

By 江江

# Basic pulmonary ultrasonography & “DYS/PNEA approach” the BLUE protocol

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陳國智醫師 雙和醫院急診醫學科

[juice119@gmail.com](mailto:juice119@gmail.com)

[POCUSacademy.com](http://POCUSacademy.com)

# 陳國智 醫師 / [POCUSacademy.com](http://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

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

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

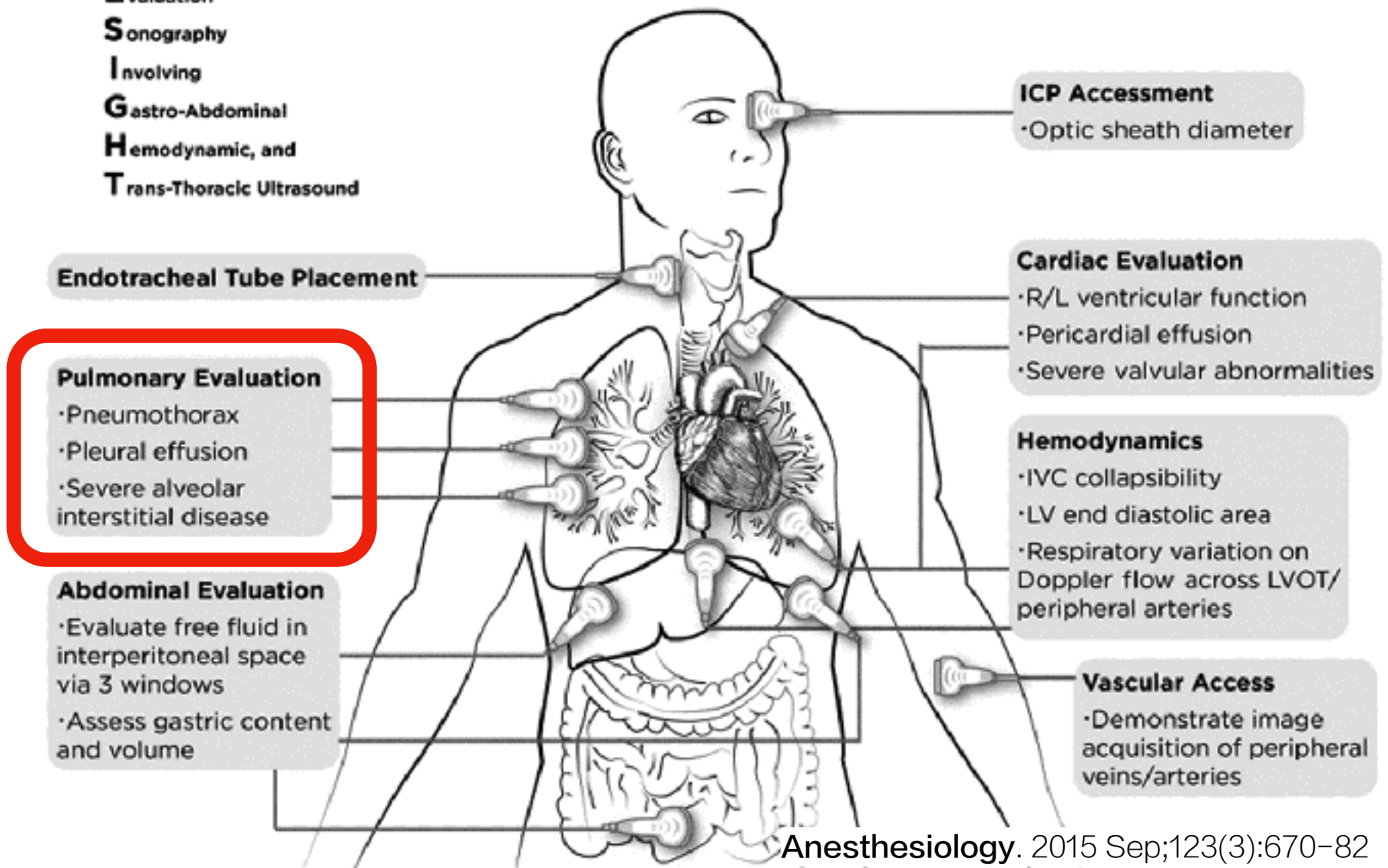
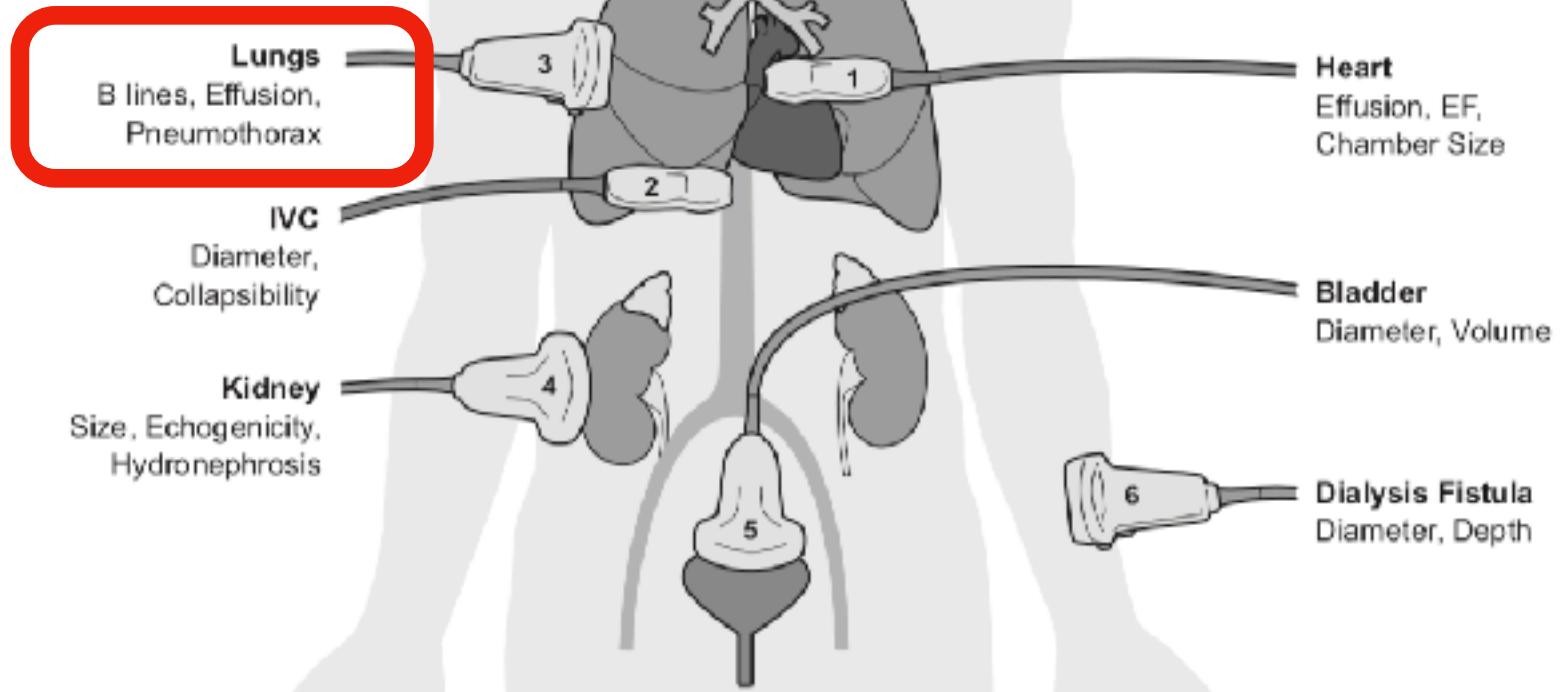


	IMAGE AREA	IMAGE ACQUISITION	PROBE
1	Heart	Parasternal Long Axis (PLAX)	Phased
2	Inferior Vena Cava	Subcostal	Phased
3	Lung	Anterior, Lateral, Posterior	Linear
4	Kidney	Longitudinal, Transverse	Curved
5	Bladder	Suprapubic	Curved
6	Dialysis Fistula	Longitudinal and Transverse	Linear

Johns Hopkins **Nephrology** fellowship

POCUS curriculum



# LUS signs

Sign	Images	Description	Pathology
Sliding sign	Figure 2	Movement between the two layers of the pleura during normal respiration	Normal
A-lines	Figure 6	Hyperechoic horizontal lines parallel to pleural line occurring at regular intervals below the pleura Artefacts from reverberations between probe and pleura	Seen in normal lungs as well as pneumothorax and emphysematous lungs
B-lines	Figure 1	Hyperechoic artefacts that originate at the pleural line and extend from the probe to the edge of the screen, without fading and perpendicular to the pleural line Artefacts that occur when the interstitium and alveoli are thickened predominantly from becoming oedematous with fluid	Presence of three or more B-lines per intercostal space is evidence of interstitial fluid. If seen diffusely in two or more zones bilaterally is usually indicative of pulmonary oedema
Z-lines	-	Hyperechoic artefact that originates at and perpendicular to the pleural line but does not extend to the edge of the ultrasound window and are shorter, wider and less defined than B-lines	Normal or pneumothorax
V-lines (spine sign)	-	Fluid acts as an acoustic window to enable visualisation of the V-line of vertebral bodies and the posterior thoracic wall in a supine patient	Pleural fluid
E-lines	-	Comet tail artefacts that are superficial to the pleural line	Echogenic foreign bodies or subcutaneous emphysema
Stratosphere sign	Figure 2	The loss of lung sliding beneath the pleura	Pneumothorax
Liver sign (mirror sign)	Figure 4	Tissue similar in consistency to liver tissue seen on US	Lung consolidation absent in pleural effusion
Sea shore sign (M mode)	Figure 2	Pleura appears as horizontal lines and the underlying lung as grainy, making up the sea and sandy shore, respectively	Normal M mode appearance of lung
Bar code sign (M mode)	Figure 3	Bar code-like appearance throughout M mode	Pneumothorax



**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

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.

