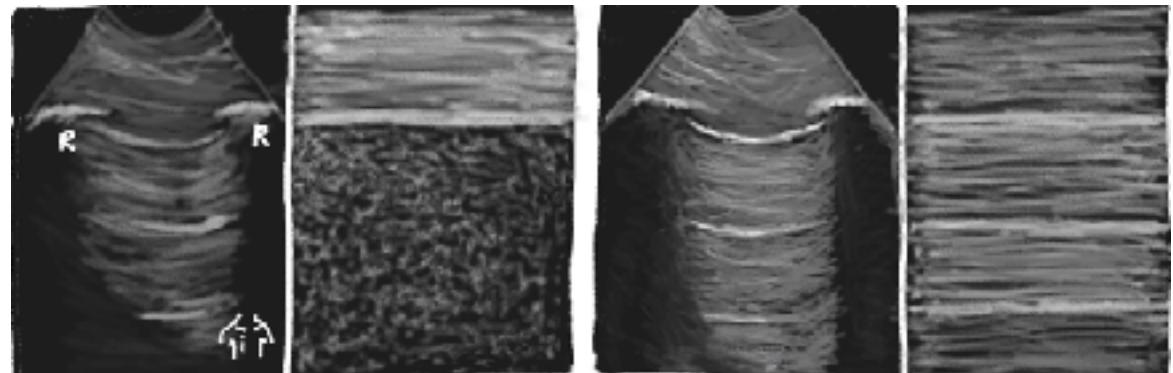




衛生福利部雙和醫院  
(委託臺北醫學大學興建經營)  
Taipei Medical University - Shuang Ho Hospital,  
Ministry of Health and Welfare



# Lung US & Diaphragm



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# 陳國智 醫師 / POCUSacademy.com



急診超音波臨床評核醫師  
醫用超音波學會指導醫師  
WINFOCUS director / instructor  
Certified Interventional Pain Sonologist

## 急診 / 重症 / 介入 / 急性疼痛

### 經歷

新光急診超音波訓練中心主任  
西園醫院急診醫學科主任  
急診醫學會超音波委員會主委  
台灣疼痛醫學會大體模擬手術講師  
急救加護醫學會重症超音波負責人

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

# F.O.R.E.S.I.G.H.T. Comprehensive Perioperative Ultrasound Examination

**F**ocused  
**P**erio**O**perative  
**R**isk  
**E**valuation  
**S**onography  
**I**nvolving  
**G**astro-Abdominal  
**H**emodynamic, and  
**T**rans-Thoracic Ultrasound

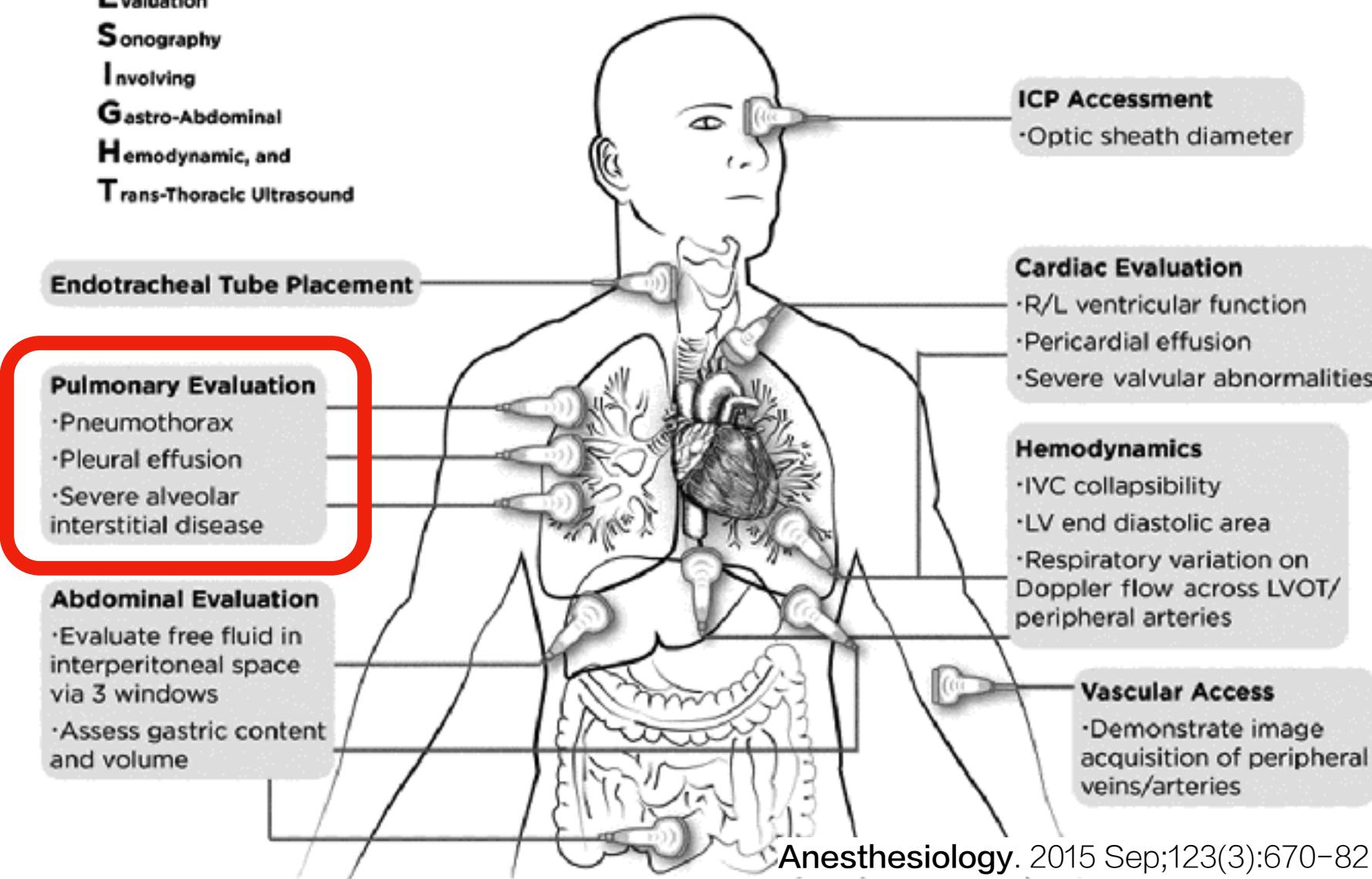
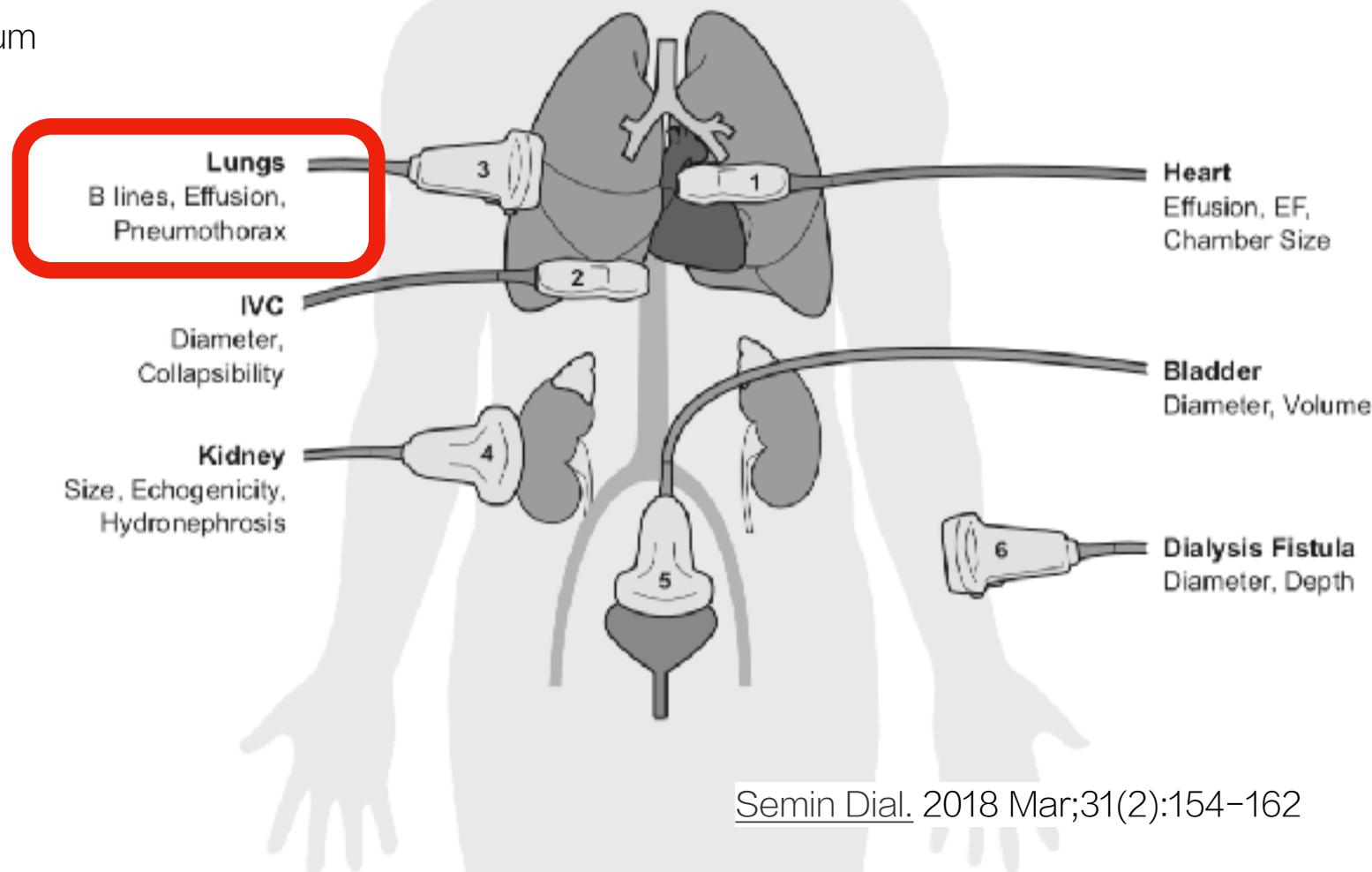


IMAGE AREA	IMAGE ACQUISITION	PROBE
1 Heart	Parasternal Long Axis (PLAX)	Phased
2 Inferior Vena Cava	Subcostal	Phased
3 Lung	Anterior, Lateral, Posterior	Linear
4 Kidney	Longitudinal, Transverse	Curved
5 Bladder	Suprapubic	Curved
6 Dialysis Fistula	Longitudinal and Transverse	Linear

Johns Hopkins **Nephrology** fellowship

POCUS curriculum



# Lung Ultrasound: The Essentials

Thomas J. Marini, MD • Deborah J. Rubens, MD • Yu T. Zhao, BA • Justin Weis, MD • Timothy P. O'Connor, MD • William H. Novak, MD • Katherine A. Kaproth-Joslin, MD, PhD

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.

*Radiology: Cardiothoracic Imaging* 2021; 3(2):e200564 • <https://doi.org/10.1148/rct.2021200564> • Content codes: CH US

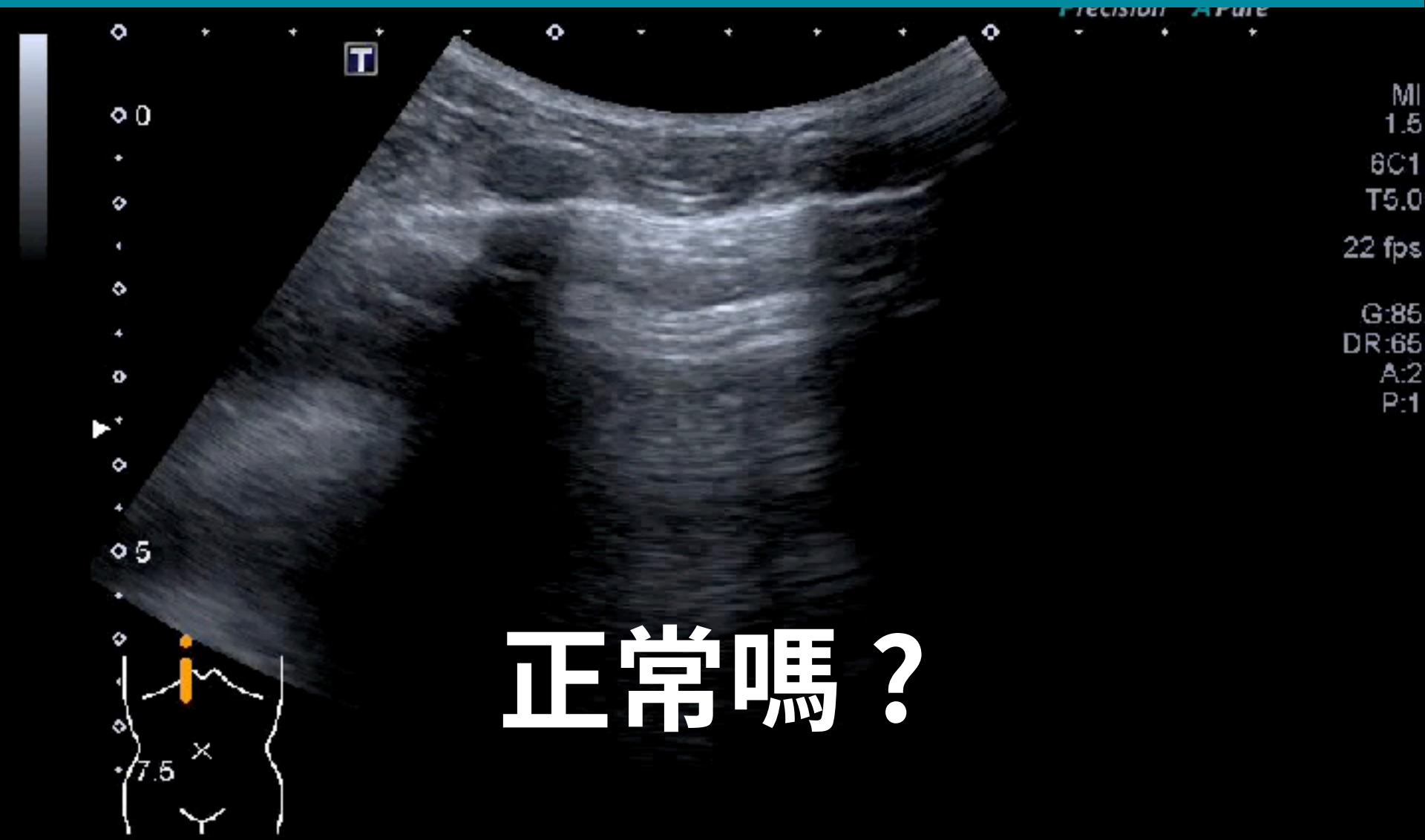
## Sensitivity and Specificity of Lung US versus Chest Radiography

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.

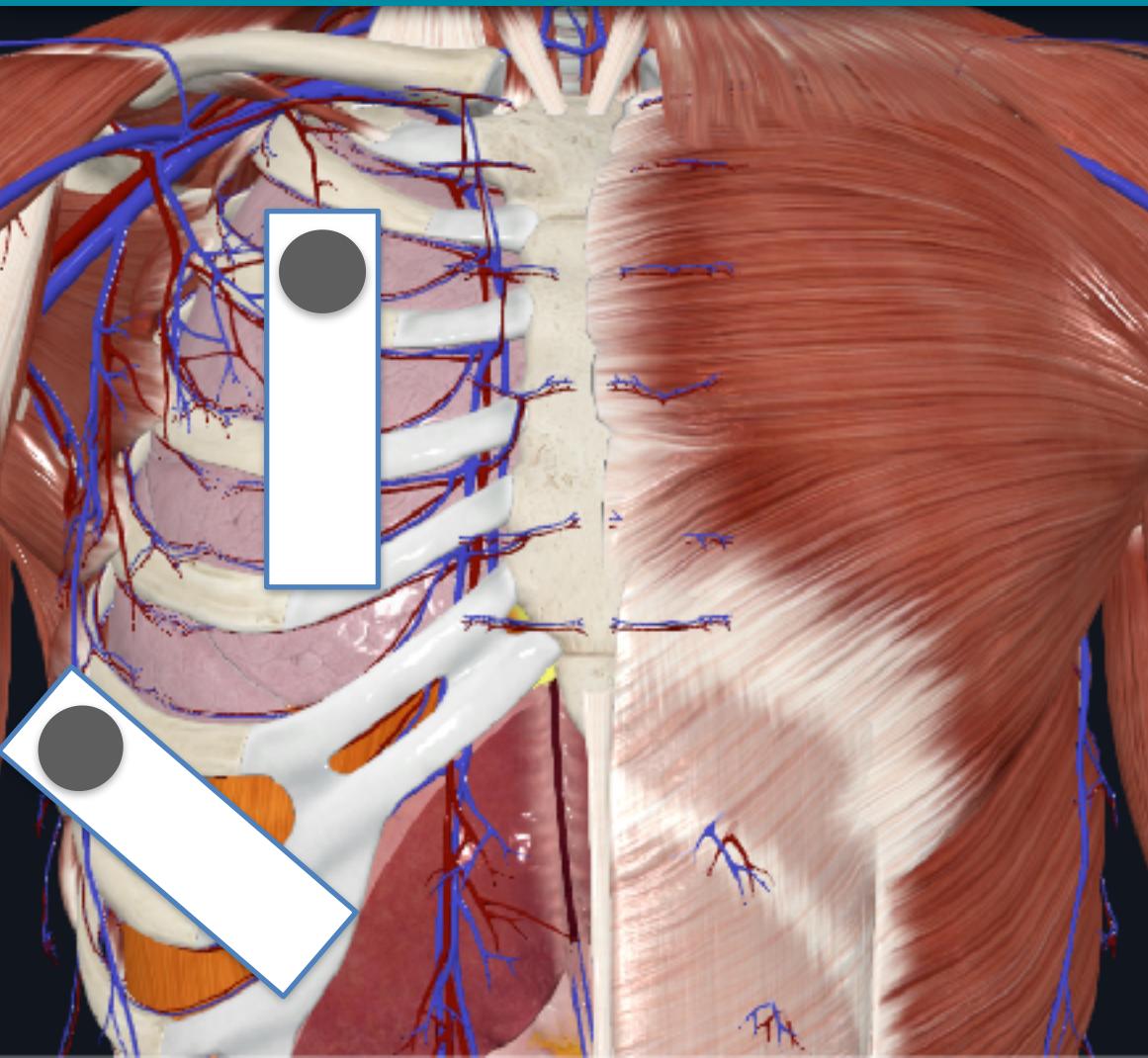


# LUNG



正常嗎？

# Lung



## 肋膜

高回音

有滑動

縱向掃描

鎖骨中線之最高點

## 橫膈膜

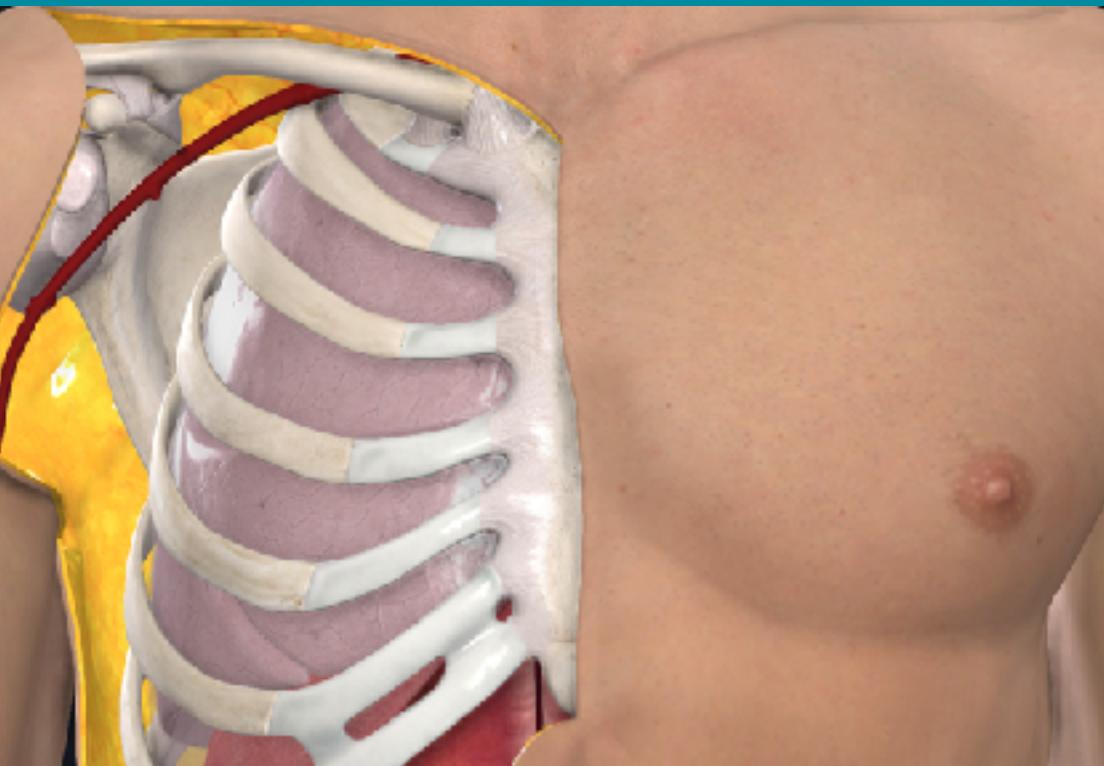
高回音

有移動

肋間掃描

劍突腋前/後線交界

# LUNG USG APPLICATIONS



Sensitivity and Specificity of Lung US versus Chest Radiography

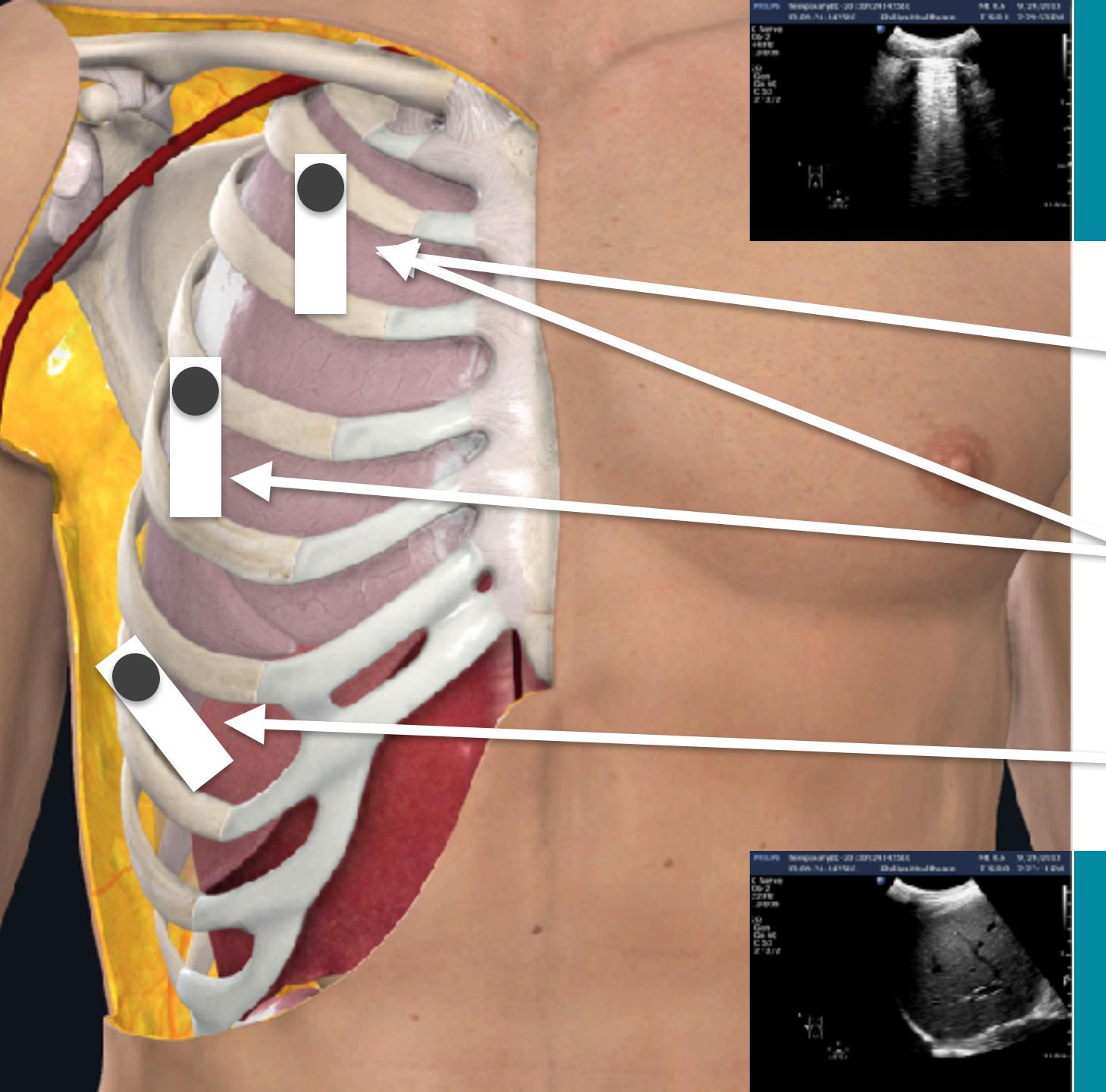
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Note.—Sensitivity and specificity values vary slightly from study to study. The pleural effusion statistics are drawn from a sample of critically ill patients.

