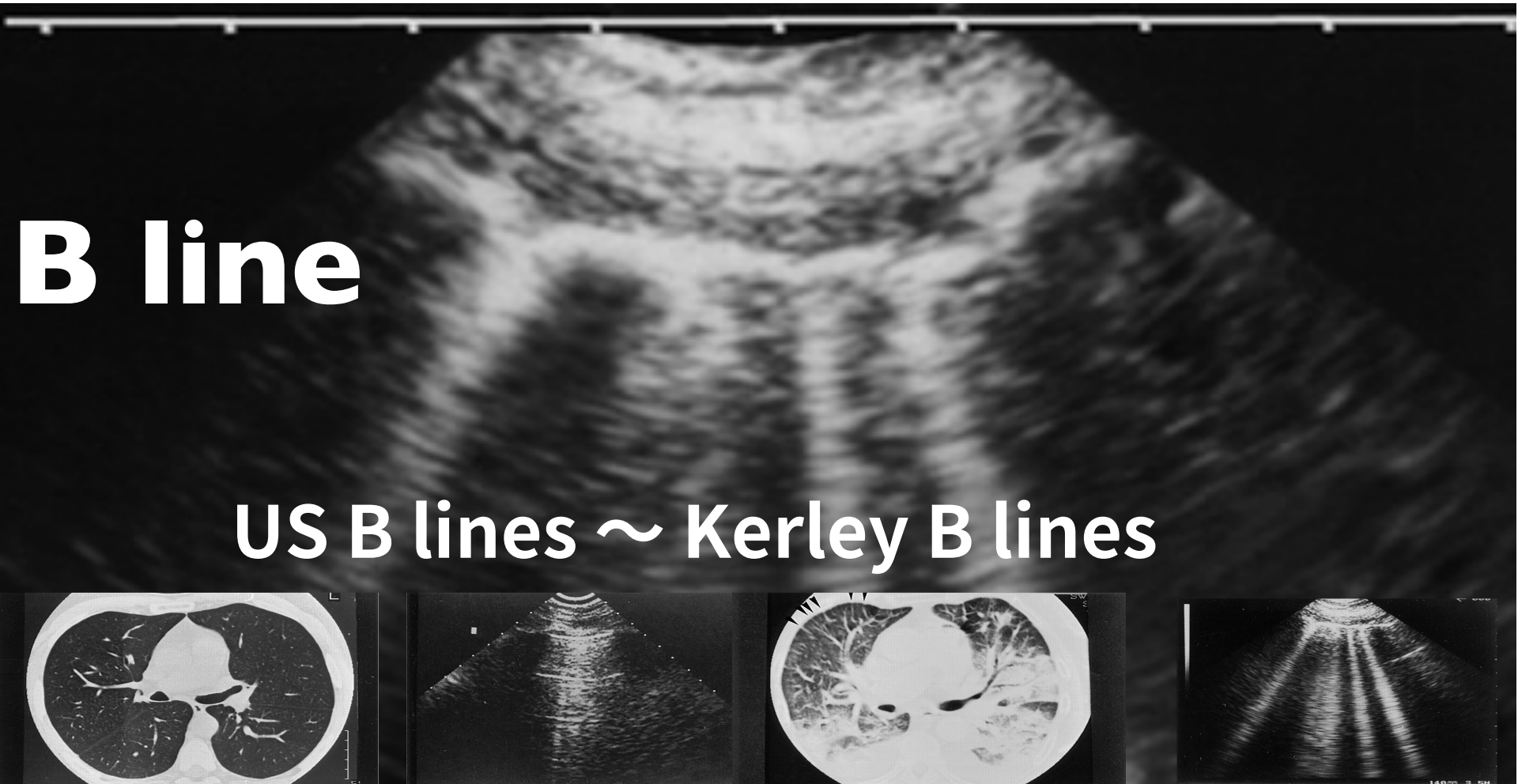
肋膜下
垂直線
大於三

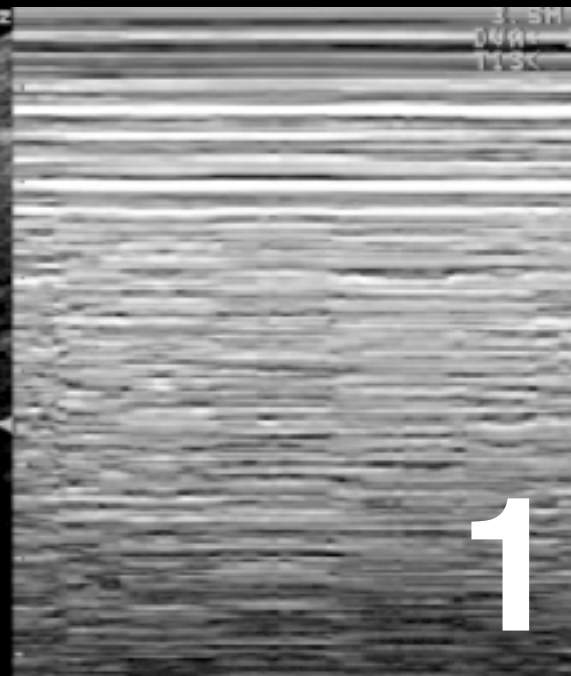
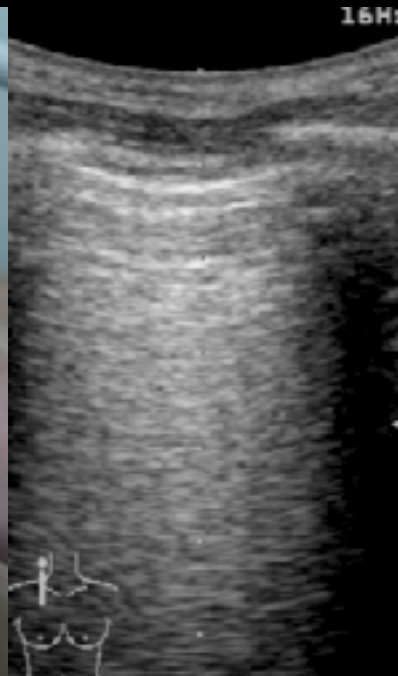
D. Lichtenstein
G. Mezière
P. Biderman
A. Gepner

The comet-tail artifact: an ultrasound sign ruling out pneumothorax

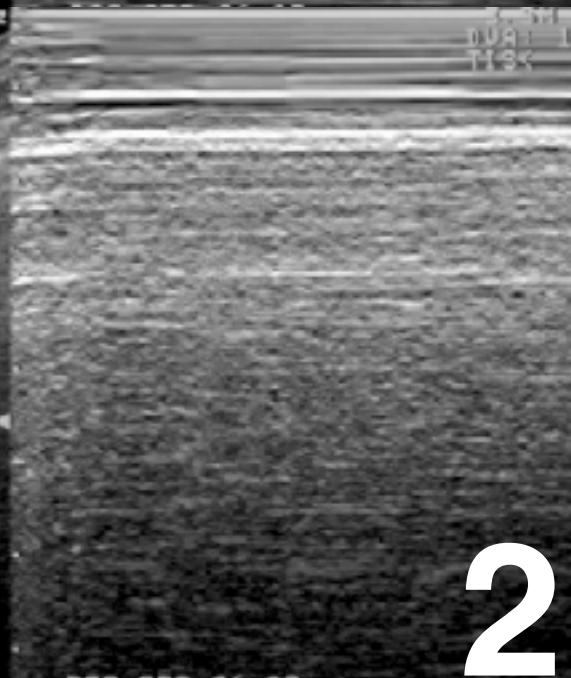
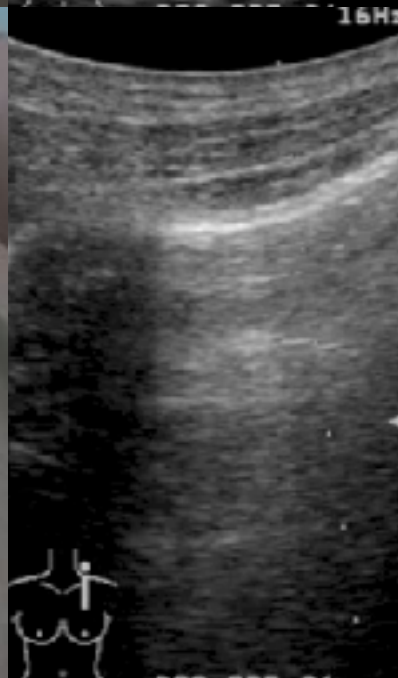
B line

US B lines ~ Kerley B lines





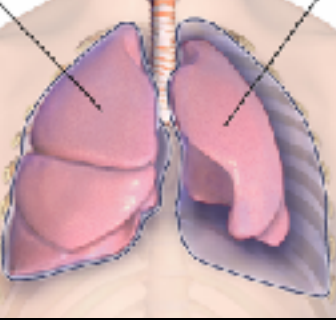
1



2

R08 G55 C4

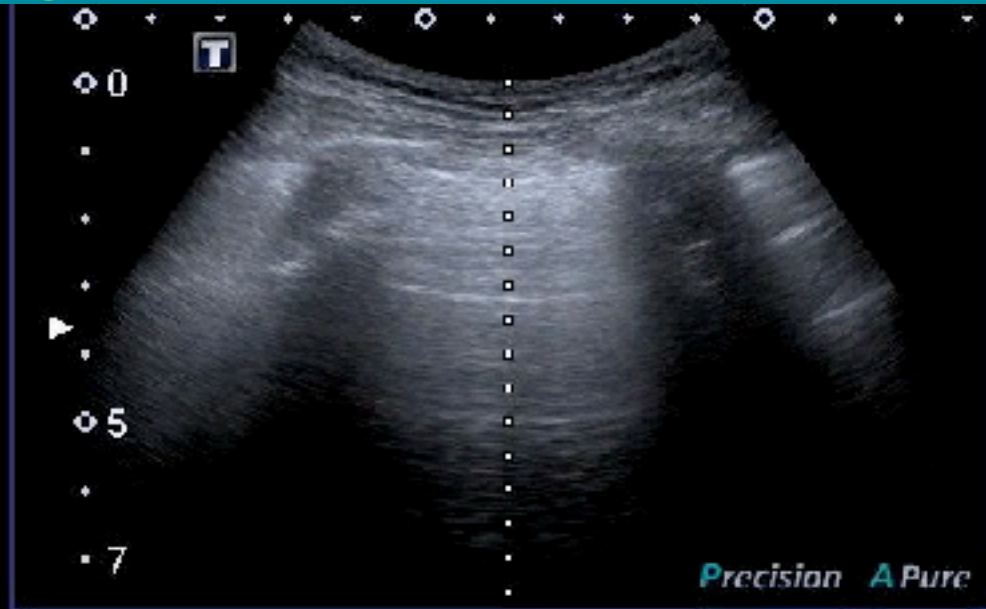
R08 G55 C6 A3



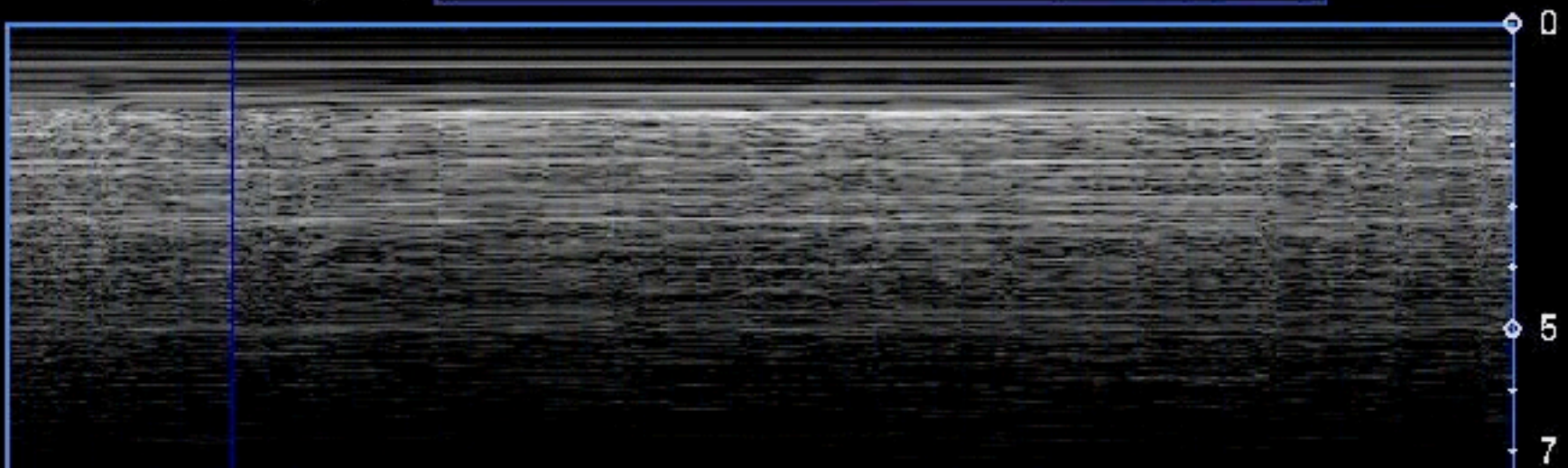
PNEUMOTHORAX ?

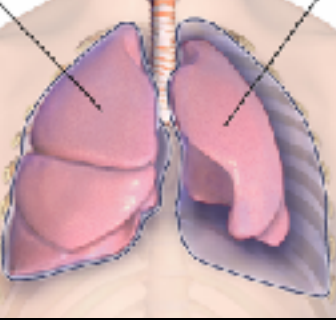
Sliding + A lines = Normal pleura

Seashore
sign



MI:1.5
6C1
T5.0
18 fps
Qscan
G:71
DR:65
A:2
P:1

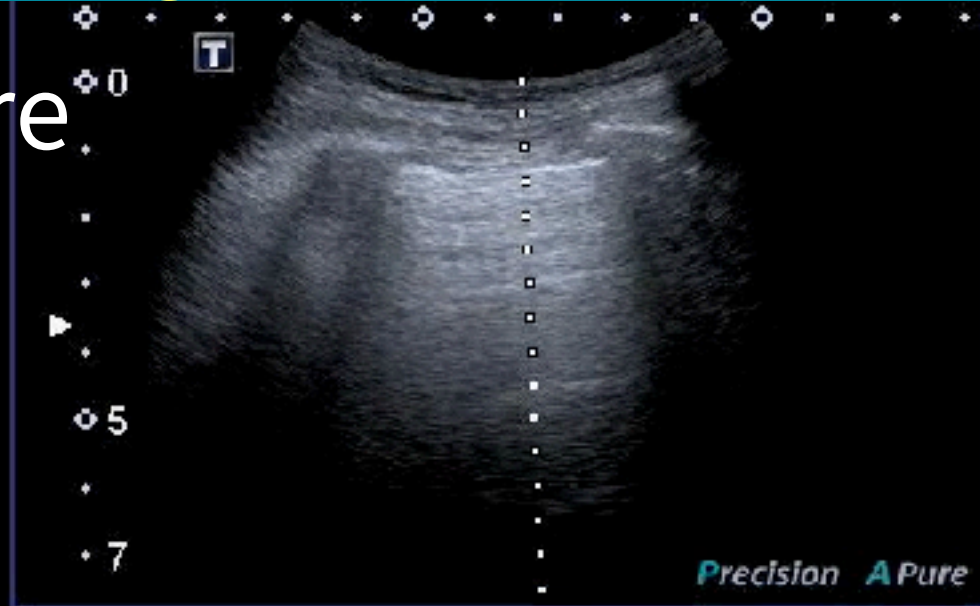




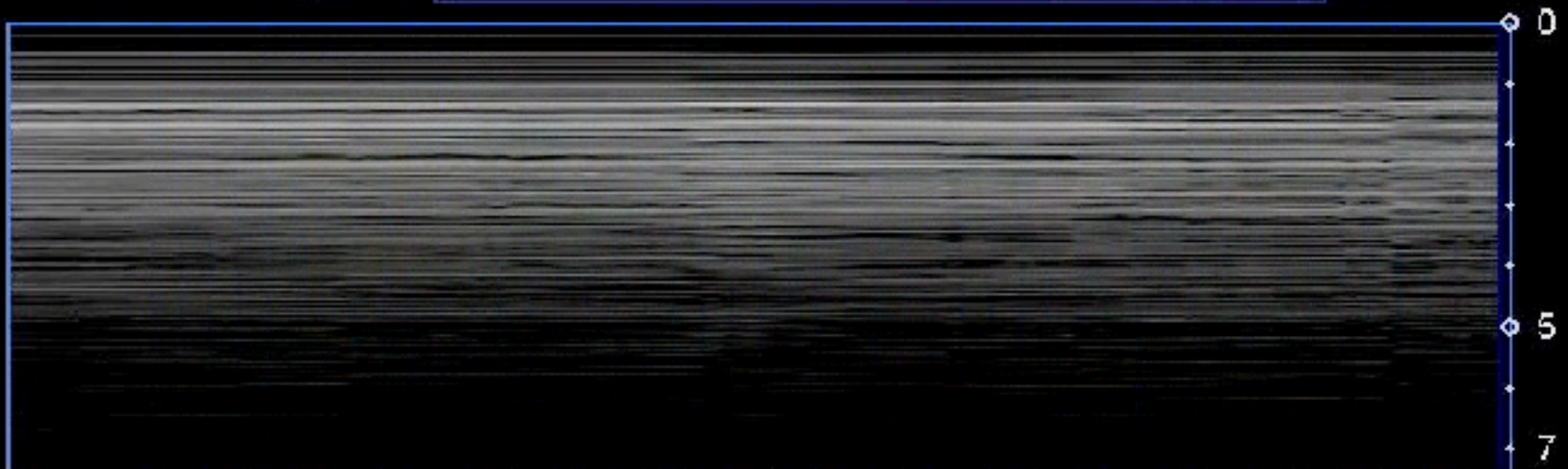
PNEUMOTHORAX ?

No Sliding + A lines >> Consider PTX

Stratosphere
sign

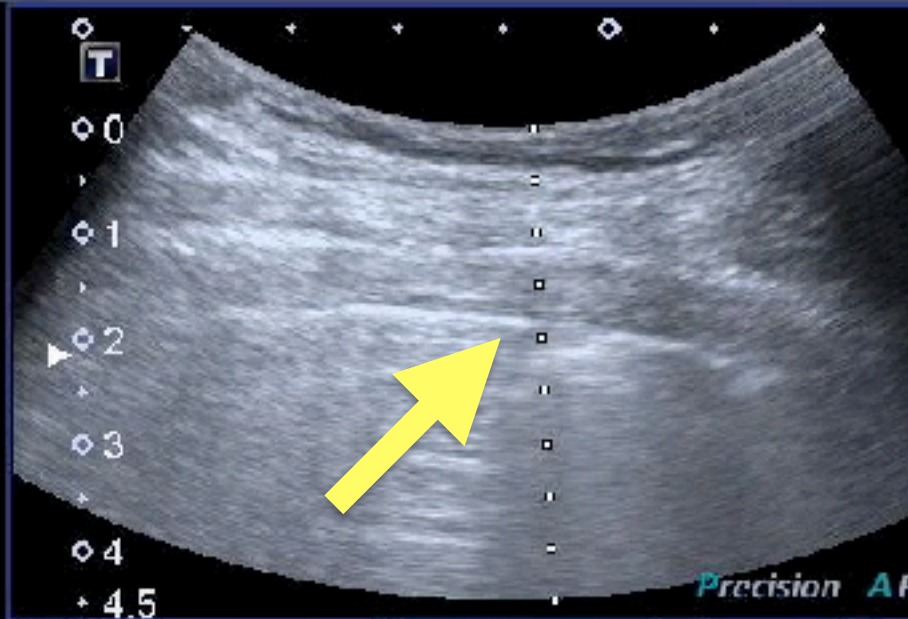


MI:1.5
6C1
T5.0
18 fps
Qscan
G:71
DR:65
A:2
P:1

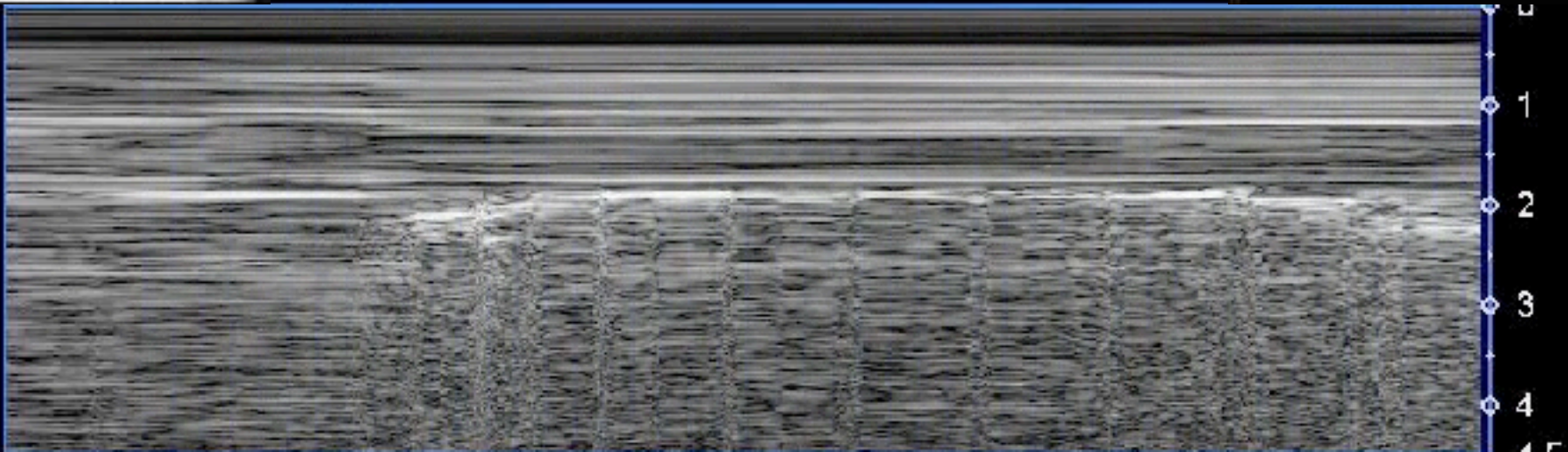


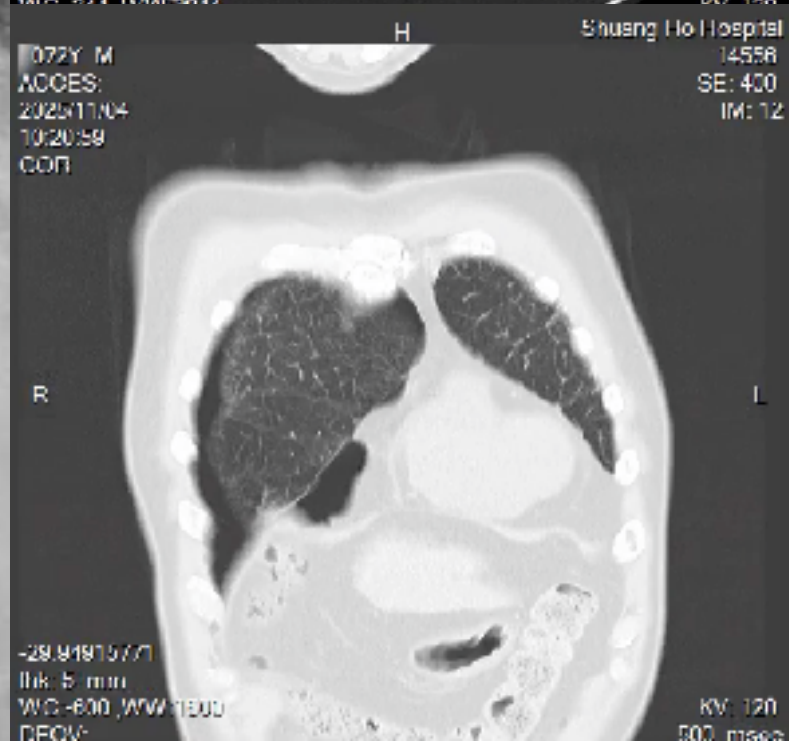
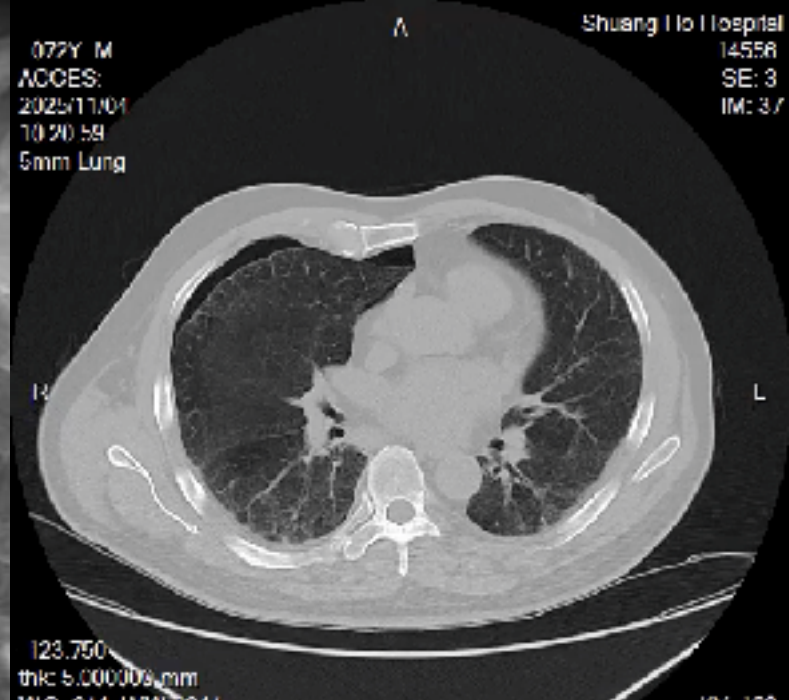
Lung Point