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## Sensitivity and Specificity of Lung US versus Chest Radiography

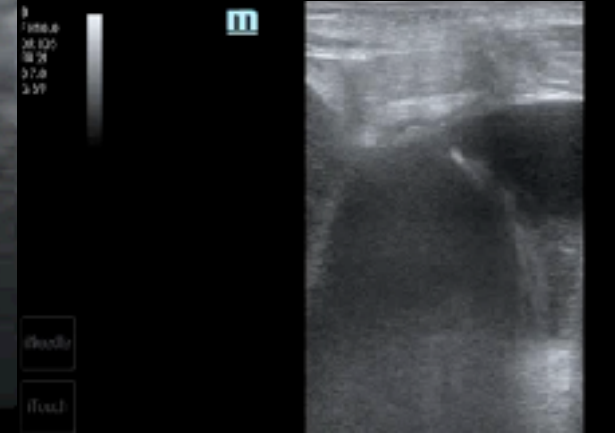
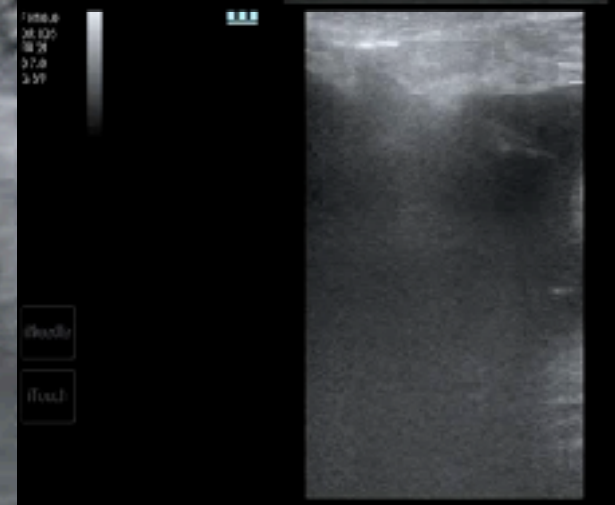
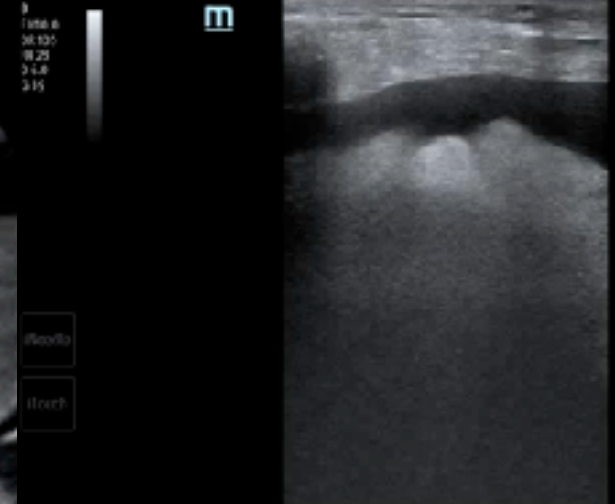
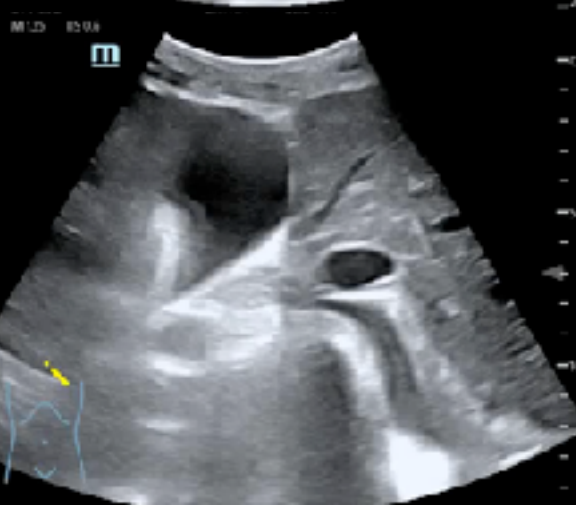
Indication	Study Type	No. of Patients	Lung US		Chest Radiography	
			Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
Pleural effusion (5)	Prospective	32	92	93	39	85
Pneumonia (7)	Systematic review with meta-analysis	742	95	90	77	91
Pneumothorax (4)	Systematic review with meta-analysis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

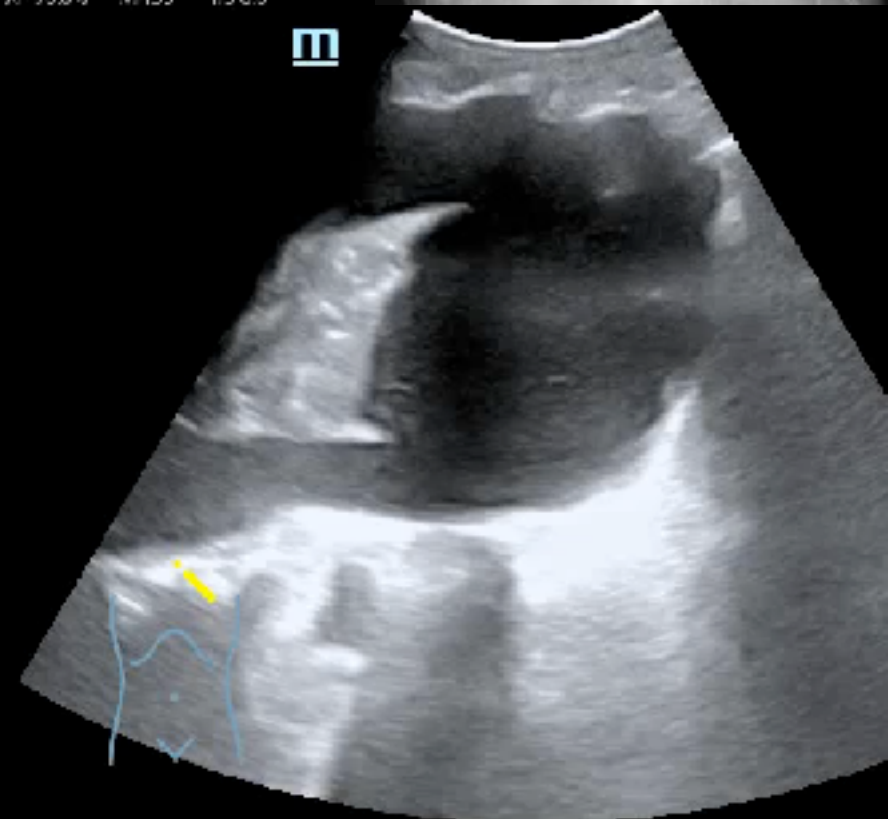
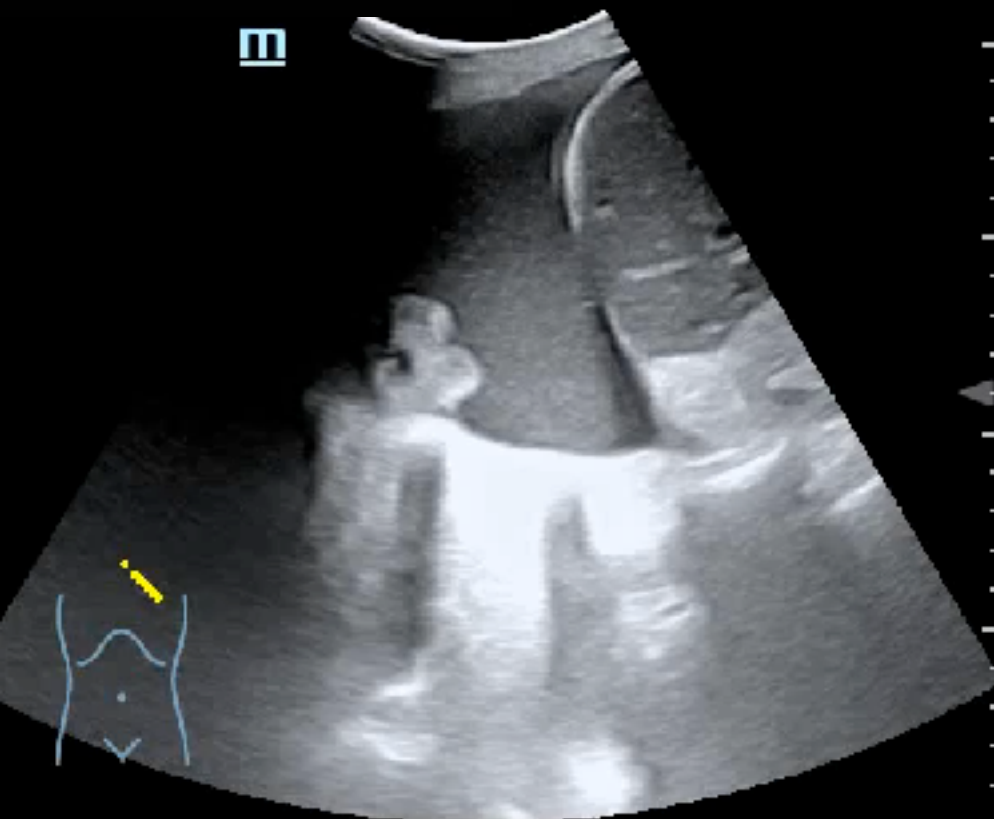
Note.—Sensitivity and specificity values vary slightly from study to study. The pleural effusion statistics are drawn from a sample of critically ill patients.