Dyspnea  
Chest pain  
Infections

PTX  
AIS  
PLE

Consolidation



AIR

PTX

AIS

PLE

FLUID

# NORMAL LUNG

肋膜/滑動

TemporaryID 20130924142510  
13 09 24 142510 Philips Healthcare



MT 0.G 9/ PHILIPS  
TIS 0.1 2:0

C Nerve  
00-2  
22 Hz  
13.0cm  
  
2D  
Cen  
Gr. 60  
C 53  
2/3/2

橫膈膜/移動

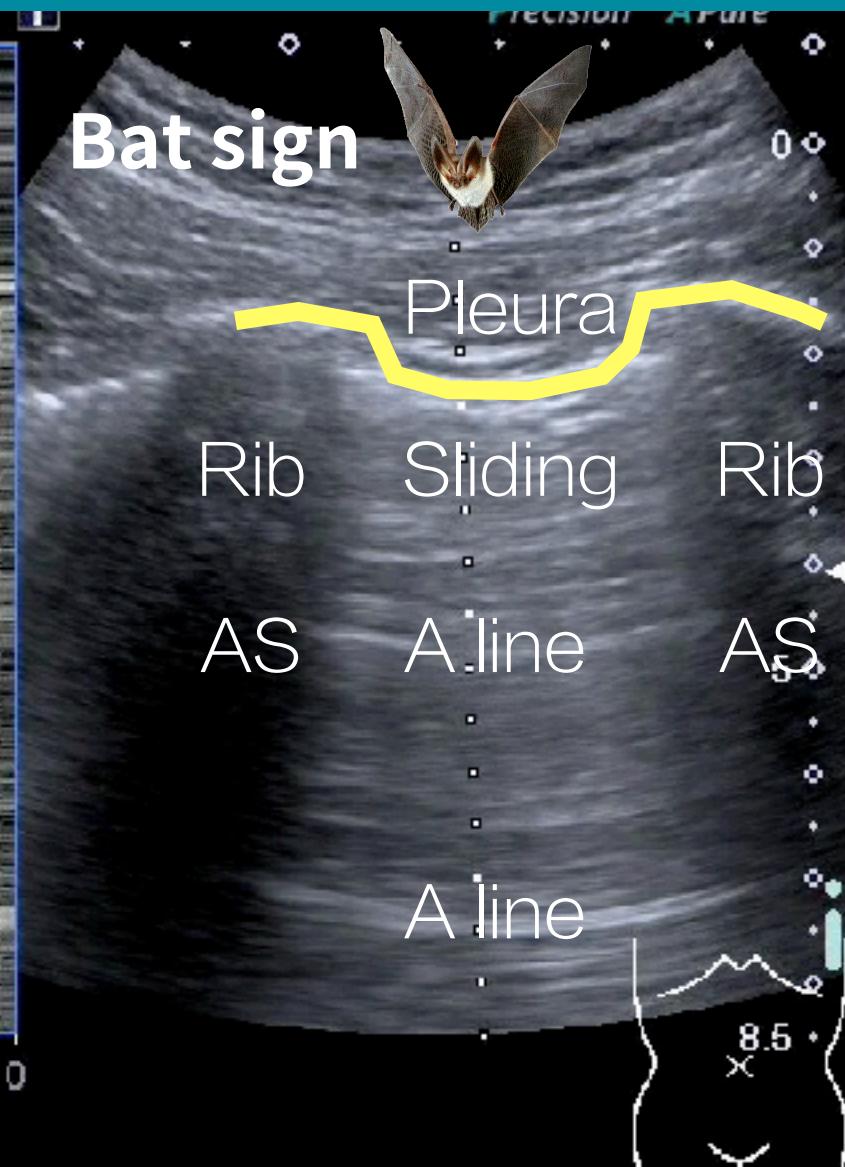
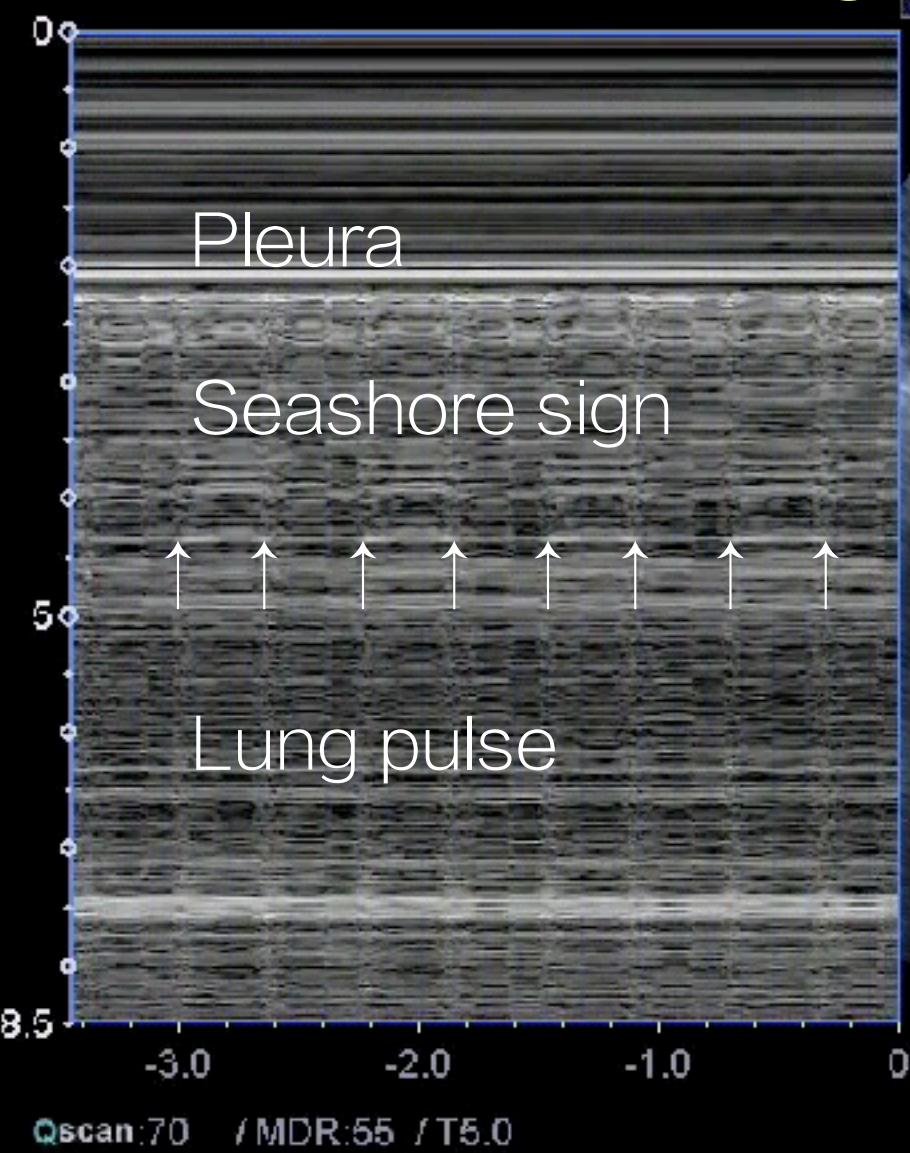
TemporaryID 20130924142510  
13 09 24 142510 Philips Healthcare



MT 0.G 9/24  
TIS 0.0 2:27

# NORMAL LUNG

Sliding + A lines



# SLIDING FIRST



A line

肋膜下  
水平線  
等距離



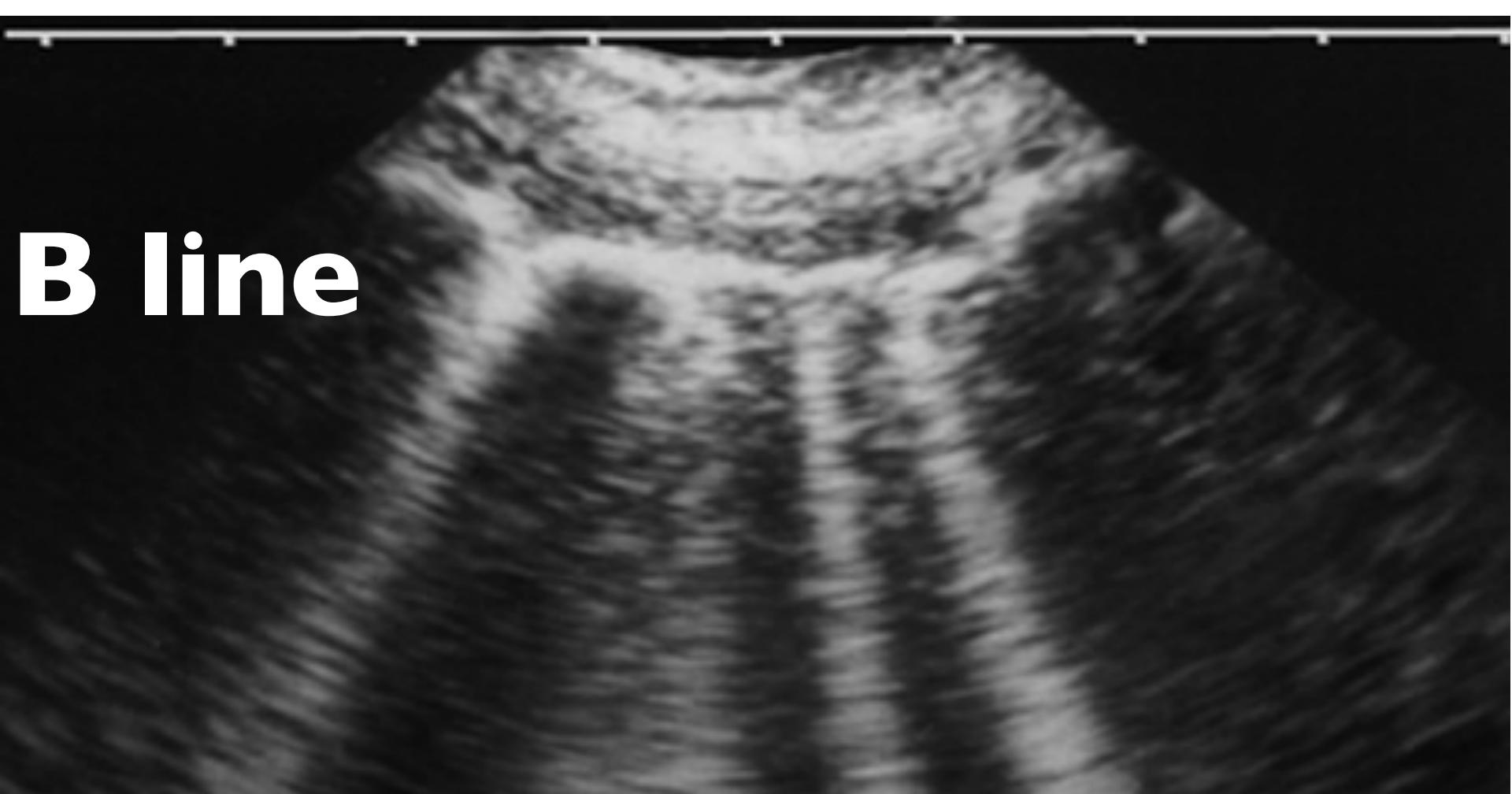
B line

肋膜下  
垂直線  
大於三

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

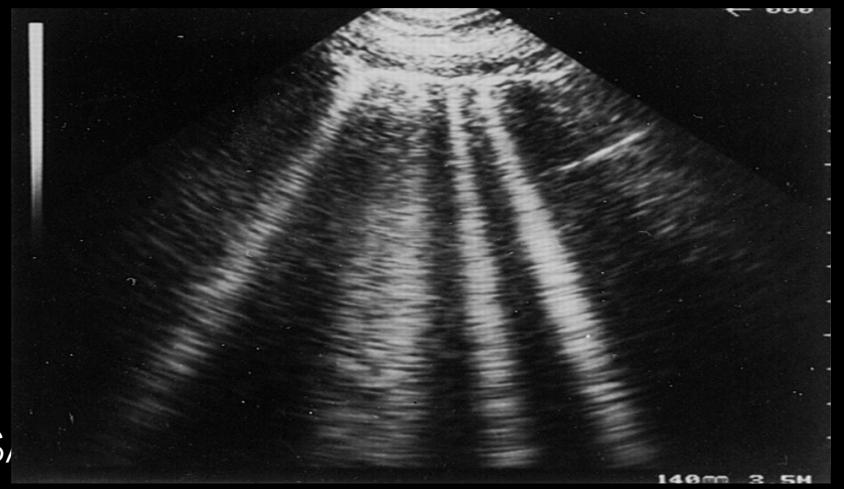
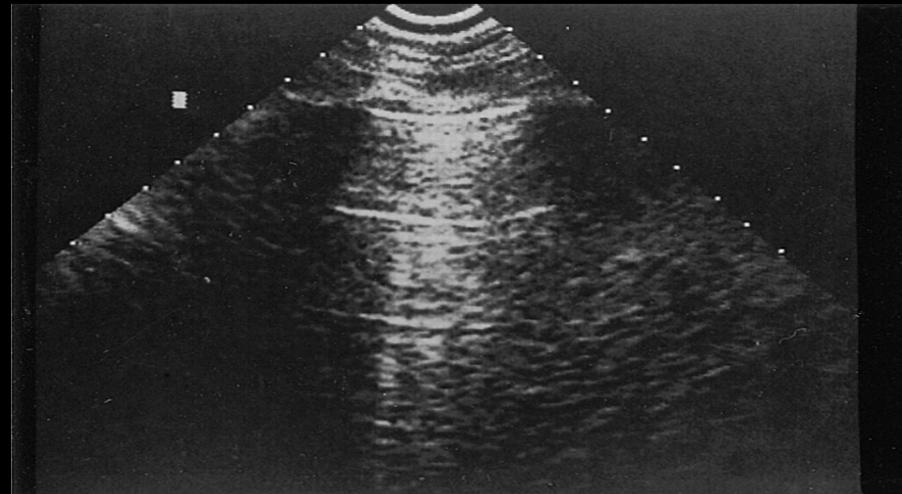
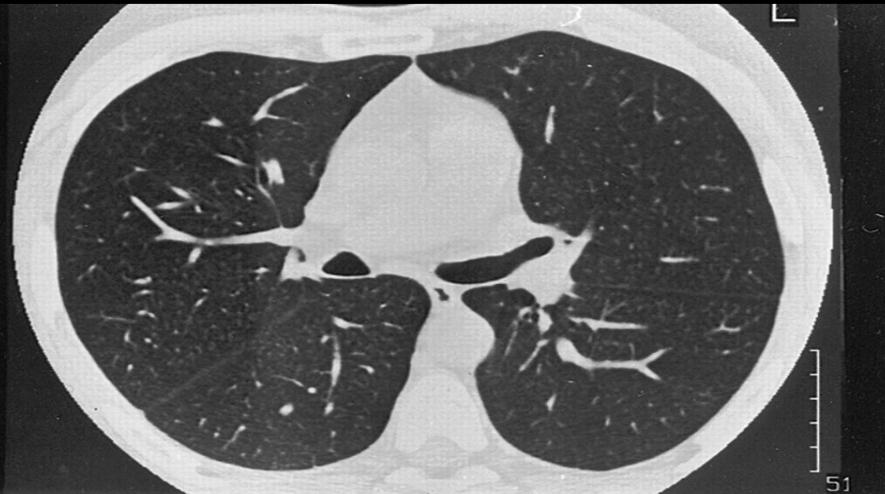
## The comet-tail artifact: an ultrasound sign ruling out pneumothorax

B line

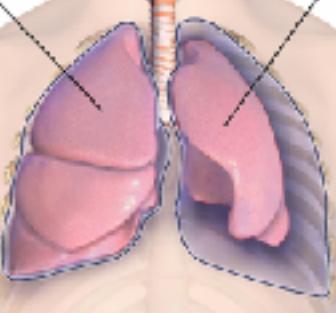


# 基本假影：A lines & B lines

US B lines ~ Kerley B lines



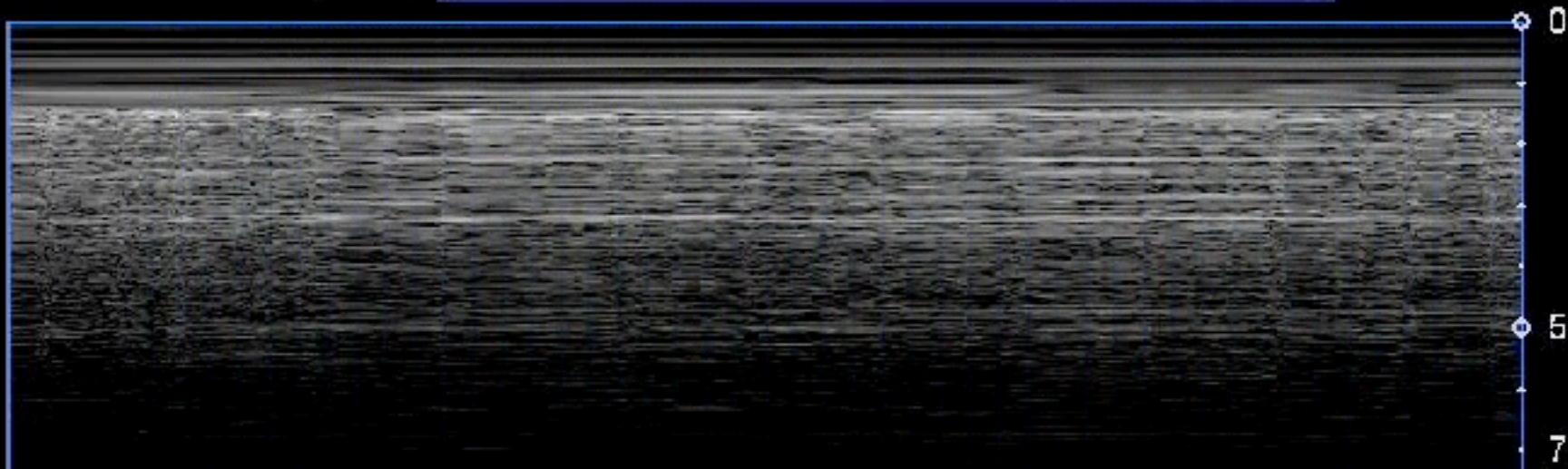
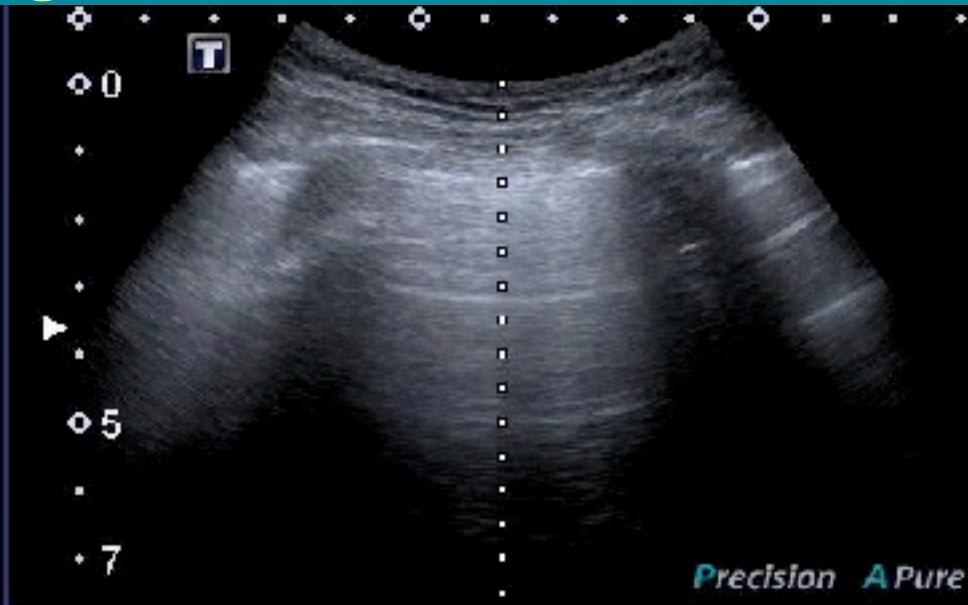
OCUS