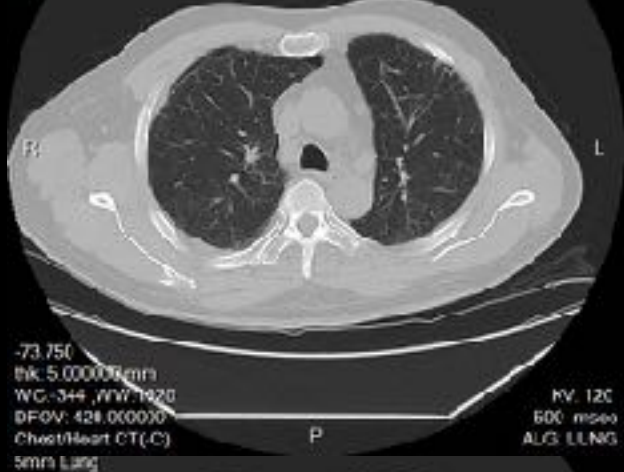
A



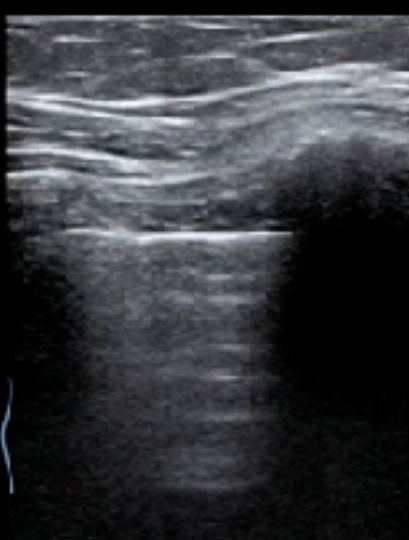
B





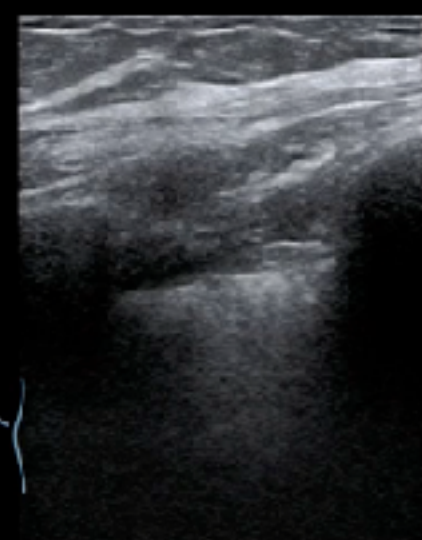


m

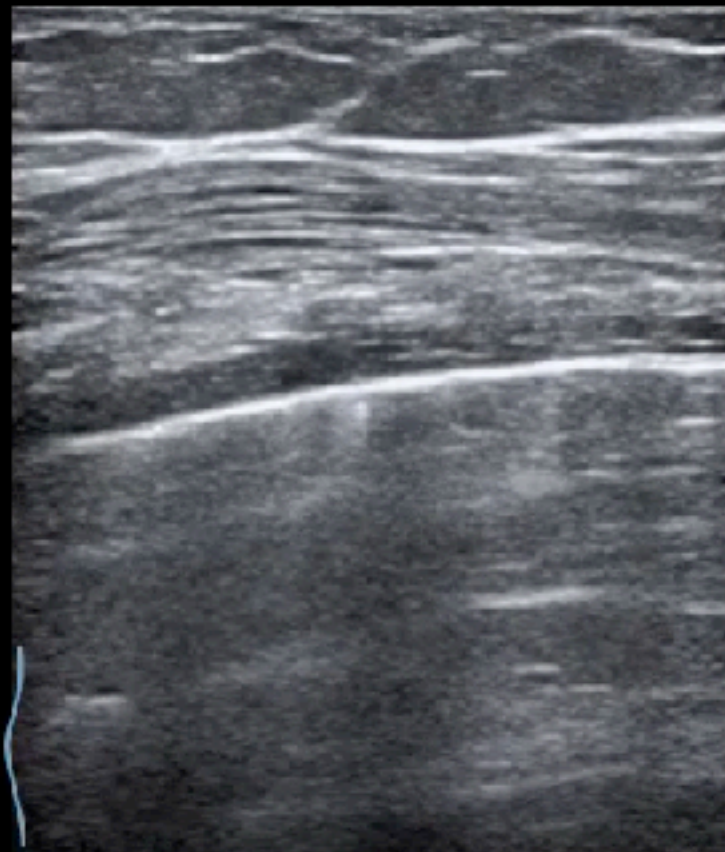


025/11/04
19.0
1100
25
5.0
55

m



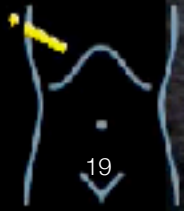
m



Needle

Touch

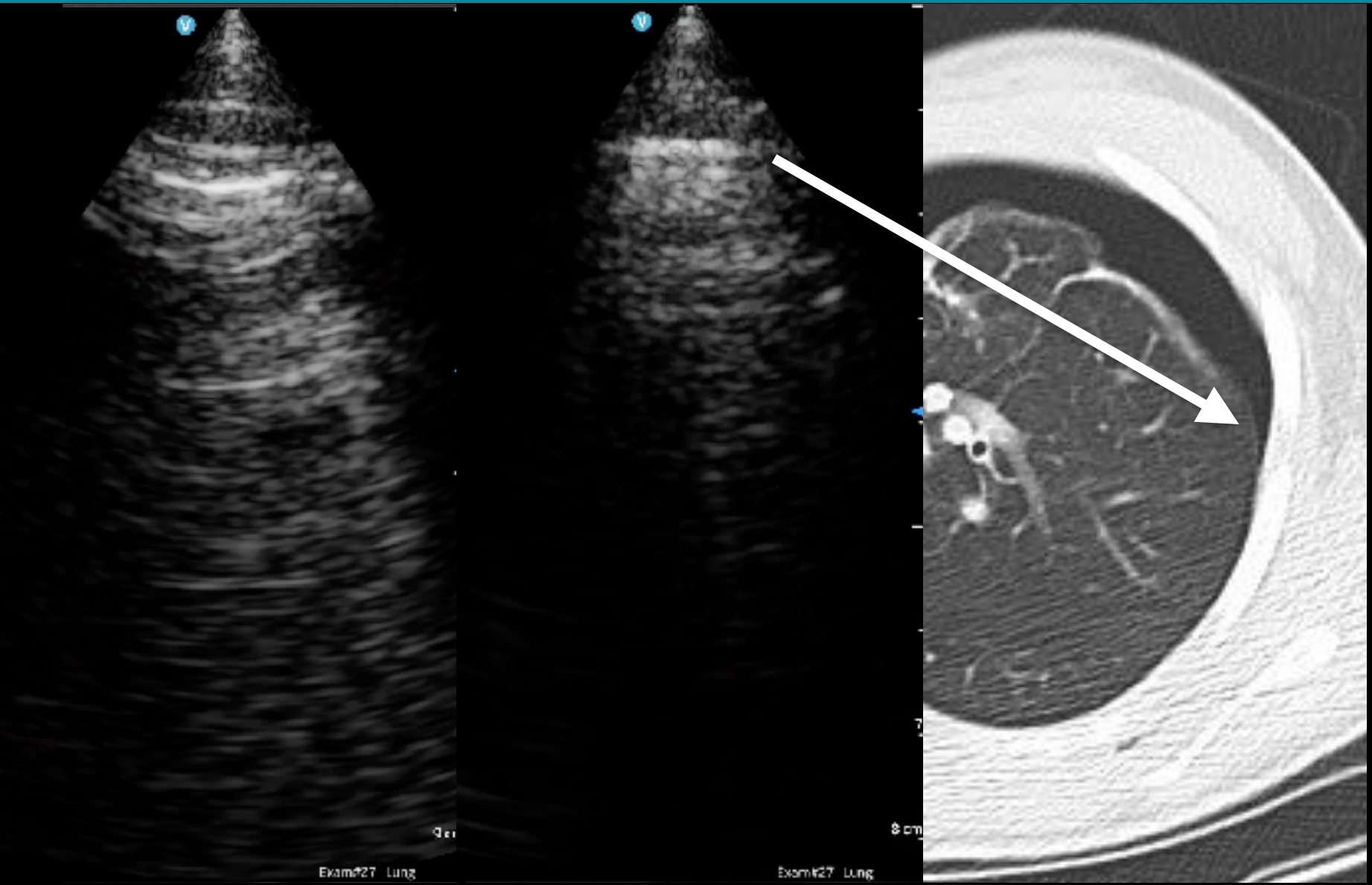
thk: mm



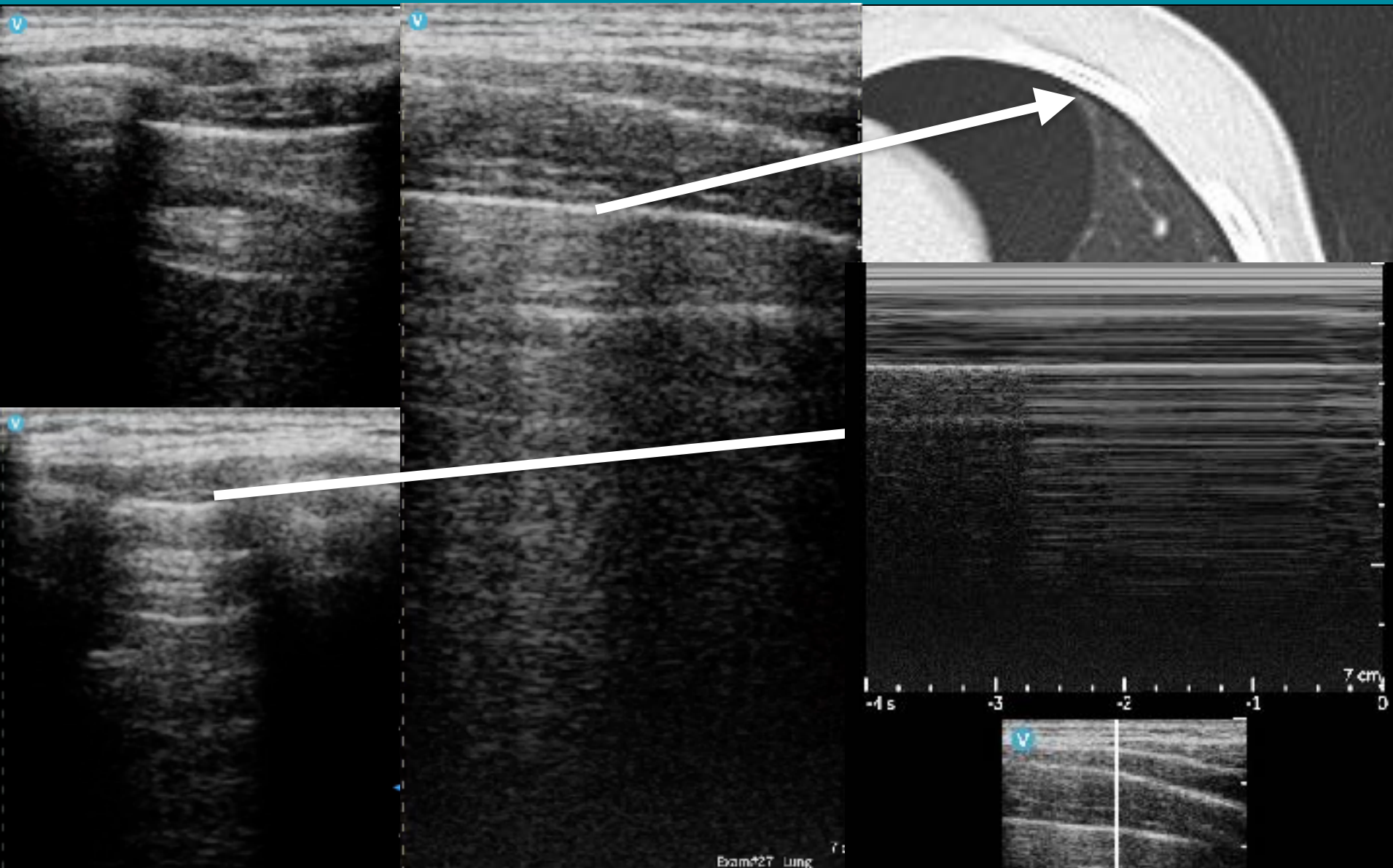
15F, ASTHMA HX , DYSPNEA



15F, ASTHMA HX , DYSPNEA



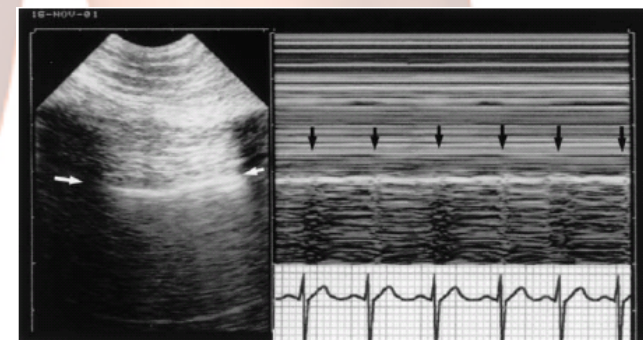
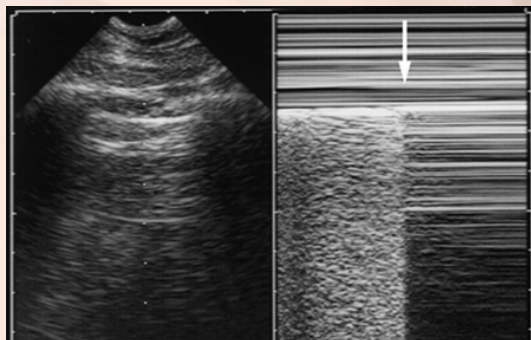
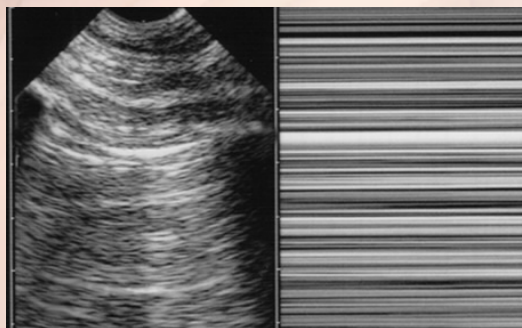
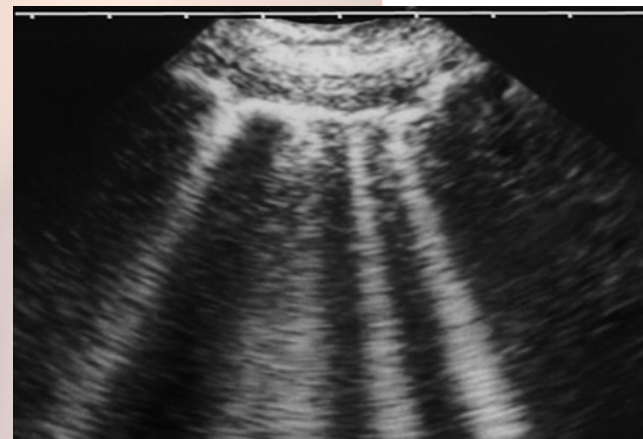
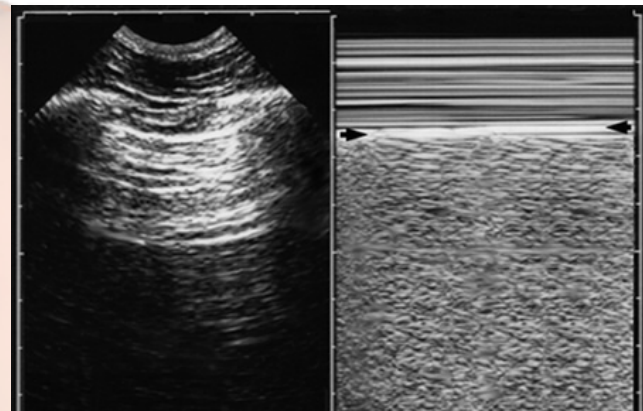
LUNG POINT & SUBCUTANEOUS EMPHYSEMA



PTX

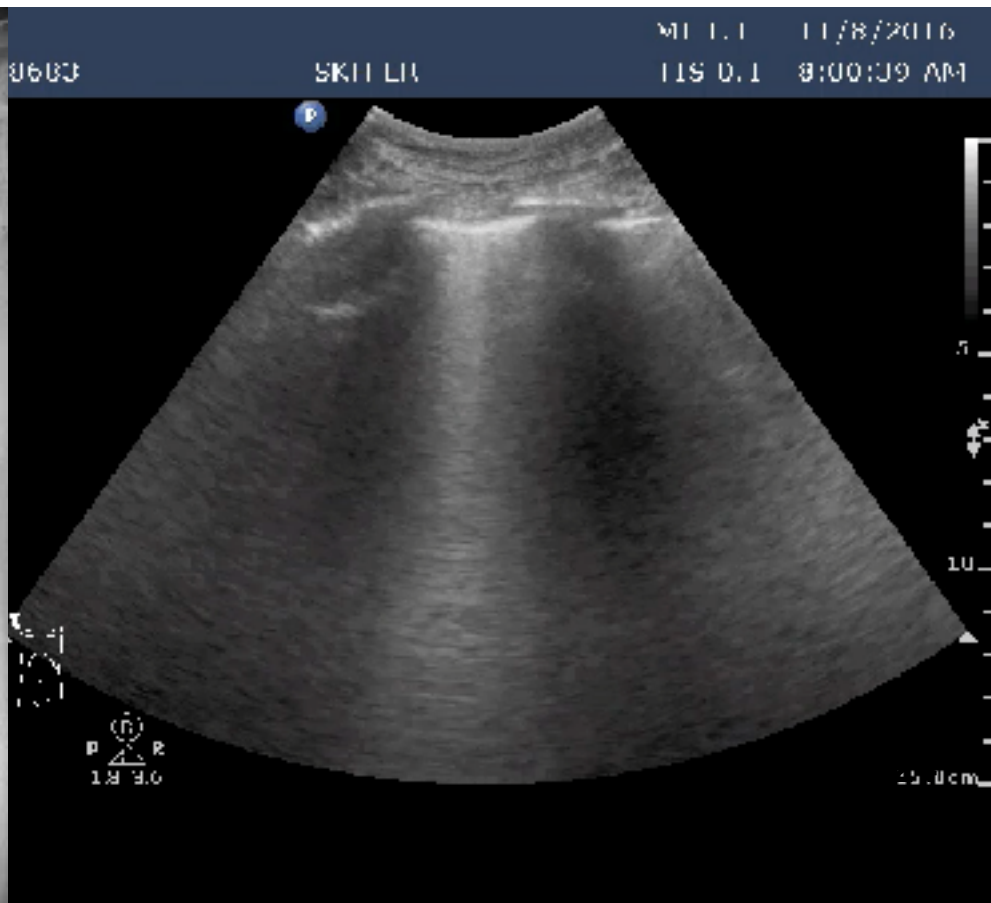
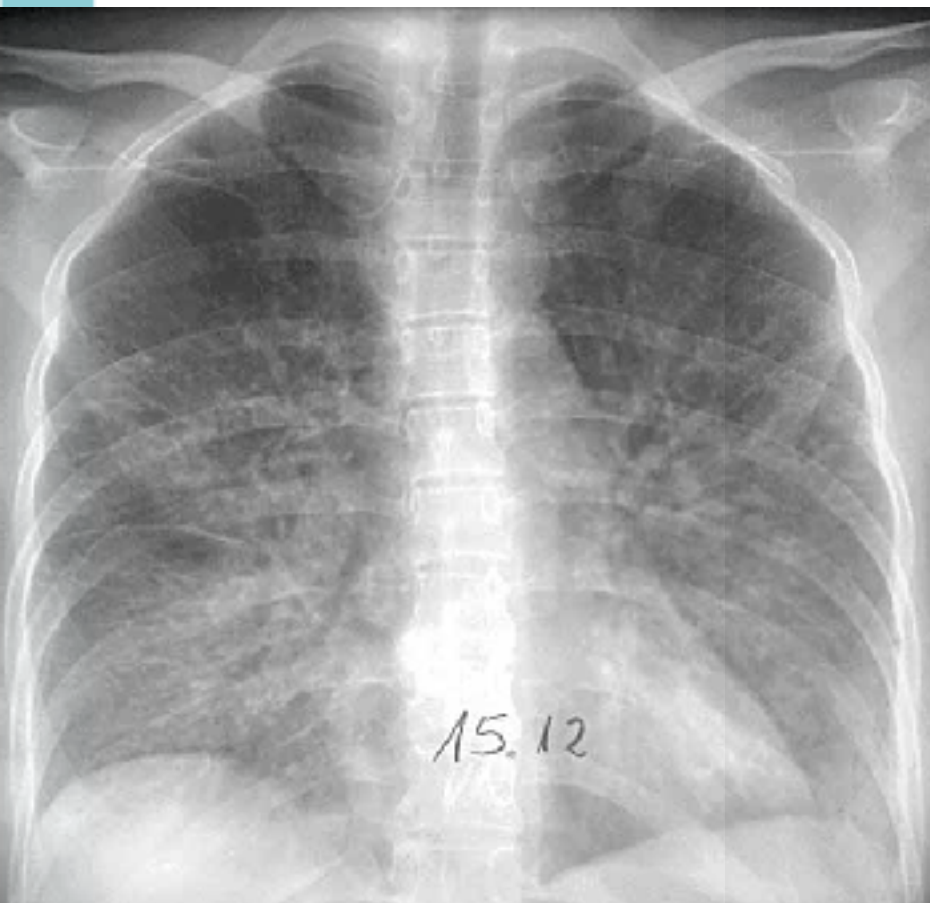
4

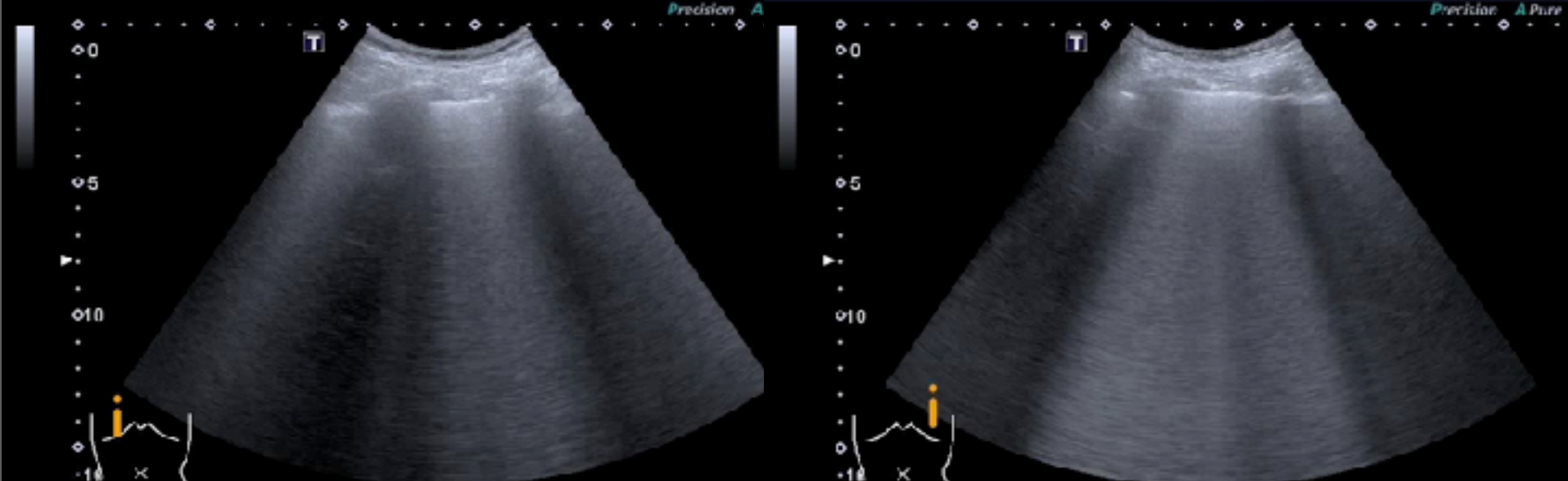
No sliding
No B lines
No pulse
Lung point