# 85M, AMS with shock, 外院轉入









# Lung US 常用探頭



弧



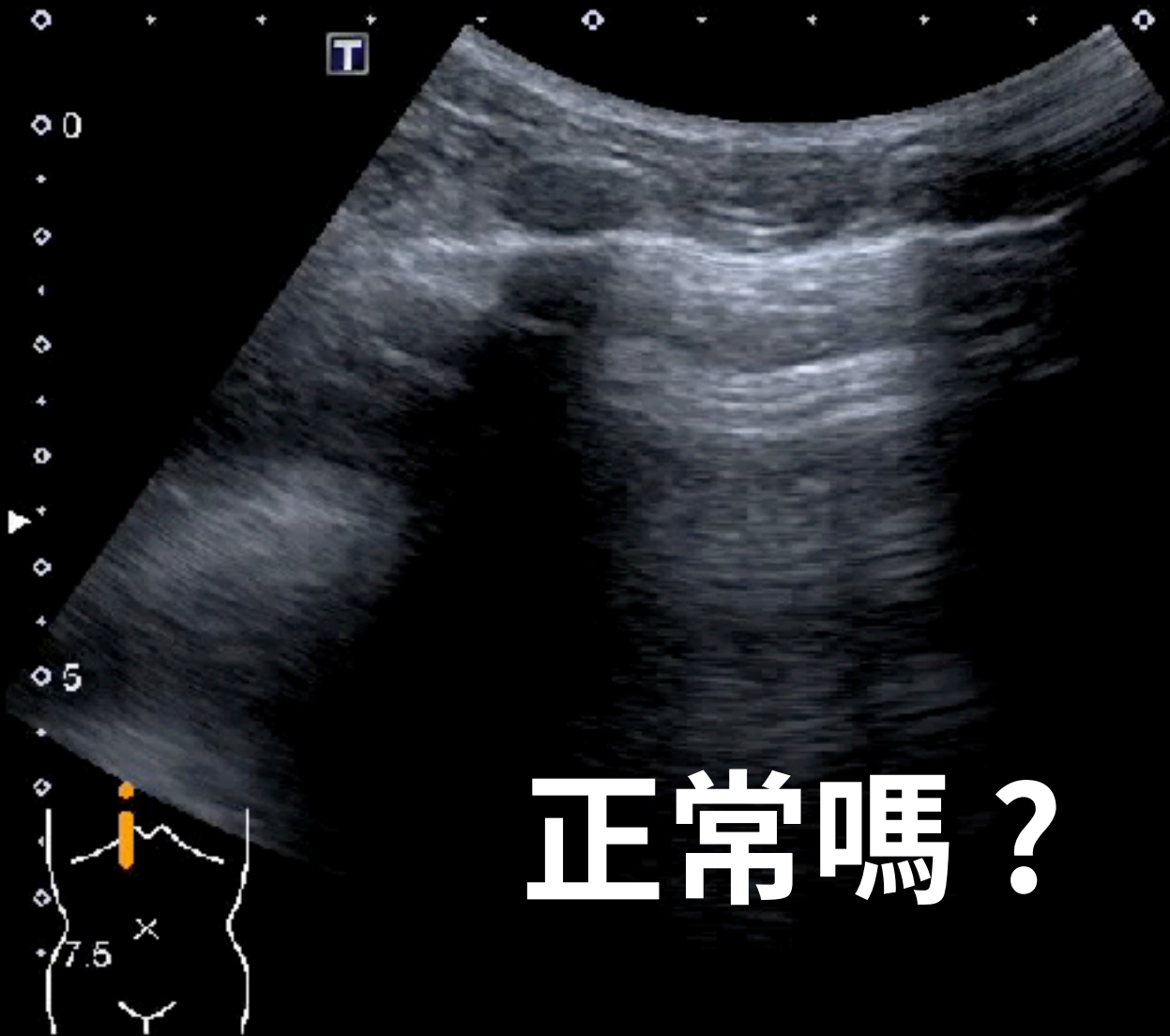
線



扇



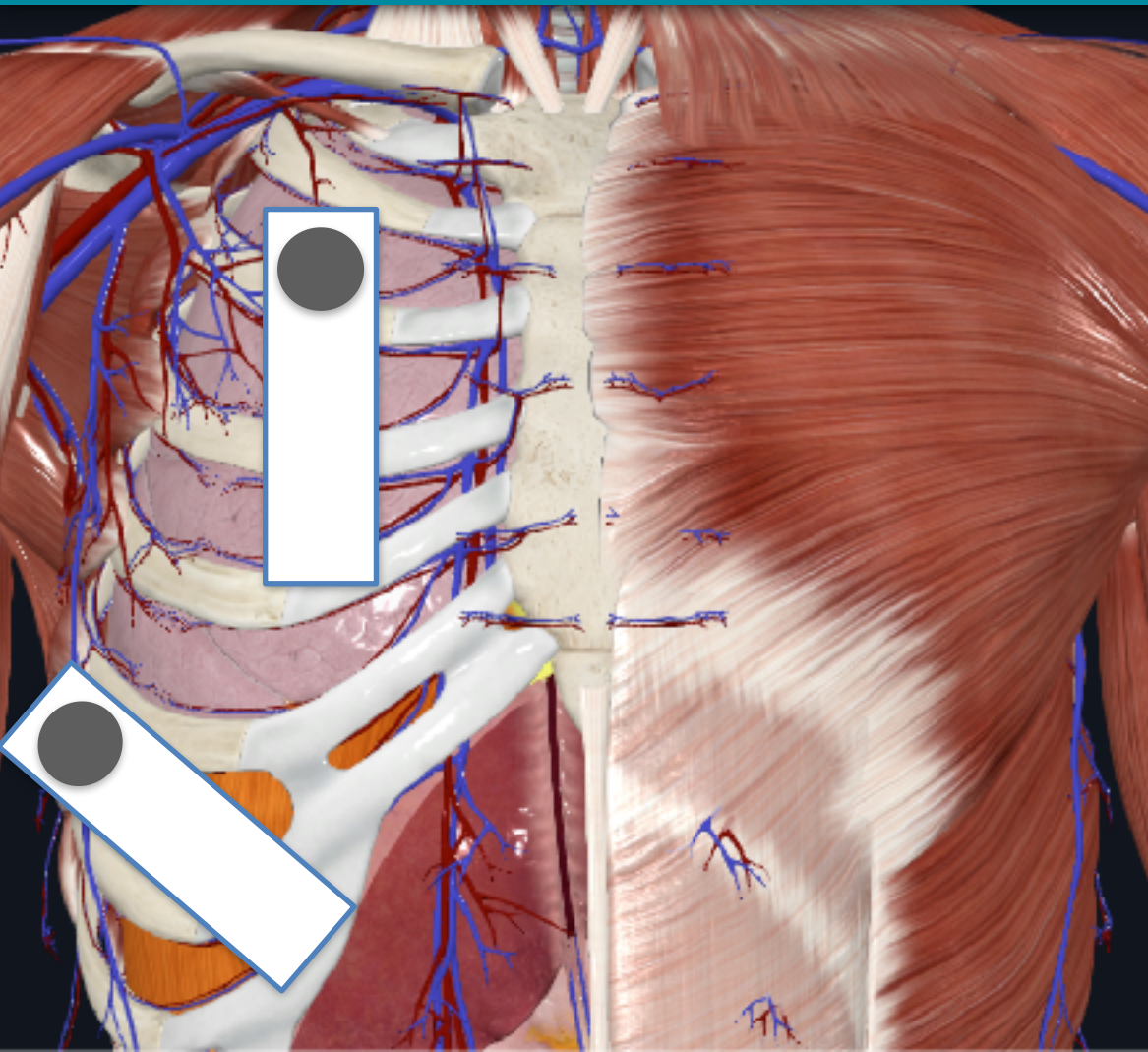
# LUNG



MI  
1.5  
6C1  
T5.0  
22 fps  
G:85  
DR:65  
A:2  
P:1

## 正常嗎？

# Lung



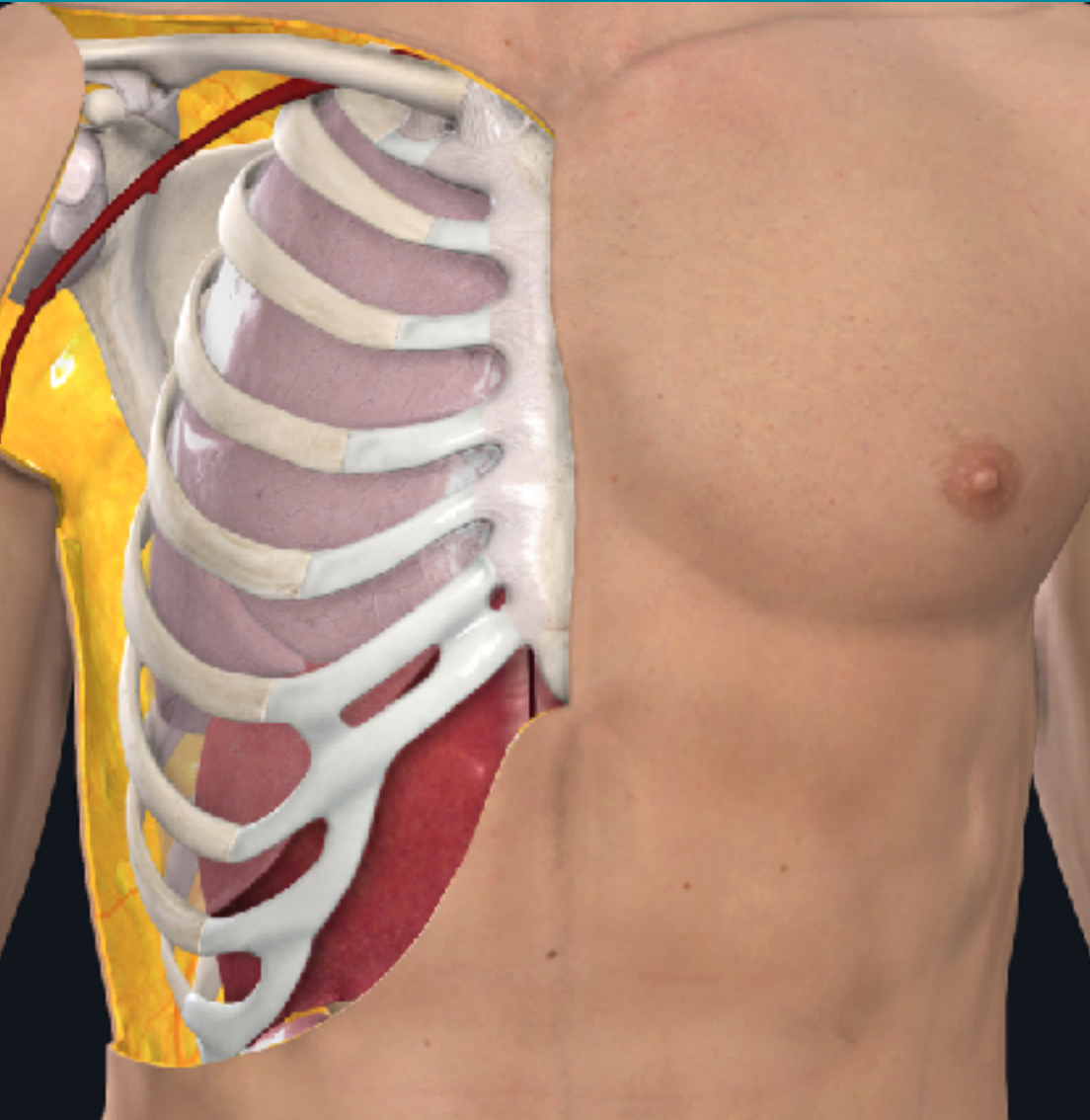
## 肋膜

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