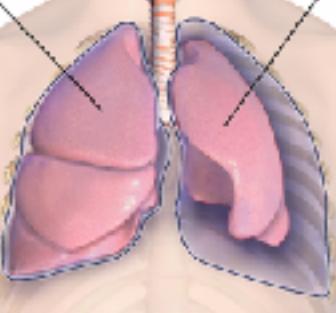


# PNEUMOTHORAX ?

**Sliding + A lines = Normal pleura**

Seashore  
sign

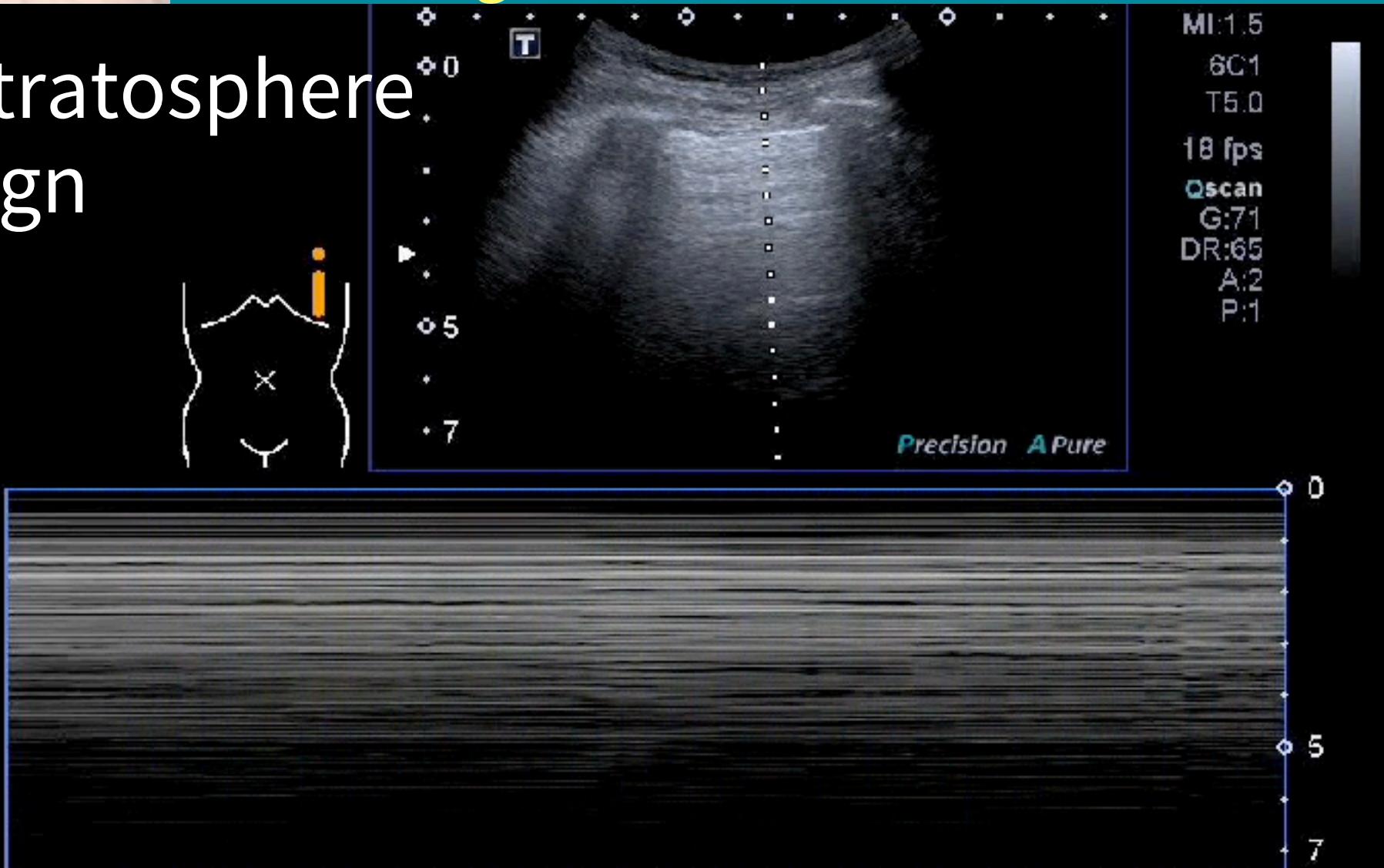


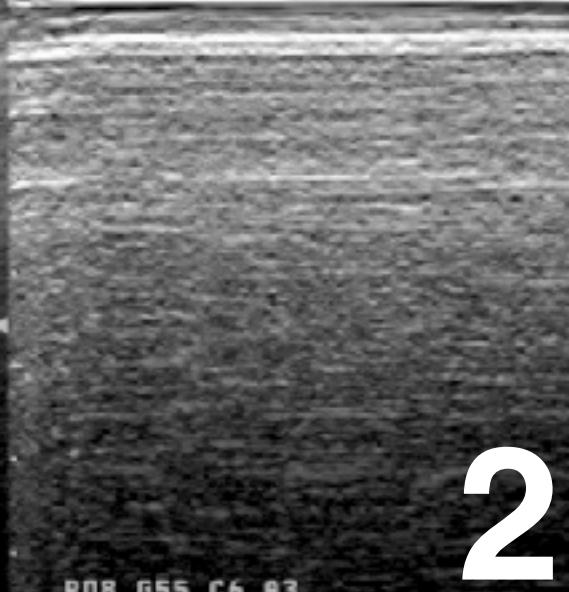
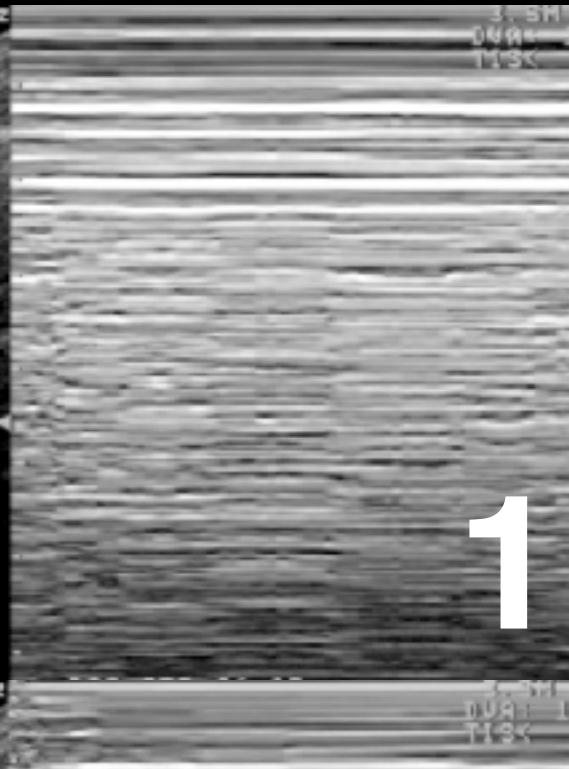
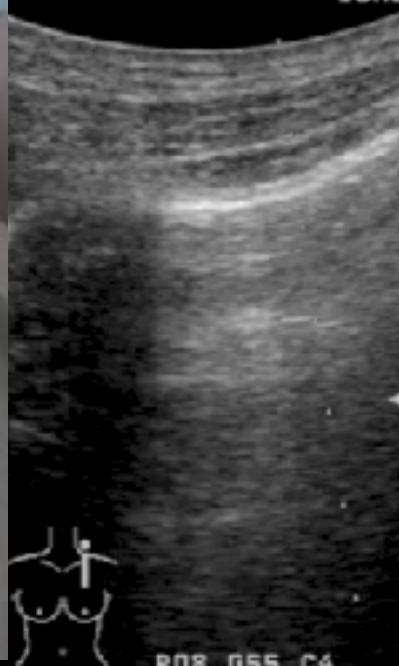


# PNEUMOTHORAX ?

No Sliding + A lines >> Consider PTX

Stratosphere  
sign



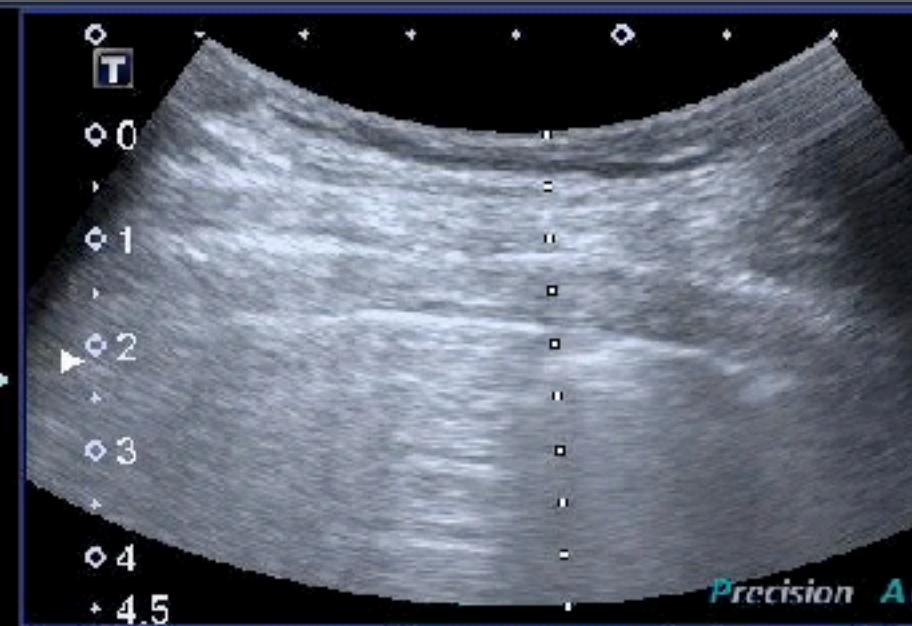


1

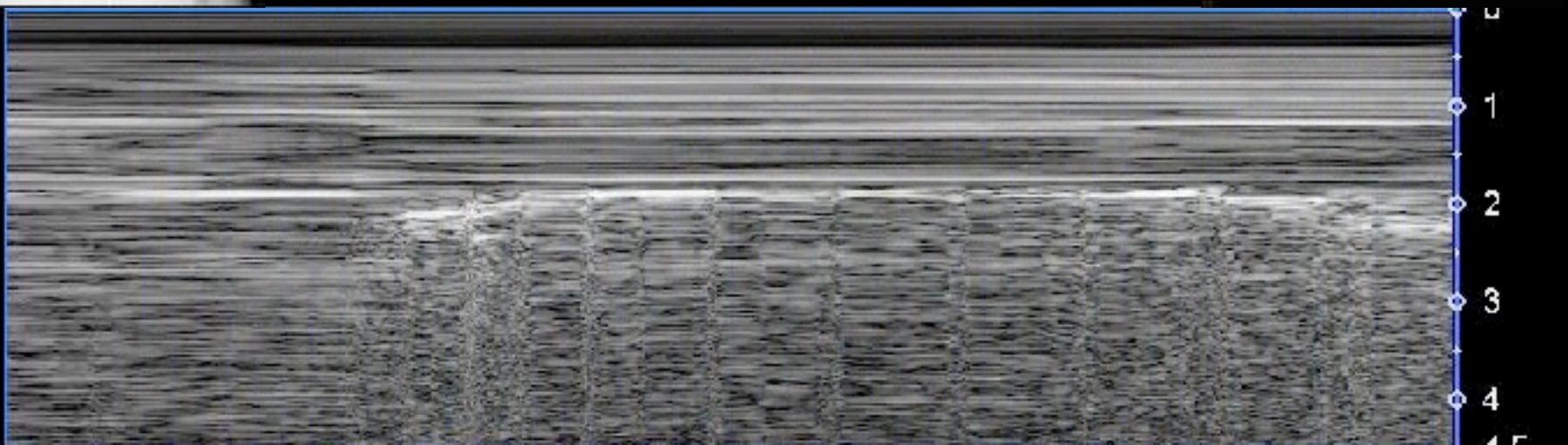
2

# Lung Point

A



B



BR  
2022-09-21 19:55:42

Accession: 14386305  
ID: 猫  
姓名:

0SH  
062

性别: 女性  
年龄: 8岁  
品种:

Female  
Age:  
Breed:

0SH  
062

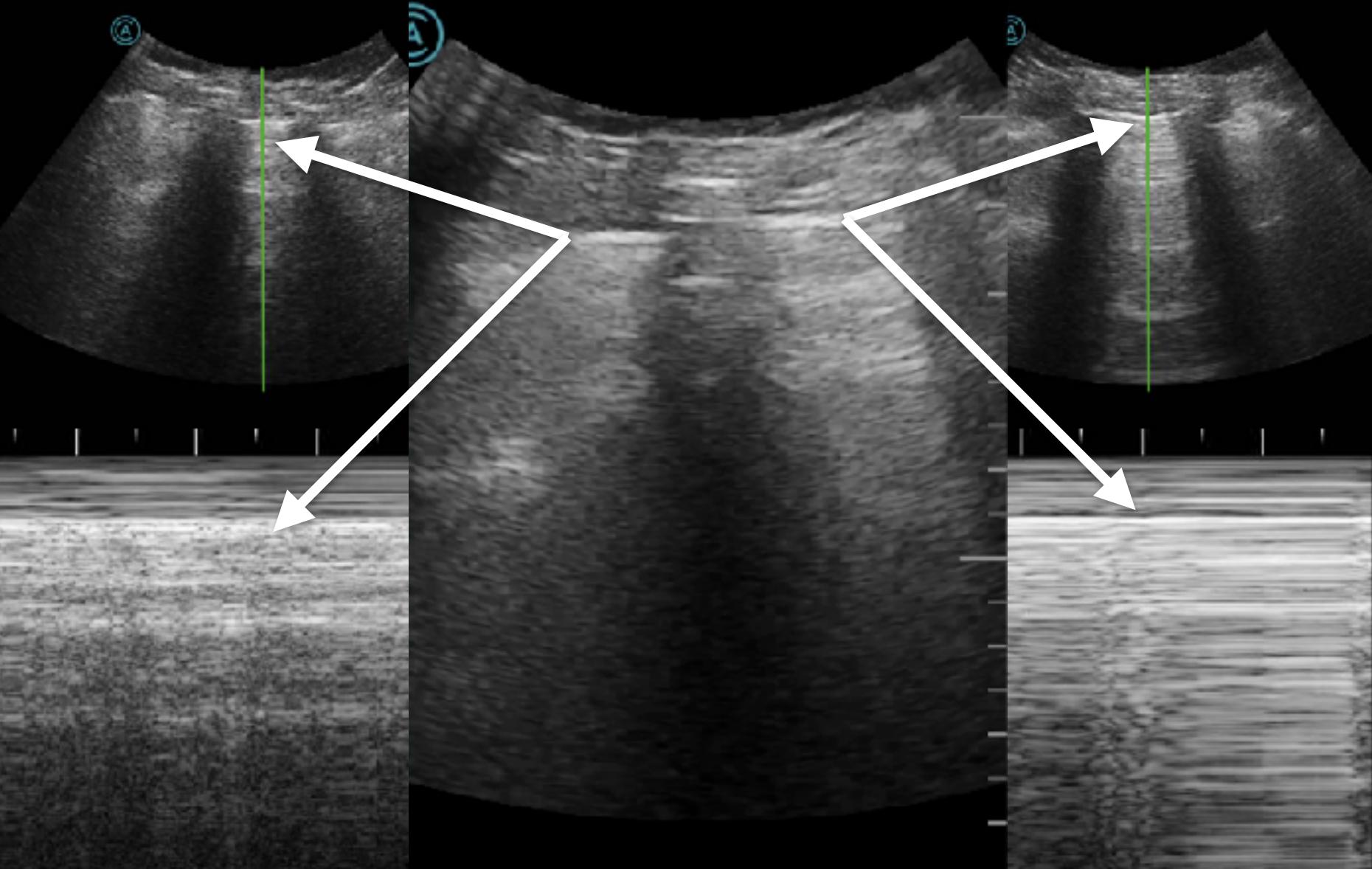
性别: 女性  
年龄: 8岁  
品种:

Female  
Age:  
Breed:

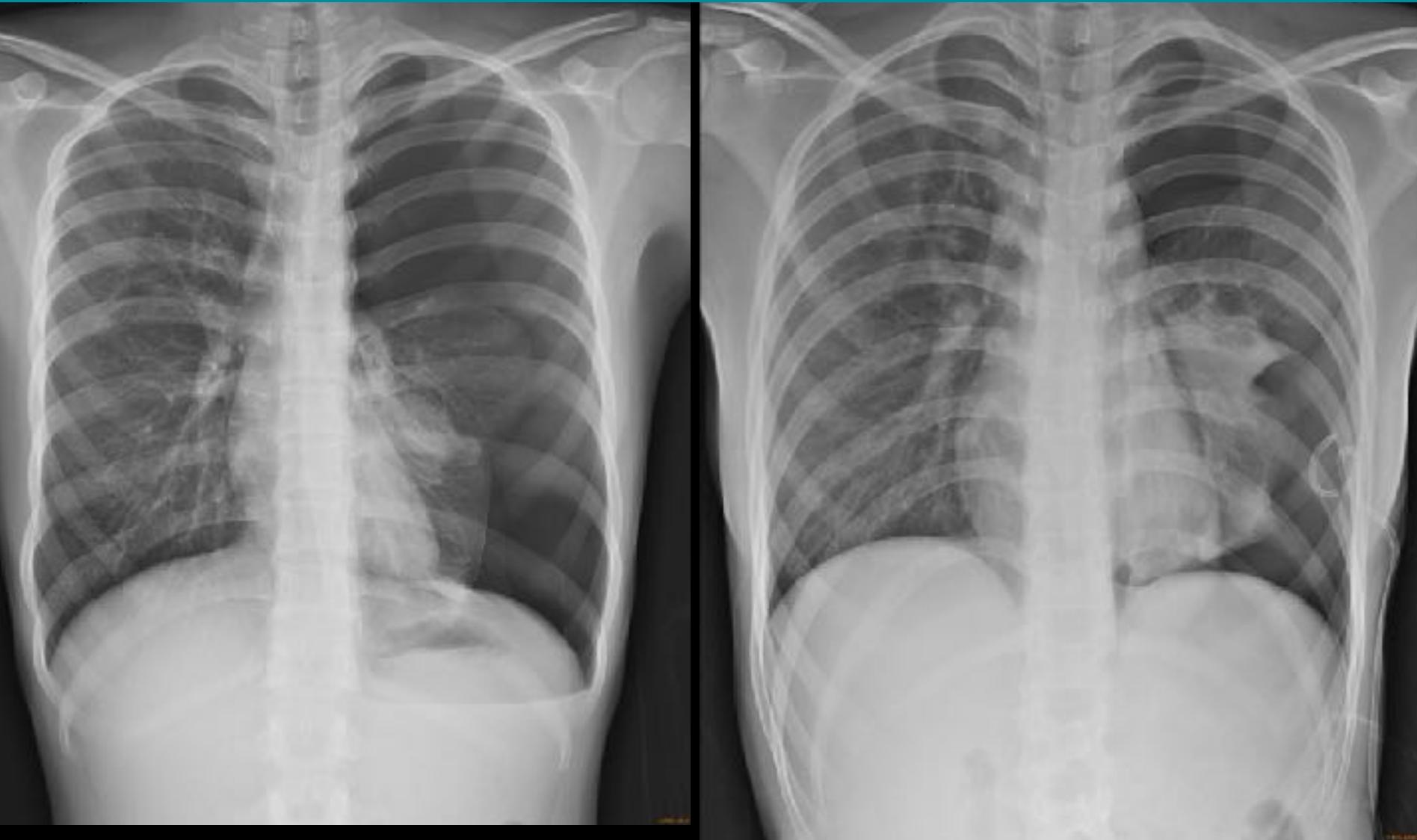
(A)

(A)

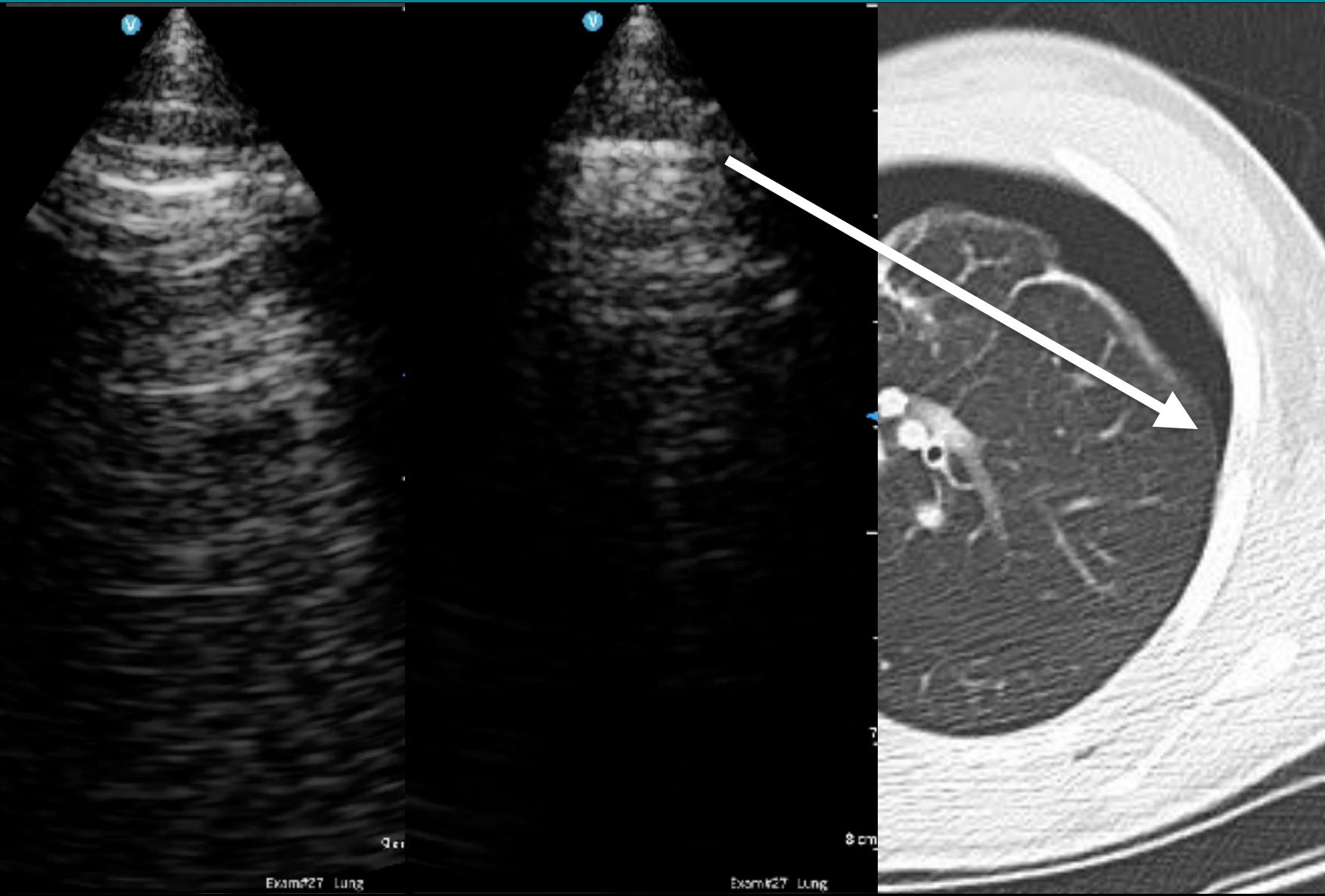
(A)