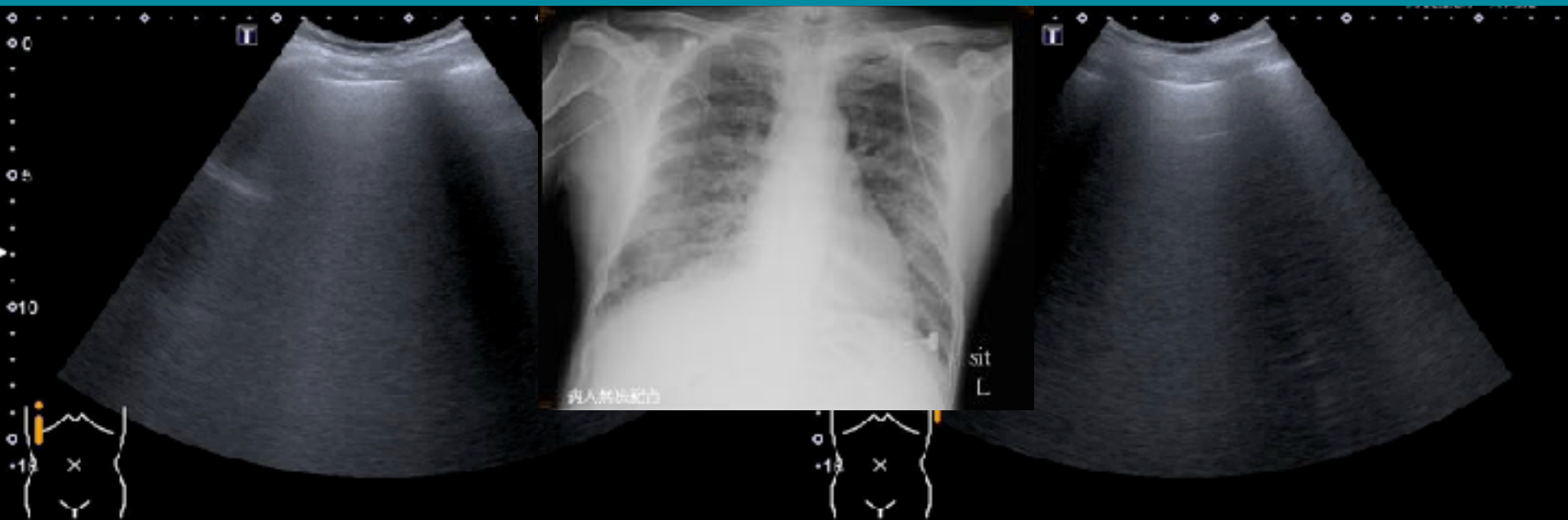
LUNG ROCKETS

ICS > 3 B lines

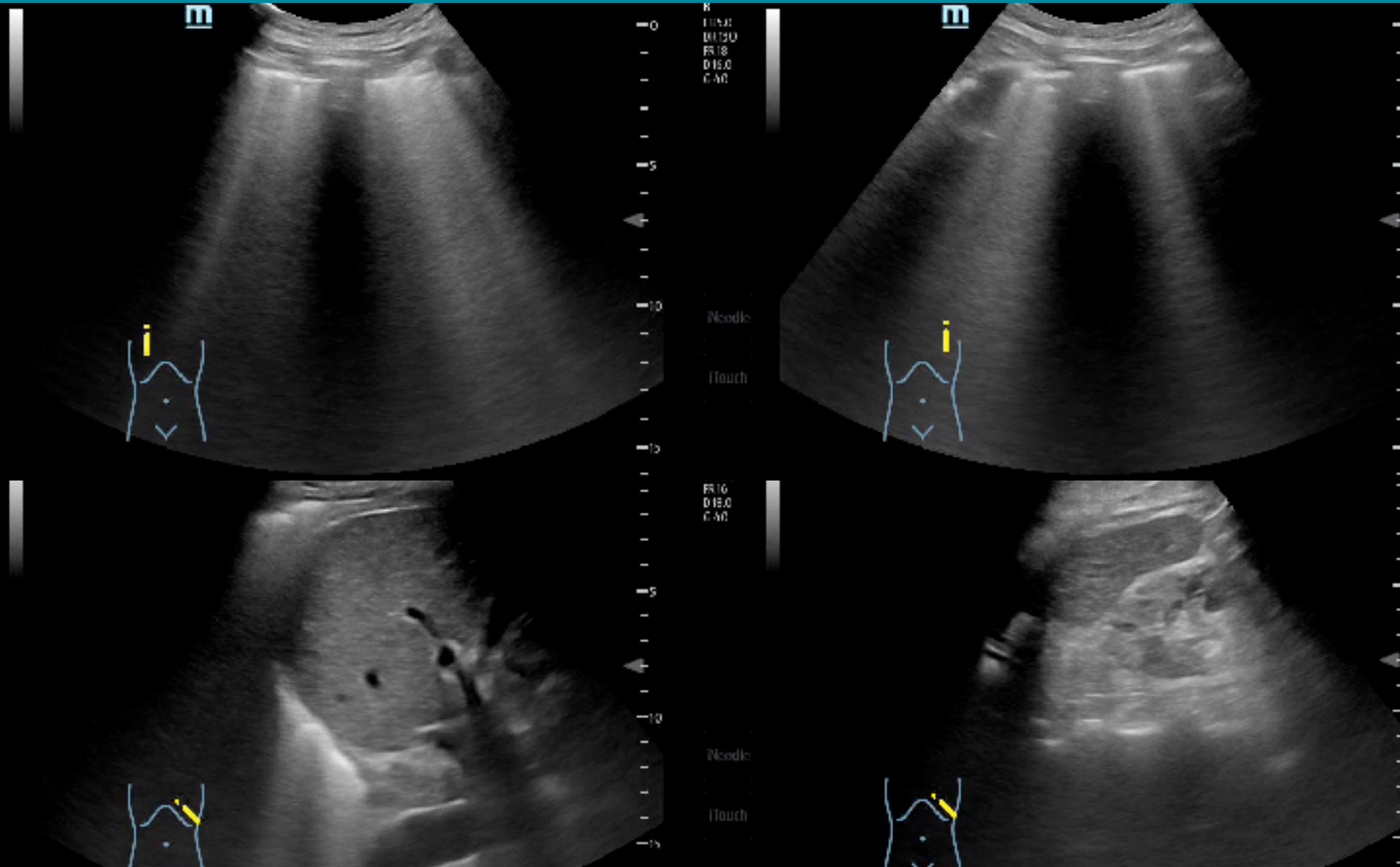




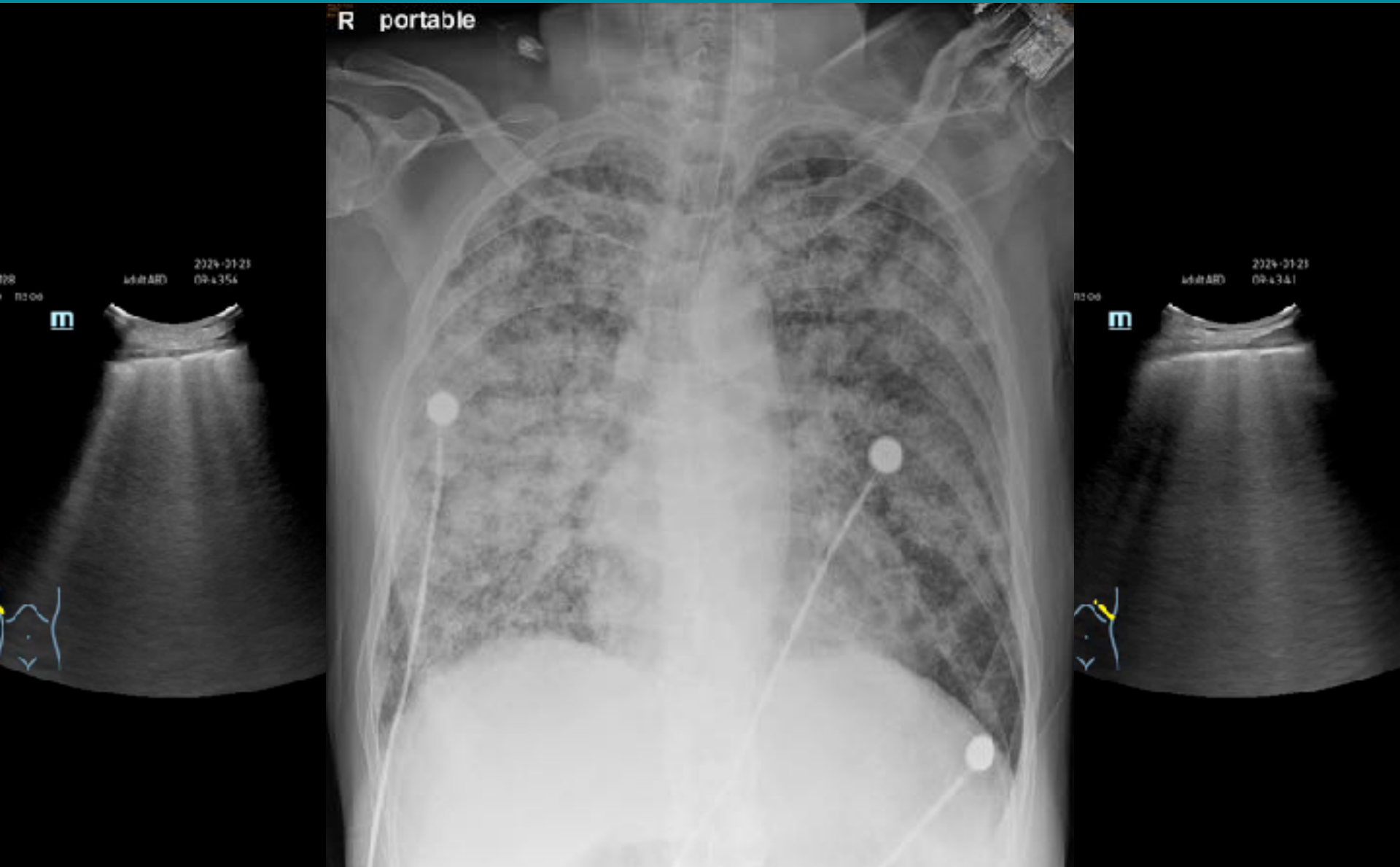
ALEVOLAR INTERSTITIAL SYNDROME



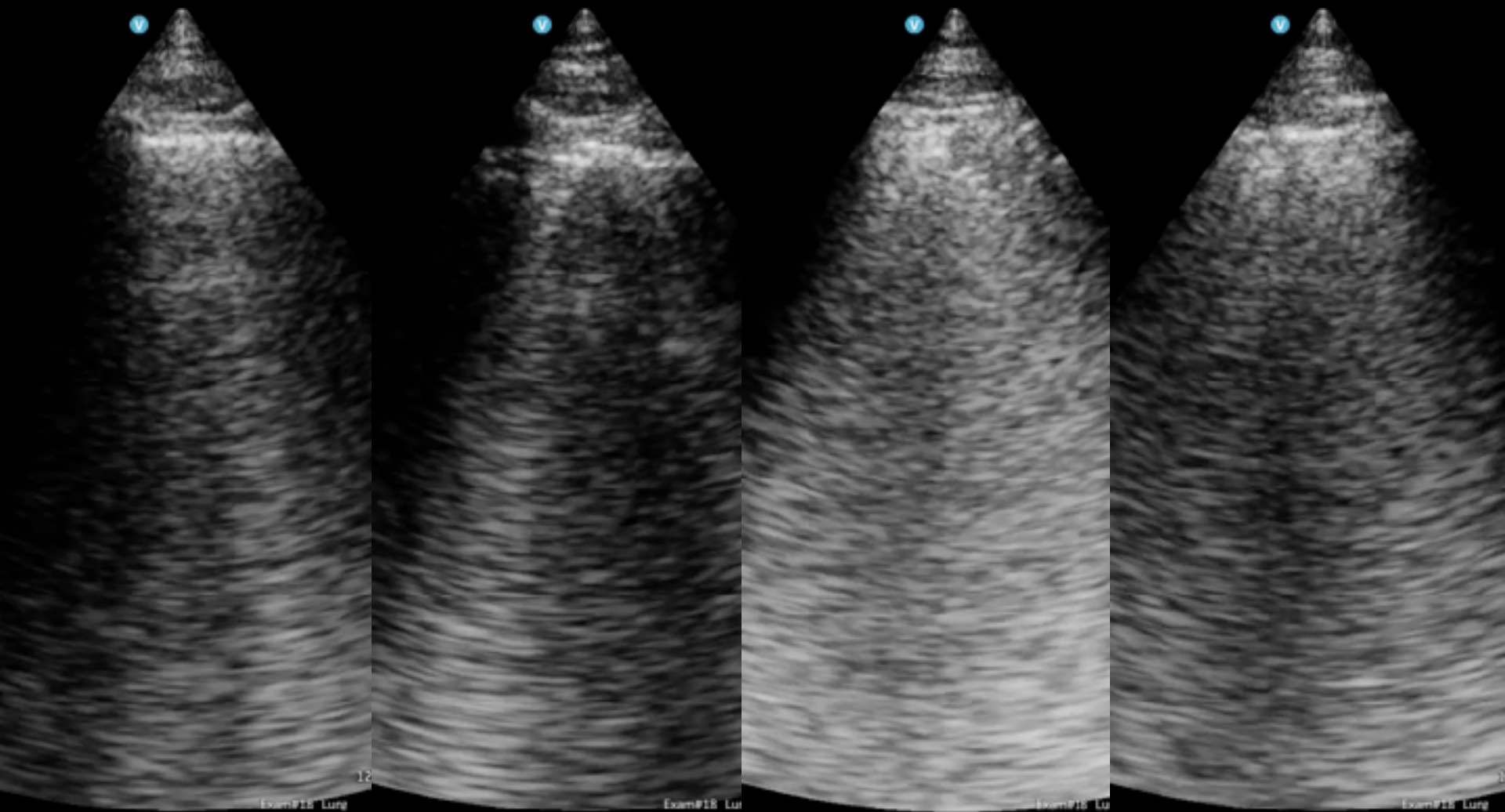
68M, ESRD ON HD QW246
APE > AAD > CPR 10' > ROSC > SHH

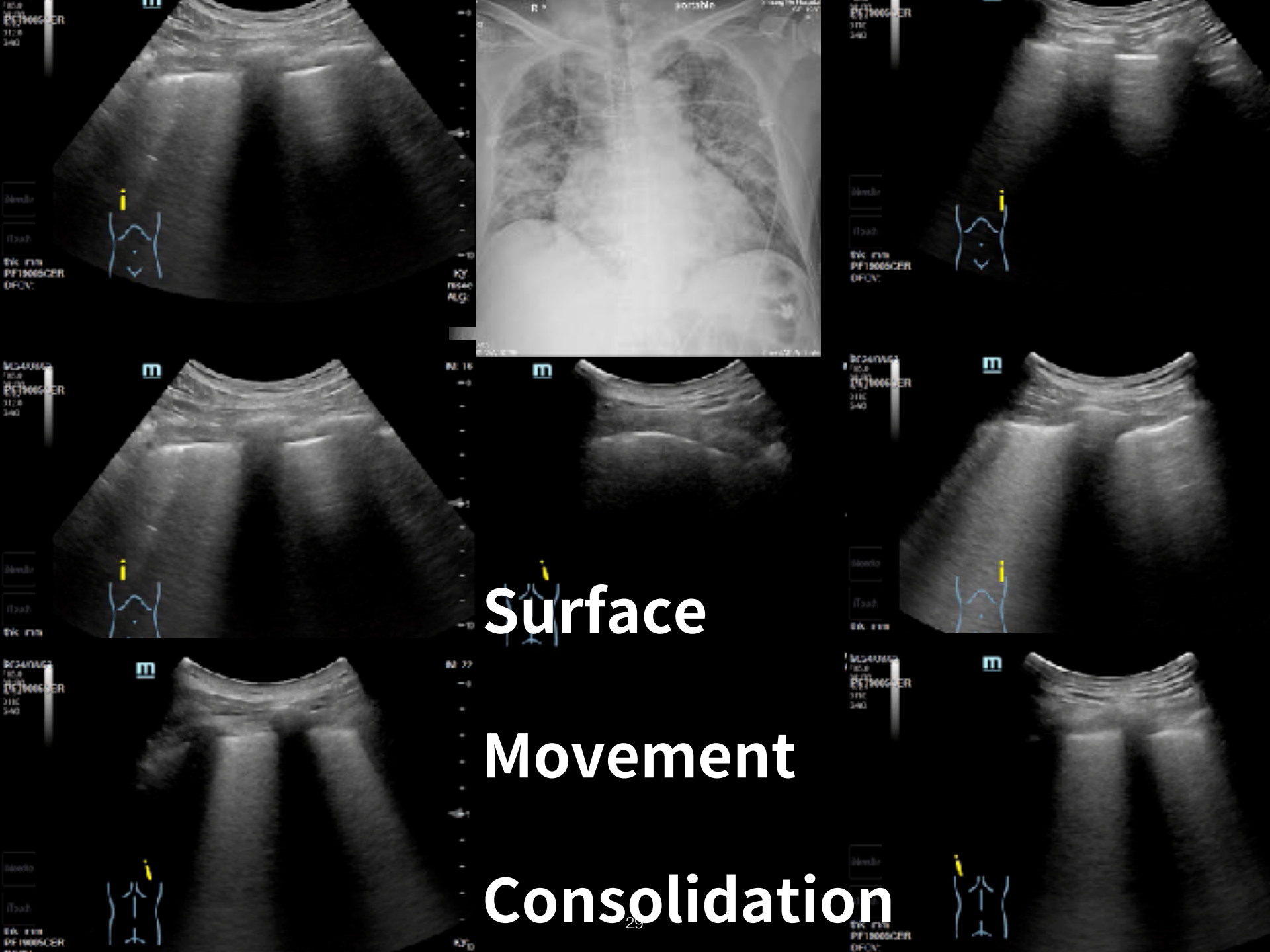


ALVEOLAR INTERSTITIAL SYNDROME

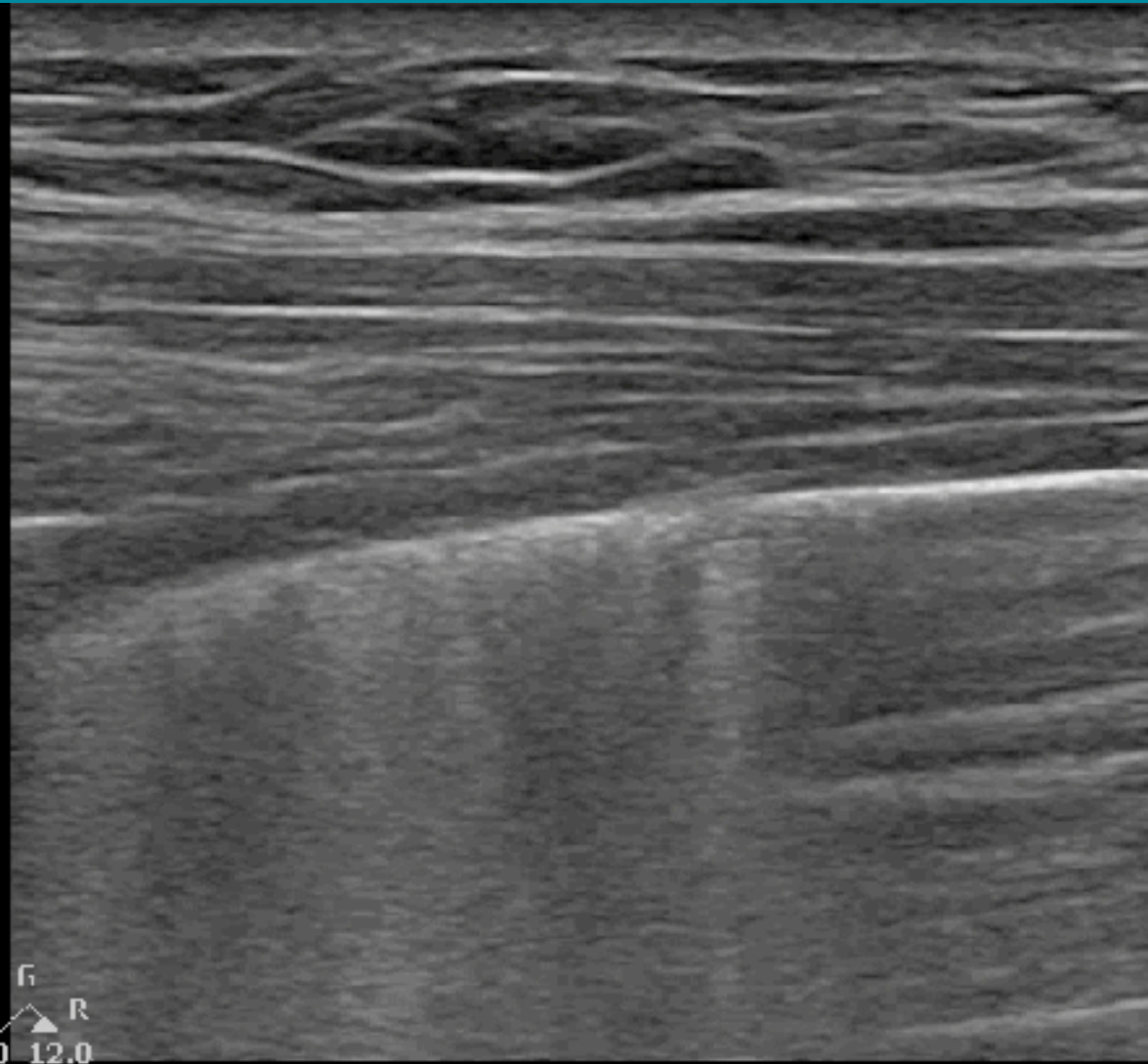


ALVEOLAR INTERSTITIAL SYNDROME





AIS: Localized



Pneumonia

Pneumonitis

Atelectasis

Contusion

Infarction

Pleural disease

Neoplasia

Normal lung

Detection

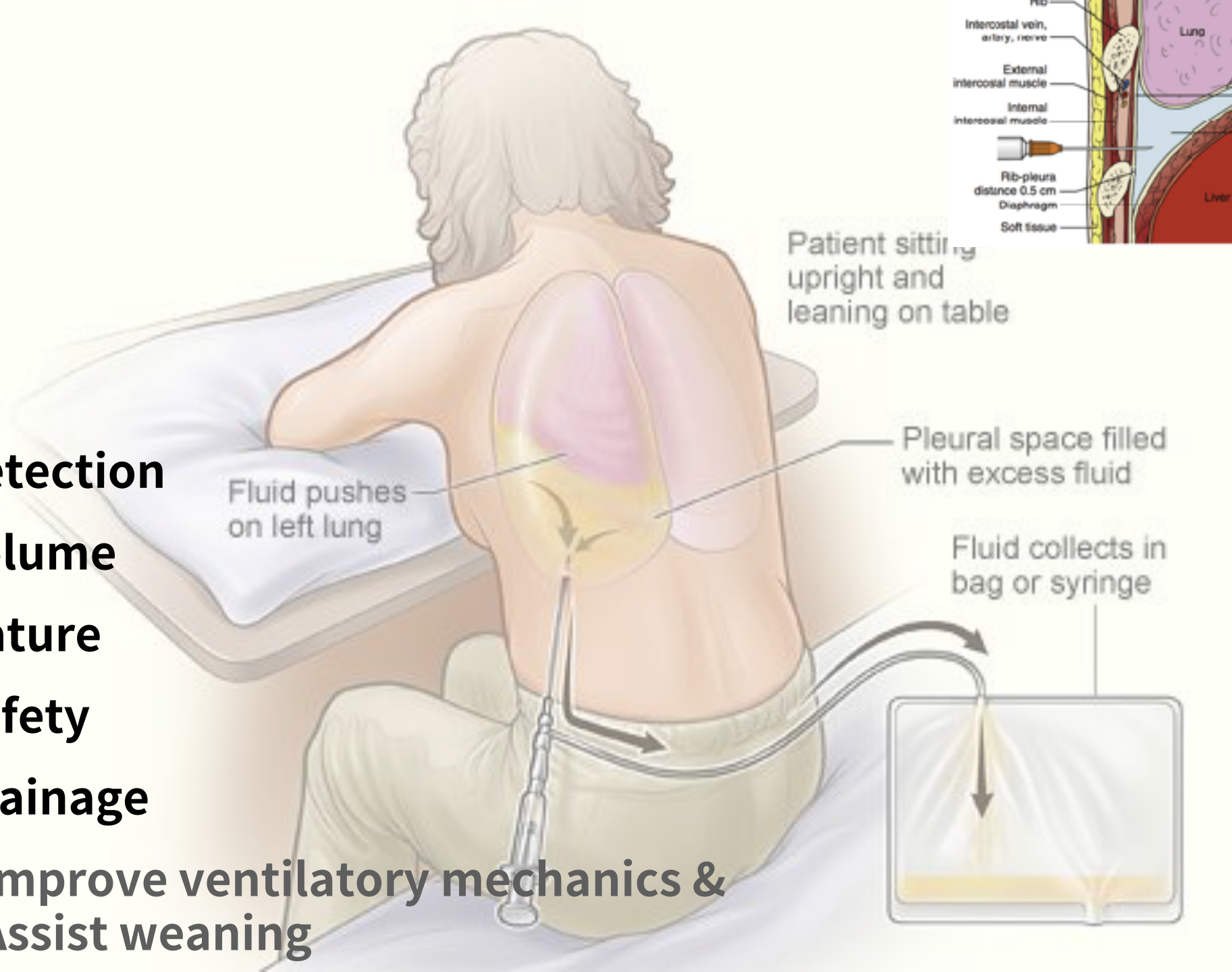
Volume

Nature

Safety

Drainage

**Improve ventilatory mechanics &
Assist weaning**



PLEURAL EFFUSION

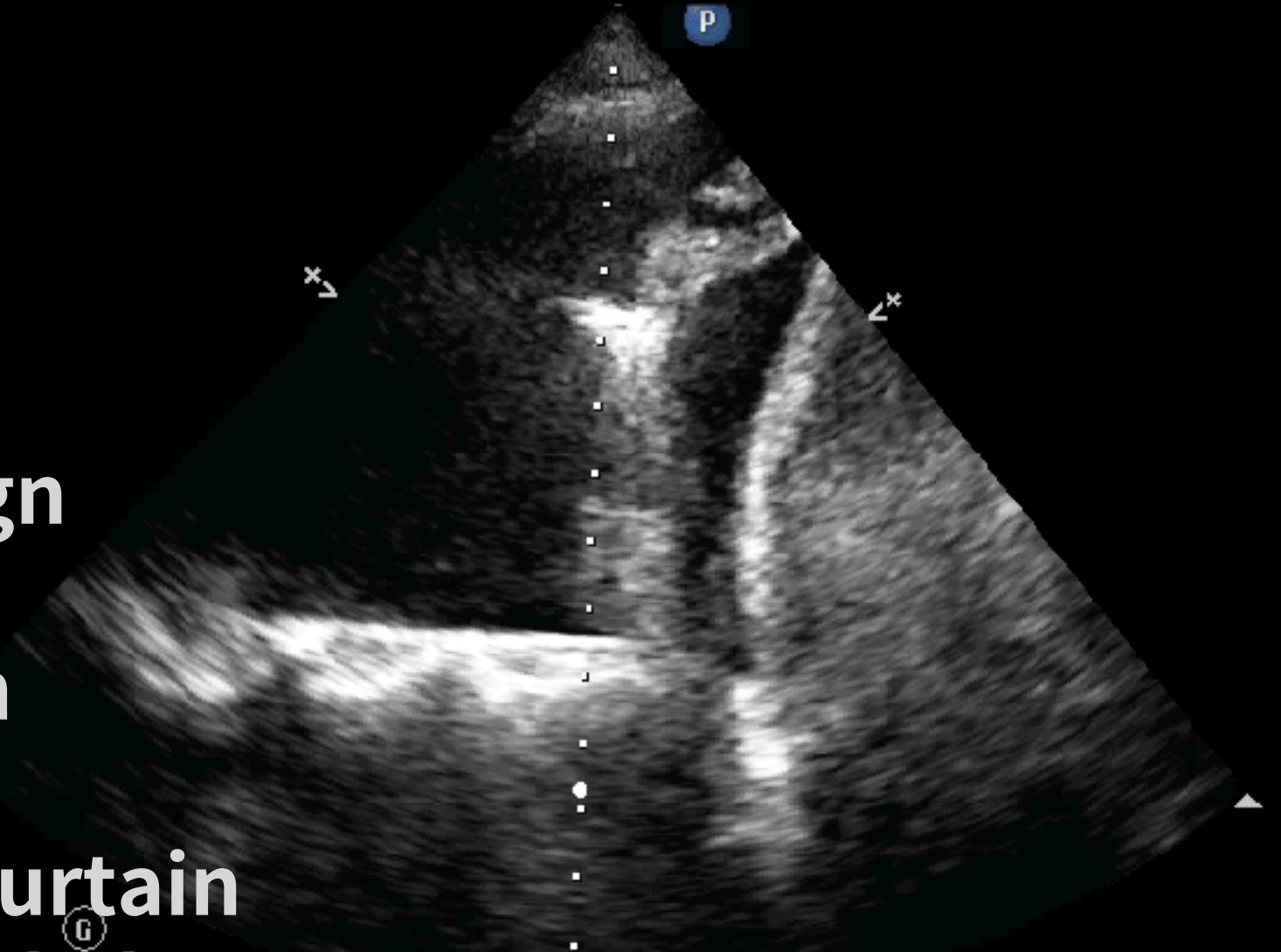
Adult Echo2
G-1
Hz
6.0cm

Gen
n 30
50
/ 2 / 0

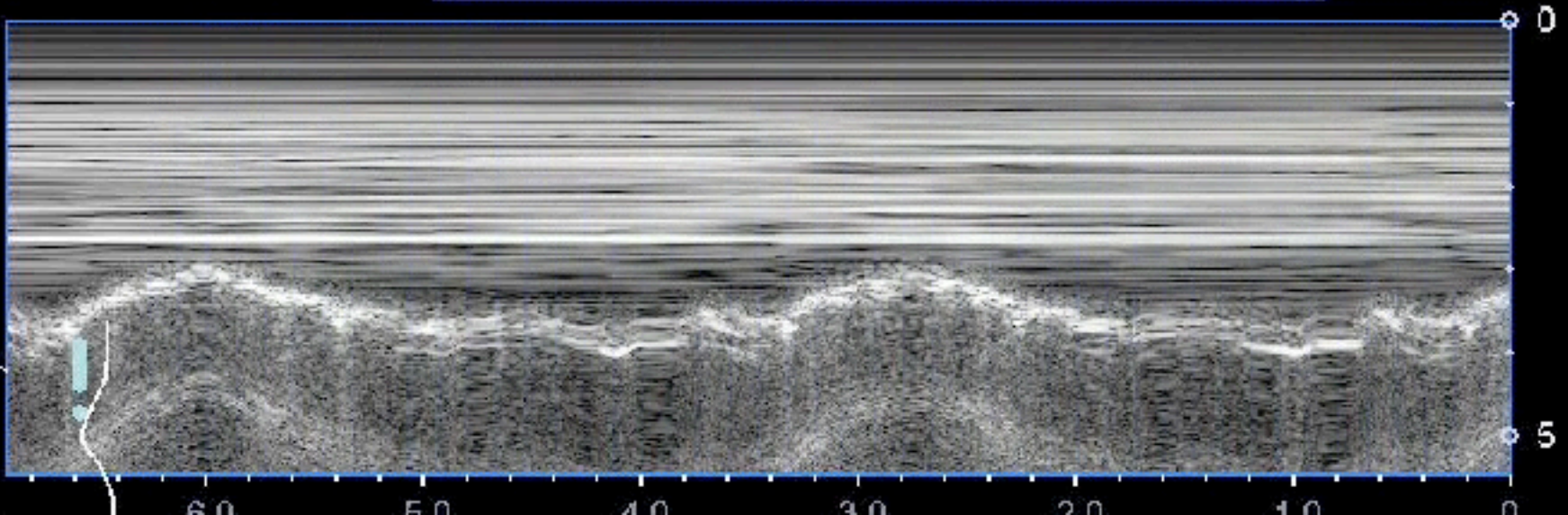
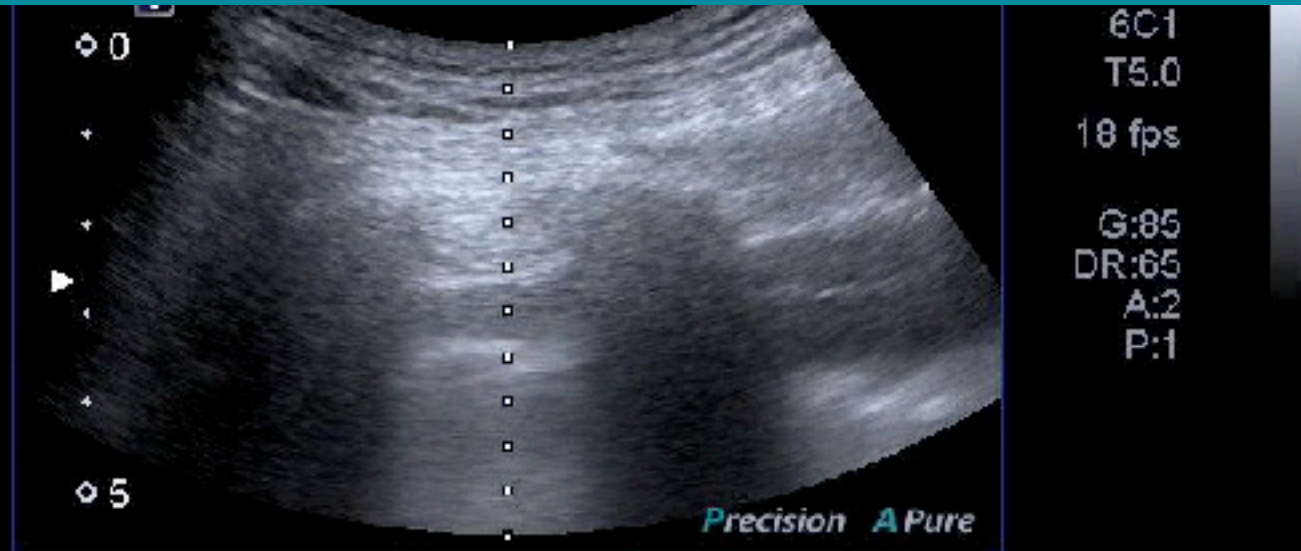
Spine sign