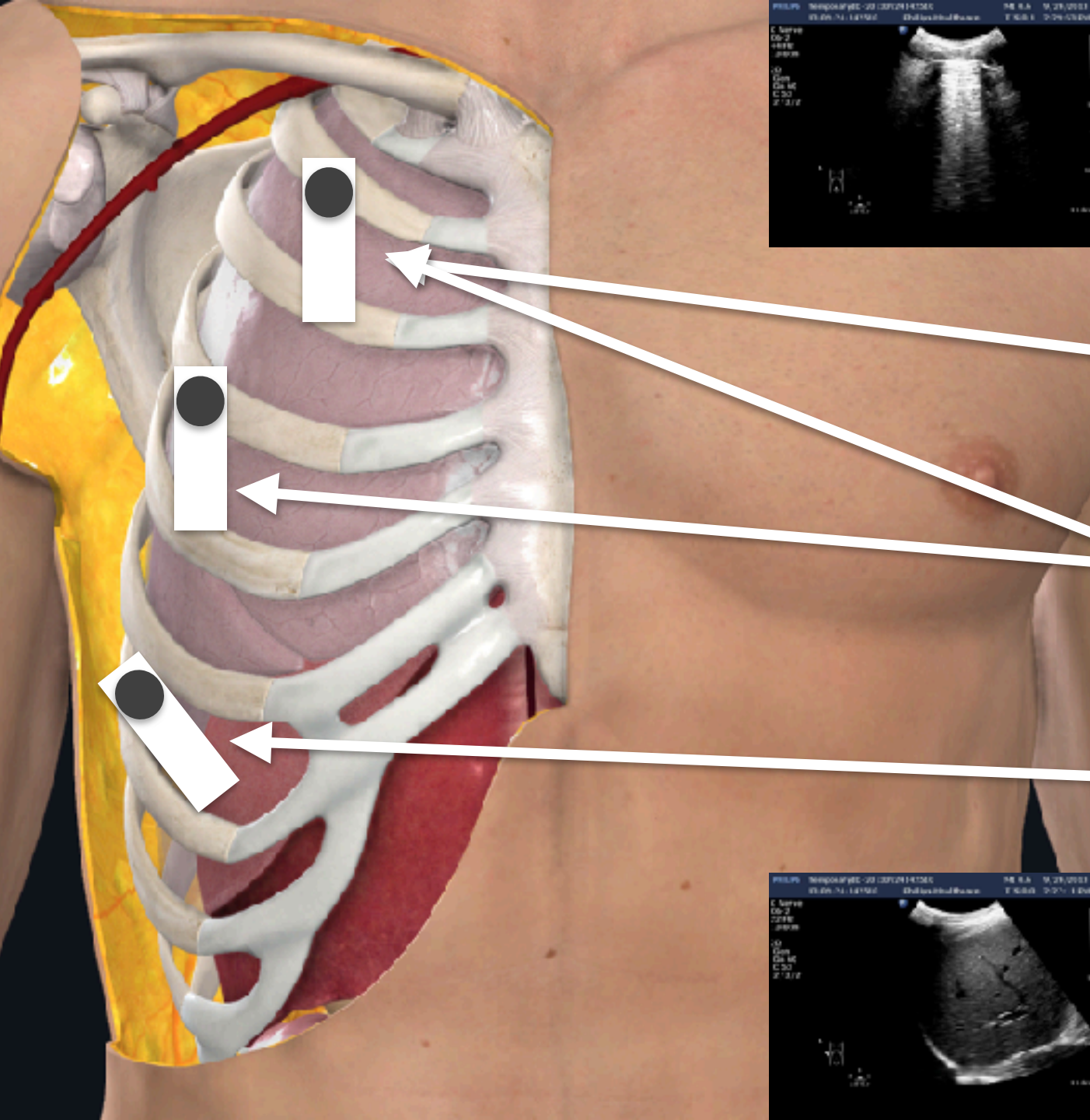
Dyspnea  
Chest pain  
Infections

**PTX**

**AIS**

**PLE**

Consolidation<sup>14</sup>

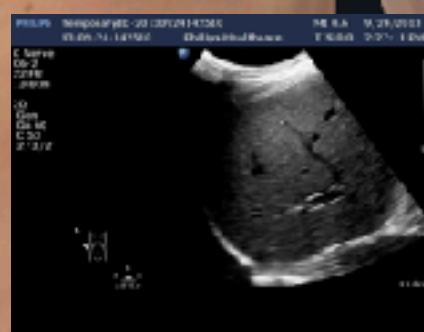


**AIR**

**PTX**

**AIS**

**PLE**



**FLUID**

# NORMAL LUNG

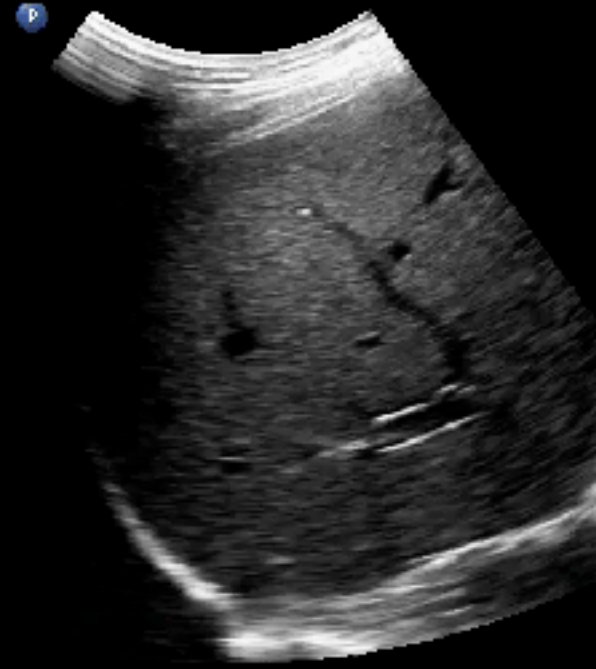
肋膜/滑動

橫膈膜/移動