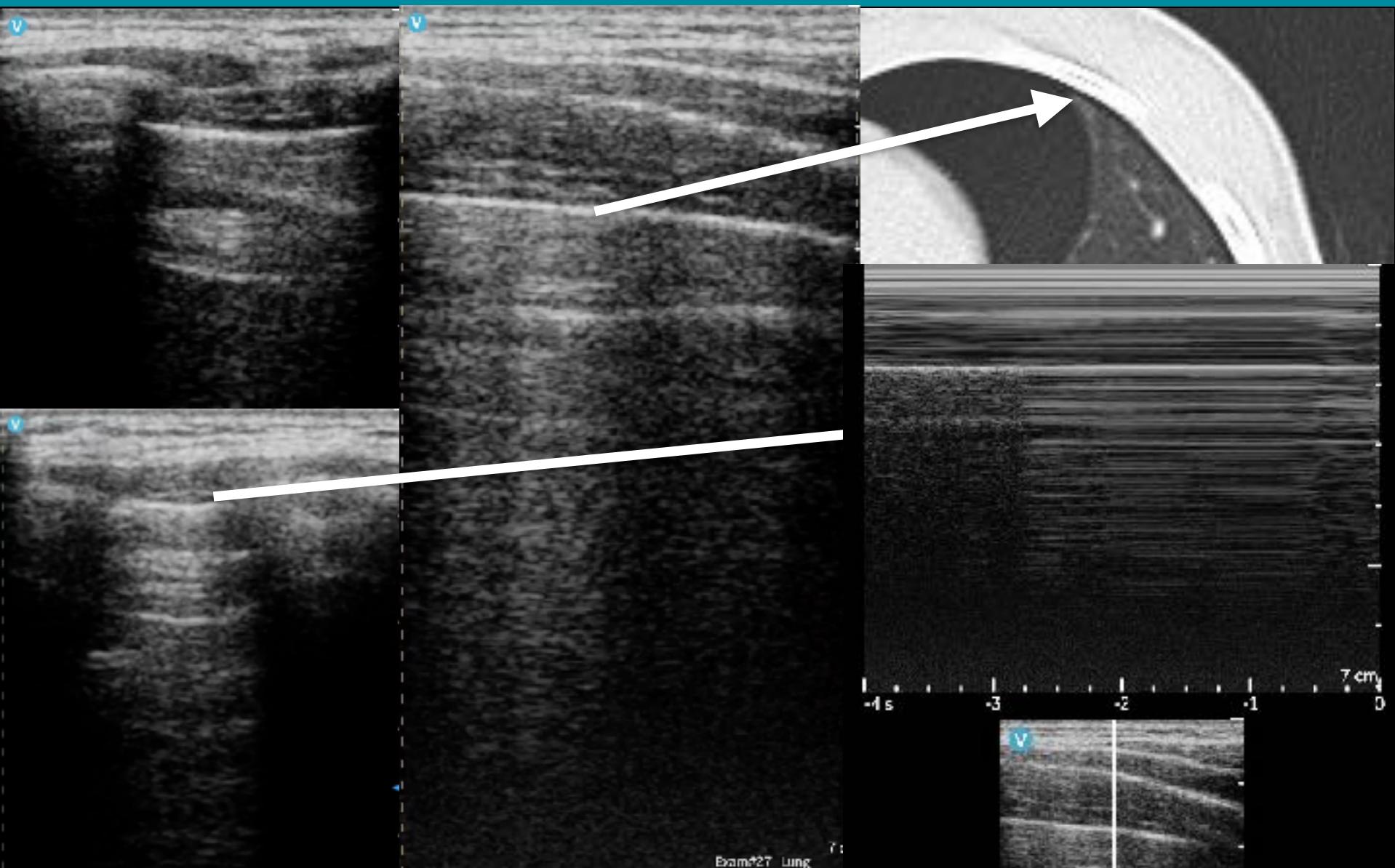
**15F, ASTHMA HX , DYSPNEA**



**15F, ASTHMA HX , DYSPNEA**



# LUNG POINT & SUBCUTANEOUS EMPHYSEMA



PTX

4

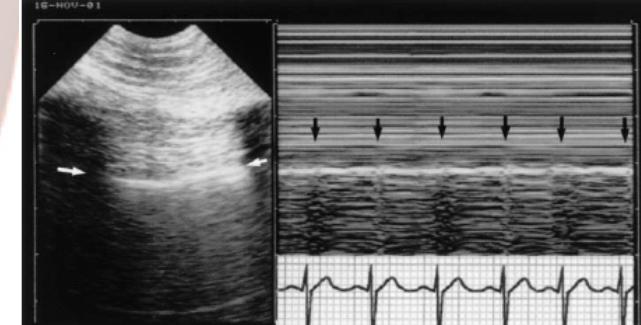
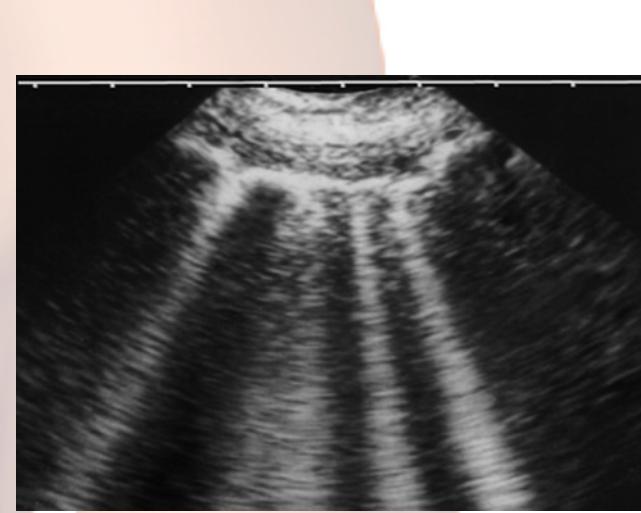
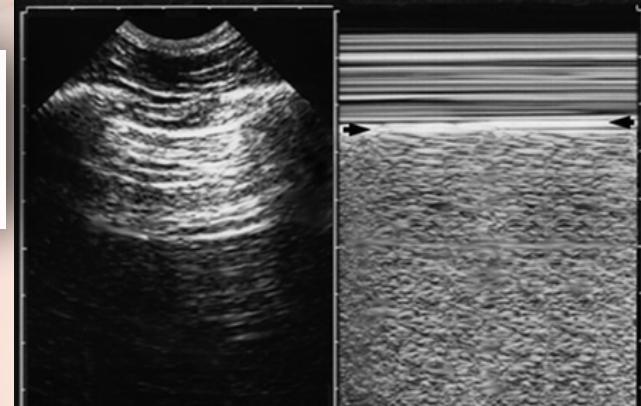
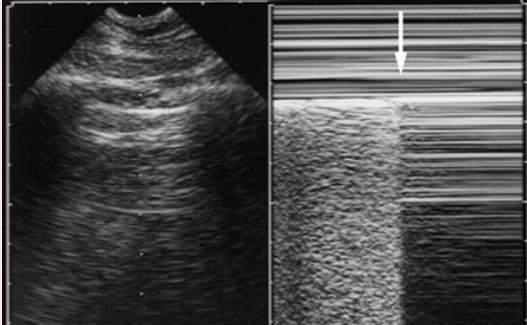
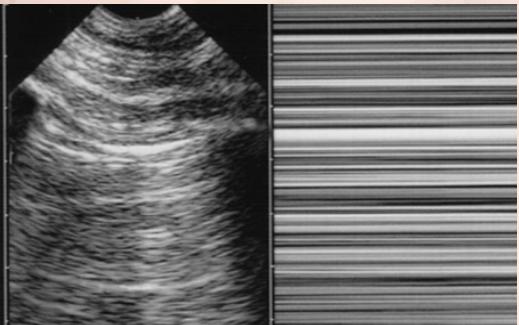
SBP Point

No sliding

No B lines

No pulse

Lung point



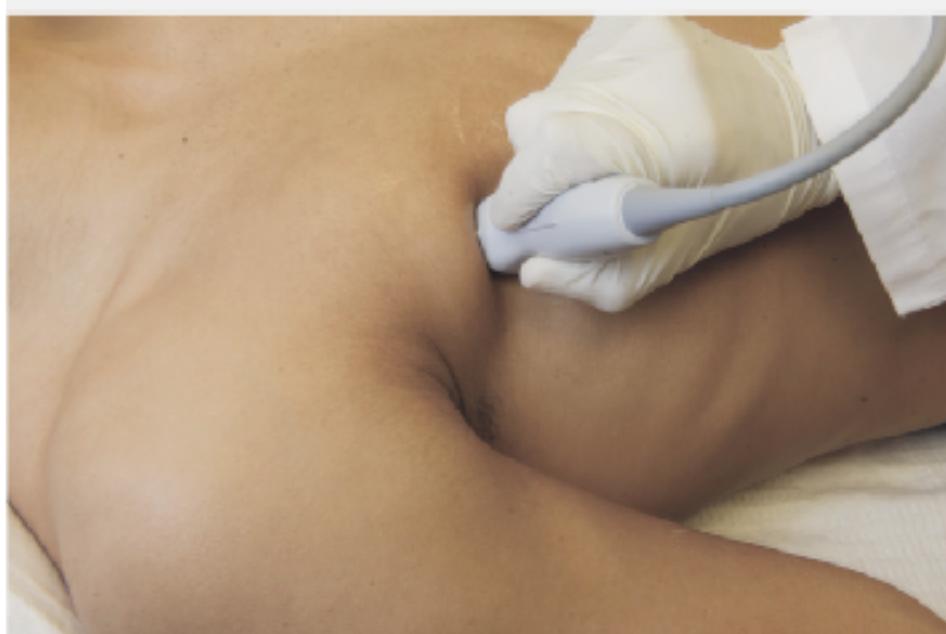
AIS

Point 1



BLUE 4 points

Point 2



Point 3



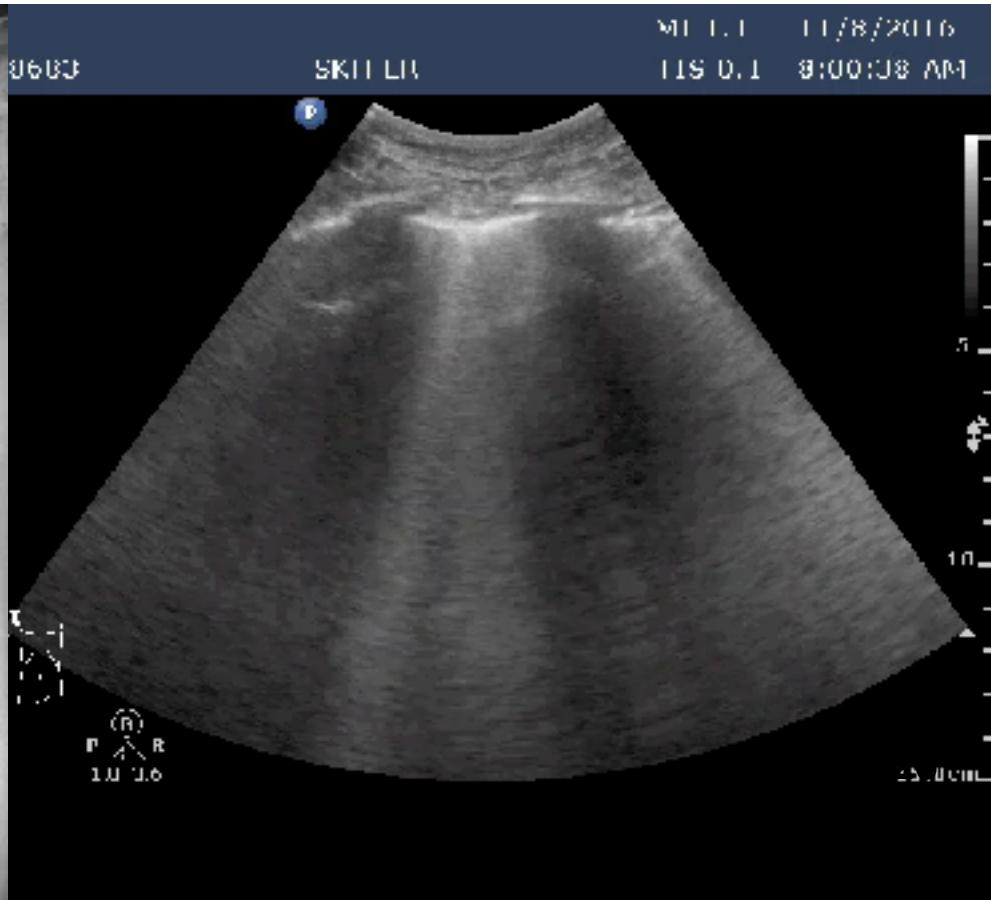
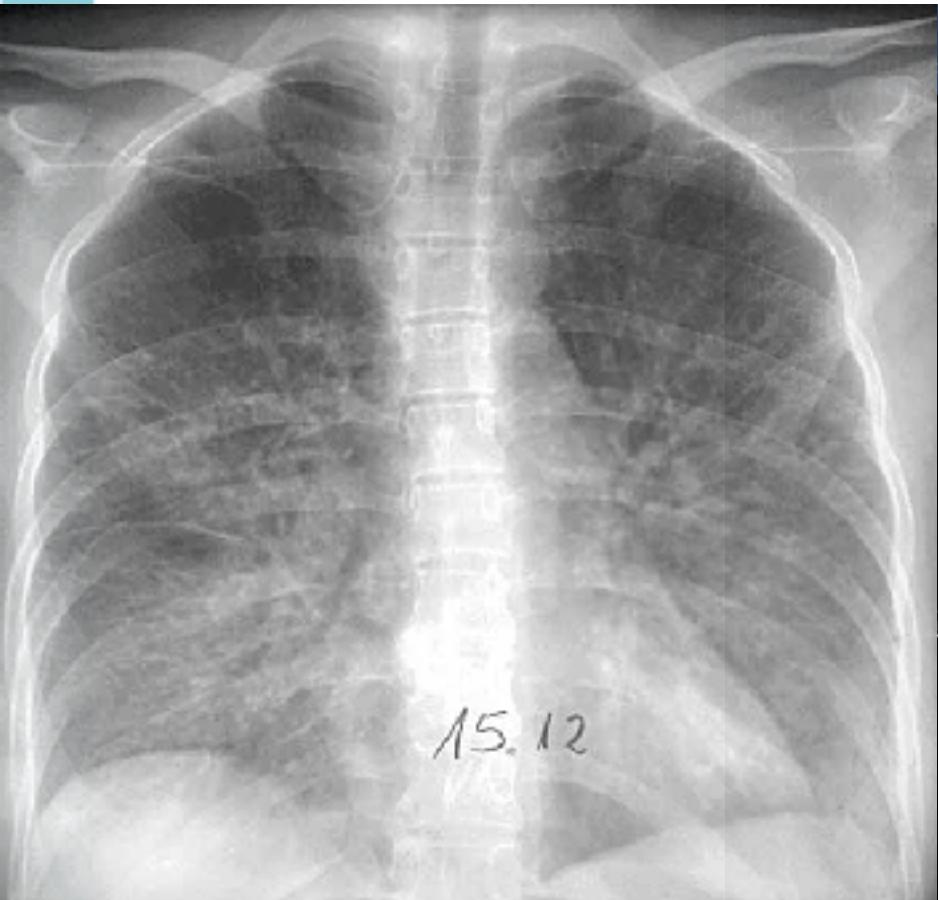
Point 4