Jelly fish

Loss of curtain



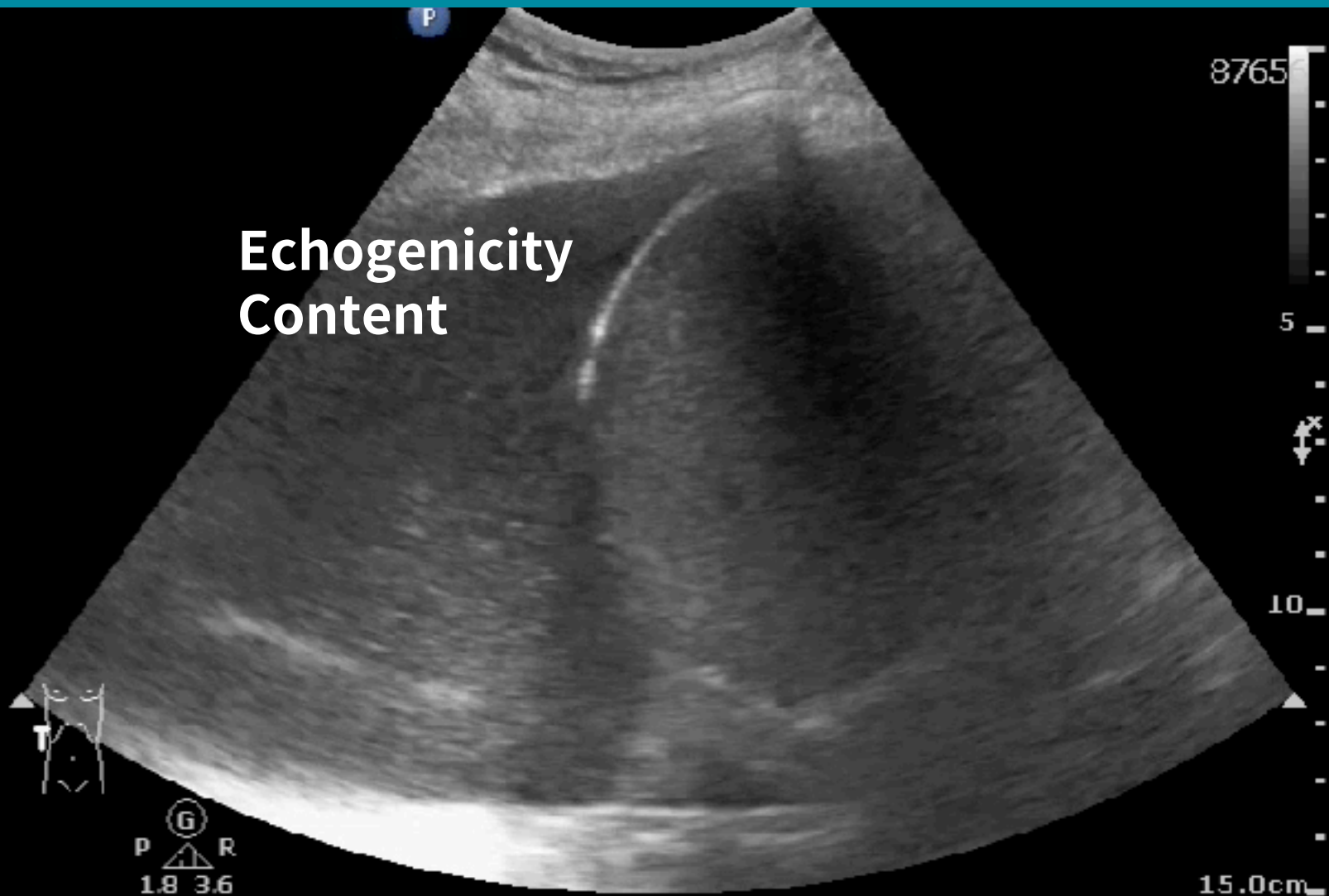
Sharp sign / Sinusoid sign



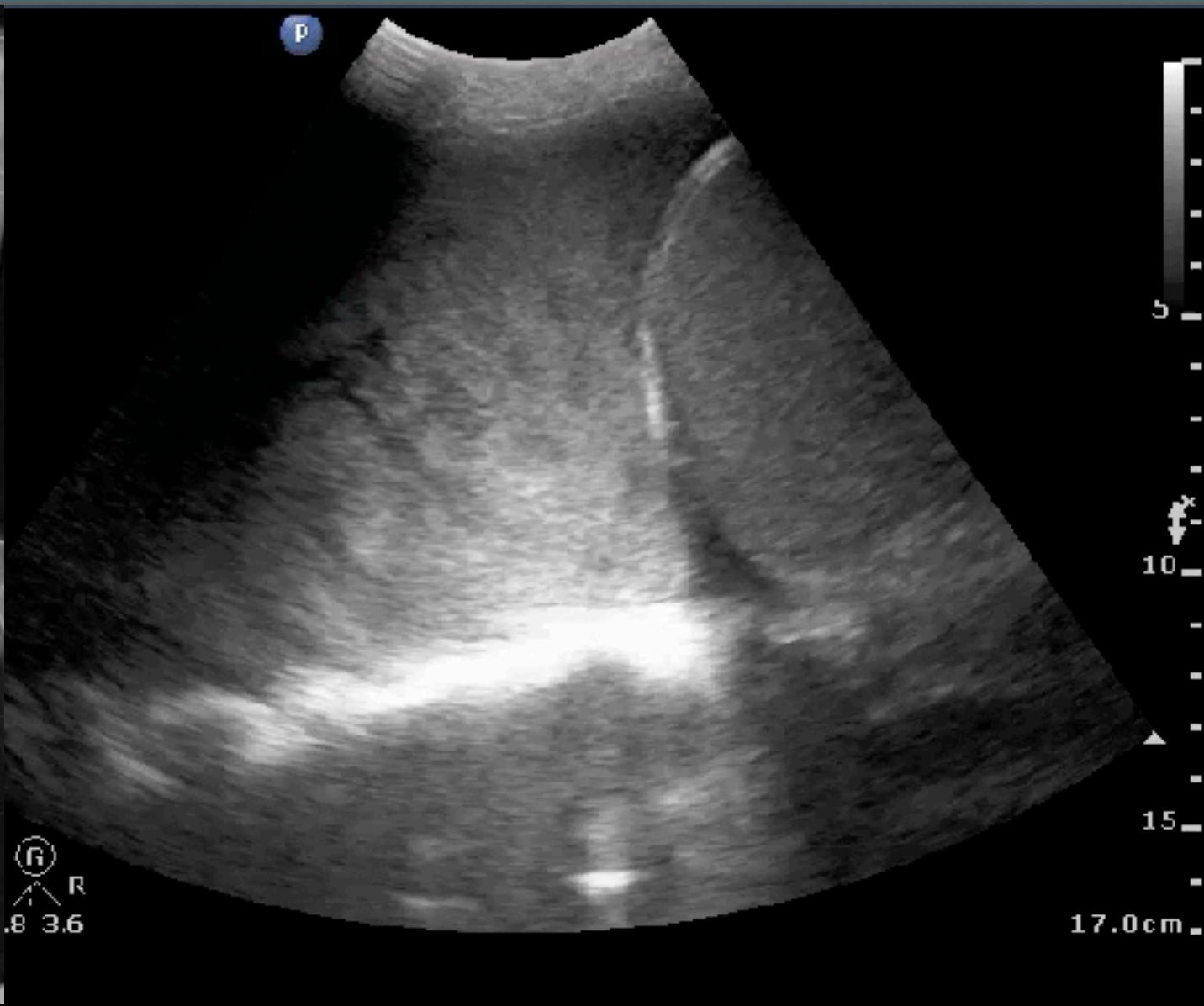
Plankton sign

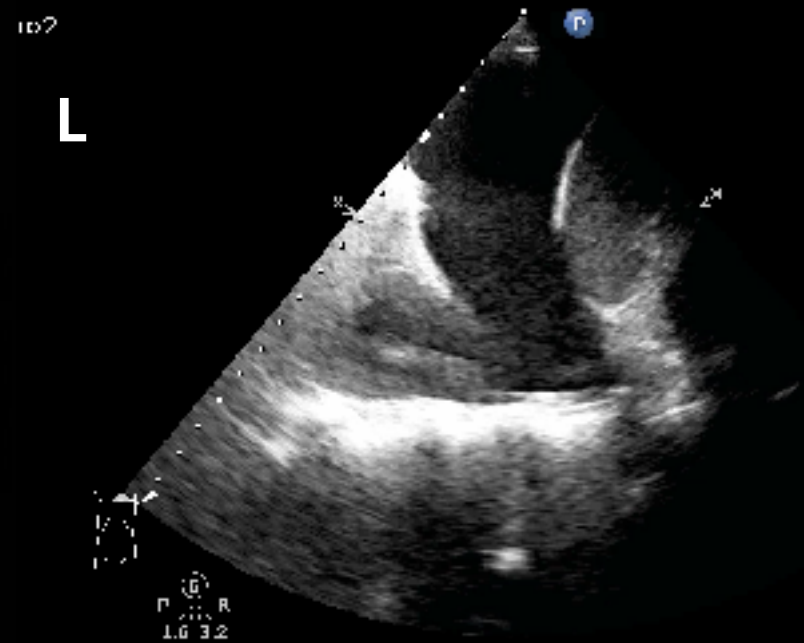
Abd Gen2
C5-1
34 Hz
15.0cm

2D
HGen
Gn 100
C 56
3/3/3



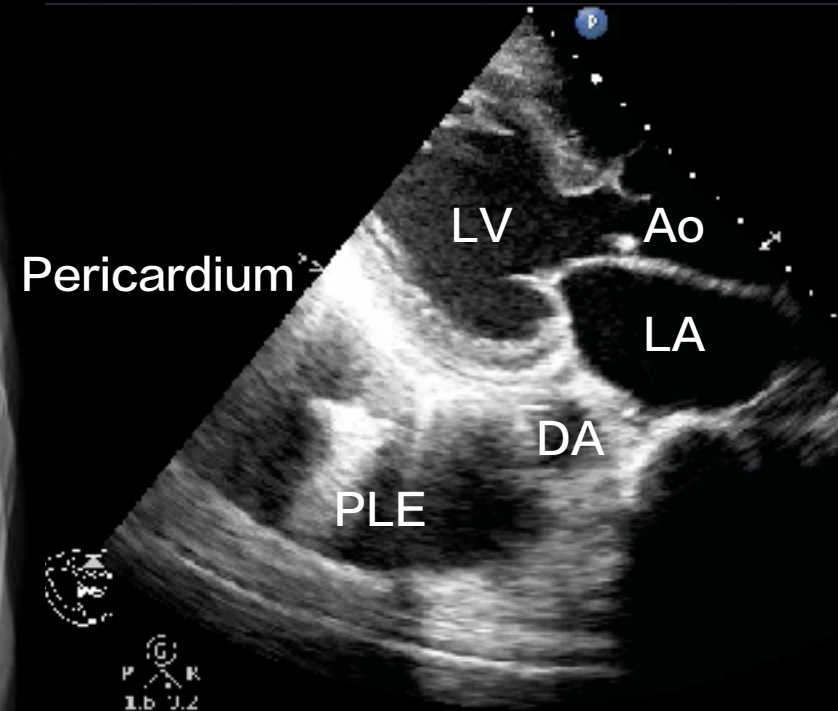
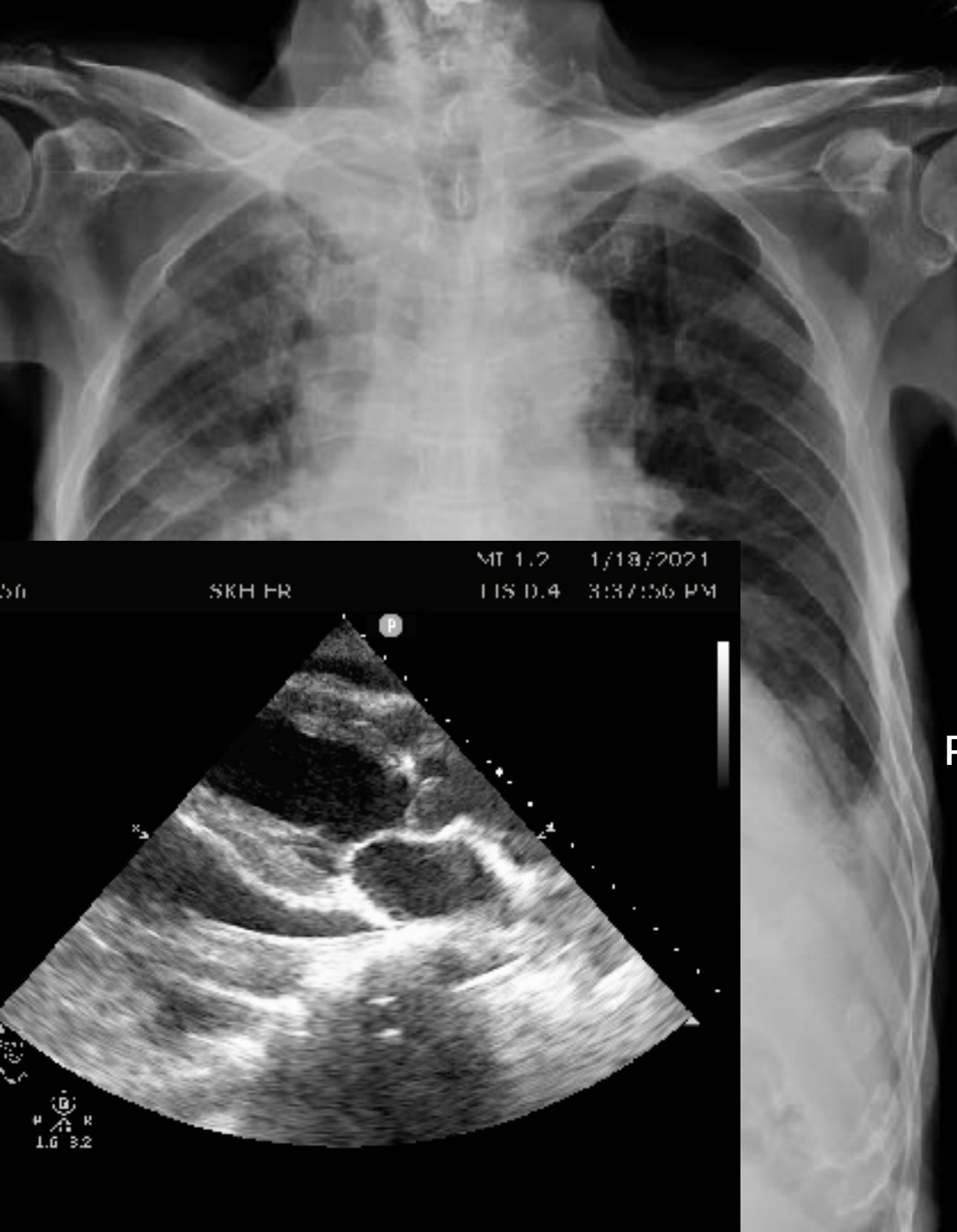
What do you see ?





D aorta

Pericardial vs Pleural



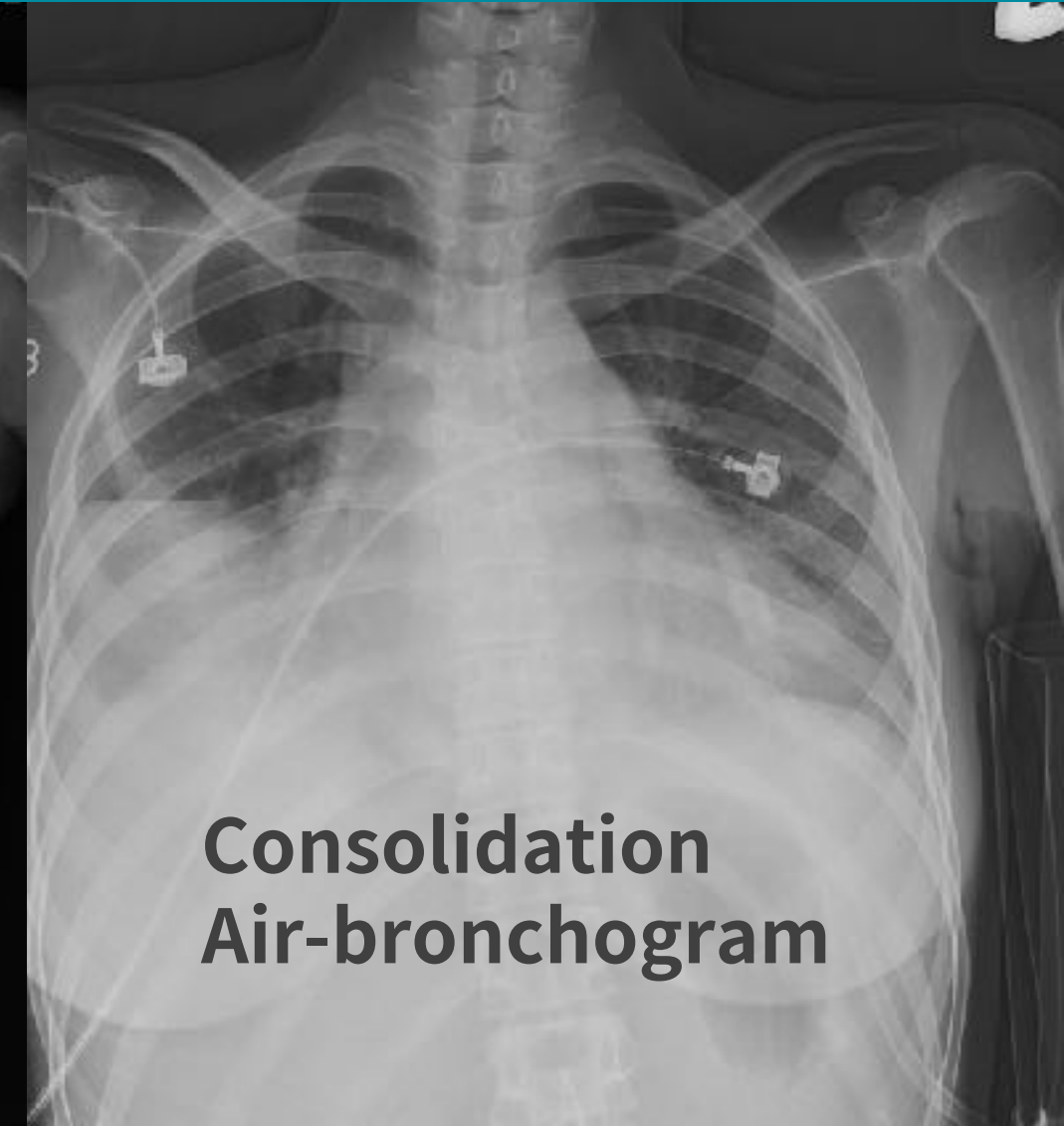
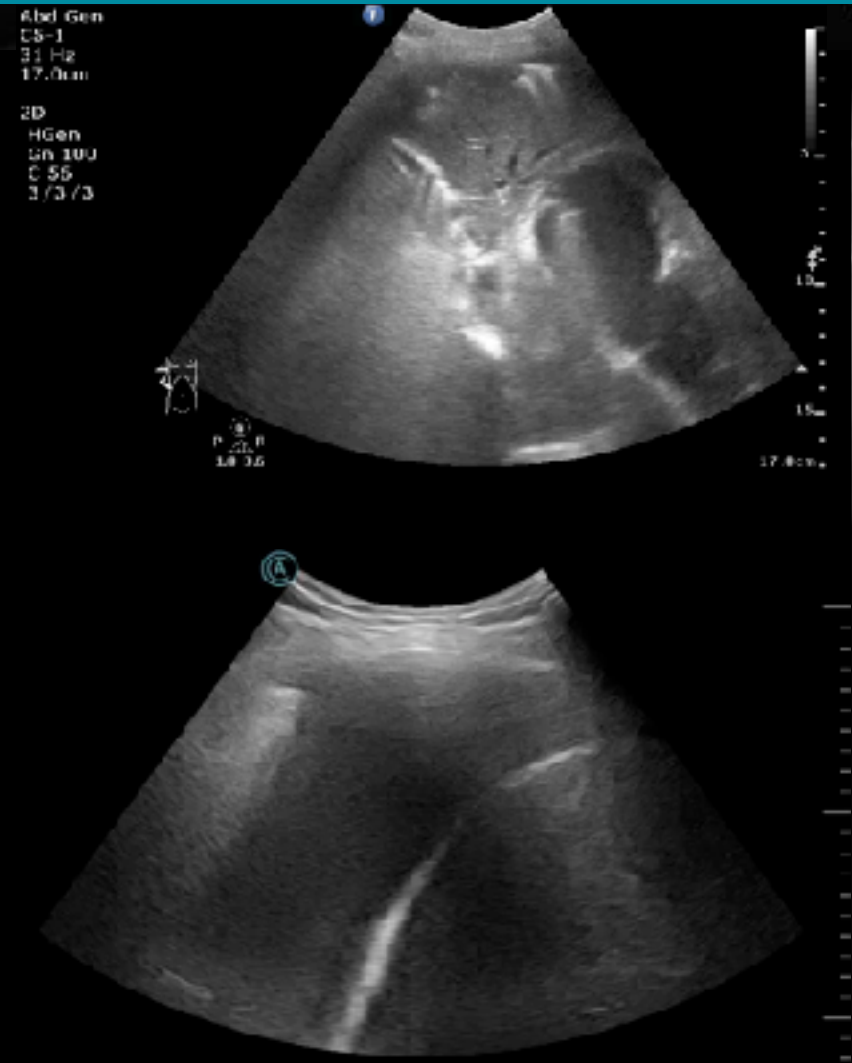
73M, F & Dyspnea



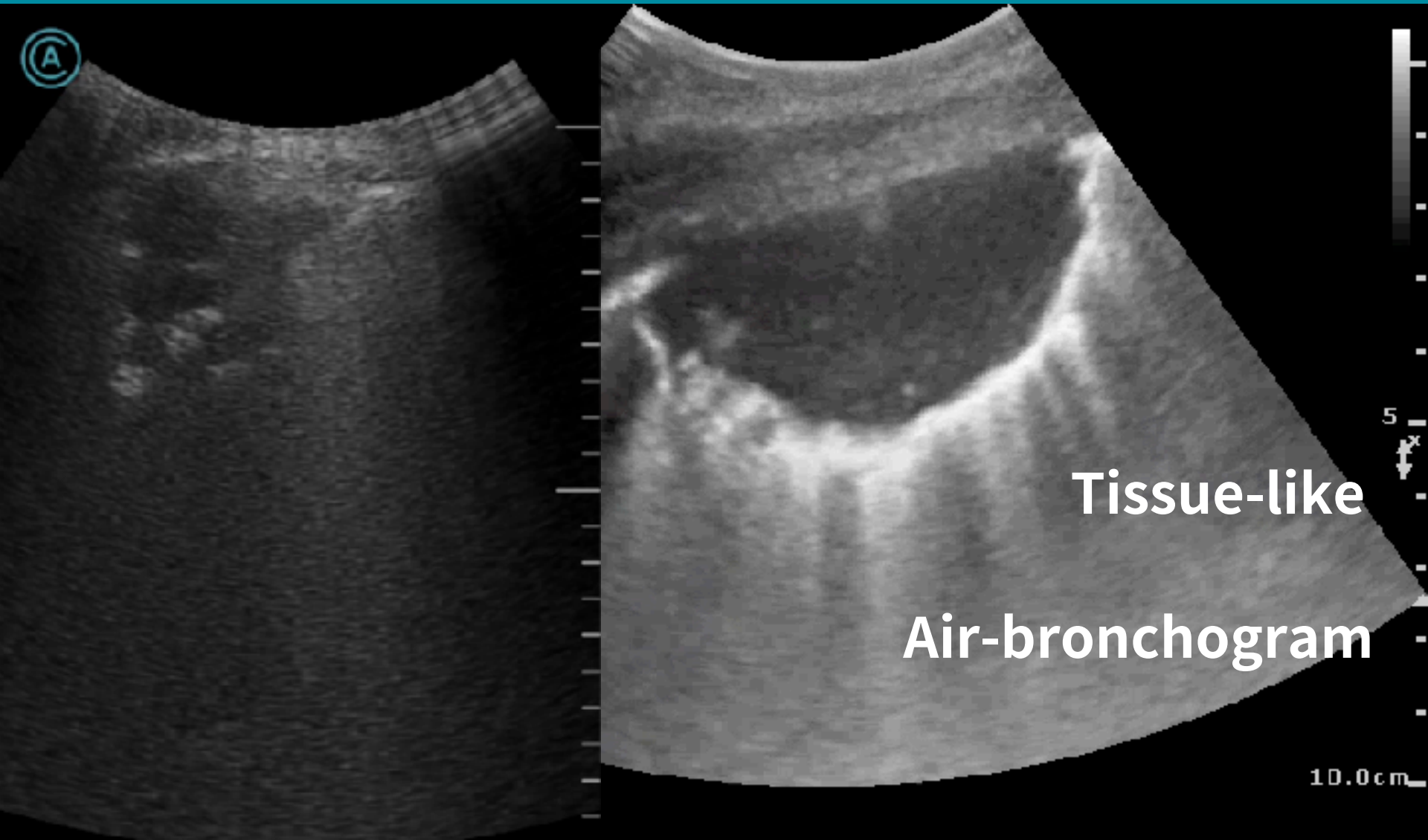
Empyema



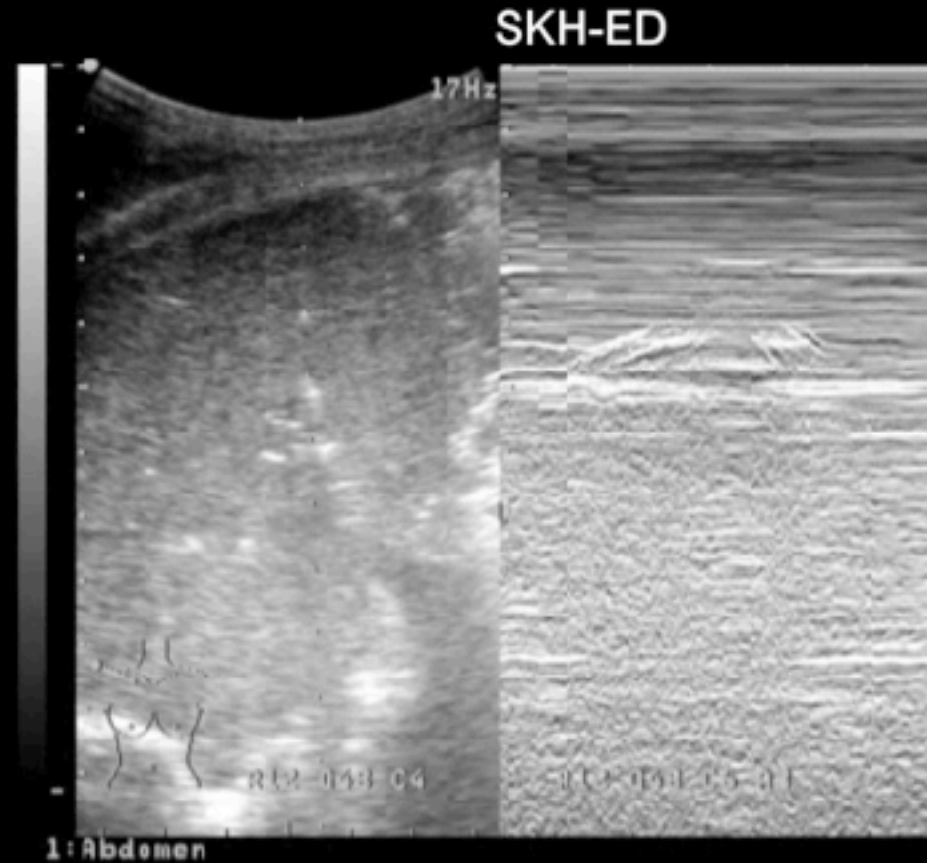
28F, 來抽肋膜積液吧 !?