TemporaryID 20130924142510 MT 0.6 9: PHILIPS 13 09 24 142510 Philips Healthcare TIS 0.1 2: TemporaryID 20130924142510 MT 0.6 9:24 13 09 24 142510 Philips Healthcare TIS 0.0 2:27



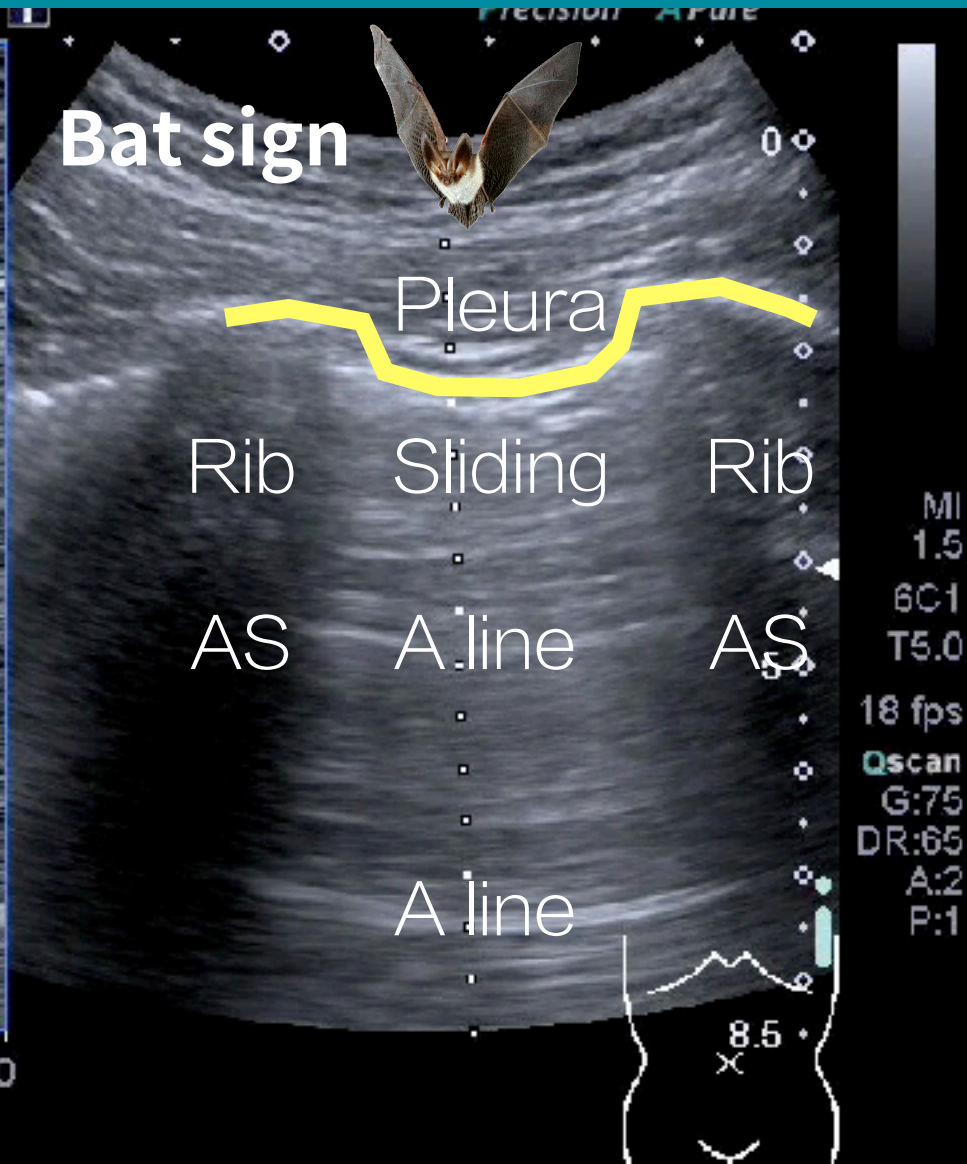
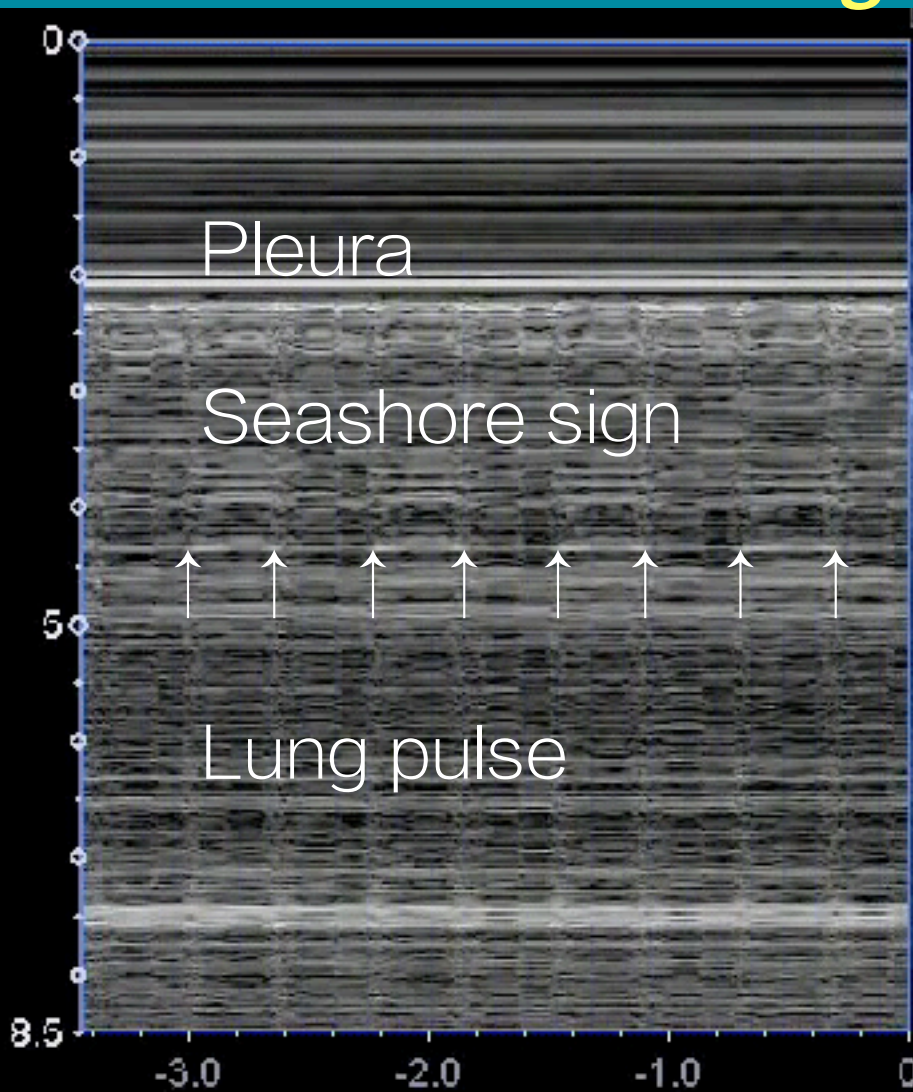
C Nerve  
CG-2  
22 Hz  
13.0cm  
2D  
Gen  
Gr 60  
C 53  
2/3/2