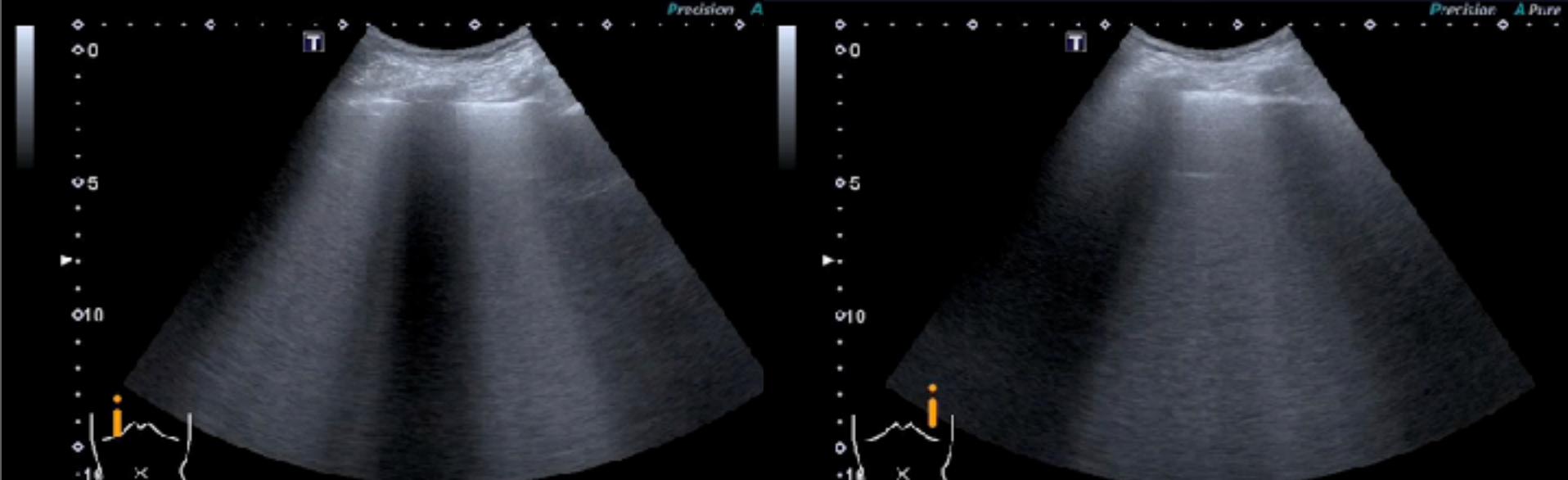
3x2

Alveolar Interstitial Syndrome

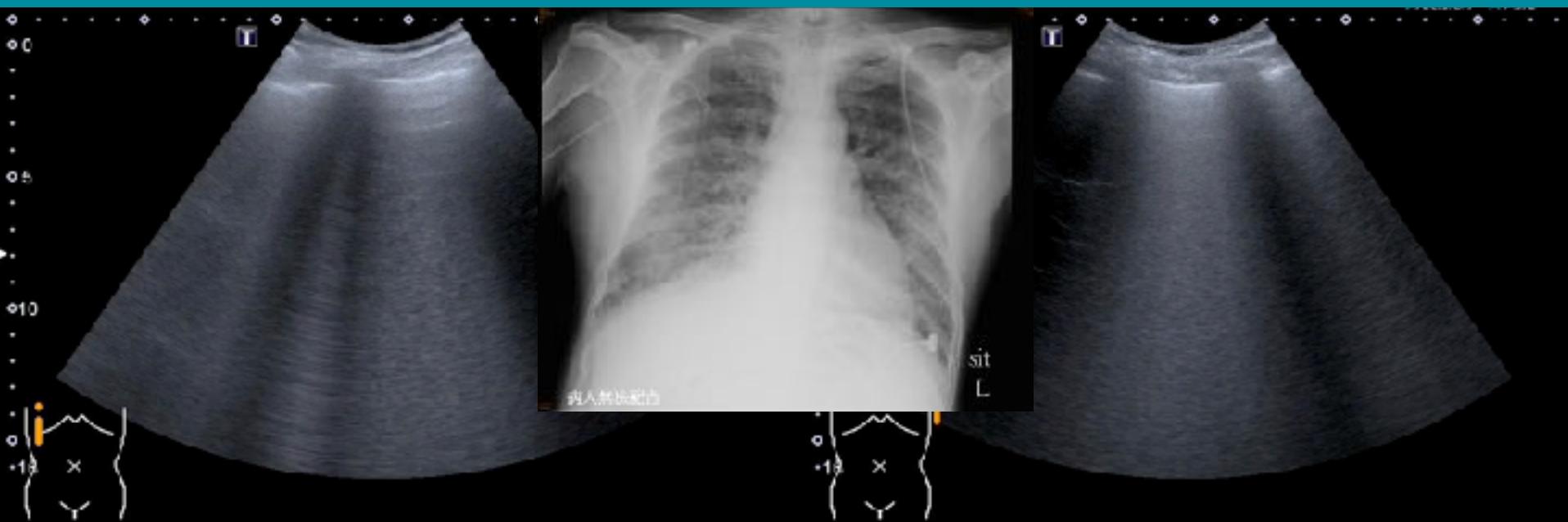
# LUNG ROCKETS

ICS > 3 B lines

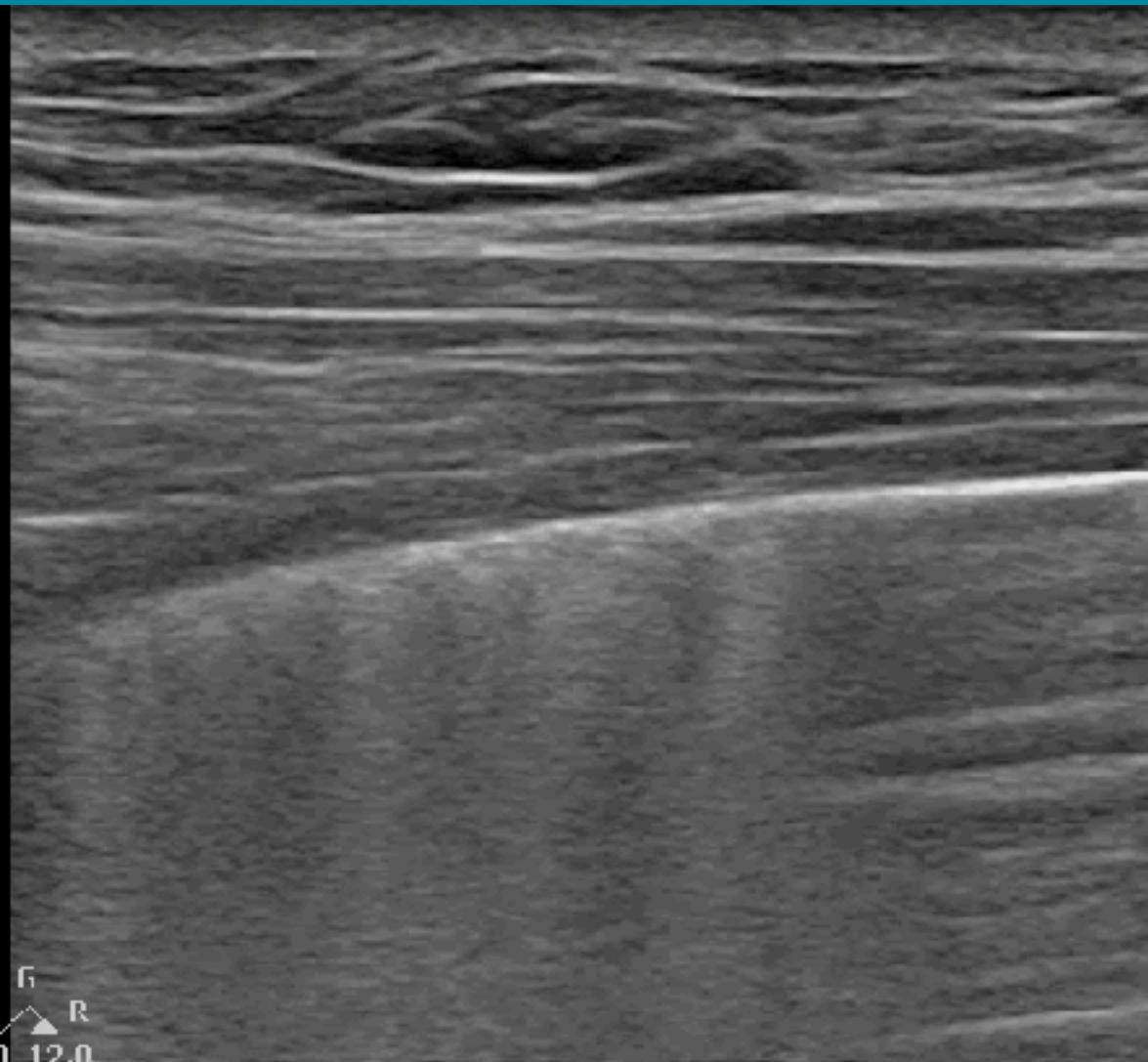




# ALEVOLAR INTERSTITIAL SYNDROME



# AIS: Localized



Pneumonia

Pneumonitis

Atelectasis

Contusion

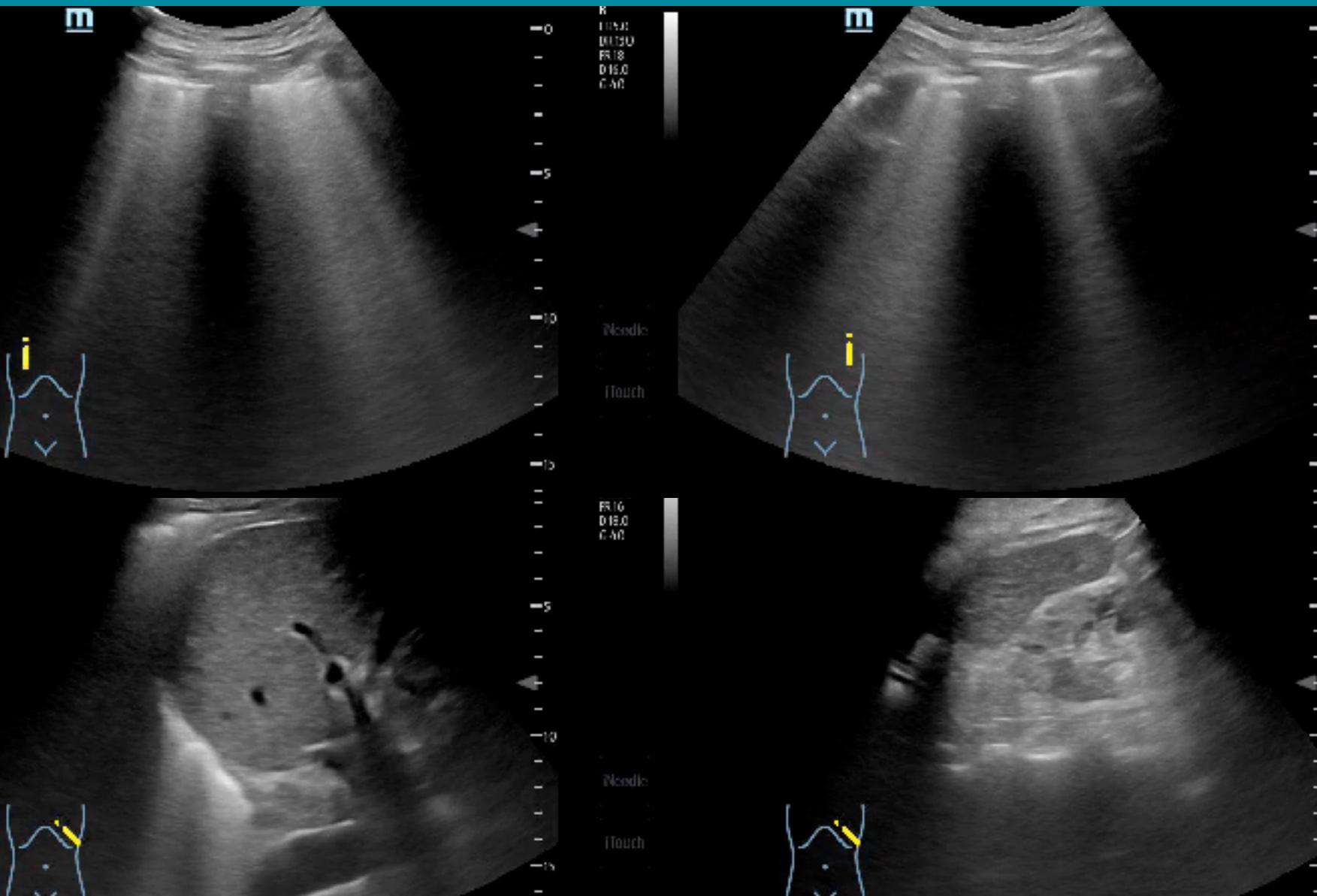
Infarction

Pleural disease

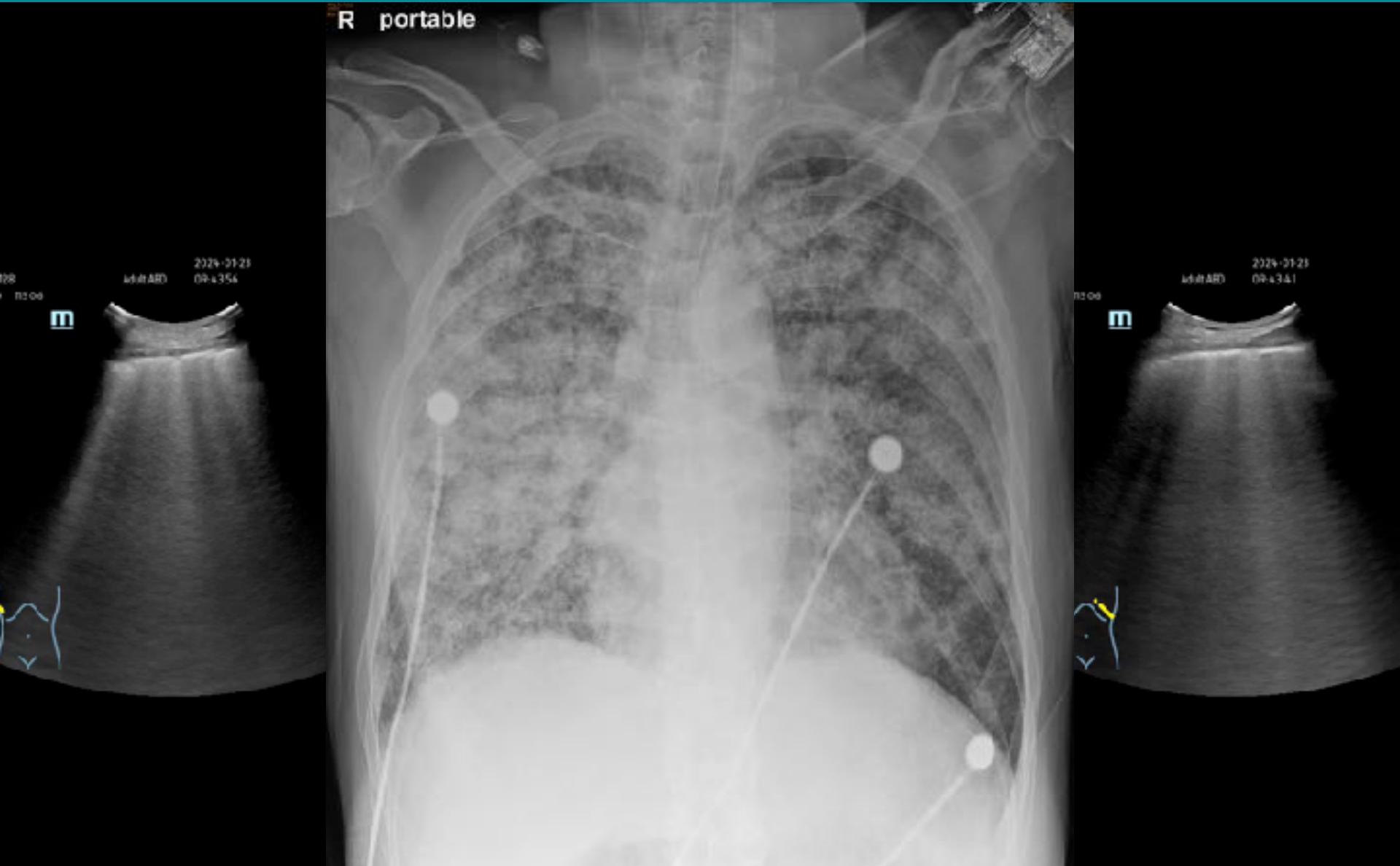
Neoplasia

Normal lung

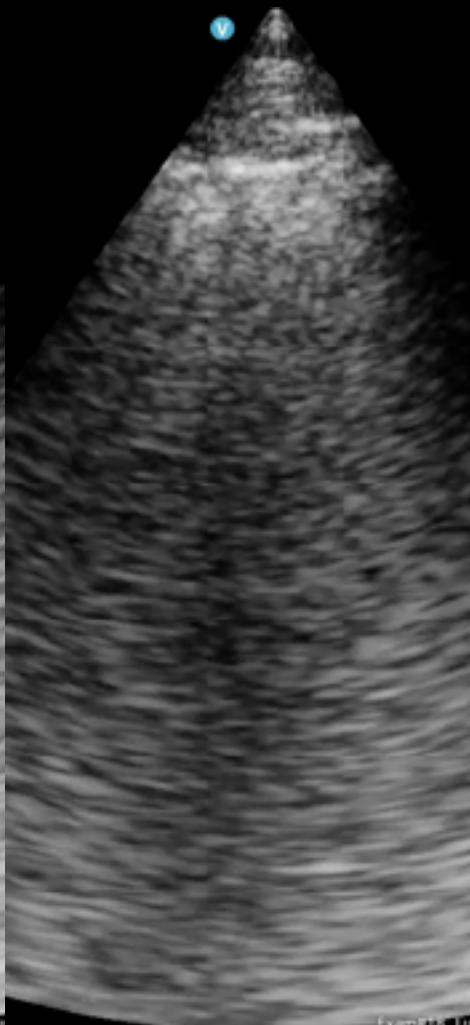
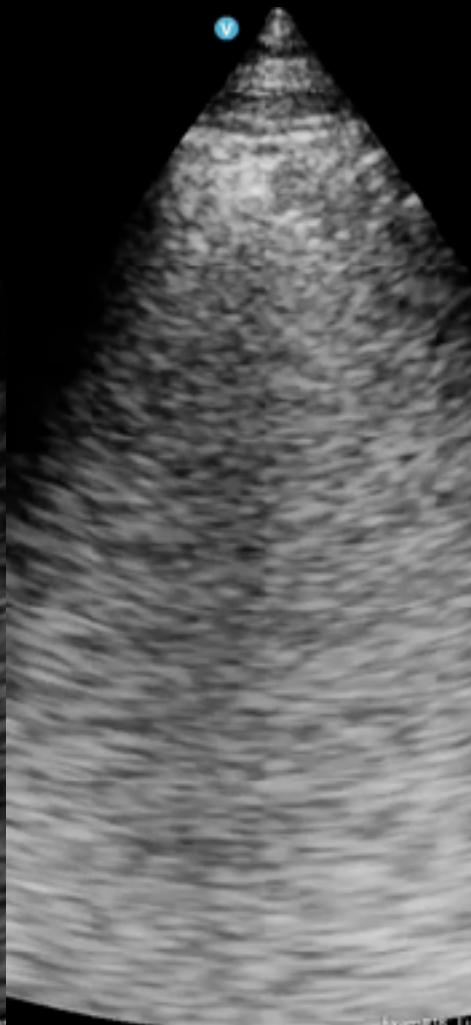
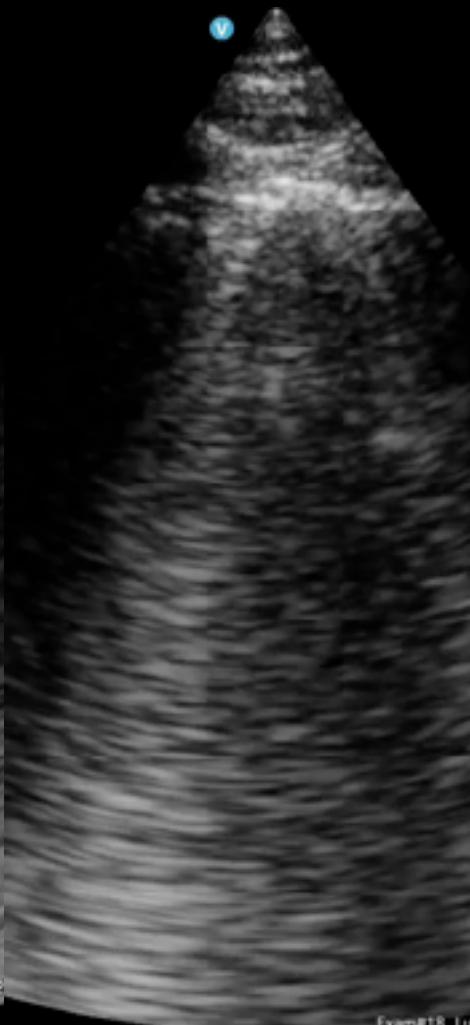
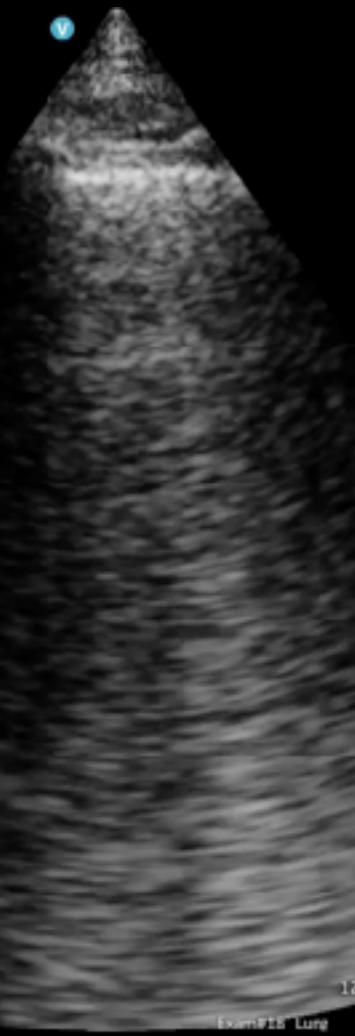
**68M, ESRD ON HD QW246  
APE > AAD > CPR 10' > ROSC > SHH**



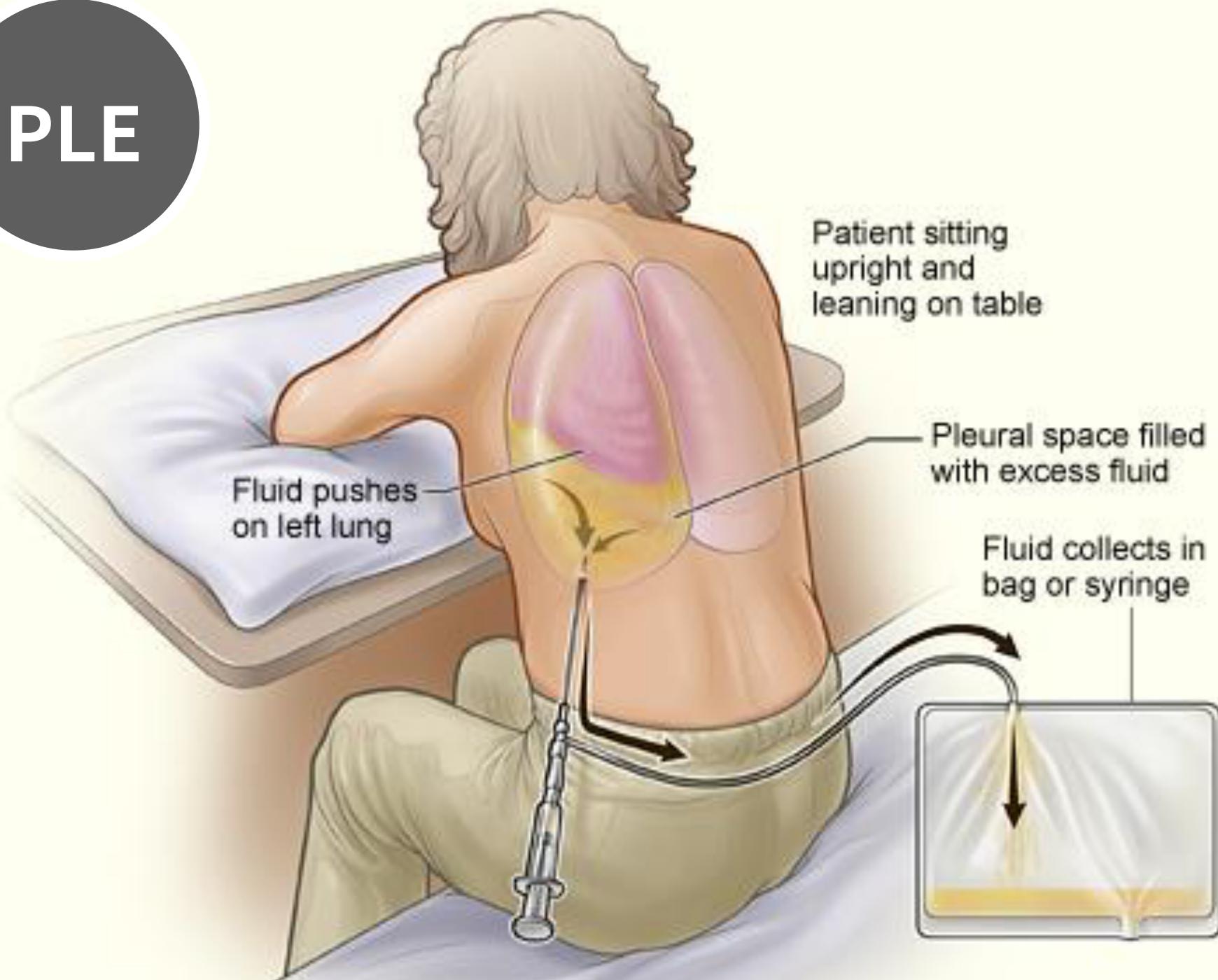
# ALVEOLAR INTERSTITIAL SYNDROME

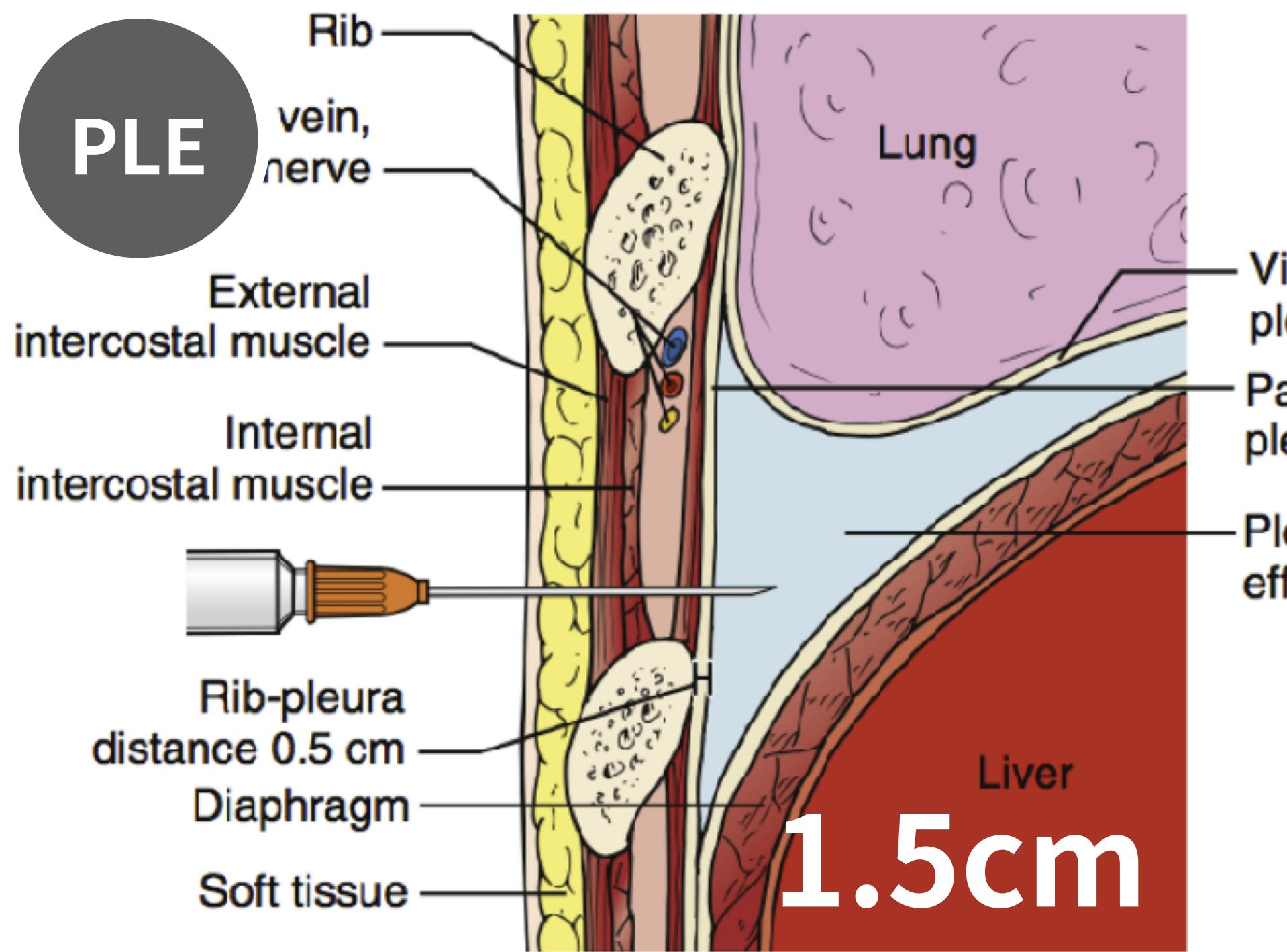


# ALVEOLAR INTERSTITIAL SYNDROME



PLE



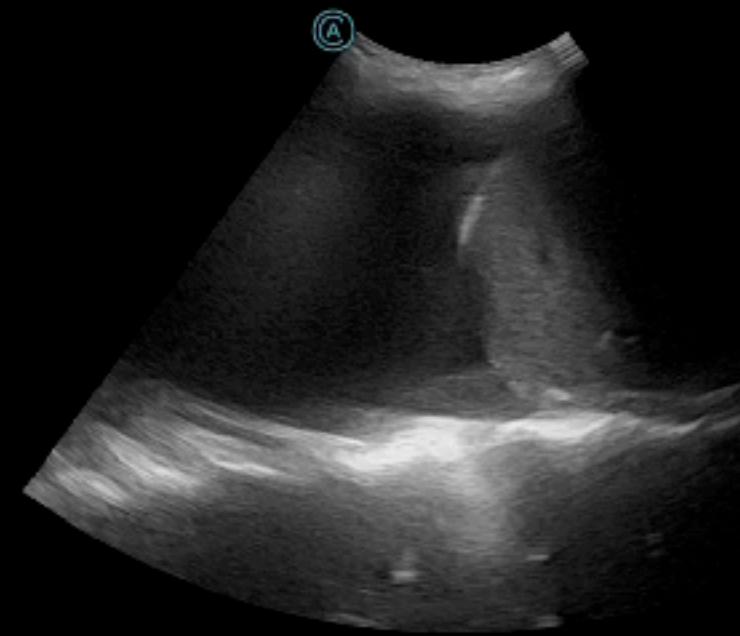
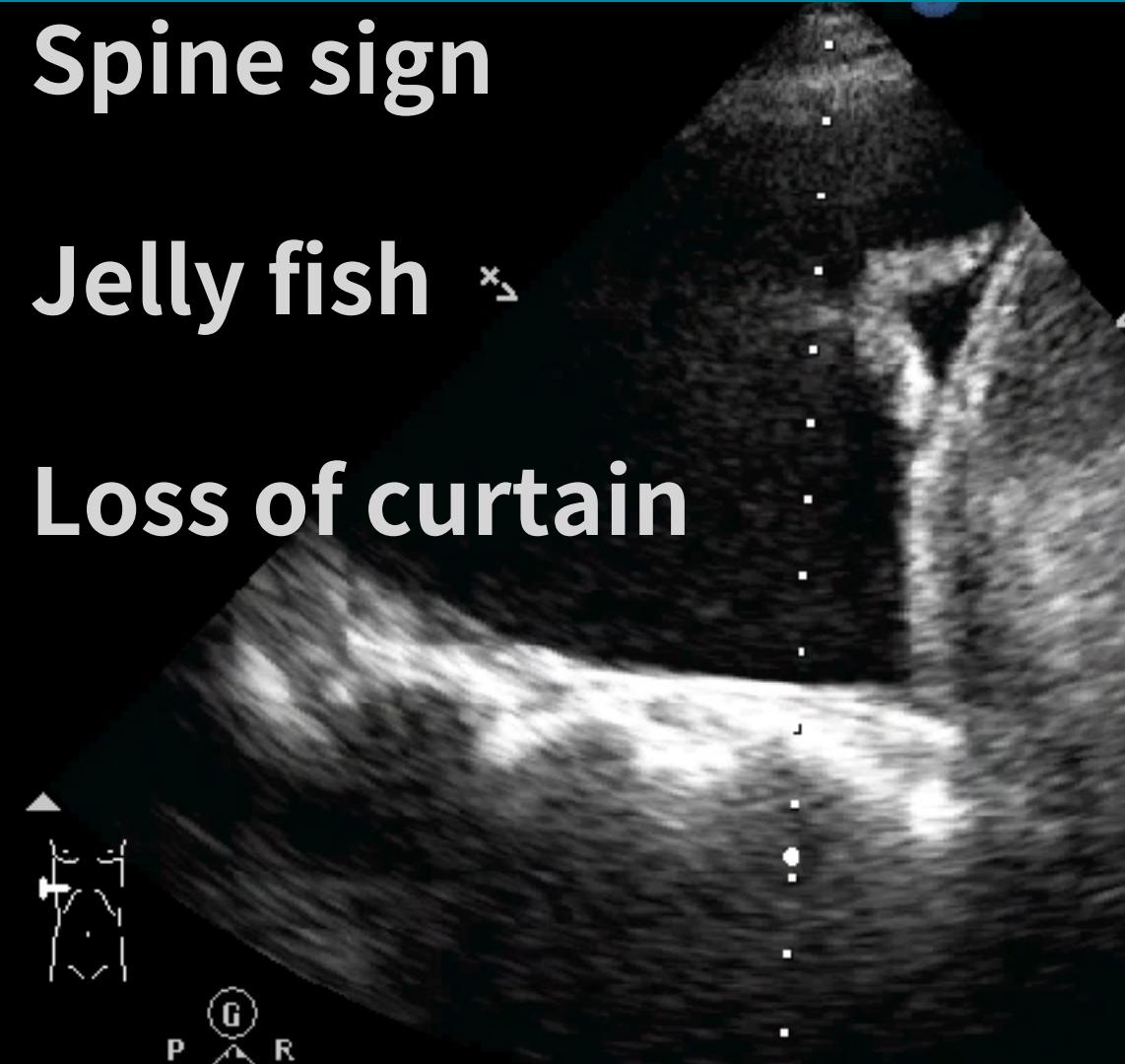