C profile



Dynamic air-bronchogram



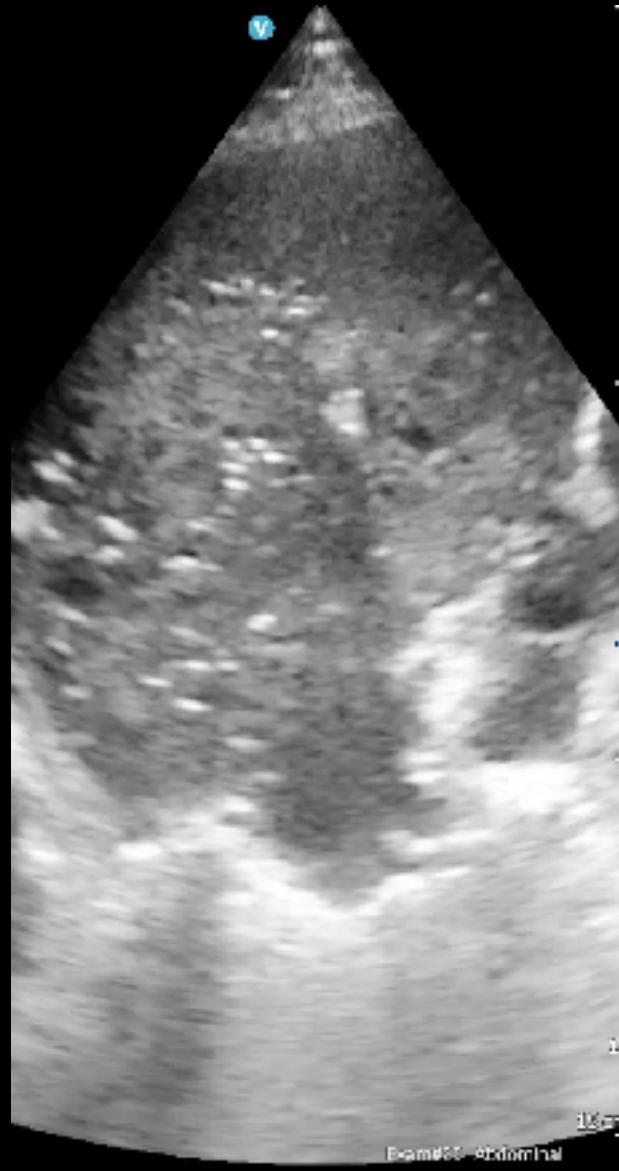
49M, FEVER & COUGH FOR 2 WEEKS



RUL PNEUMONIA

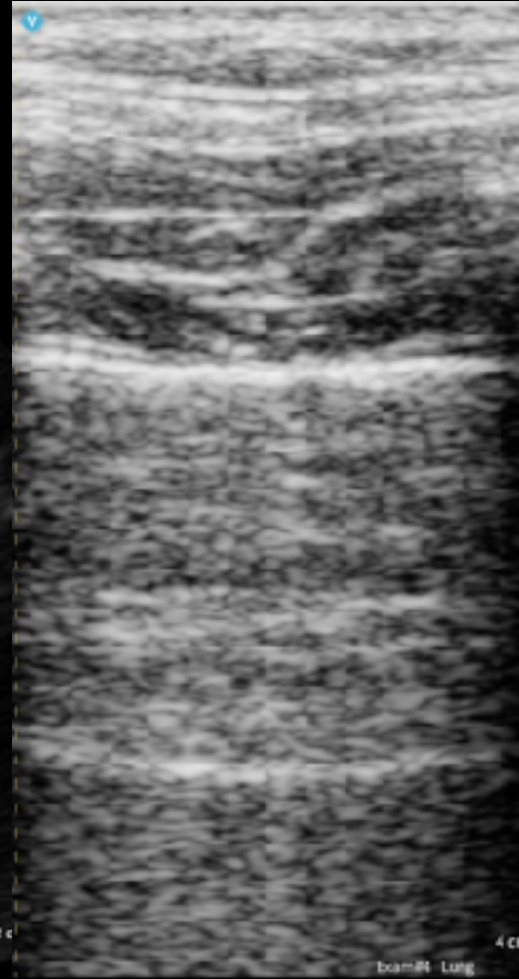
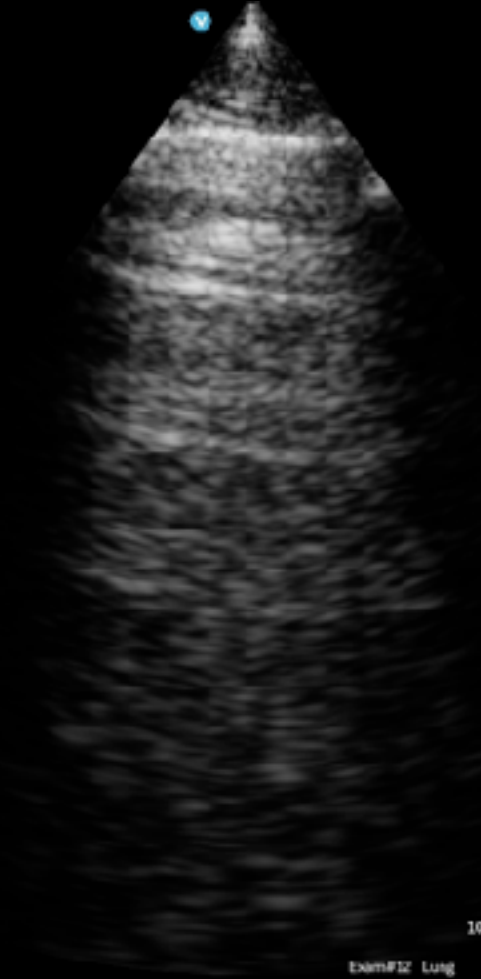


PNEUMONIA



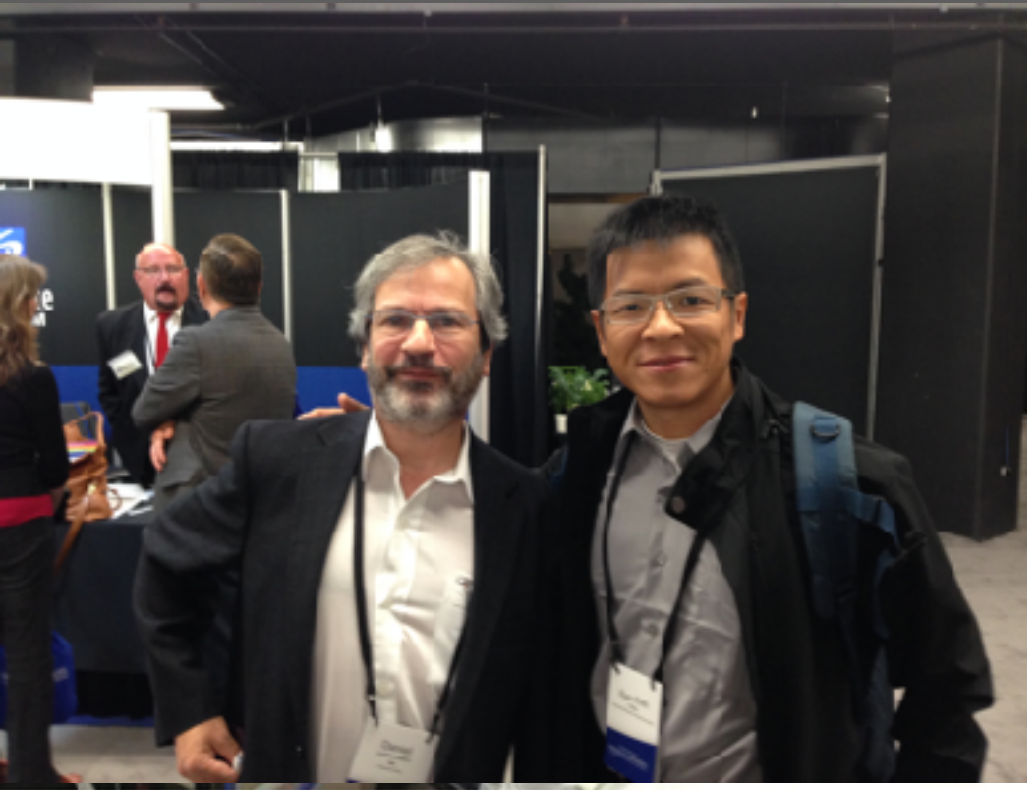
NORMAL PLEURA (CL / SL)

請多熟悉和嘗試不同的設定



BLUE Protocol

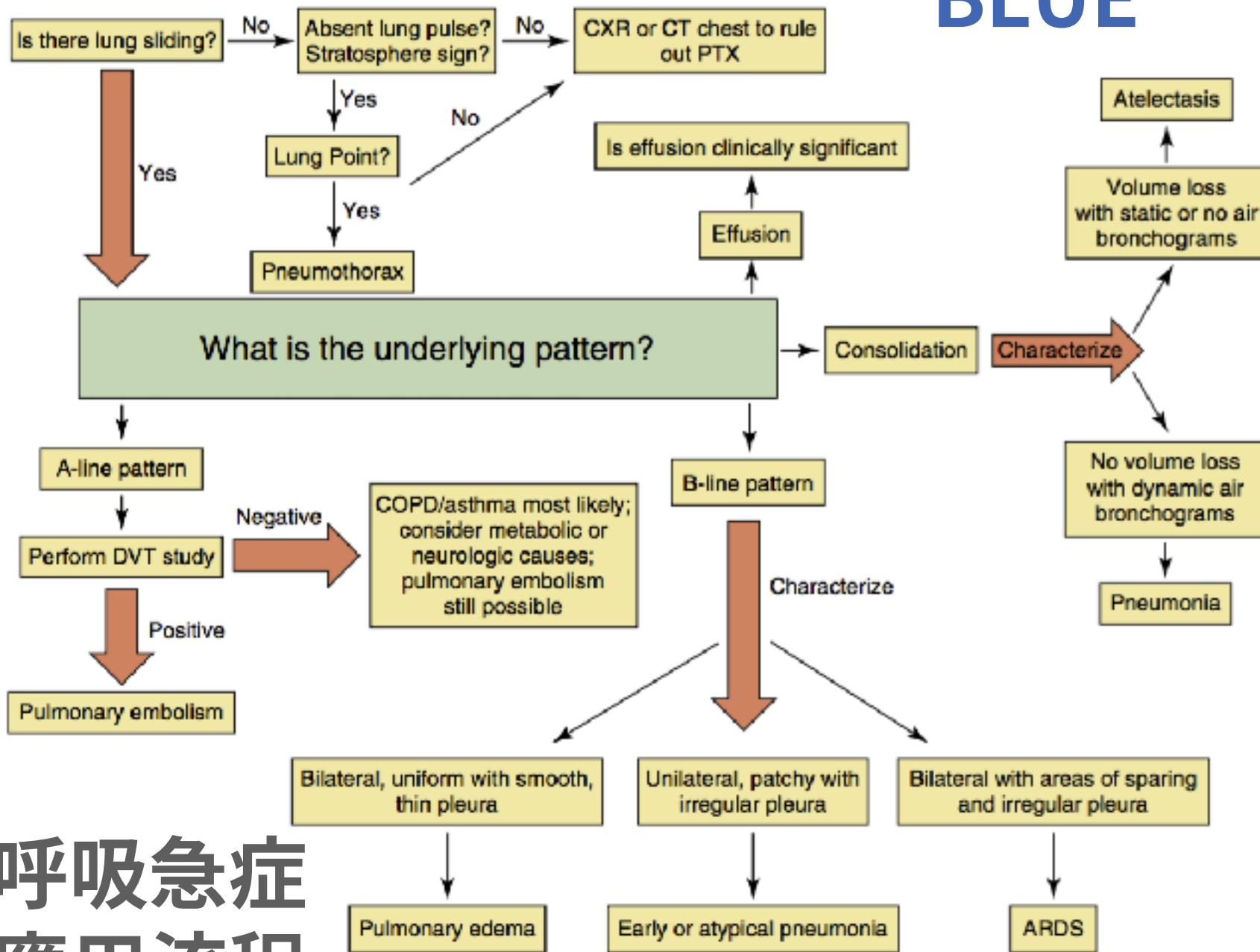
(Bedside Lung Ultrasound in Emergency Protocol)



Daniel Lichtenstein

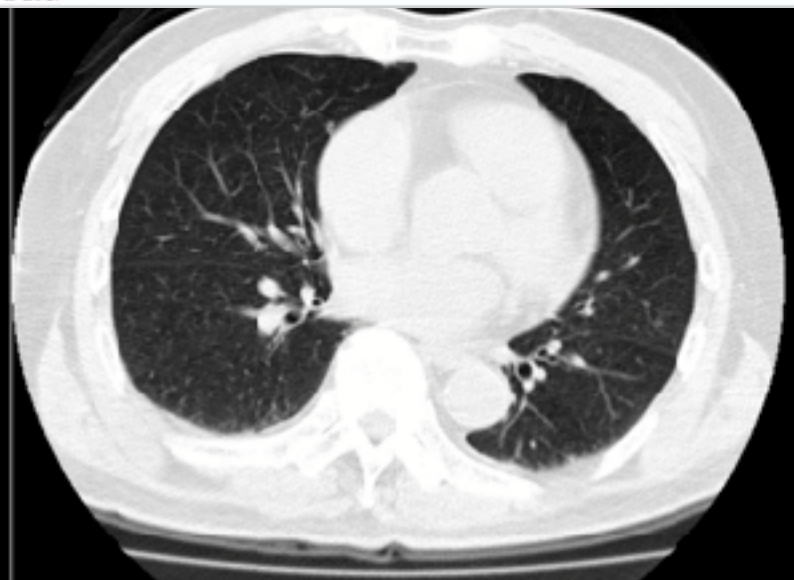
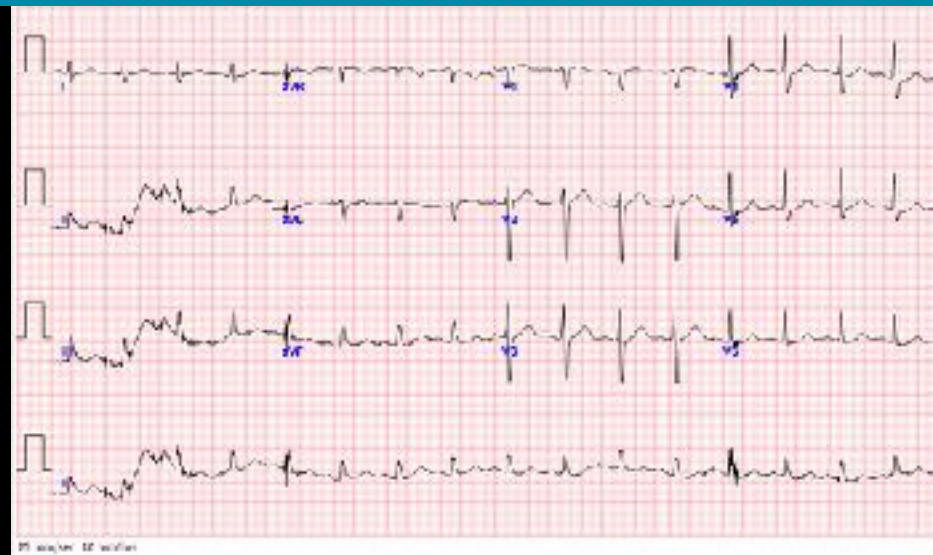
BLUE

S
A
B
E
C



呼吸急症
應用流程

76M, Dyspnea & desaturation



76M, Dyspnea & desaturation



PSLA

D sign

McConnell's sign

Pulmonary infarction

Wedge shaped



呼吸喘看肺—心—靜

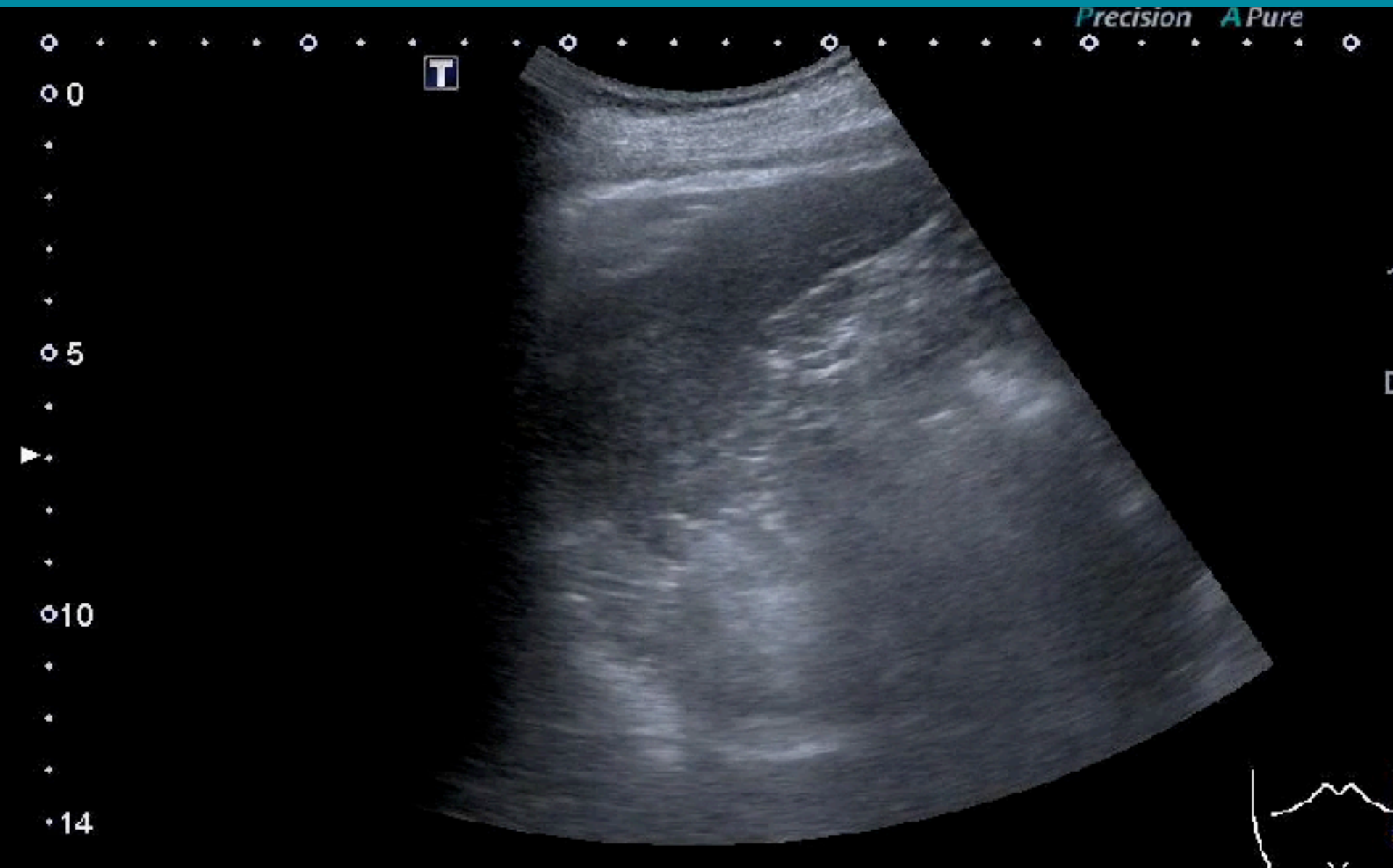
肺栓塞看靜—心—肺 4.9cm



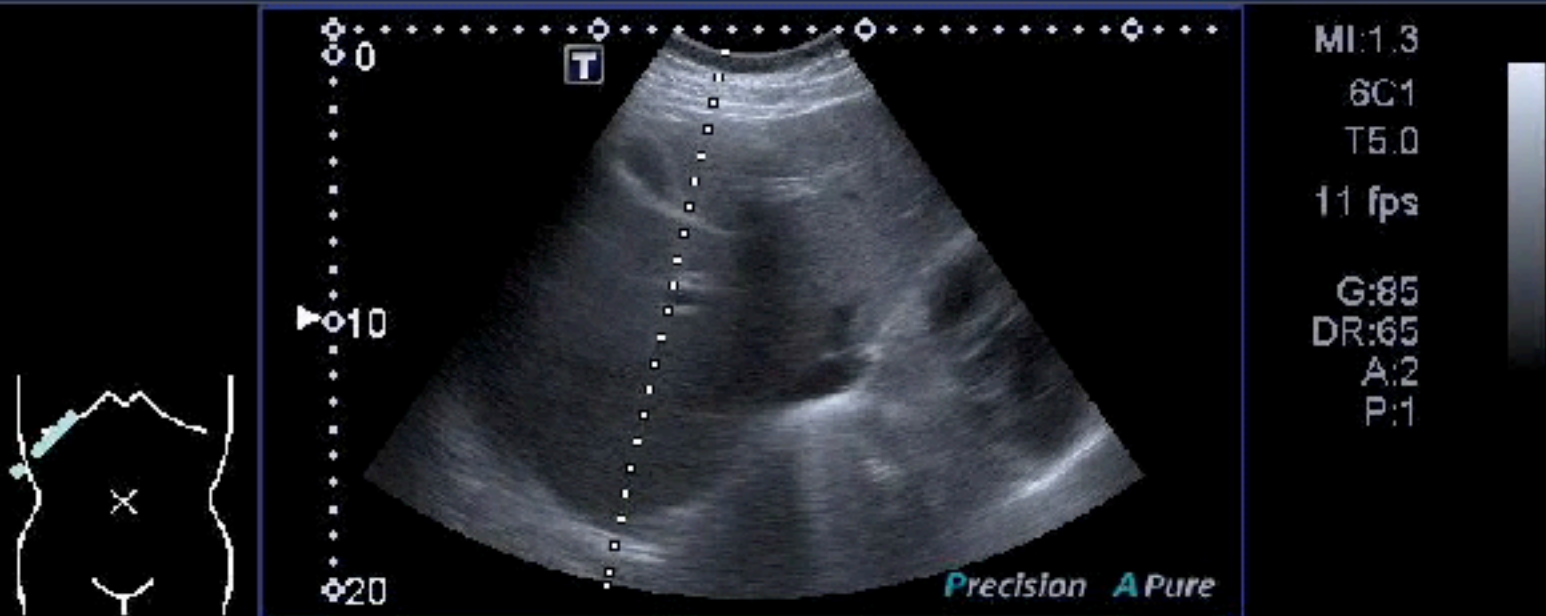
Curtain sign & Diaphragm movement



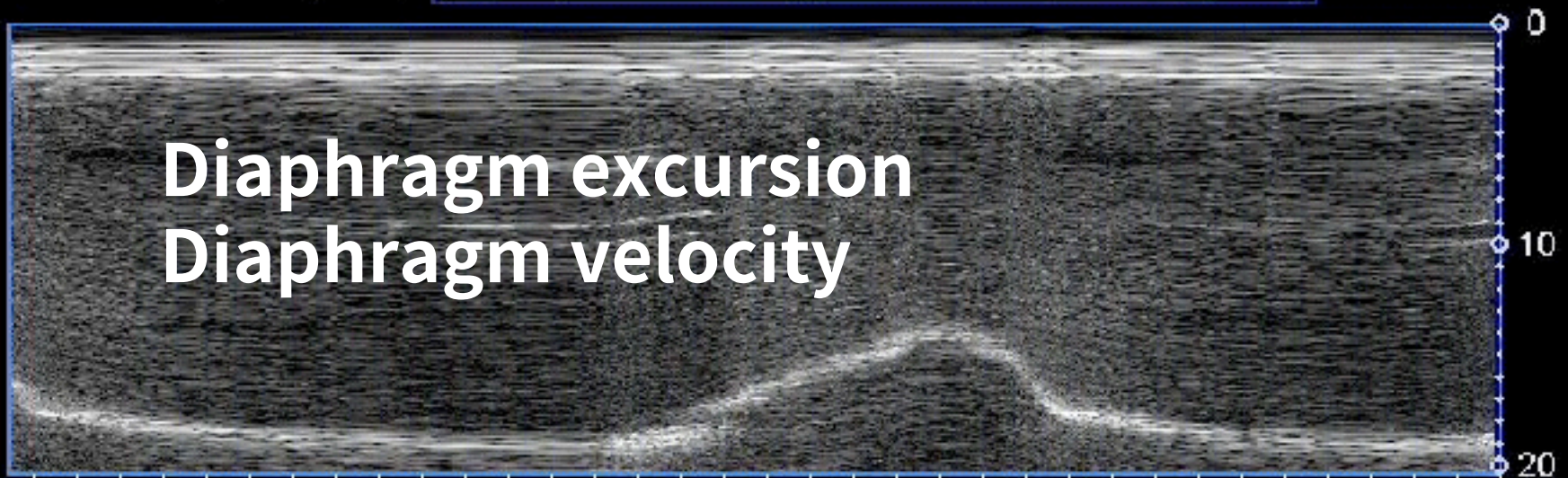
Greatest motion of sliding



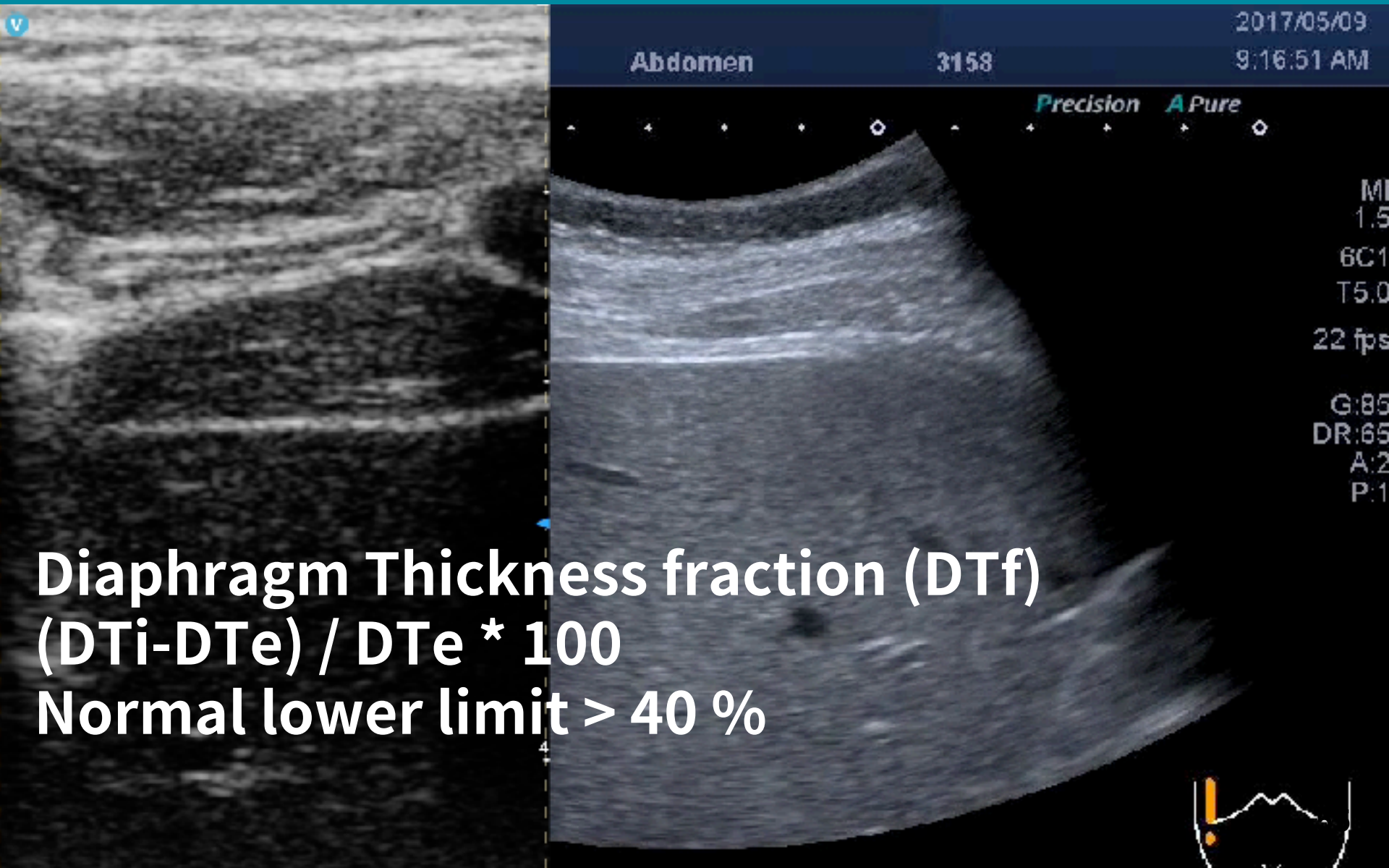
Respiratory drive



Diaphragm excursion
Diaphragm velocity



Respiratory drive



Diaphragm Thickness fraction (DTf)
 $(DTi - DTe) / DTe * 100$
Normal lower limit > 40 %

Back !!!



Abd Gen2
C5-1
39 Hz
12.0cm

2D
HGen
Gn 100
C 56
3/3/3

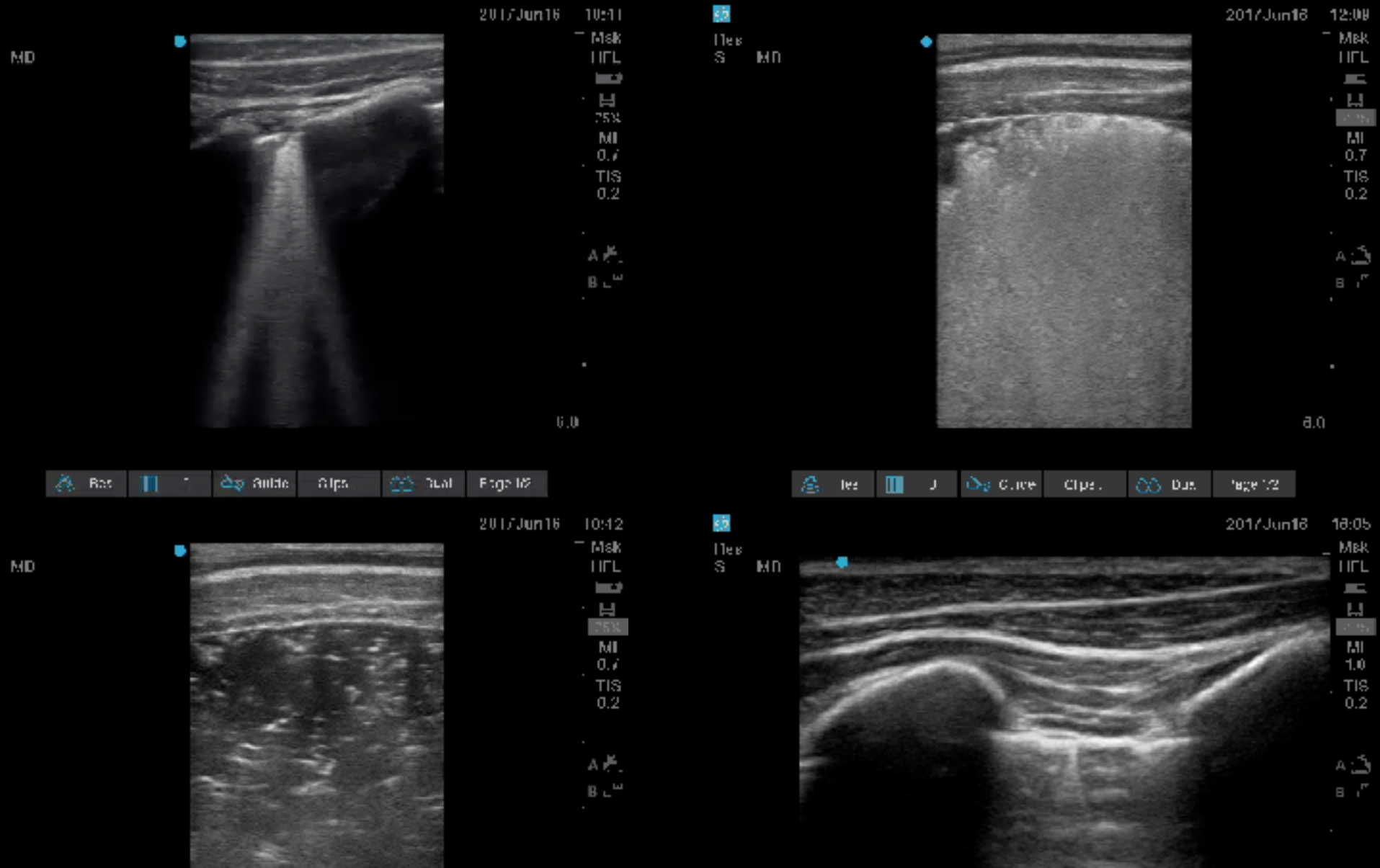


Abd Gen2
C5-1
39 Hz
12.0cm

2D
HGen
Gn 100
C 56
3/3/3



Atelectasis



Indication

- Respiratory symptoms and/or signs
- Unclear chest radiograph findings
- Monitoring and prognosis

← Pretest probability

- History
- Physical examination
- ABG
- ECG

DIAGNOSTIC HYPOTHESIS

Pleural effusion suspected

PTX suspected

Increased lung density suspected

Patient position
Probe selection & orientation
Protocol selection

Picture optimization

- Semisitting (or supine)
- Low-frequency probe
- Maintain postprocessing artifacts reduction algorithms
- Start examination from lung bases; identify diaphragm and spine

- Ideally supine
- If possible, high-frequency probe
- Consider M-mode and Power Doppler
- Identify least dependent zone

- Semisitting or supine
- Low-frequency and high-frequency probes
- If B-line pattern analysis, deactivate post-processing artifacts reduction algorithms
- Complete lung examination (anterior, lateral, and posterior surfaces, bilaterally)

Acquisition

Interpretation

PLEURAL LINE INTERFACE

Fluid

Pleural effusion/
Hemothorax

- Size
- Fluid characteristics

A-line Pattern

- Lung sliding? **YES**
- Lung pulse? **YES**
- Vertical artifact? **YES**
- NO**

PTX likely

Lung point?