# NORMAL LUNG

## Sliding + A lines



# SLIDING FIRST



**A line**

肋膜下  
**水平線**  
等距離



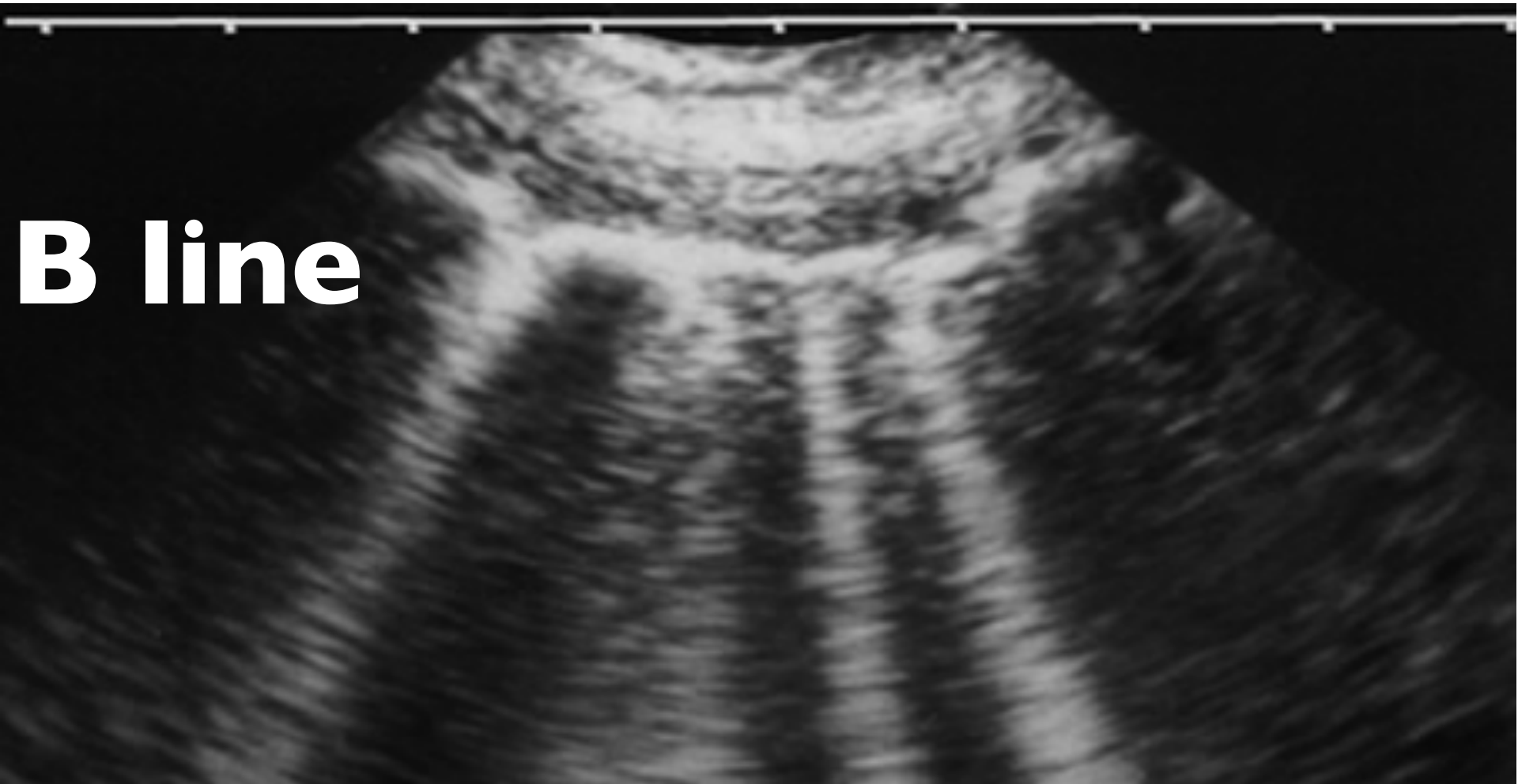
**B line**

肋膜下  
**垂直線**  
大於三

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

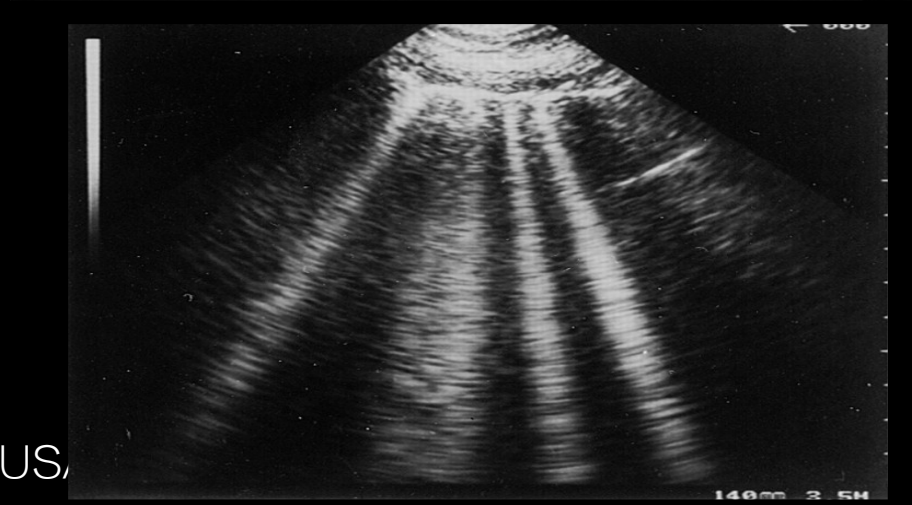
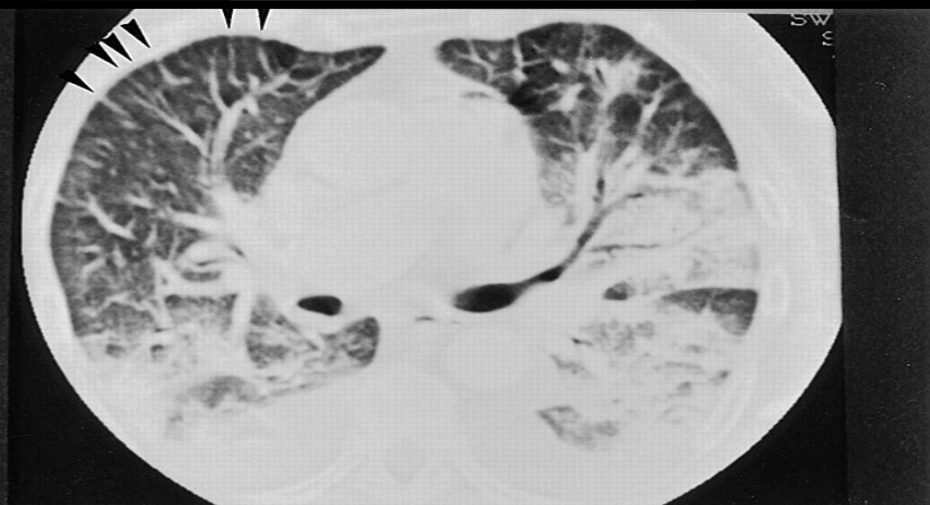
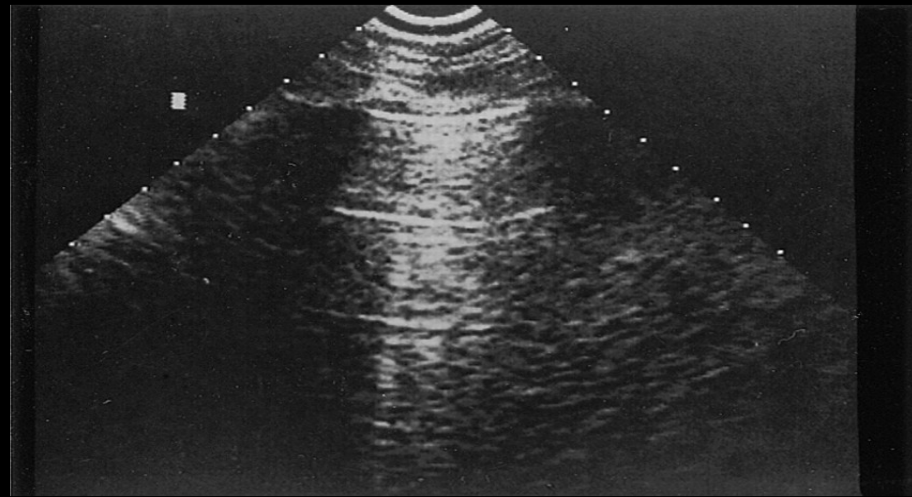
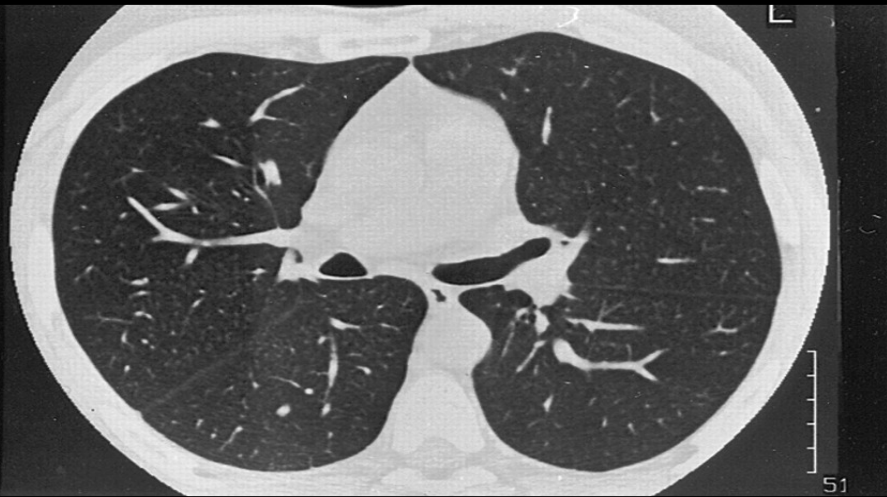
## The comet-tail artifact: an ultrasound sign ruling out pneumothorax