# PLEURAL EFFUSION

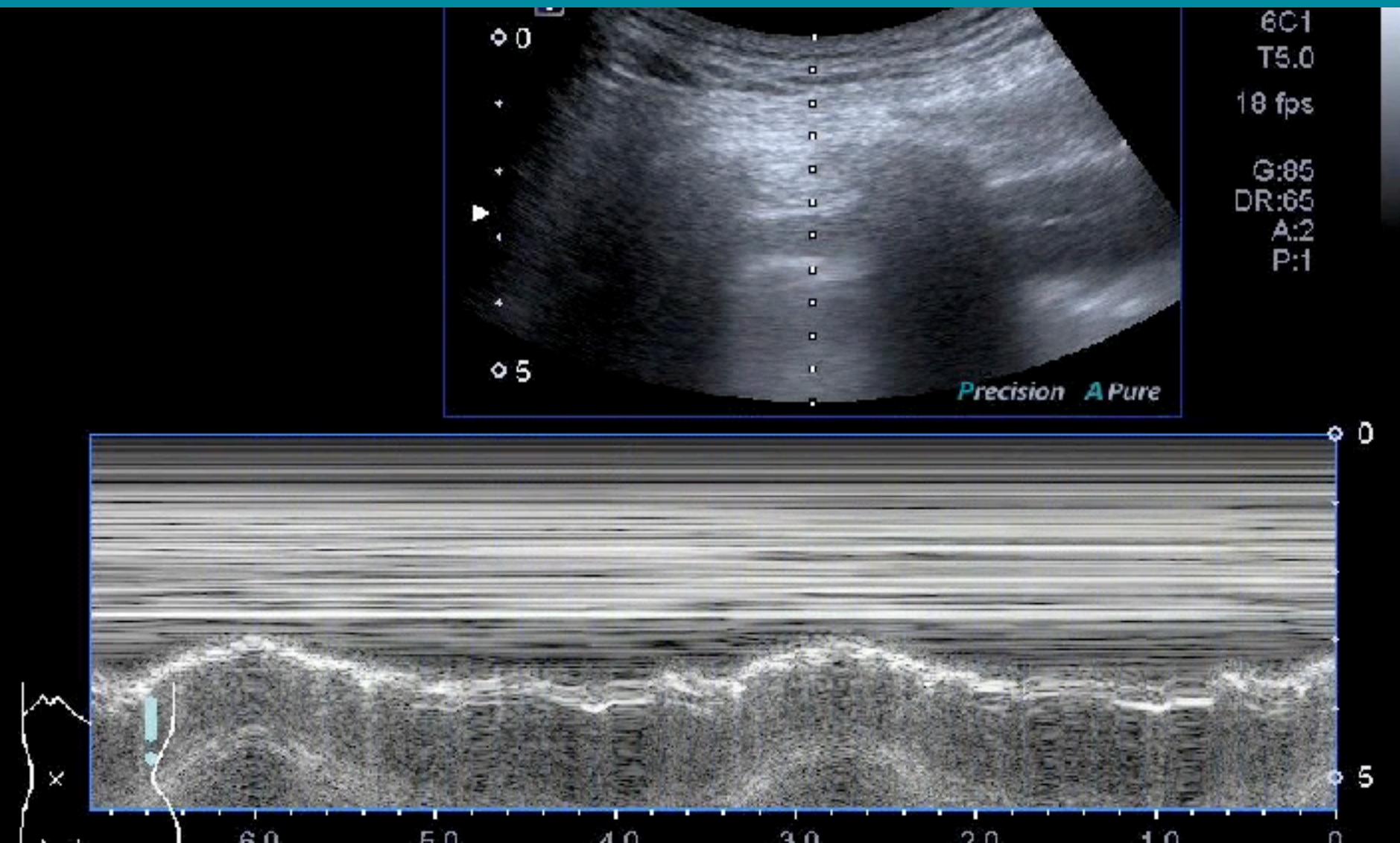
Spine sign

Jelly fish 

Loss of curtain



# Sharp sign / Sinusoid sign

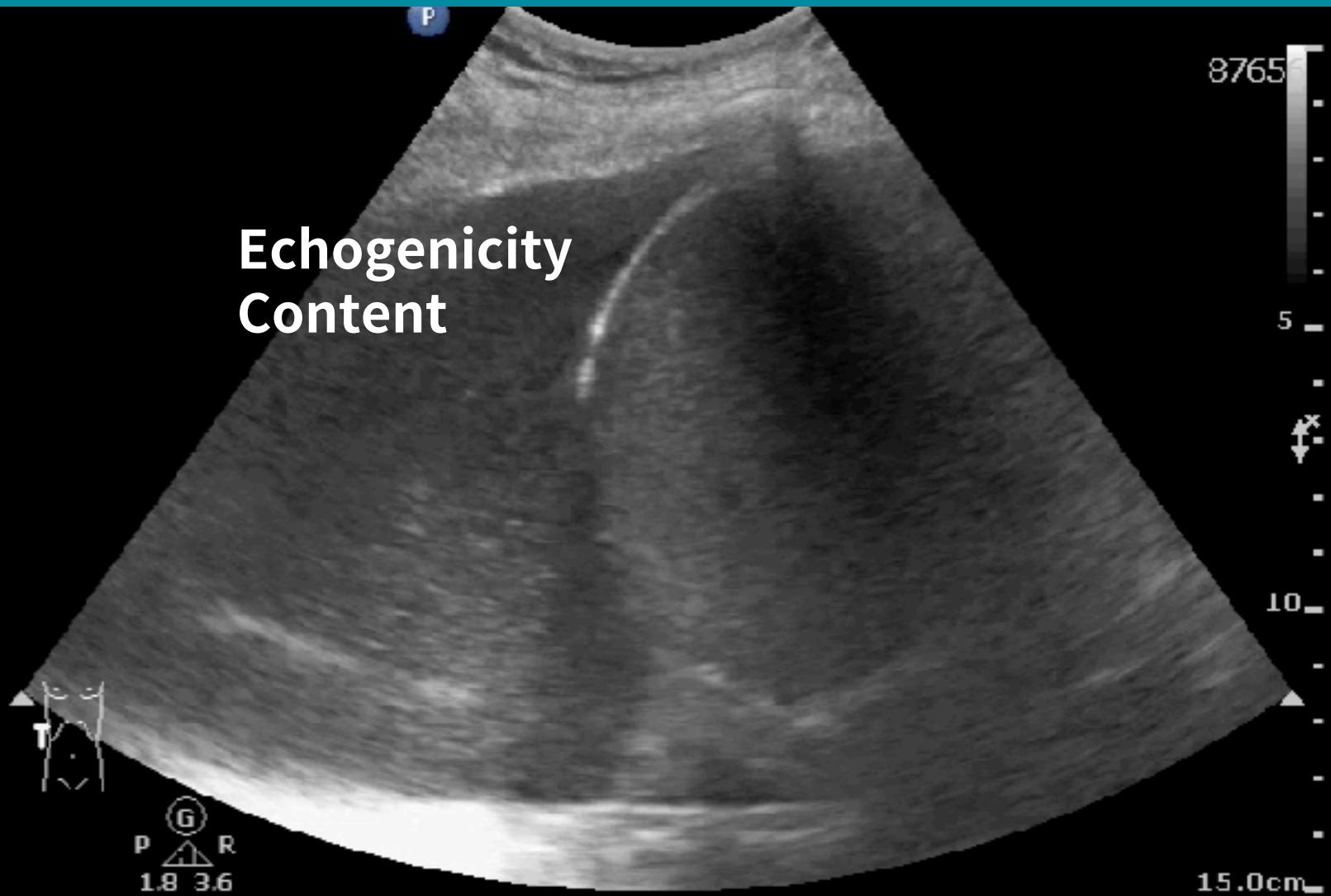


# Plankton sign

Abd Gen2  
C5-1  
34 Hz  
15.0cm

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

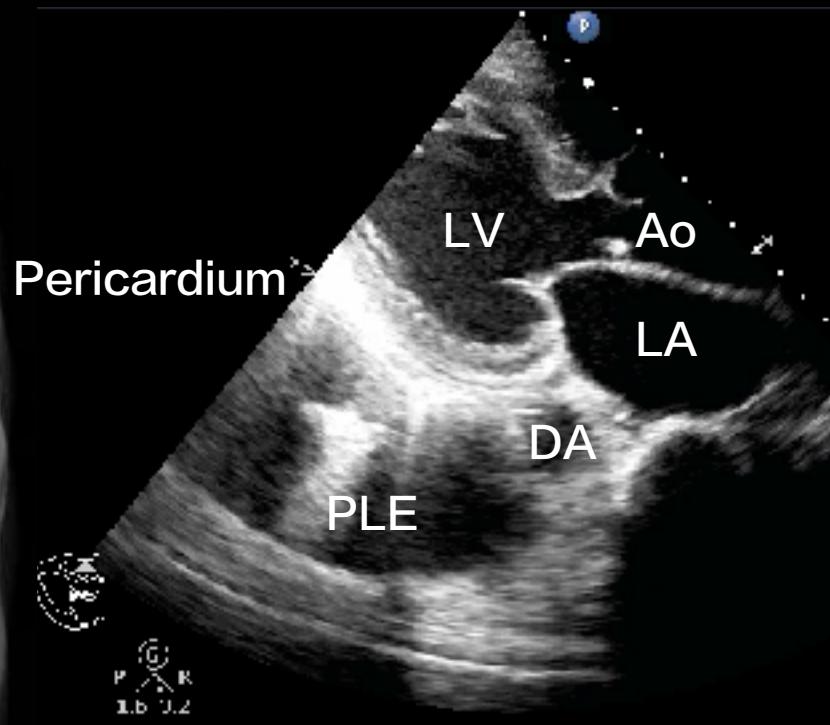
Echogenicity  
Content





# D aorta

## Pericardial vs Pleural



# 73M, F & Dyspnea

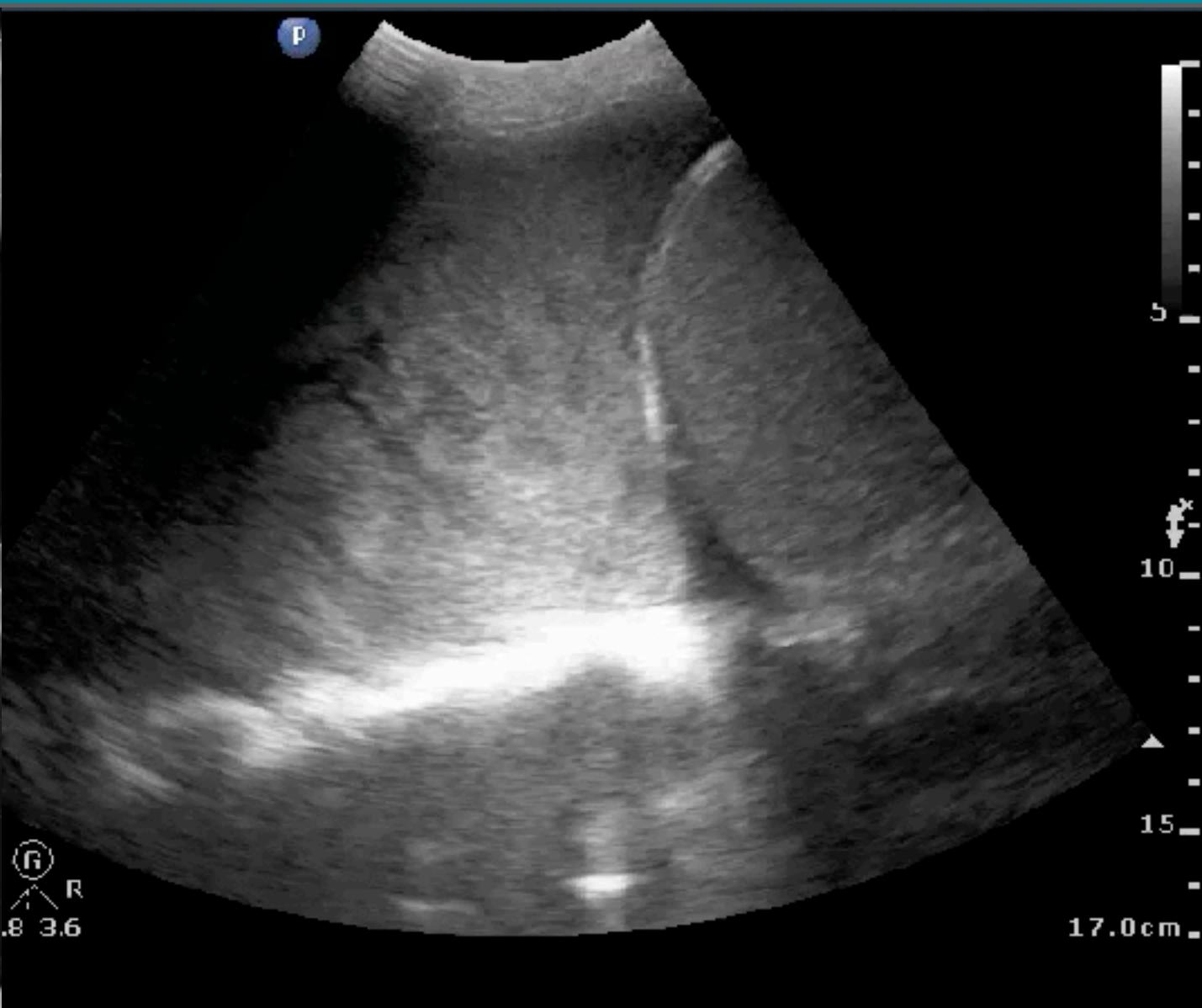


Empyema

Septation  
Fibrin  
Particles



# What do you see ?



# US for PLE

**Detection**

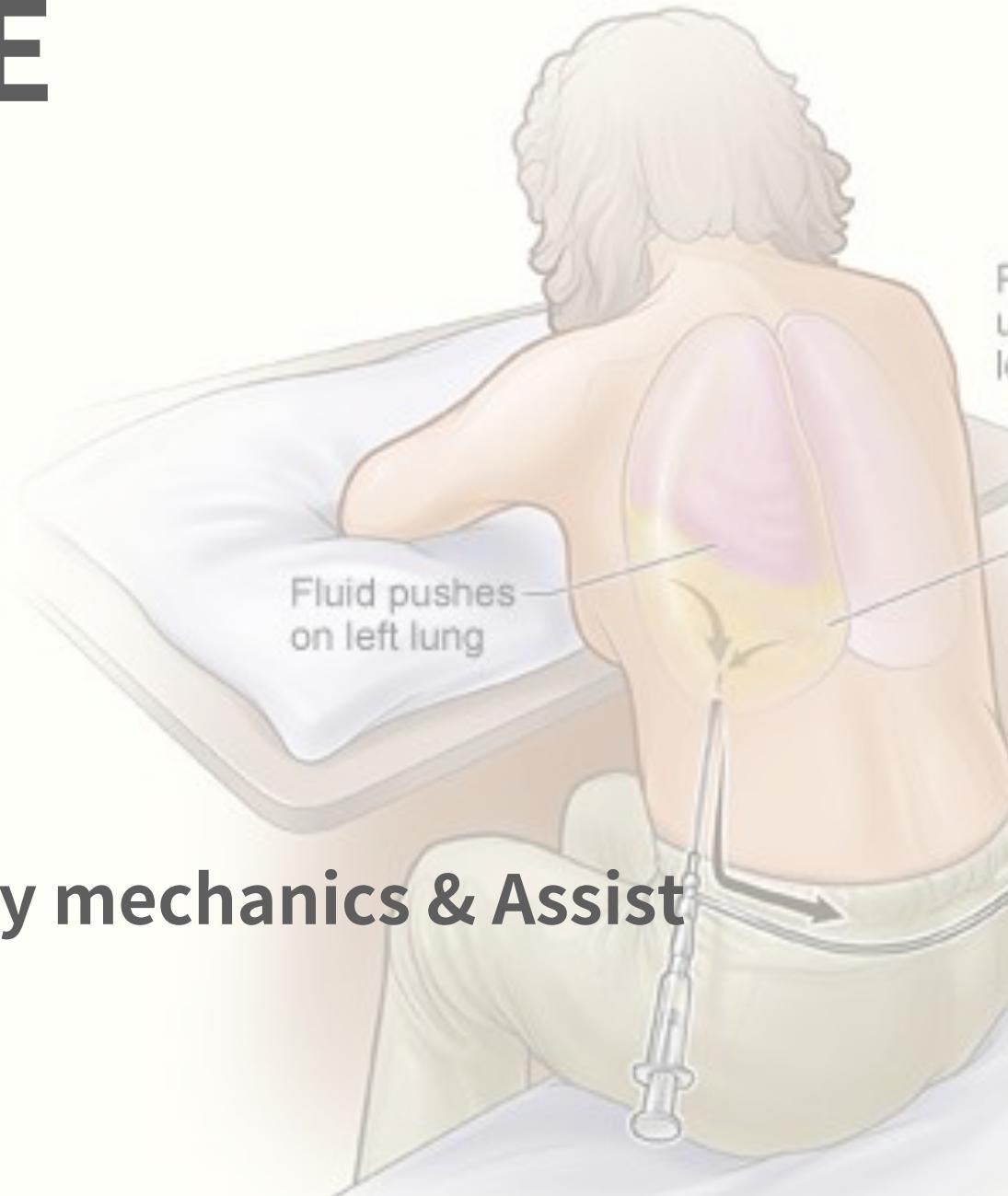
**Volume**

**Nature**

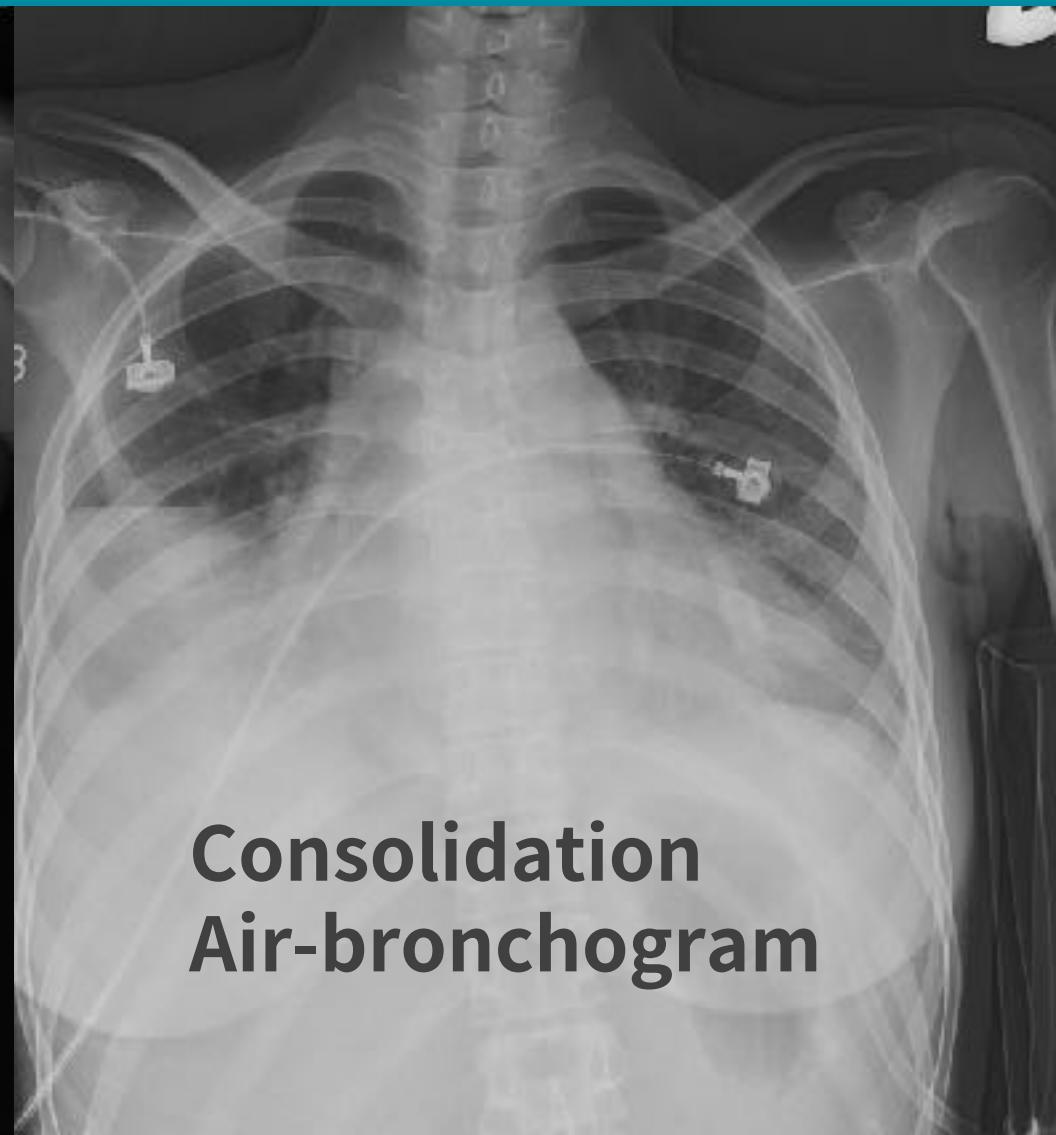
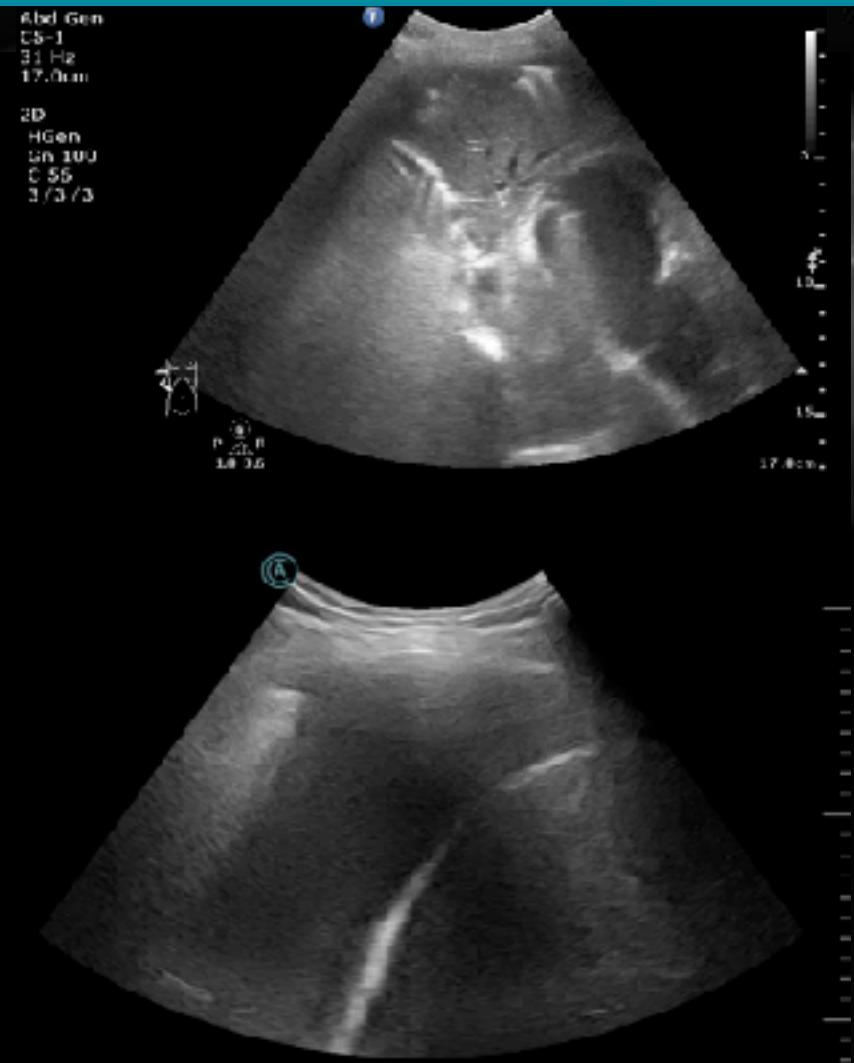
**Safety**