PTX highly likely

Normal lung density
at pleural line

- Consider:
- PEEP effect/lung overinflation
 - Lung pathology not reaching pleural line
 - Early stages of lung pathology
 - Performance of further tests

Diagnostic

Nondiagnostic

Increased Lung Density

- Increased lung weight (water, cells, pus, blood, proteins, connective tissue, lipids) and/or
- Lung deflation

B-line Pattern

Diffuse

Focal

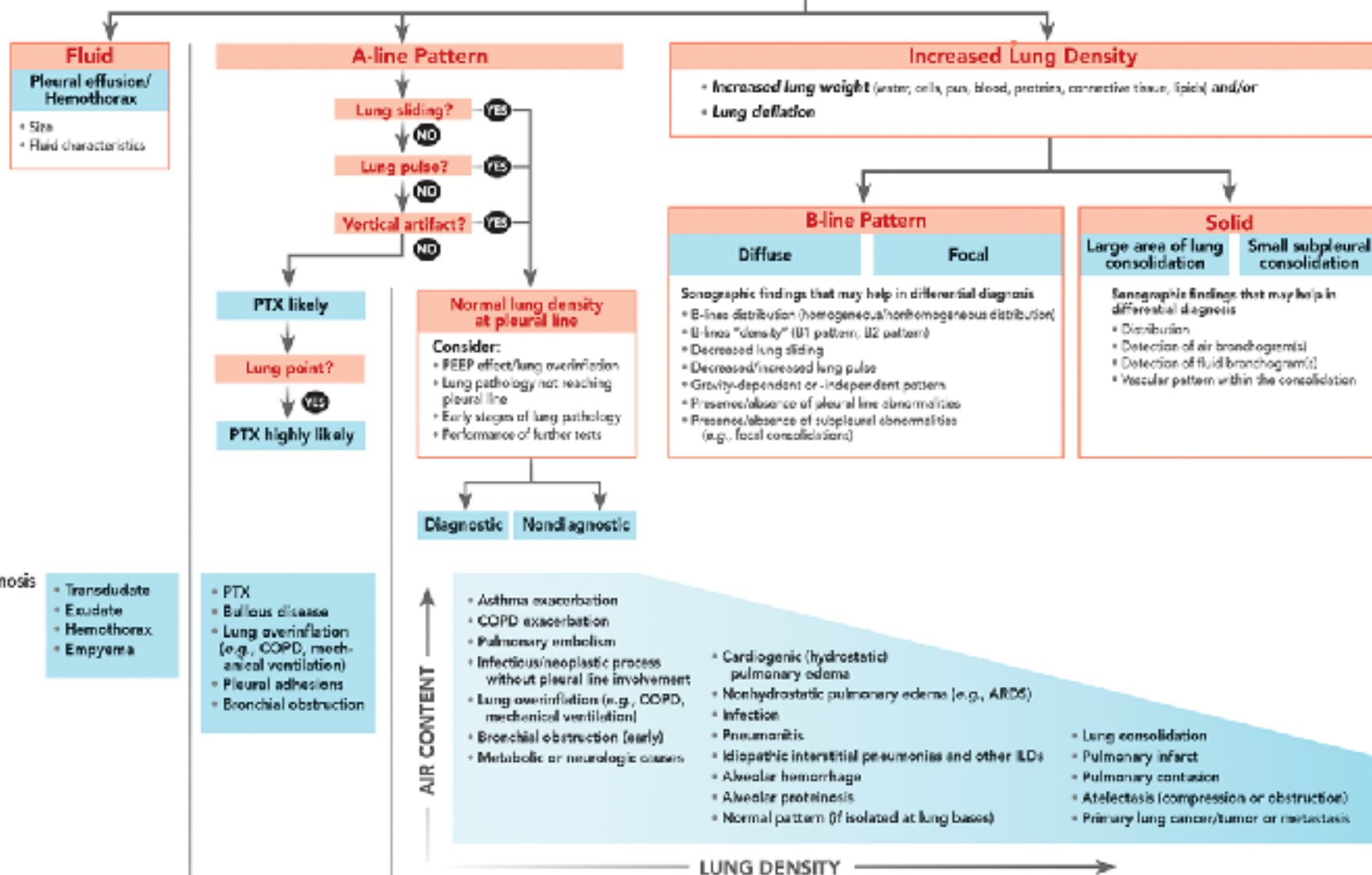
- Sonographic findings that may help in differential diagnosis
- B-lines distribution (homogeneous/nonhomogeneous distribution)
 - B-lines "density" (U1 pattern, U2 pattern)
 - Decreased lung sliding
 - Decreased/increased lung pulse
 - Gravity-dependent or -independent pattern
 - Presence/absence of pleural line abnormalities
 - Presence/absence of subpleural abnormalities (e.g., focal consolidation)

Solid

Large area of lung
consolidation

Small subpleural
consolidation

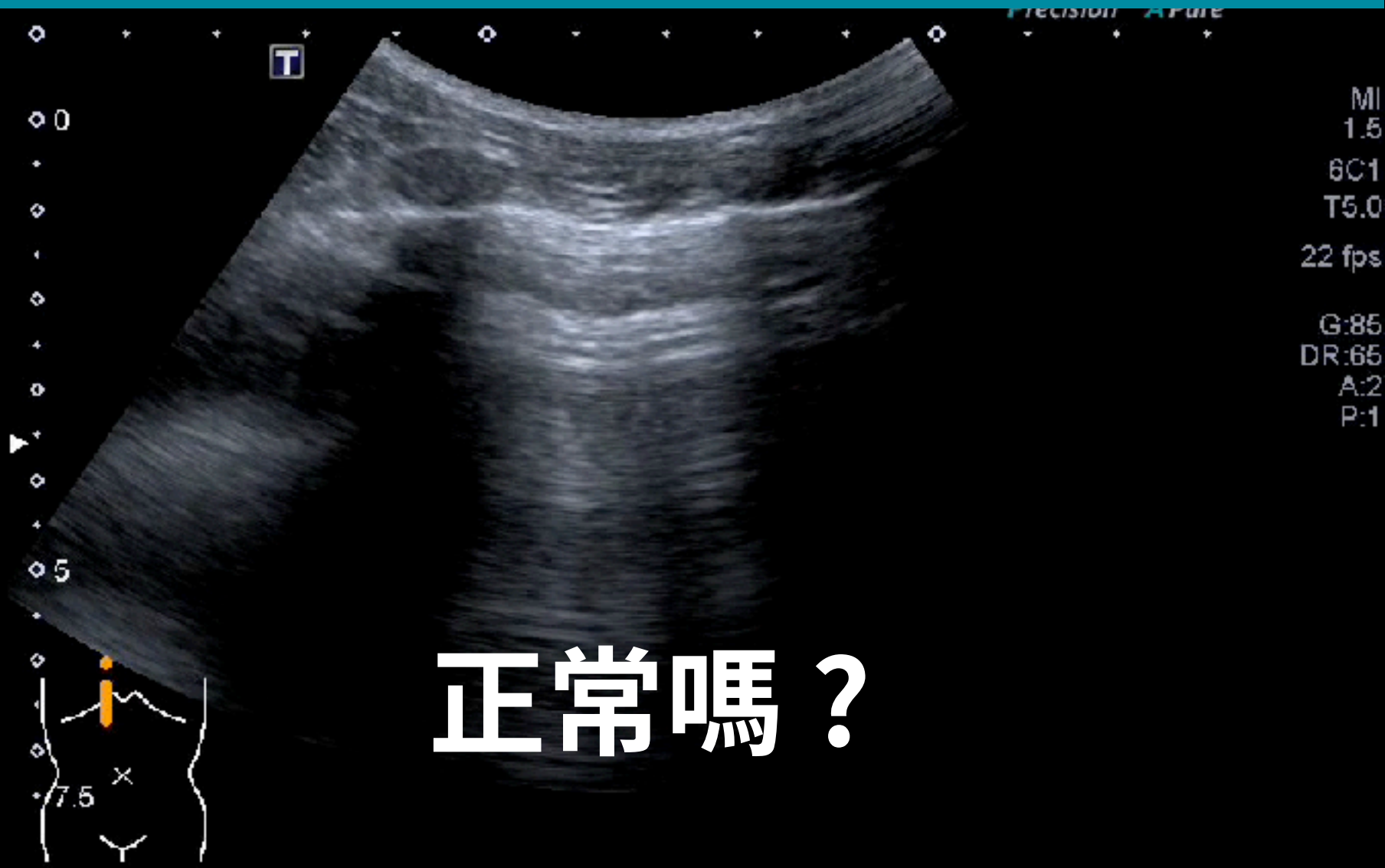
- Sonographic findings that may help in differential diagnosis
- Distribution
 - Detection of air bronchogram(s)
 - Detection of fluid bronchogram(s)
 - Vascular pattern within the consolidation



- Integration with clinical context (pretest probability)
- Consistency or inconsistency of findings with pretest diagnostic hypothesis
- LUS diagnostic or nondiagnostic
- Changes in diagnostic and therapeutic approach



LUNG USG : S - ABCDE



正常嗎？

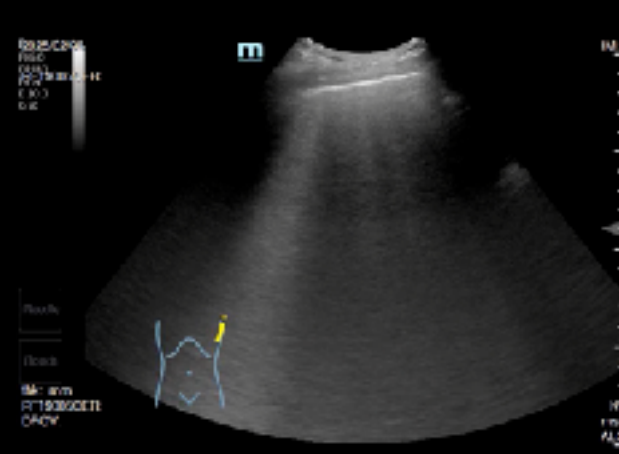
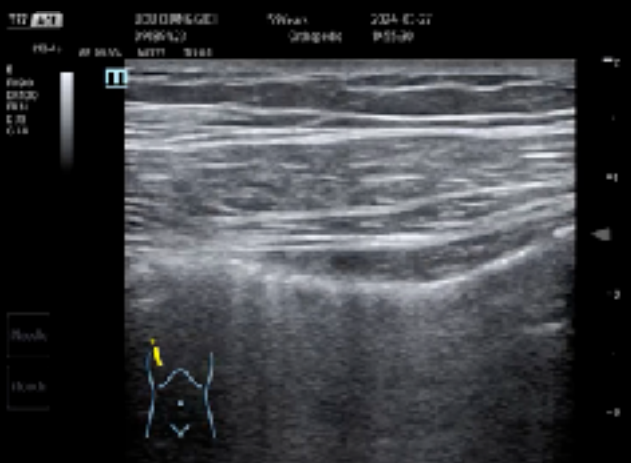
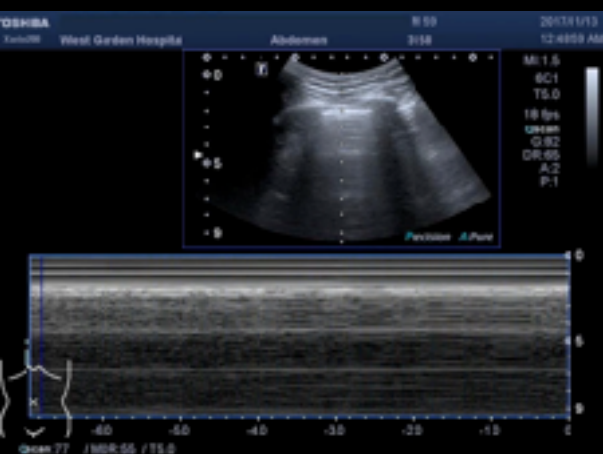
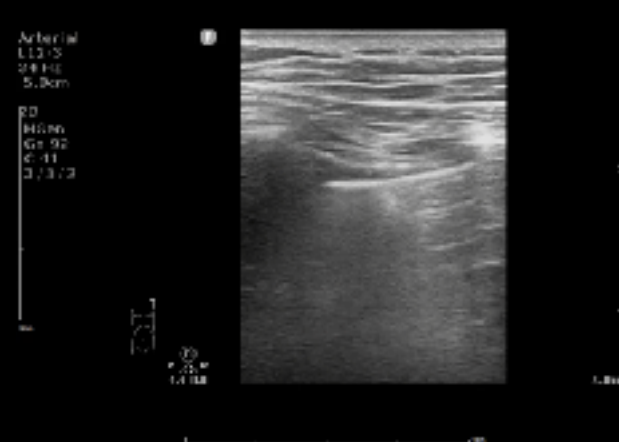
LUNG USG : S - ABCDE