**B line**



# 基本假影：A lines & B lines

## US B lines ~ Kerley B lines

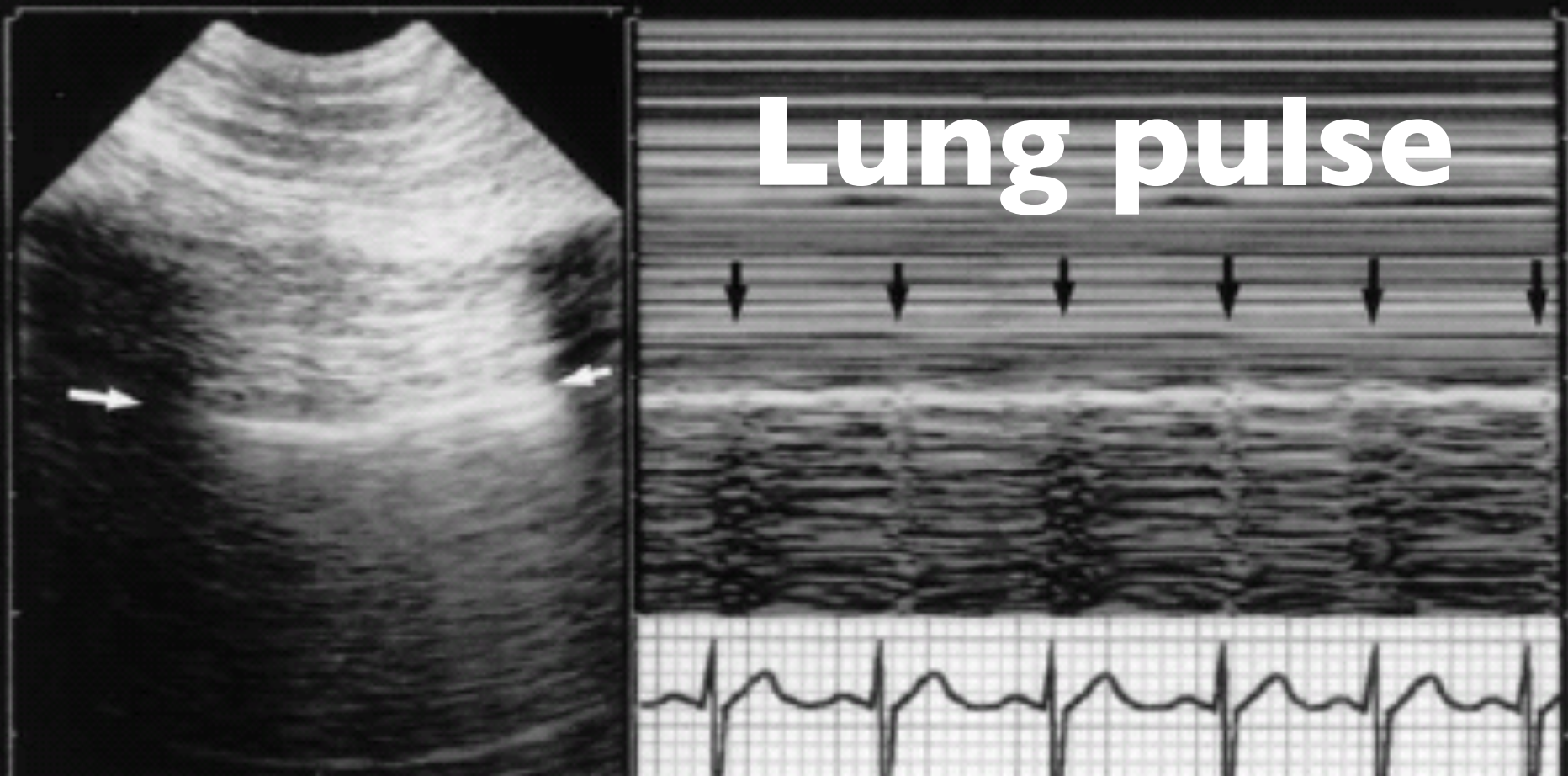


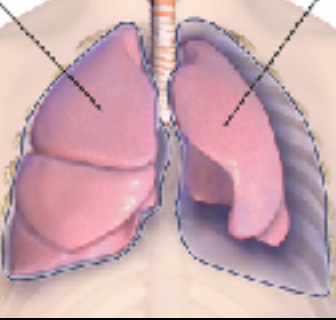
OCUS

Daniel A. Lichtenstein  
Nathalie Lascols  
Sébastien Prin  
Gilbert Mezière

## The “lung pulse”: an early ultrasound sign of complete atelectasis

16-NOV-01

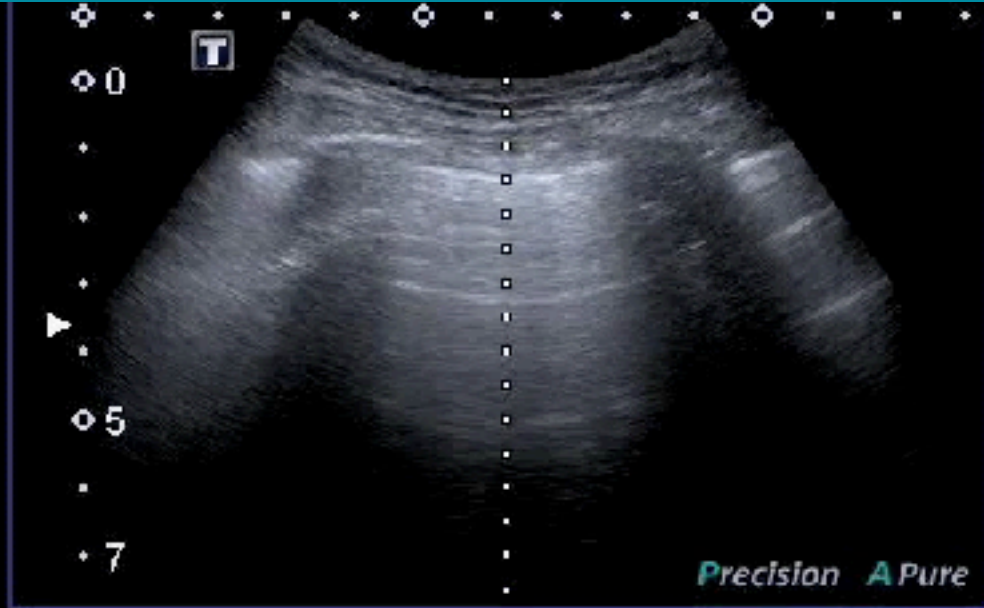




# PNEUMOTHORAX ?

Sliding + A lines = Normal pleura

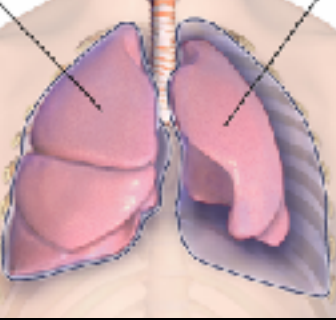
Seashore sign