**Drainage**

**Improve ventilatory mechanics & Assist weaning**

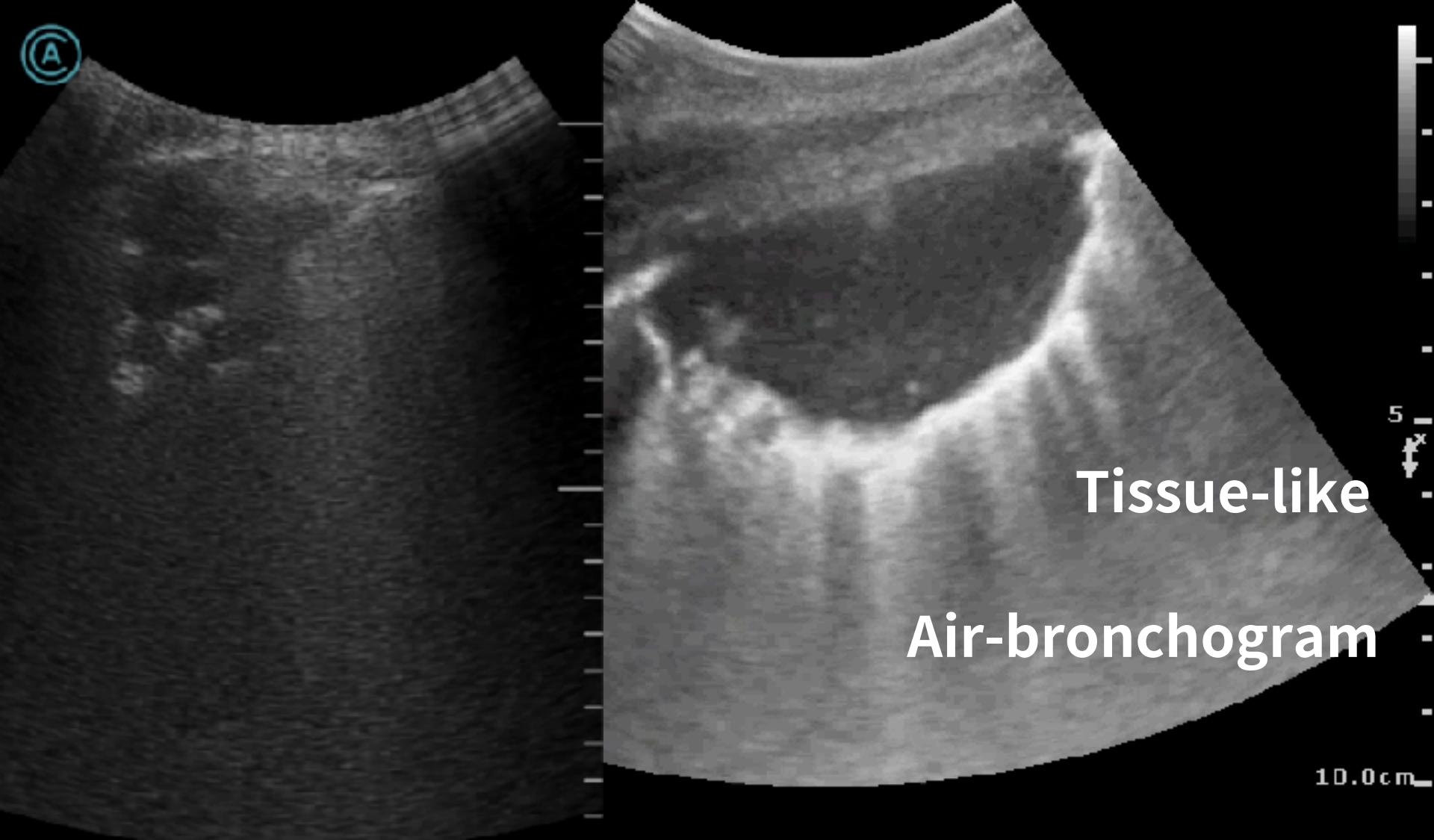


# 28F, 來抽肋膜積液吧 !?



Consolidation  
Air-bronchogram

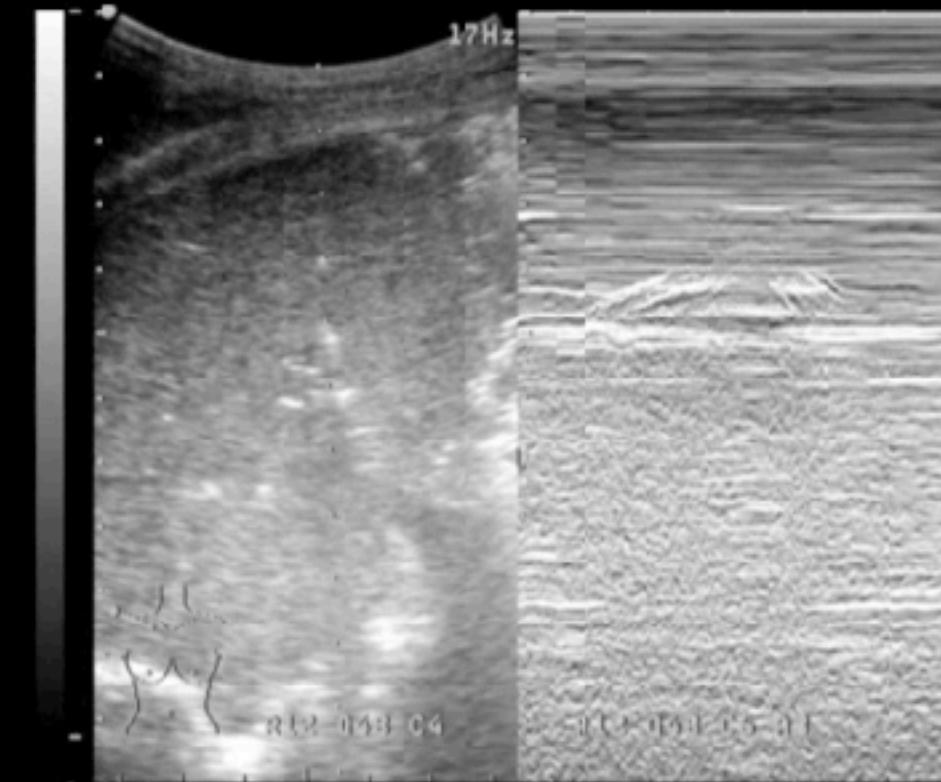
# C profile



# Dynamic air-bronchogram



L

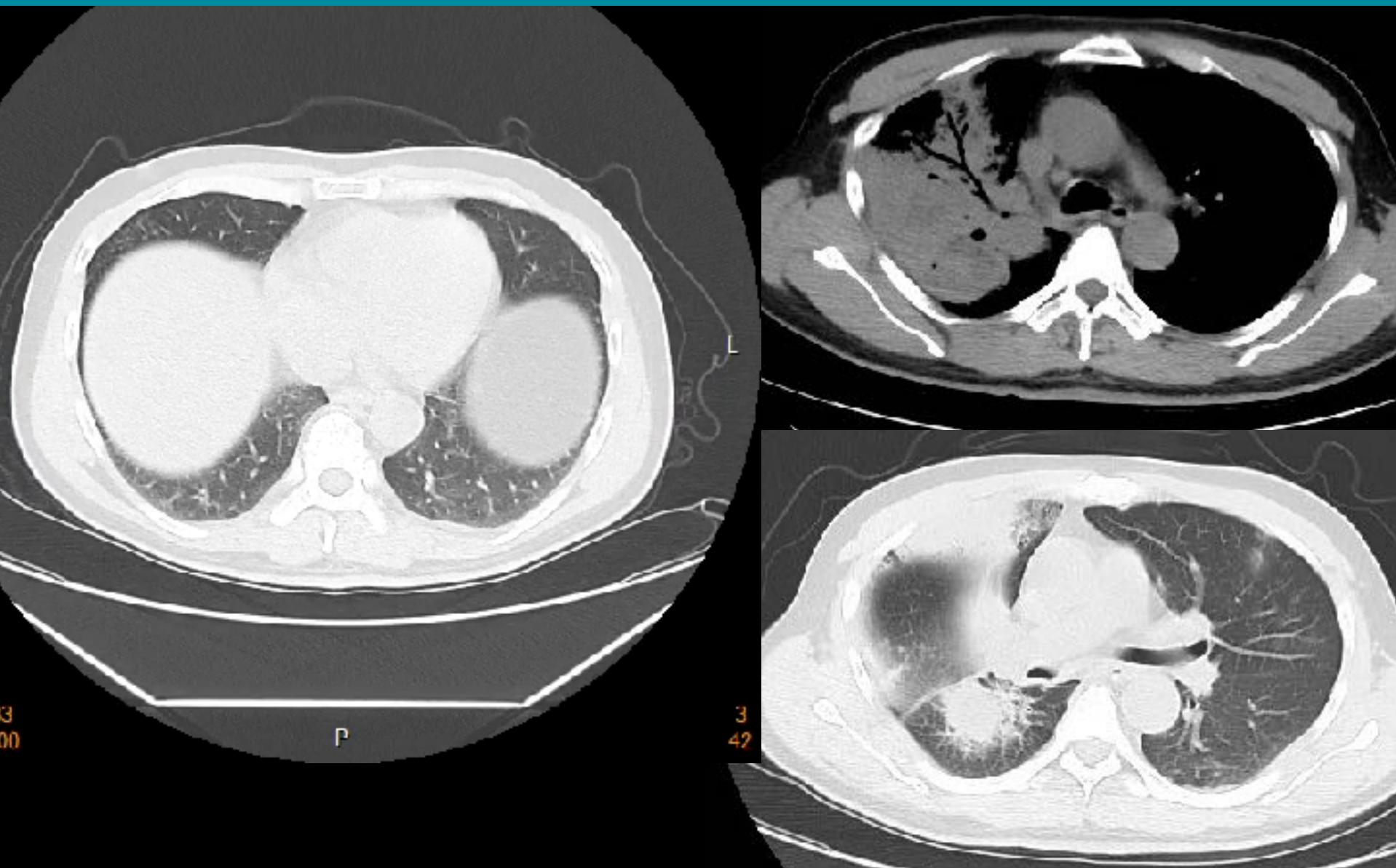


1: Abdomen

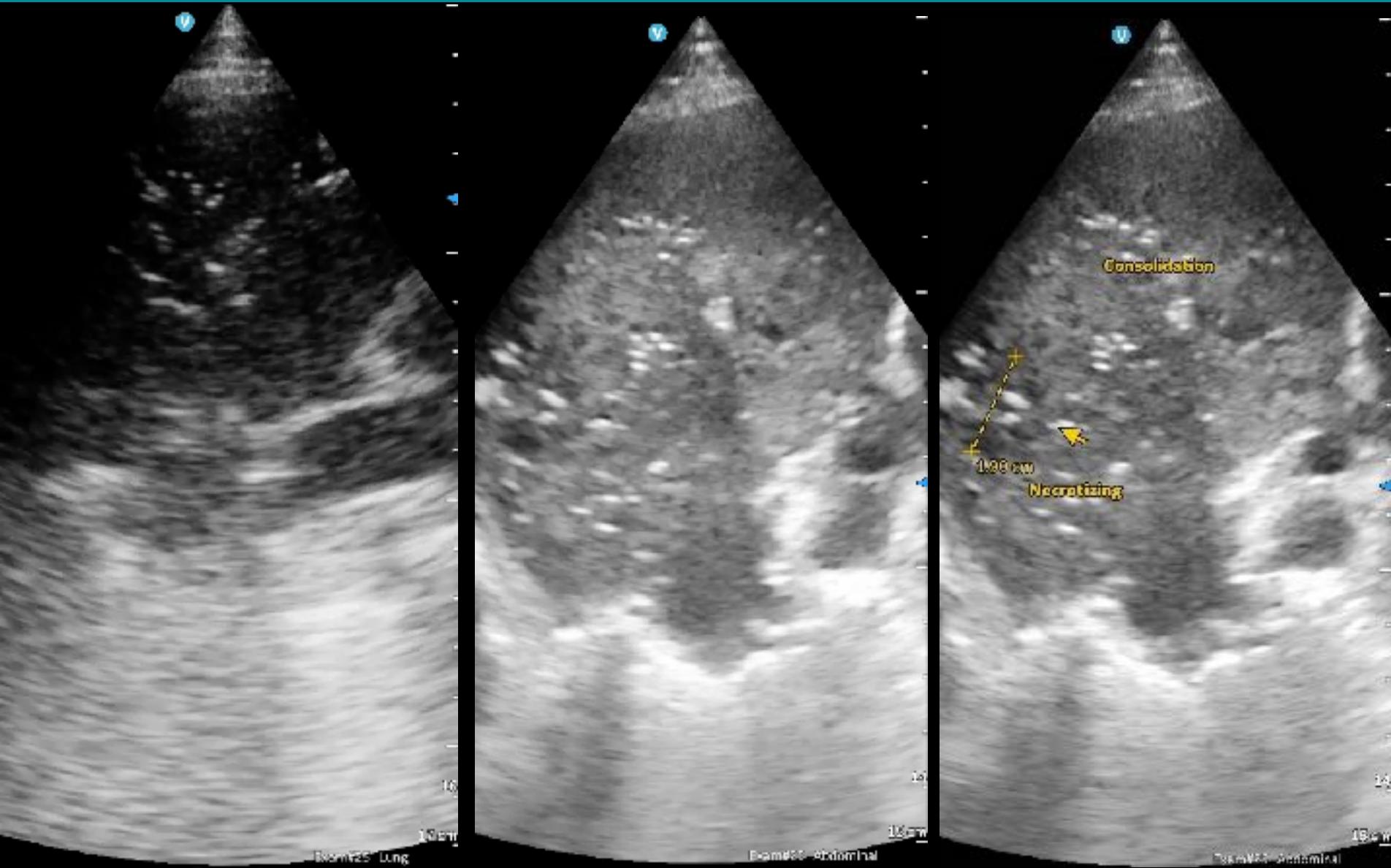
**49M, FEVER & COUGH FOR 2 WEEKS**



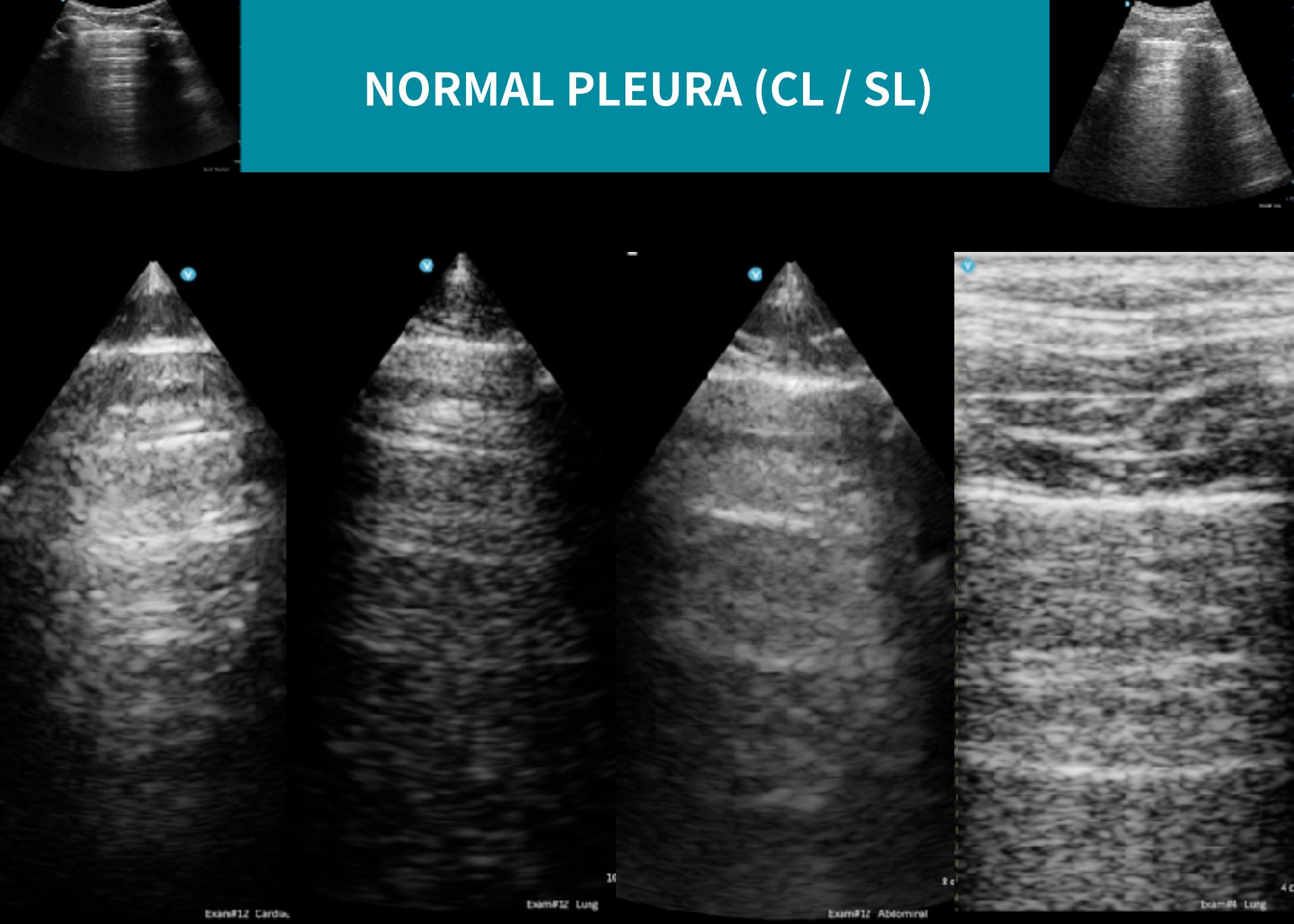
# RUL PNEUMONIA



# PNEUMONIA

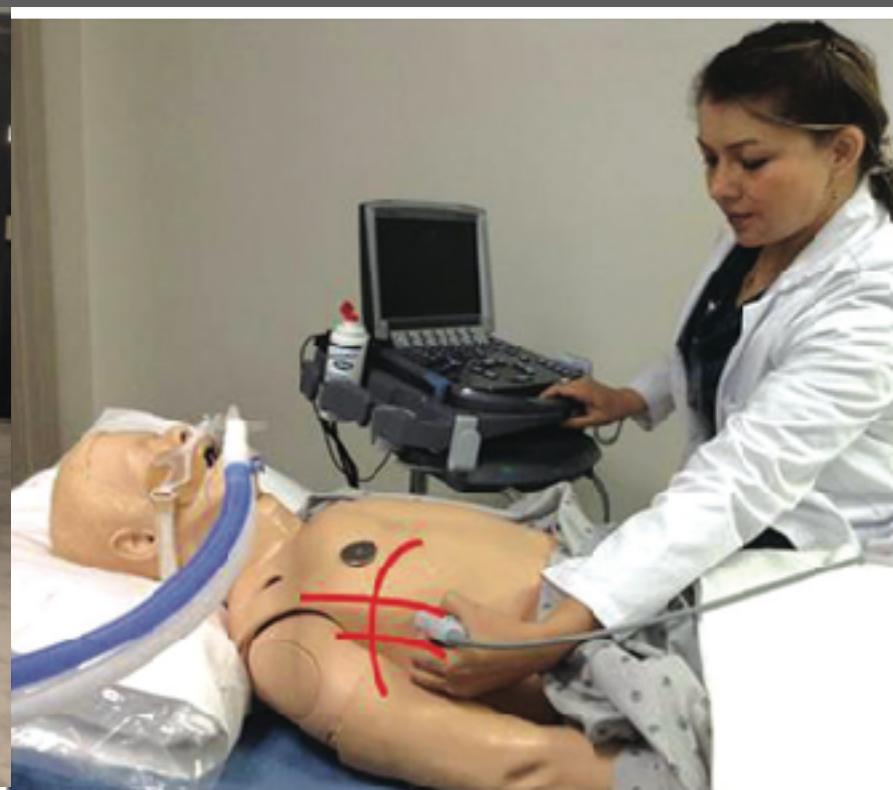
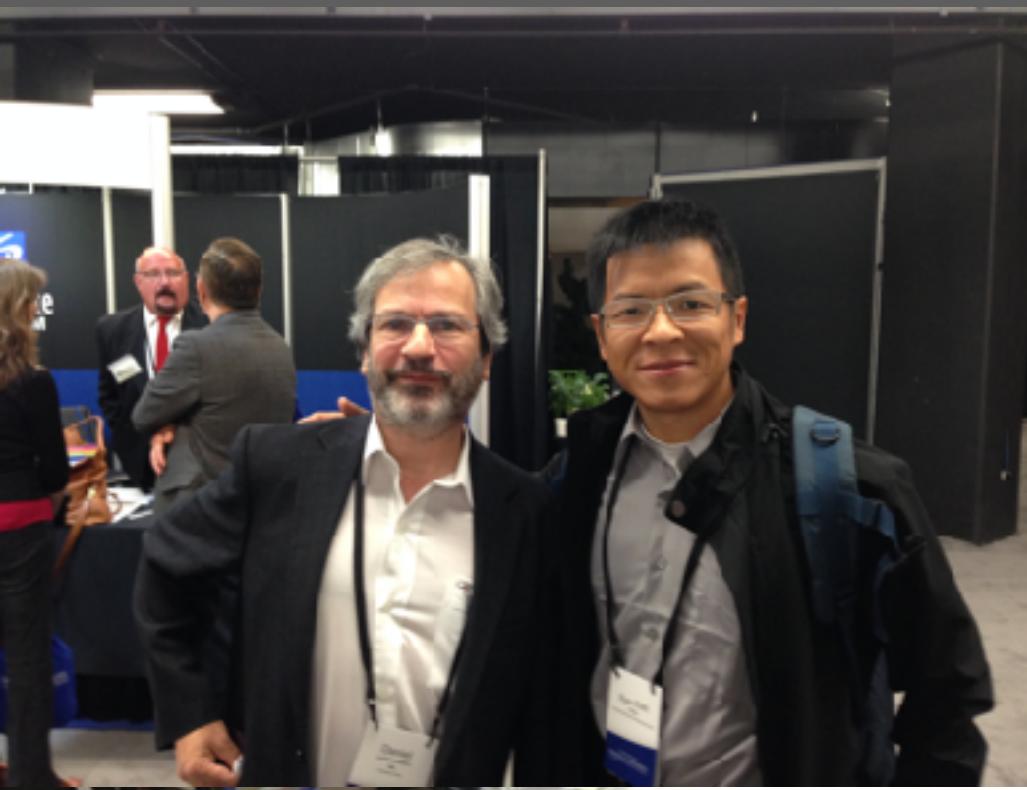