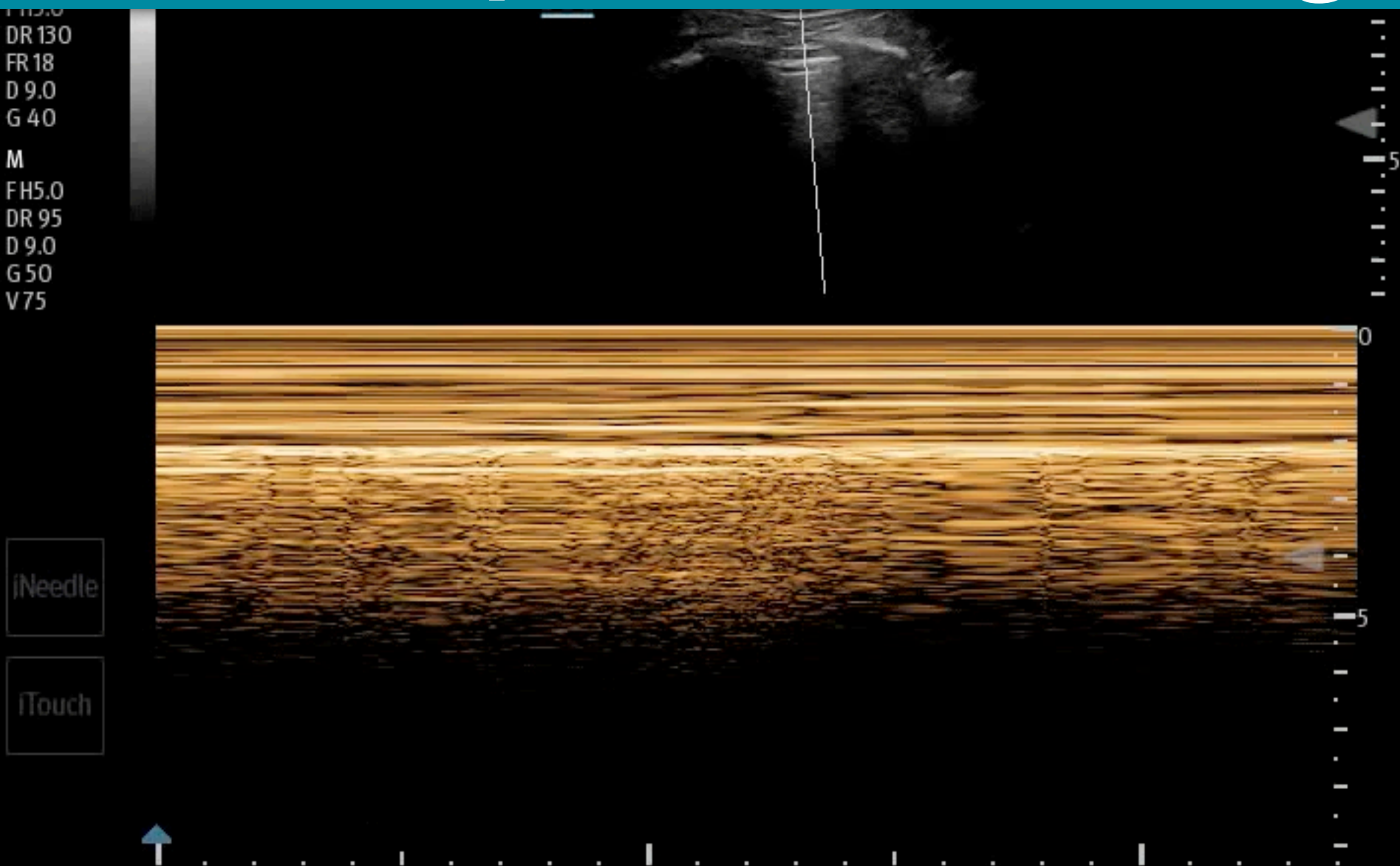
Dyspnea
Chest pain
Infections

PTX
AIS
PLE

Consolidation⁶²



Normal pleura w/ sliding



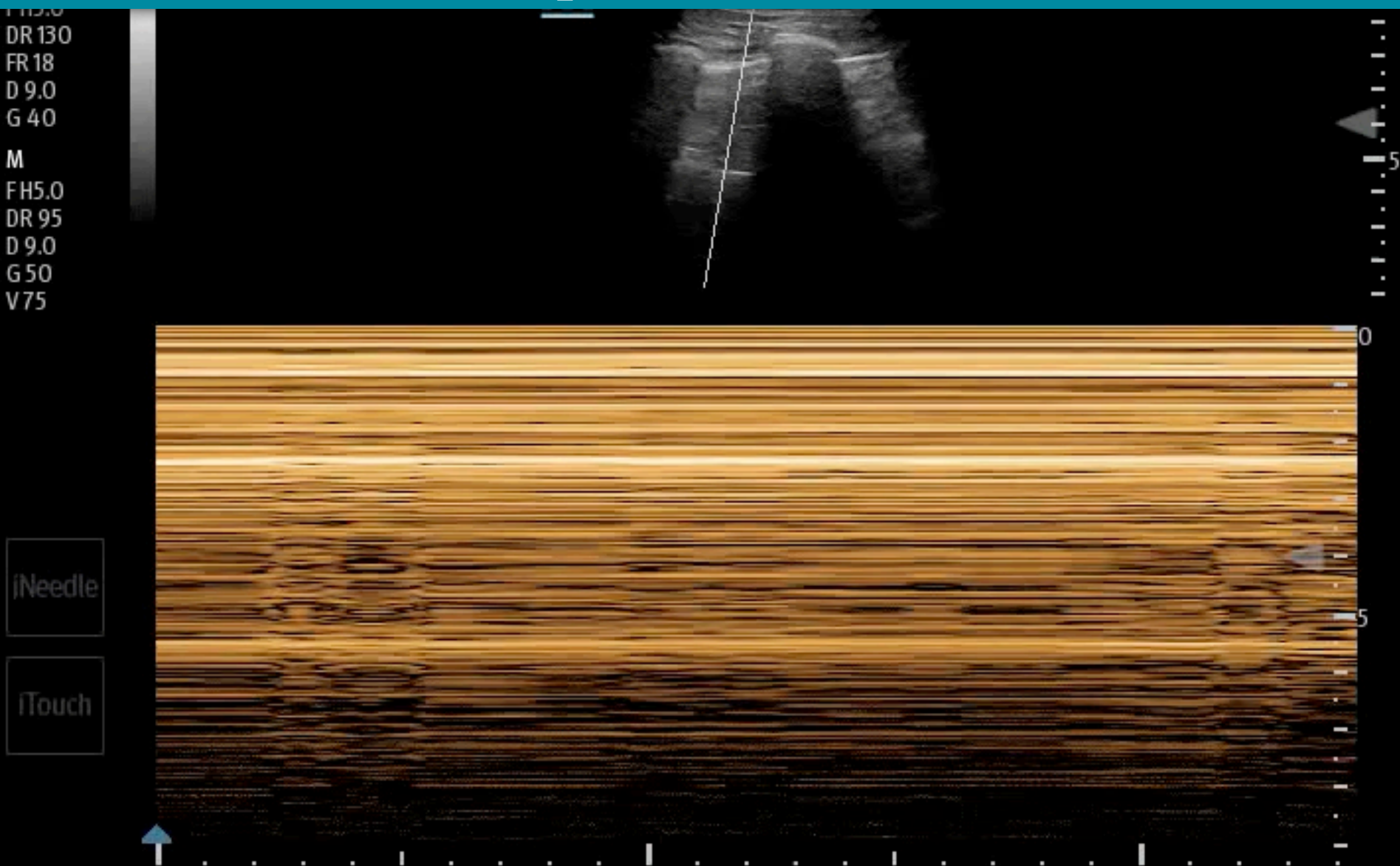


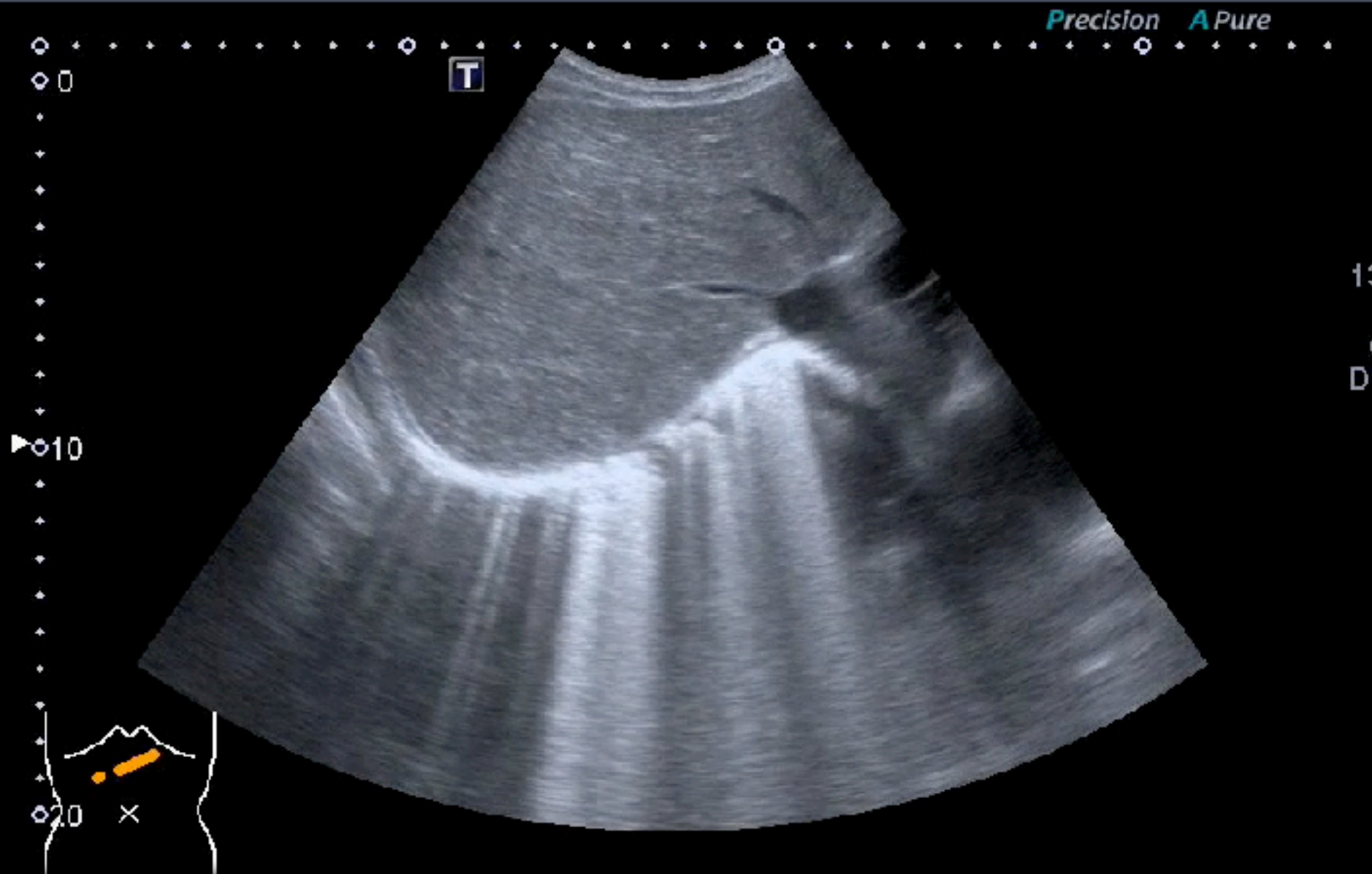
Normal diaphragm function



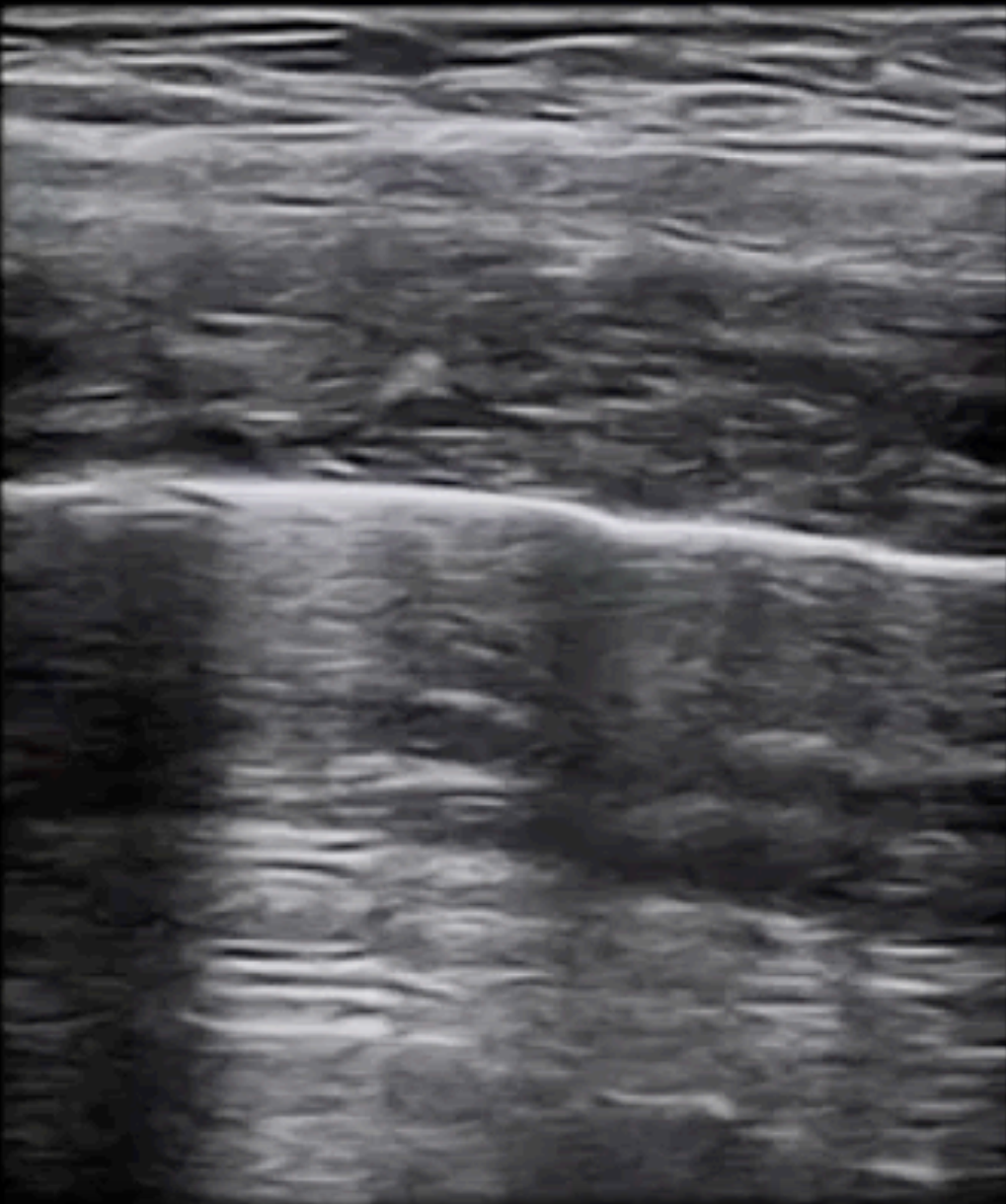
Normal diaphragm & movement

Possible pneumothorax





Pneumonia



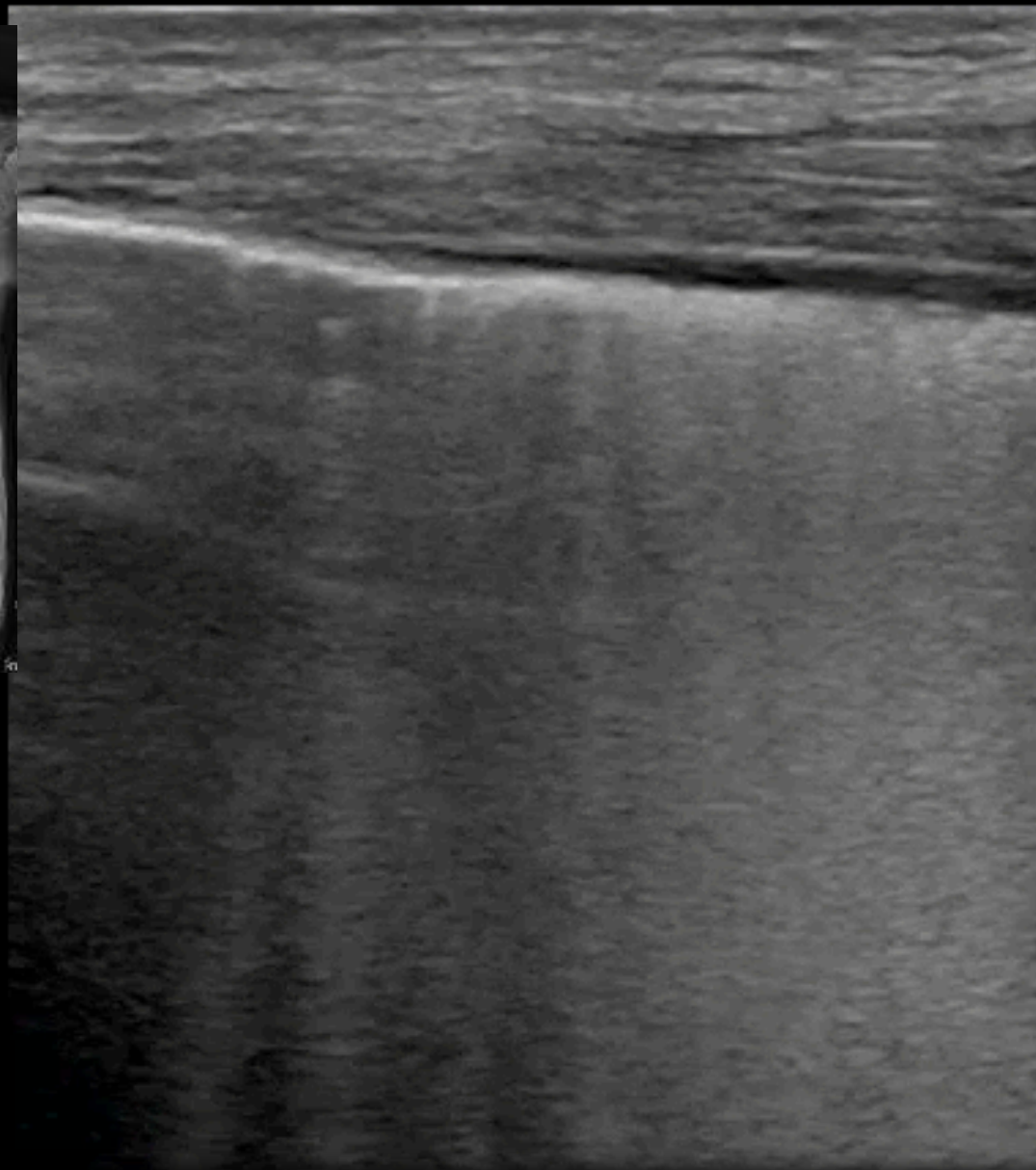
Double lung points

nd Gen
-1
Hz
.0cm

Gen
n 60
56
/3/3



Hydrothorax / Cirrhosis

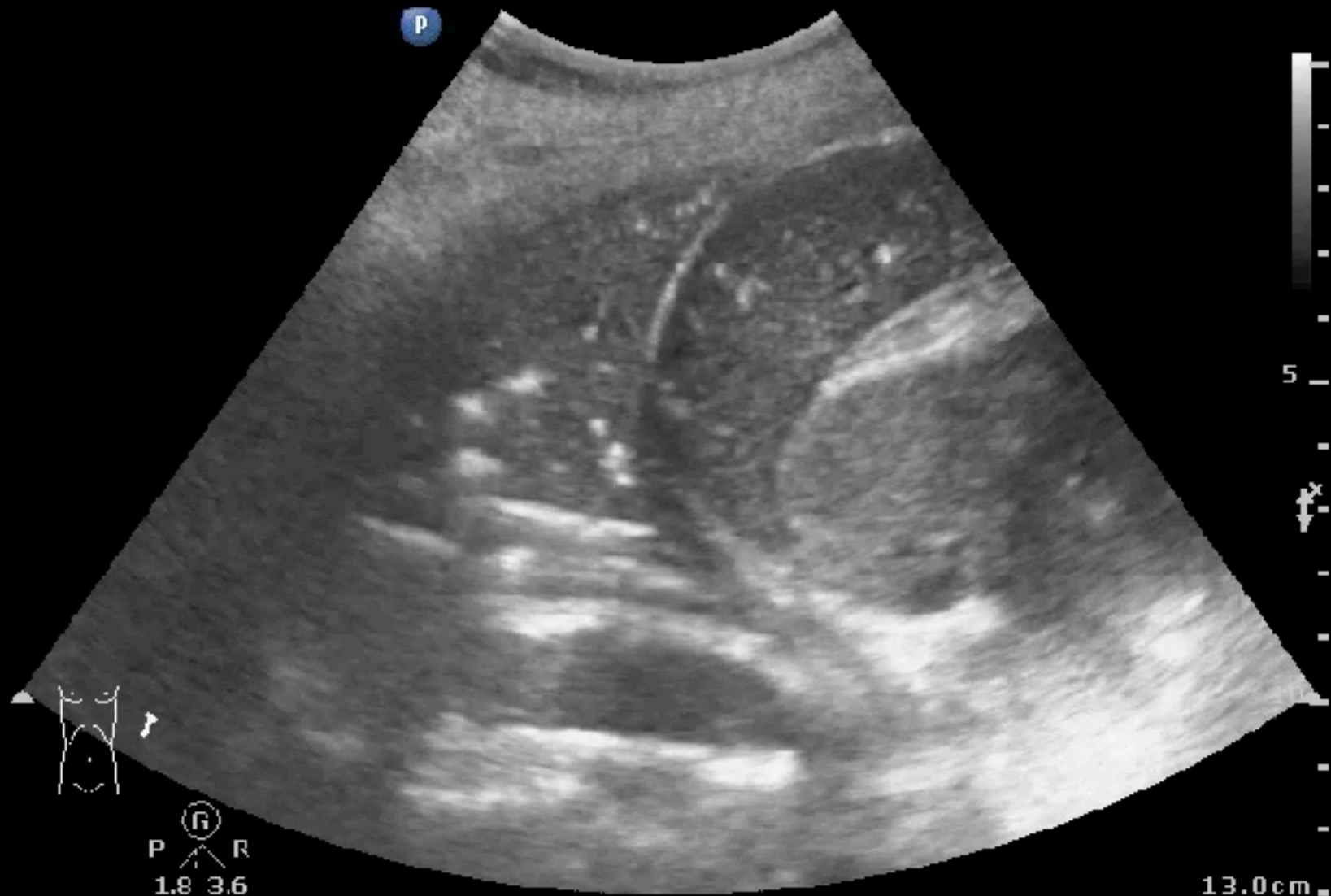


G

Pneumonia

Abd Gen
C5-1
38 Hz
13.0cm

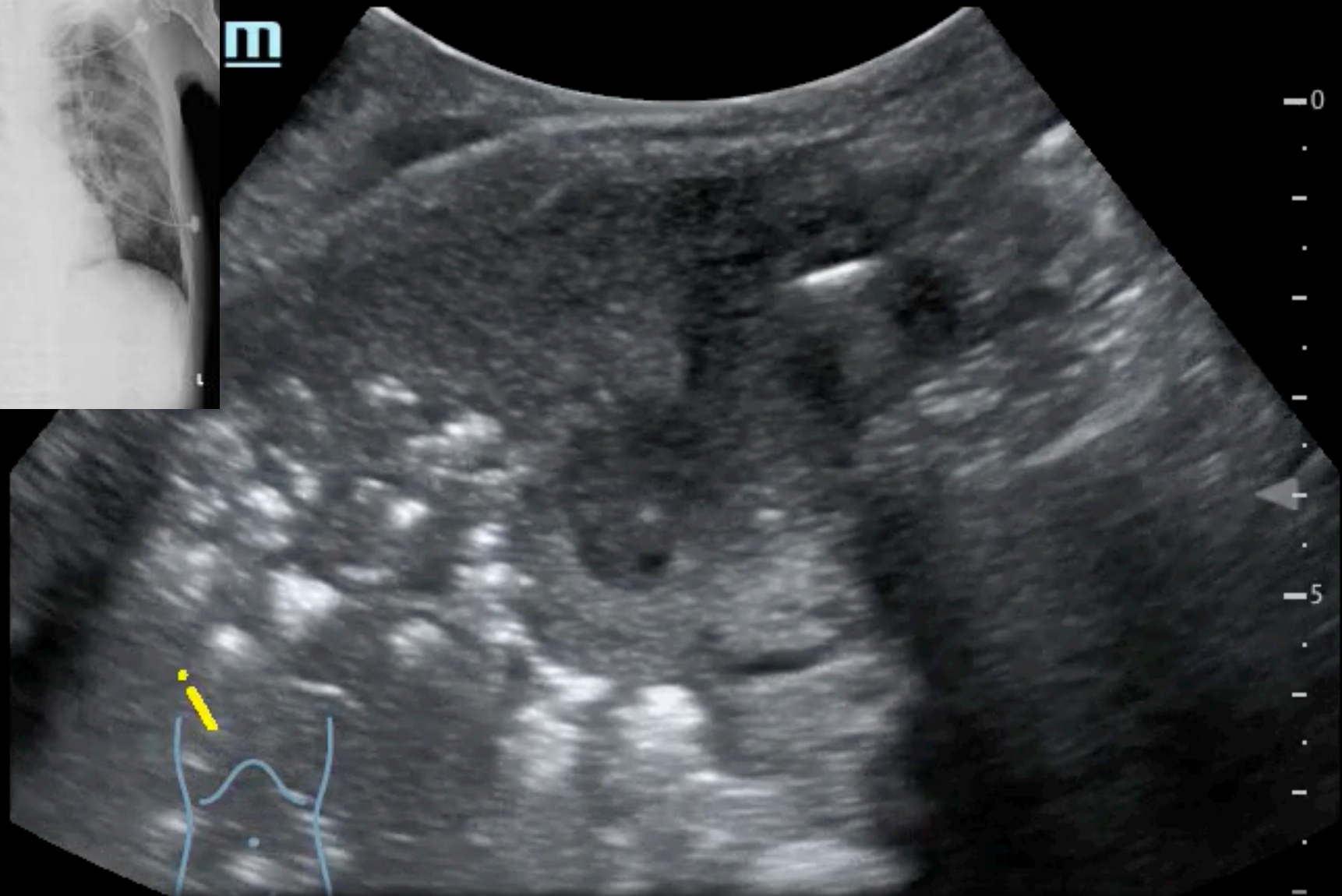
2D
HGen
Gn 100
C. 56
3/3/3



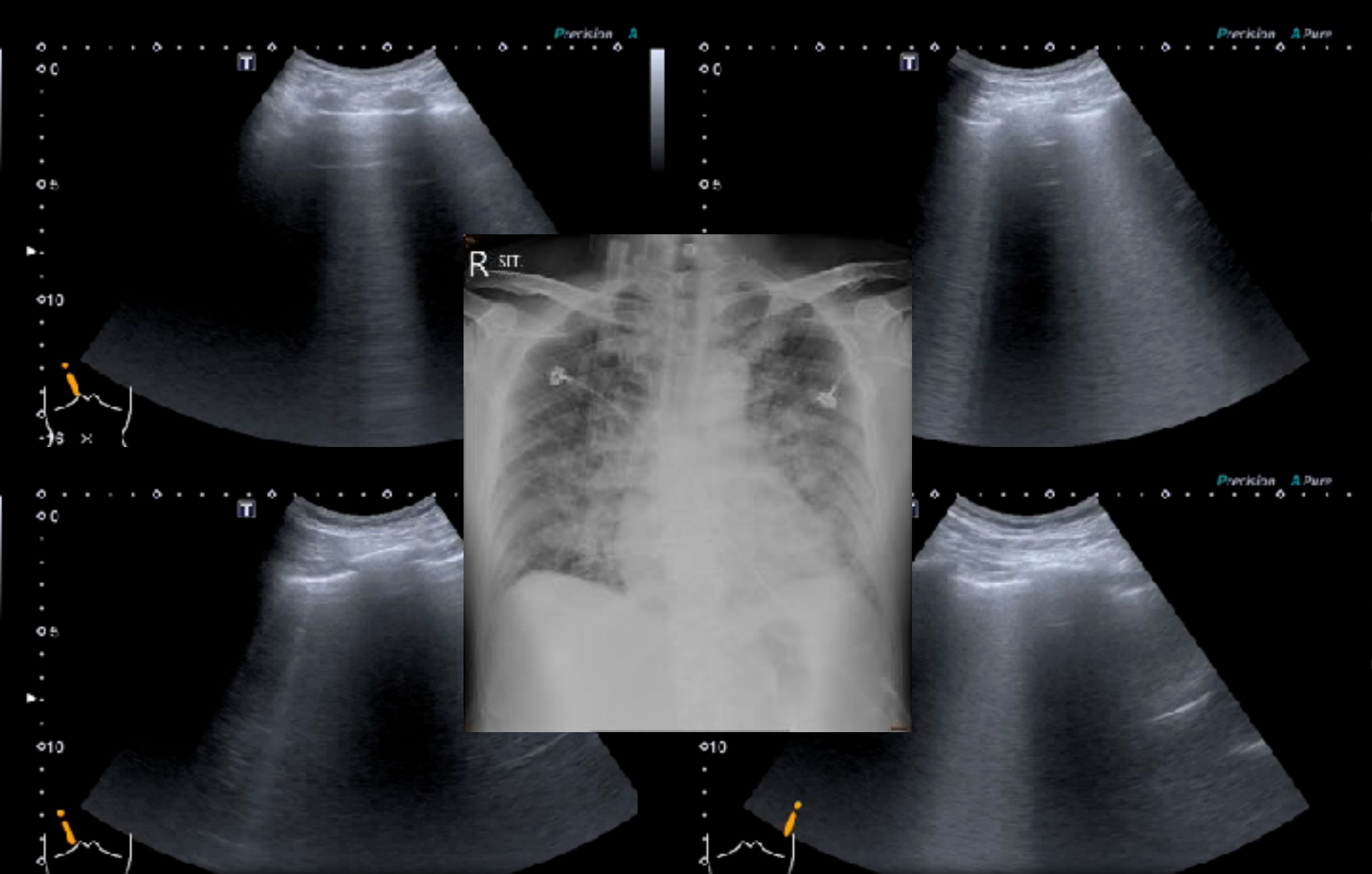
Dynamic air-bronchogram



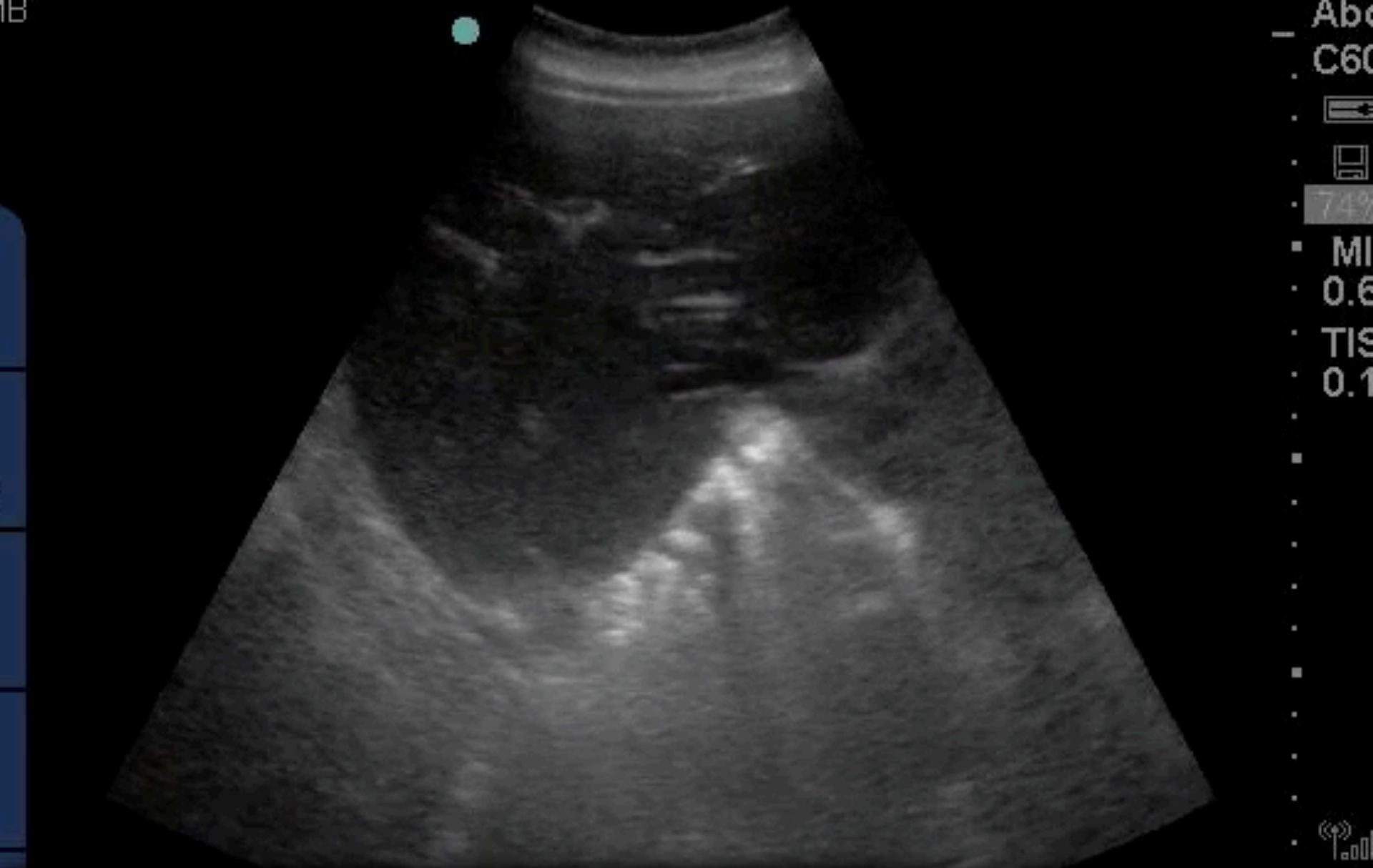
m



Lung abscess



Acute lung edema



Pneumonia



Abd Gen
Gn 1
12 Hz
11.0cm

2D

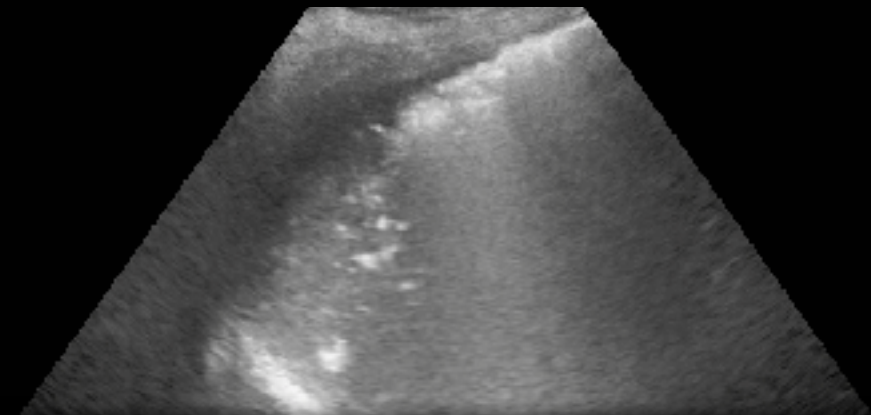
11Gnn
Gn 90
D 56
3/3/3



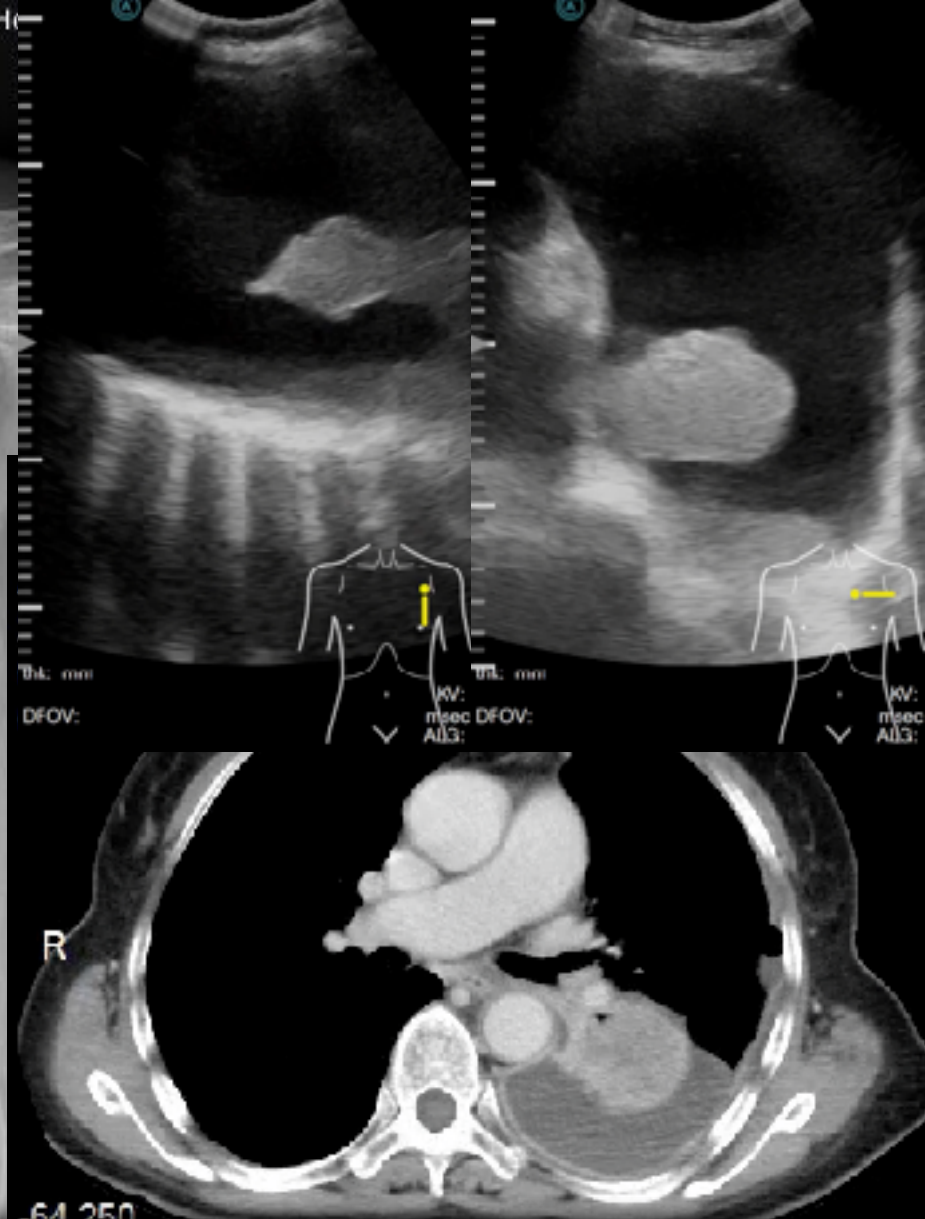
32 Hz
16.0cm

2D

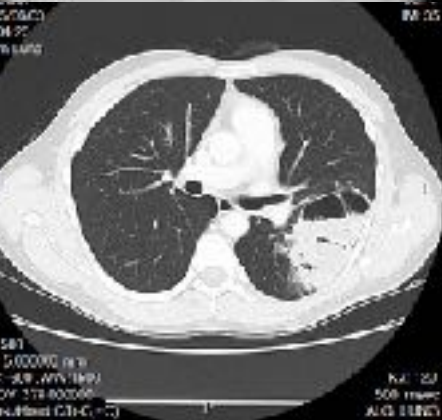
11Gnn
Gn 90
D 56
3/3/3



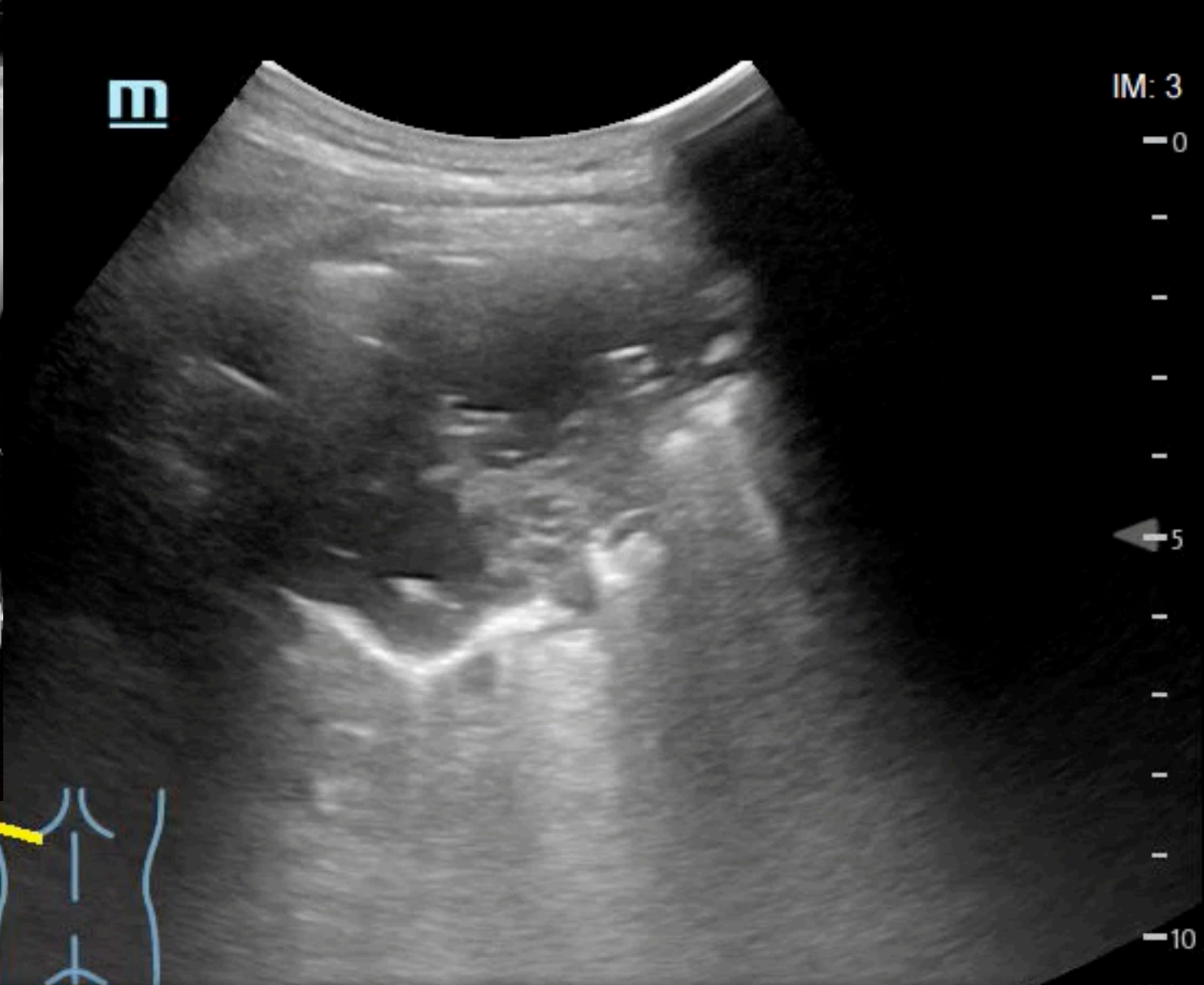
ARDS



Lung ca with PLE

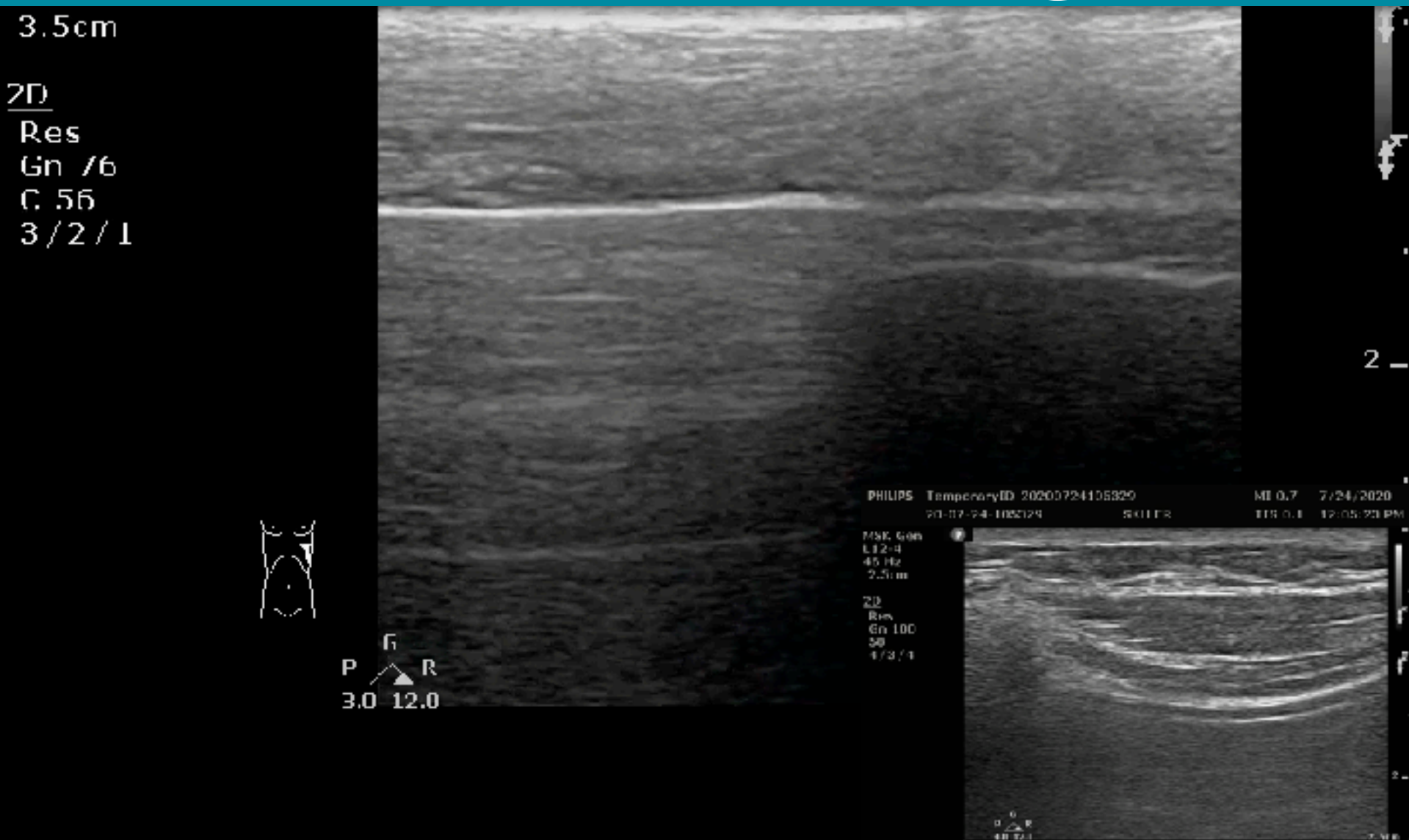


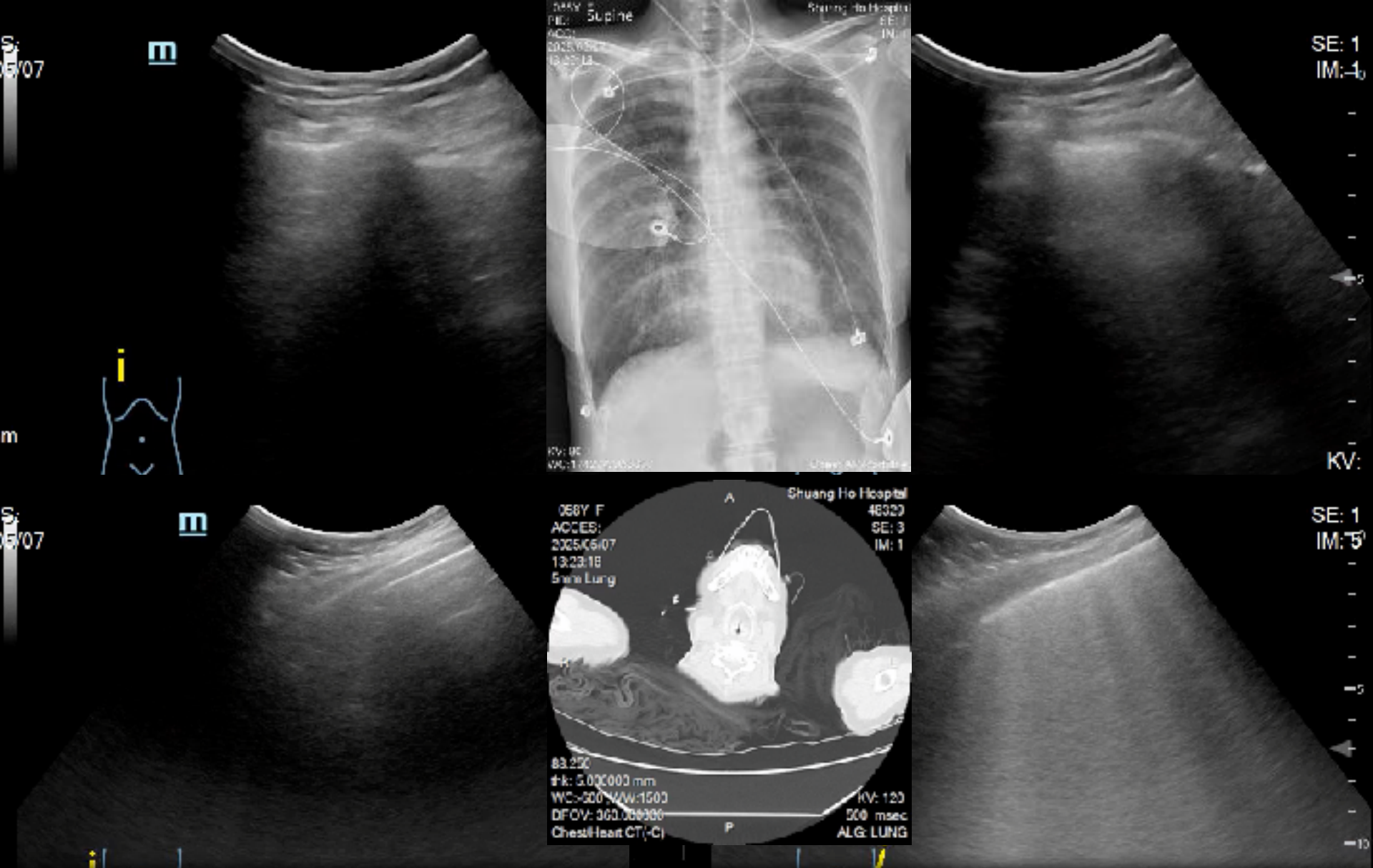
m



Lung abscess

Pseudo-sliding





PRIS - lung injury



Shuang Ho Hospit

SE

IM

SCN 000
18.0
4.75
19.0
160

Needle

Touch

SCN 000
18.0
4.75
19.0
173

Needle