# NORMAL PLEURA (CL / SL)



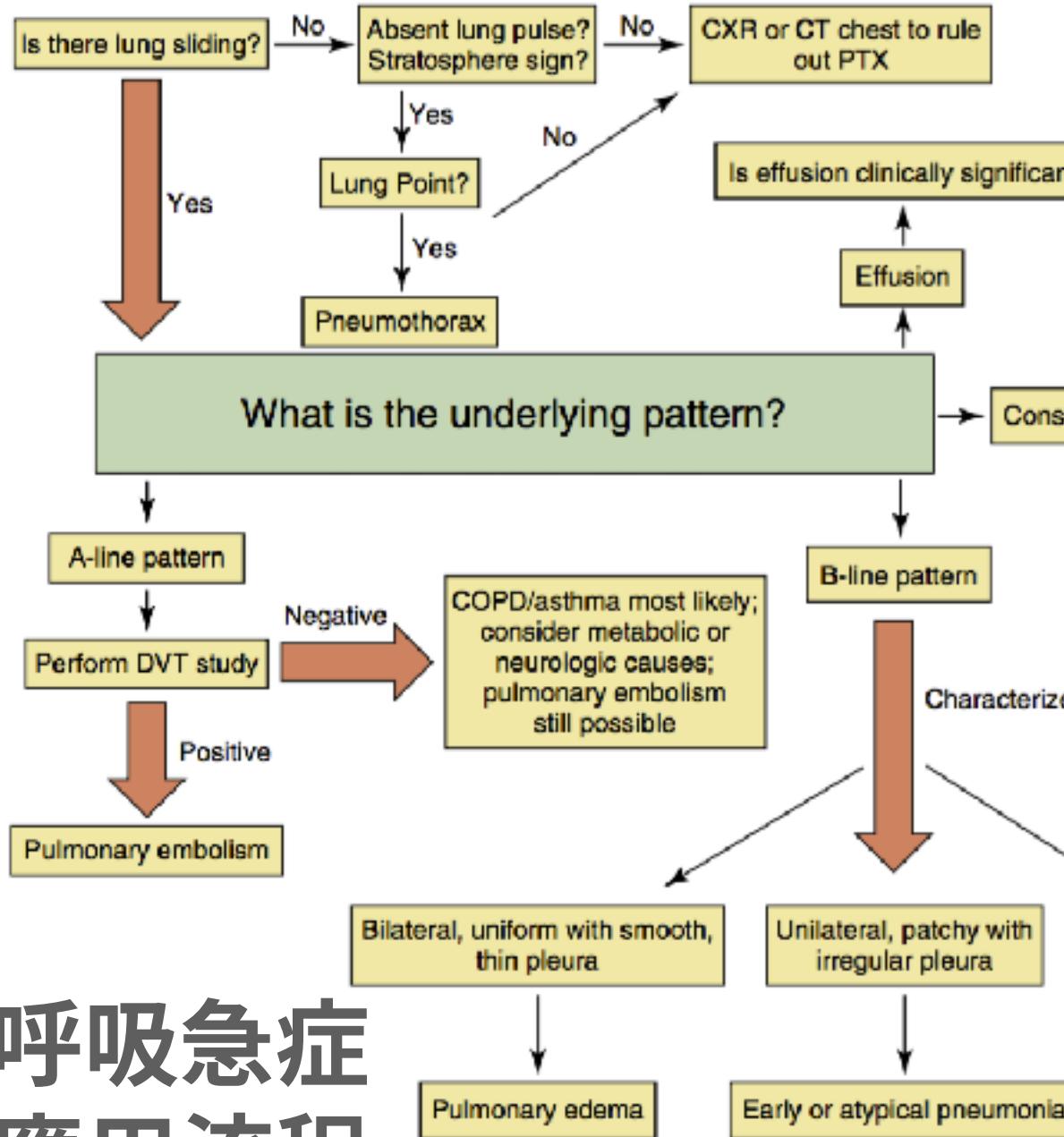
# BLUE Protocol

(Bedside Lung Ultrasound in Emergency Protocol)



Daniel Lichtenstein

# BLUE



S  
A  
B  
E  
C

# 呼吸急症 應用流程



# Curtain sign & Diaphragm movement





# Greatest motion of sliding



# Respiratory drive



TOSHIBA

Xario 200

West Garden Hospital

Abdomen

3158

2017/05/09

9:20:45 AM

MI:1.3

6C1

T5.0

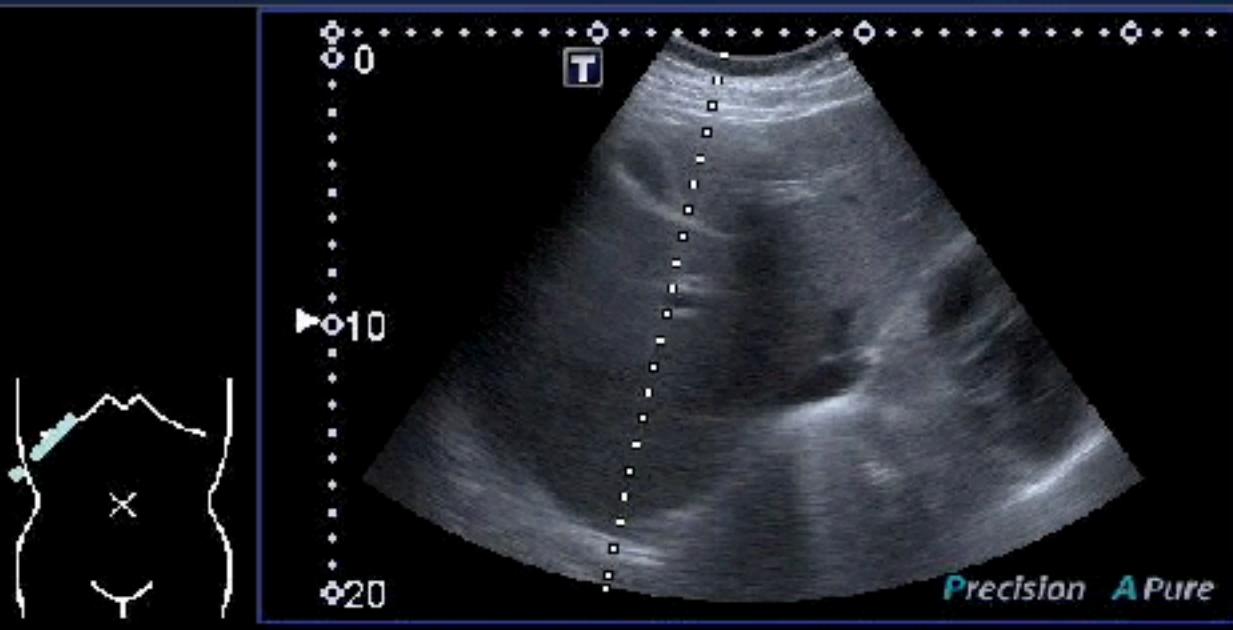
11 fps

G:85

DR:65

A:2

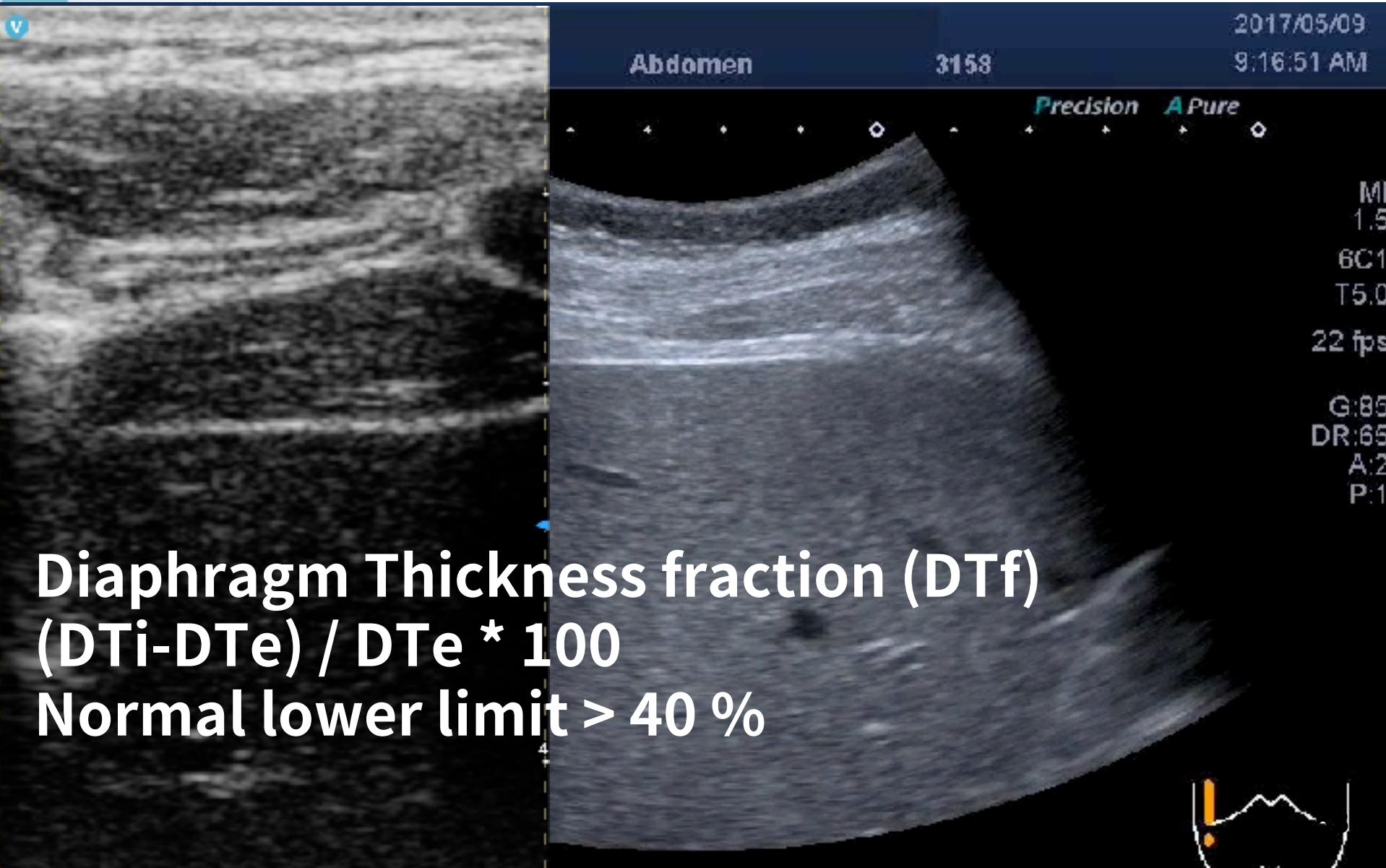
P:1



Diaphragm excursion  
Diaphragm velocity



# Respiratory drive



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

# Back !!!



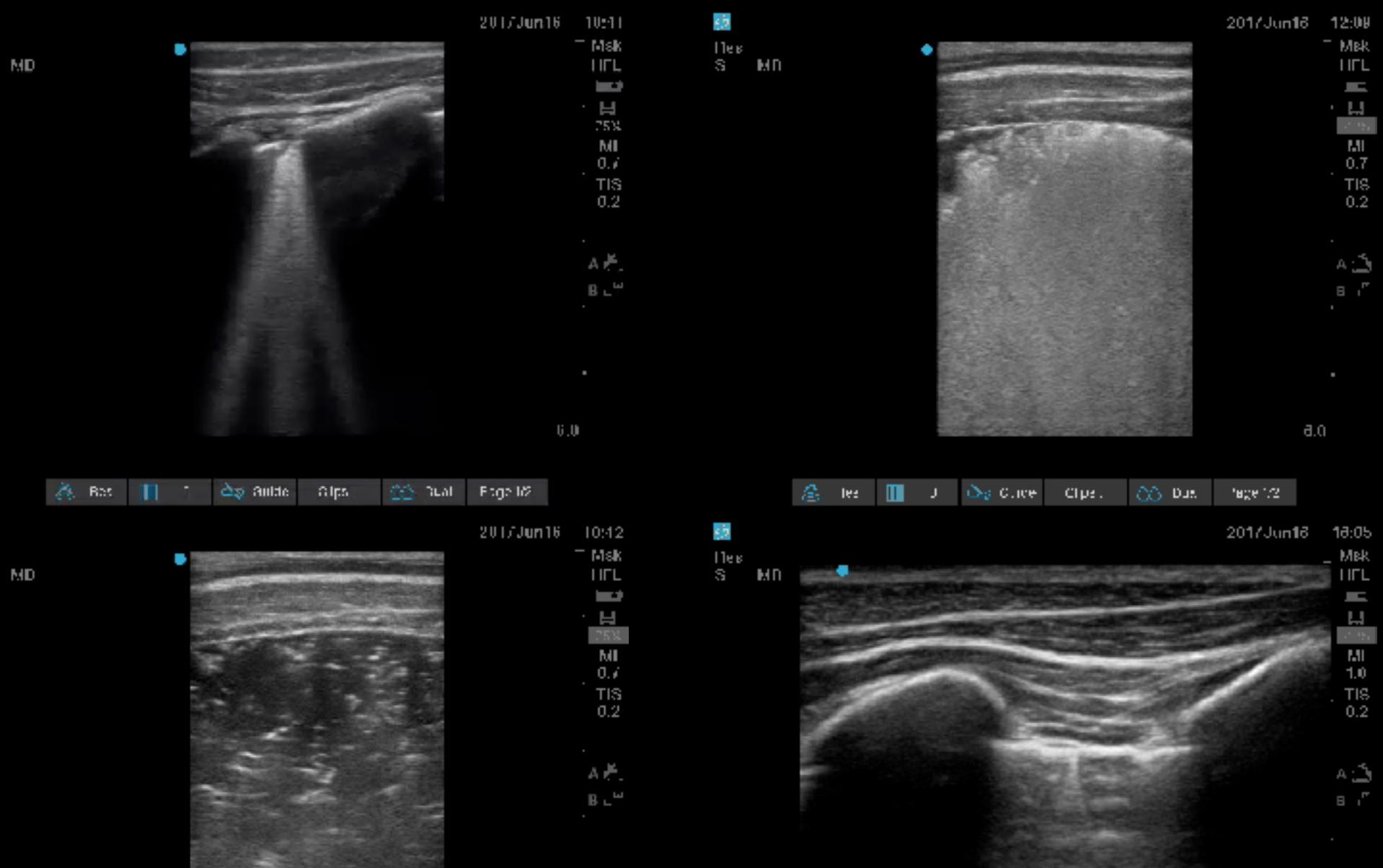
Abd Gen2  
C5-1  
39 Hz  
12.0cm  
2D  
HGen  
Gn 100  
C 56  
3 / 3 / 3



d Gen2  
-1  
Hz  
.0cm  
Gen  
n 100  
56  
/3/3



# Atelectasis



## Indication

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

- History
- Physical examination
- ABG
- ECG

Pretest probability

## DIAGNOSTIC HYPOTHESIS

### Pleural effusion suspected

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

### PTX suspected

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

### Increased lung density suspected

- Semireclining 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

- Patient position
- Probe selection & orientation
- Protocol selection
- Picture optimization

## Interpretation

## PLEURAL LINE INTERFACE

### Fluid

#### Pleural effusion/ Hemothorax

- Size
- Ruid 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

### 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" (B1 pattern, B2 pattern)
- Decreased lung sliding
- Decreased/increased lung pulse
- Gravity-dependent or -independent patterns
- Presence/absence of pleural line abnormalities
- Presence/absence of subpleural abnormalities (e.g., focal consolidations)

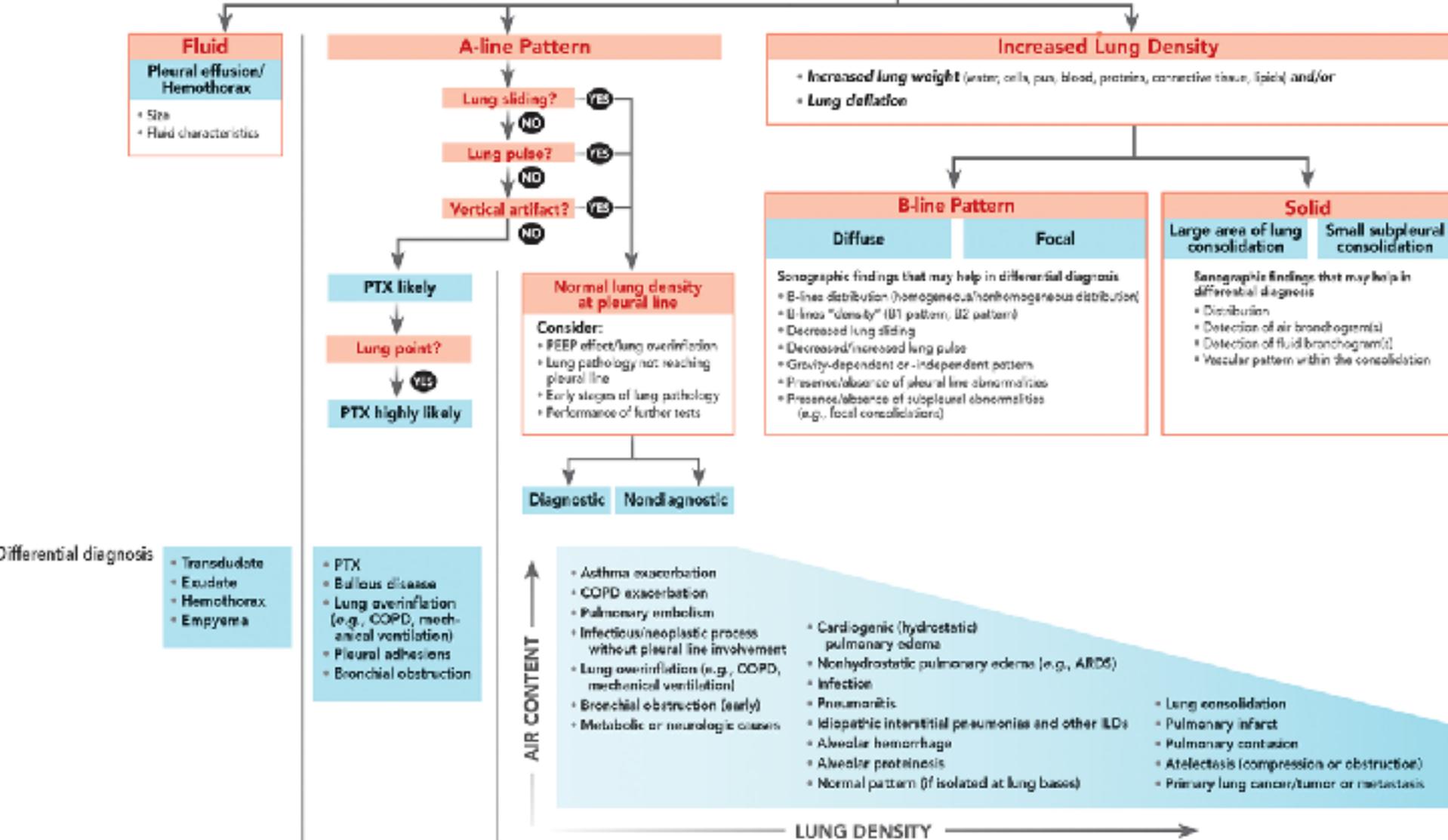
### Solid

#### 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

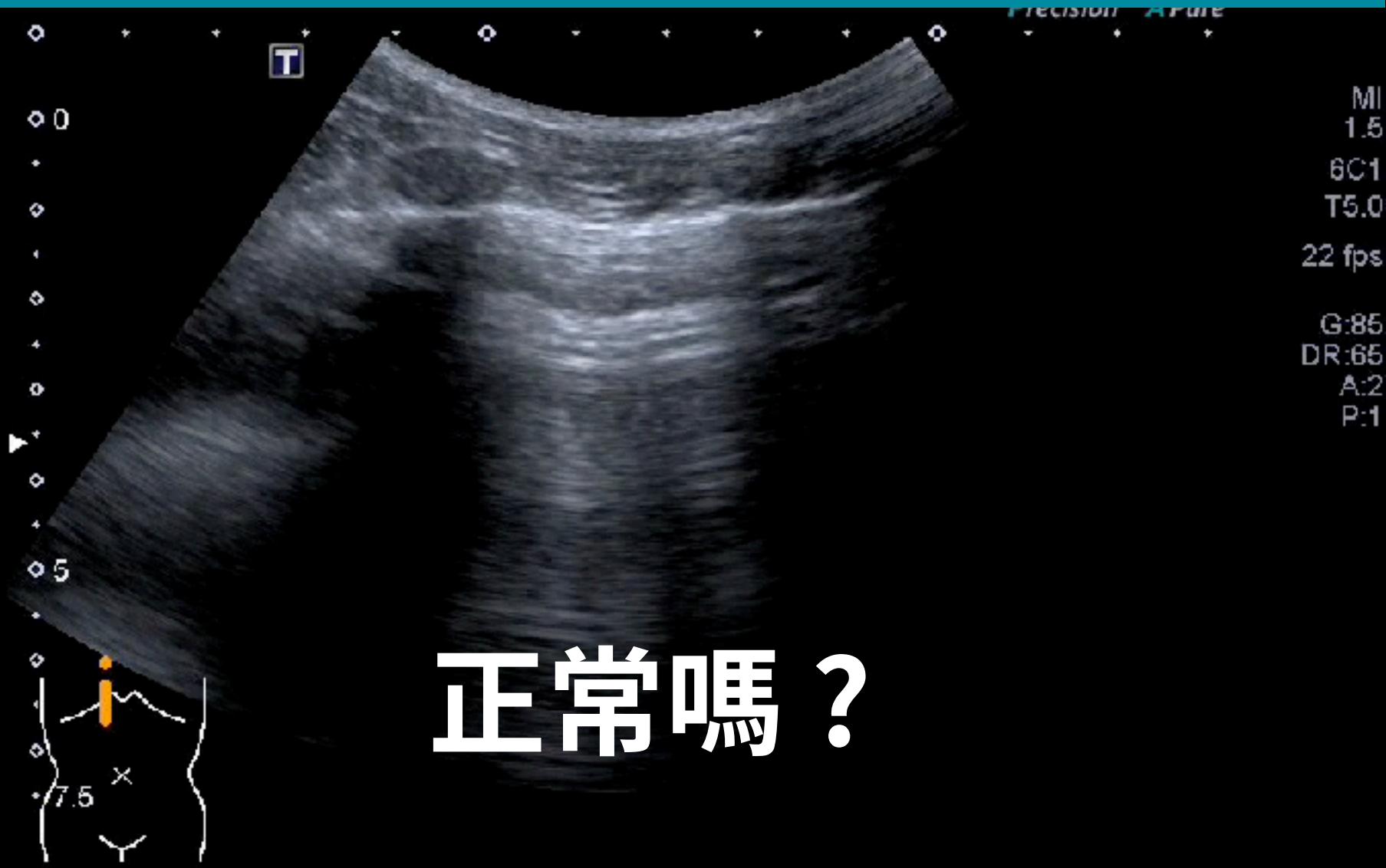


## Medical Decision-making

- 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  
Consolidation<sup>60</sup>