Touch

Ex. mm

DFCM

m

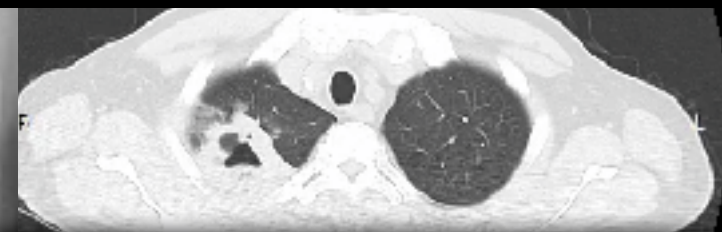
m

IM 17

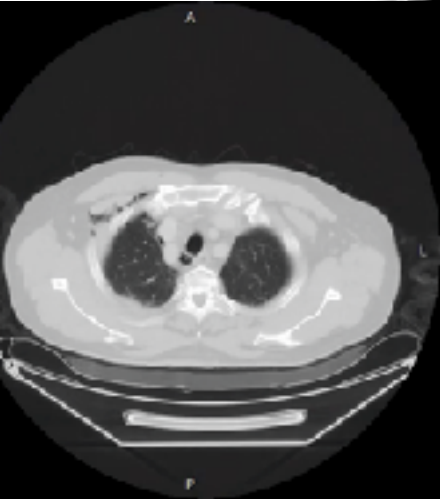
IM 19

IM
18.0
4.75
19.0
173

ChenKC@POCJSacodmy

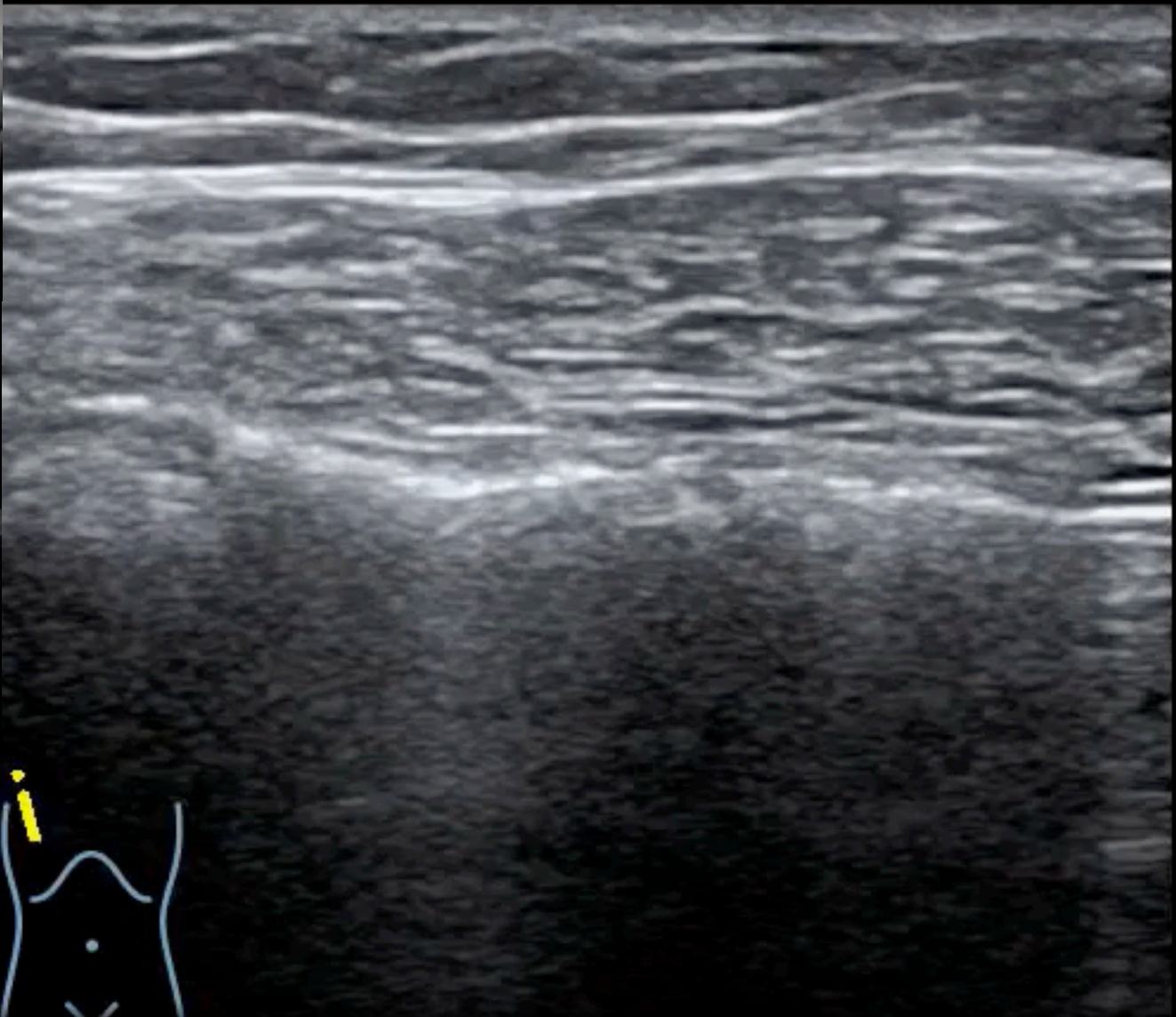


Lung abscess



iNeedle

iTouch



0
-1
-2
-3

Subcutaneous emphysema

Arterial
L12-D
37 Hz
4.0cm

2D
HGen
Gn 50
C 41
3/3/2



ChenKC@PCCUSacademy

4.0cm

Arterial
L12-D
37 Hz
4.0cm

2D
HGen
Gn 50
C 41
3/3/2

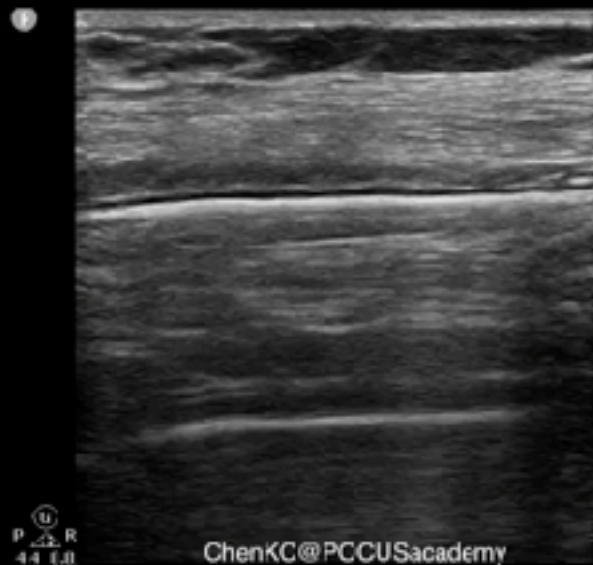


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4.0cm

Arterial
L12-D
37 Hz
4.0cm

2D
HGen
Gn 50
C 41
3/3/2

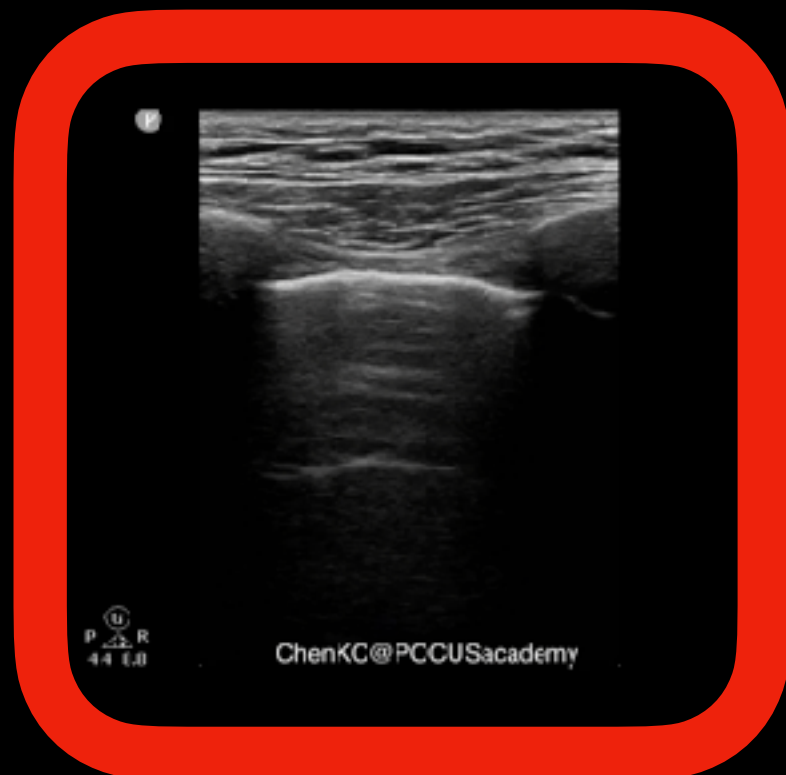


ChenKC@PCCUSacademy

4.0cm

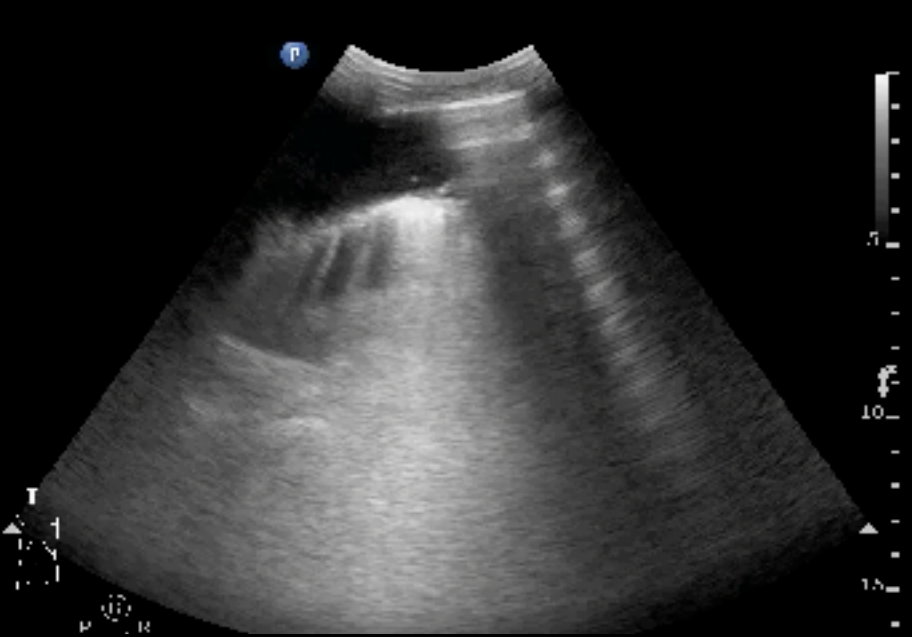
Arterial
L12-D
34 Hz
5.0cm

2D
HGen
Gn 50
C 41
3/3/2



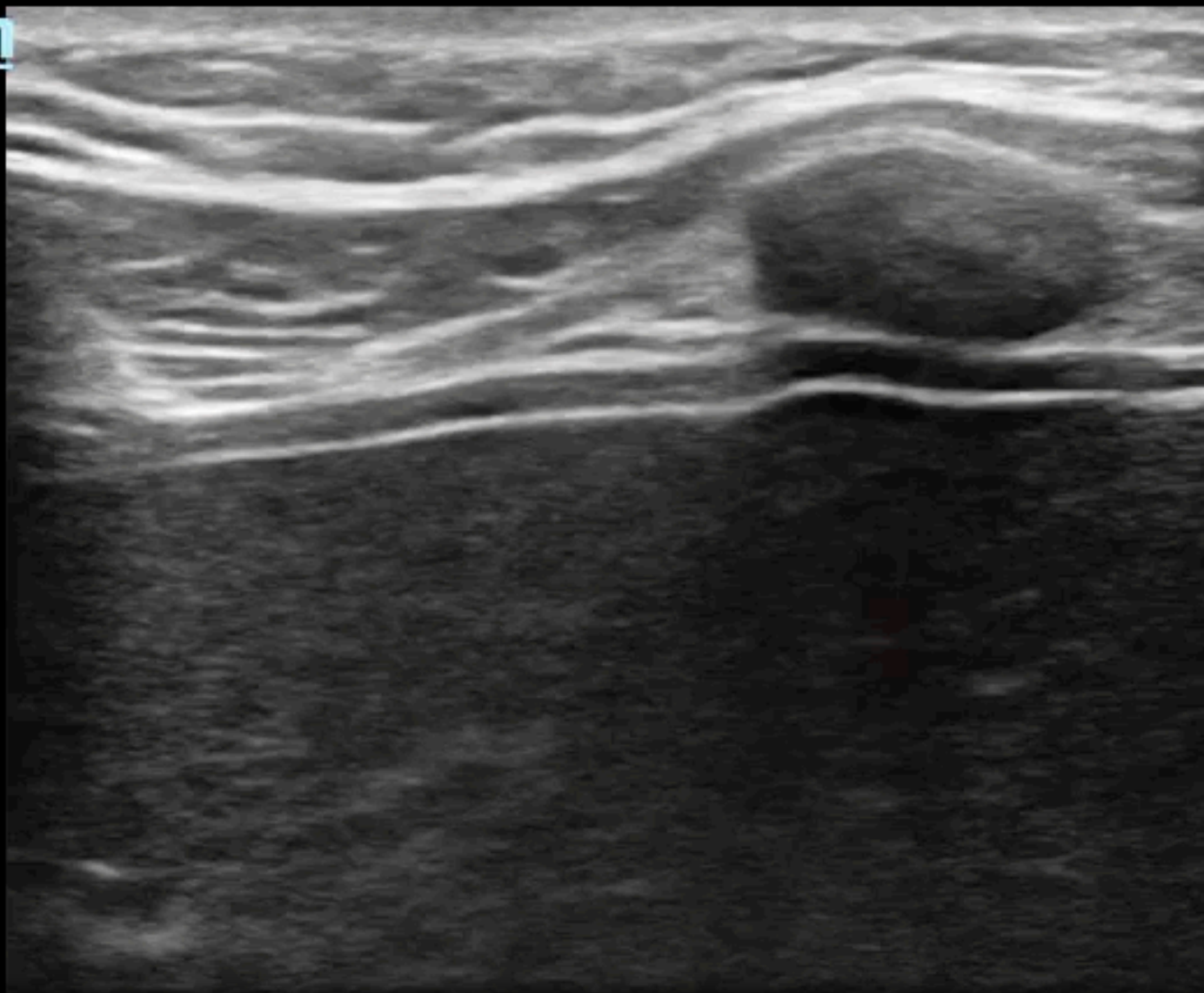
ChenKC@PCCUSacademy

5.0cm



Pyopneumothorax

2024/12/25
F 6.6~13.0
DR 115
FR 45
D 3.5
G 84



IM: 12

-1

-2

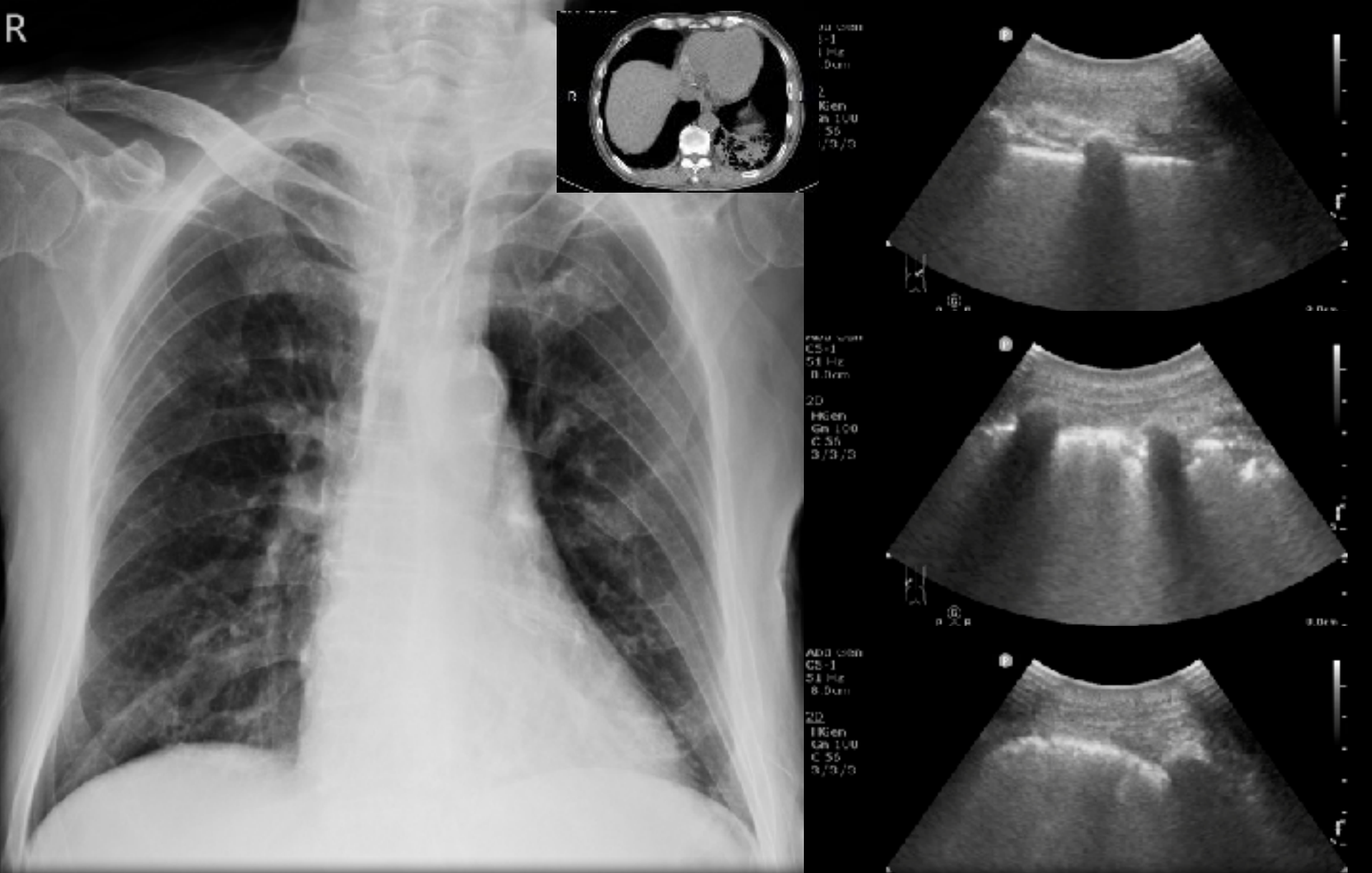
-3

iNeedle

iTouch

thk: mm

MG crisis



Pneumonia - retrocardiac

2025/04/17
FH5.0
DB 130
PR 18
D16.0
G 55



IM: 6
-0
-
-
-
-
-5
-
-
-10
-
-
-15

iNeedle

iTouch

thk: mm

DE19007BER

Hepatization/ Air-bronchogram

2025/04/17
FH5.0
DR 13.0
DE19007BER
PR 18
D 16.0
G 55

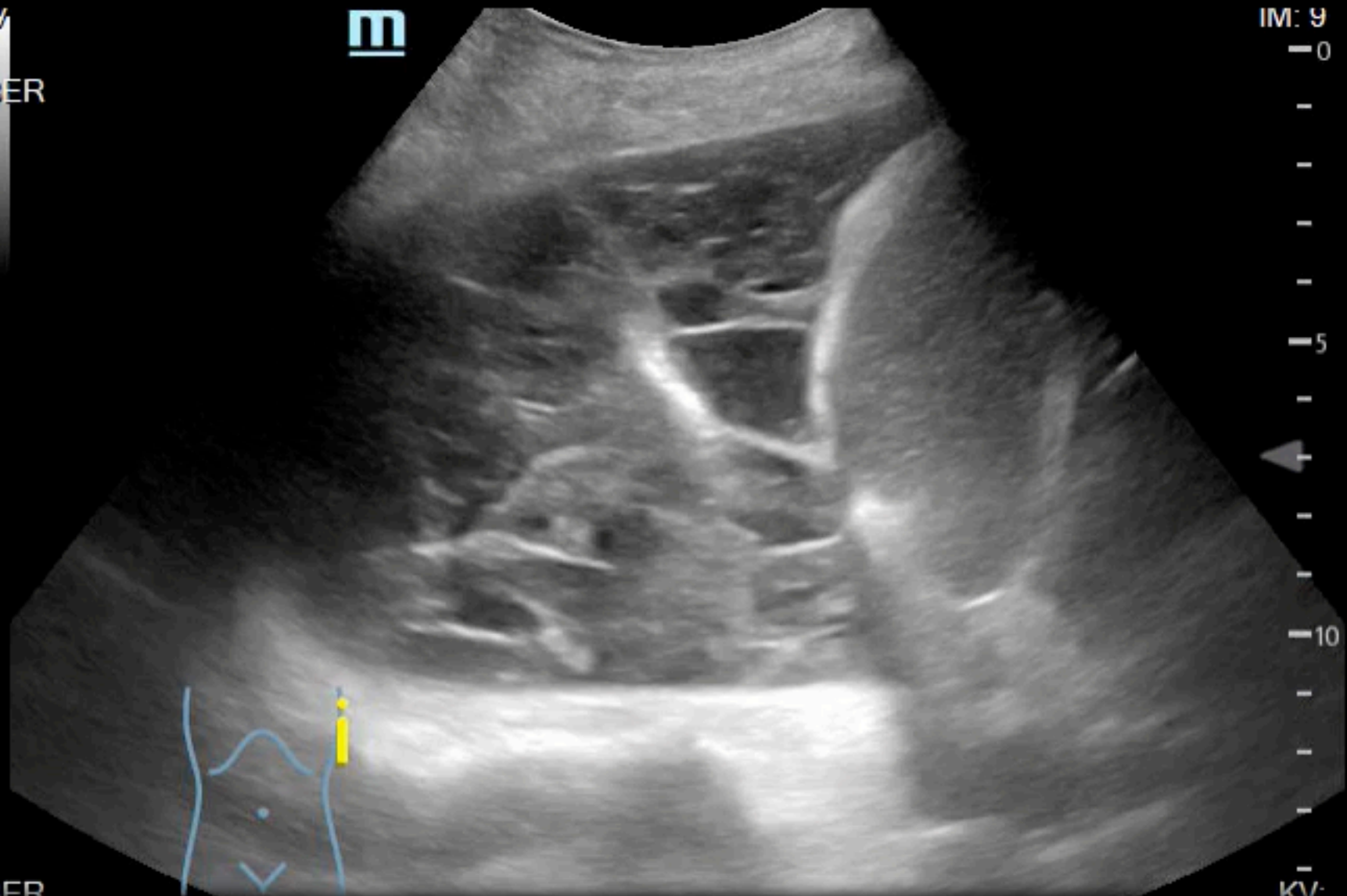


IM: 9
0
-
-
-
-
-
5
-
-
-
10
-
-
-
KV

iNeedle

iTouch

thk: mm
DE19007BER



Empyema