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



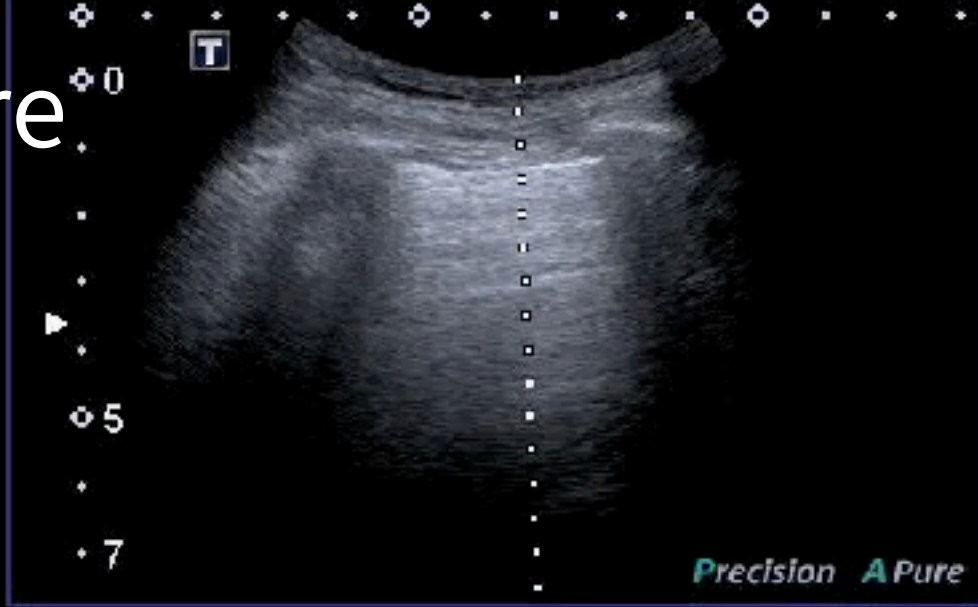
0  
5  
7



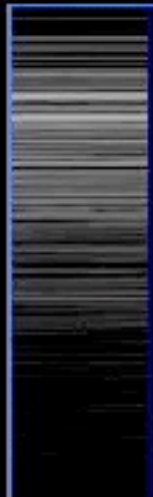
# PNEUMOTHORAX ?

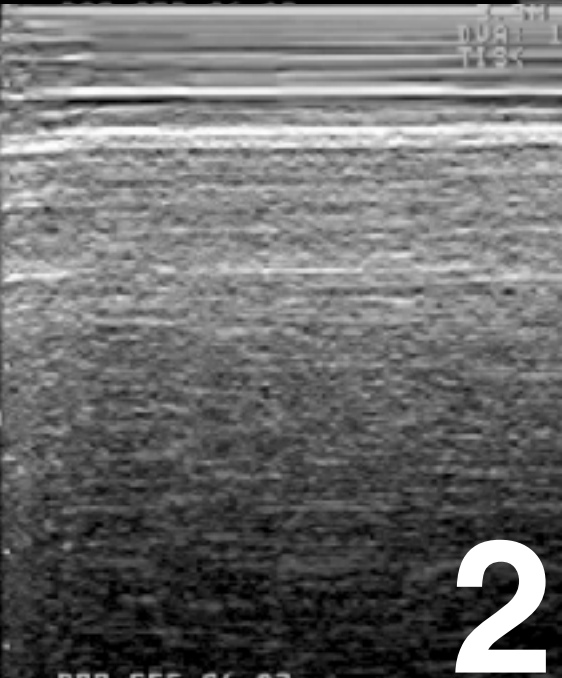
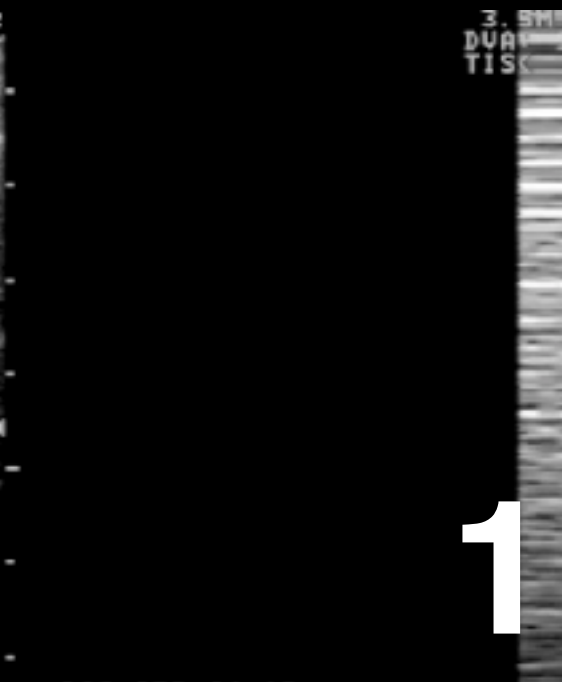
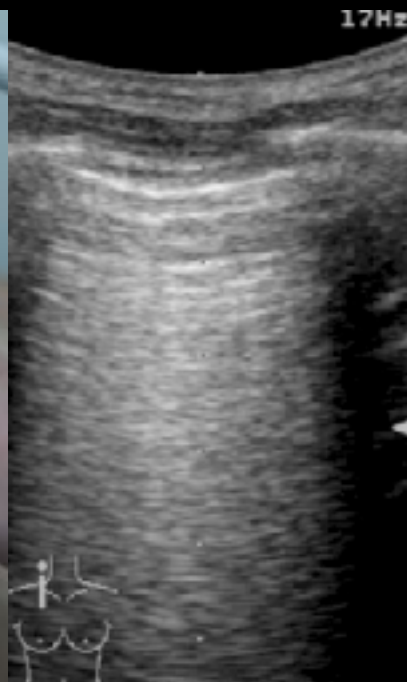
No Sliding + A lines >> Consider PTX

Stratosphere  
sign



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

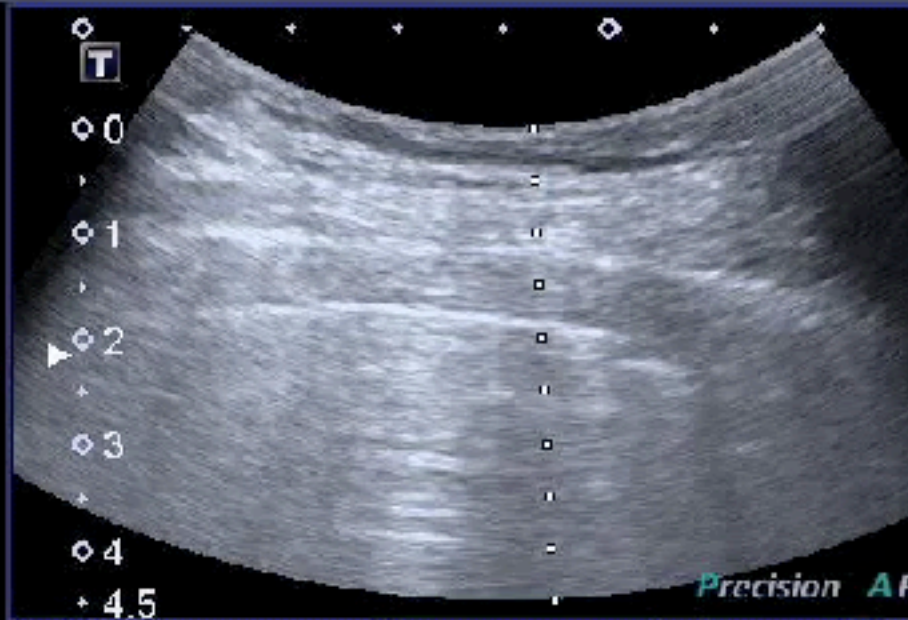




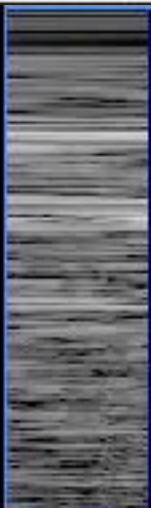


# Lung Point

**A**

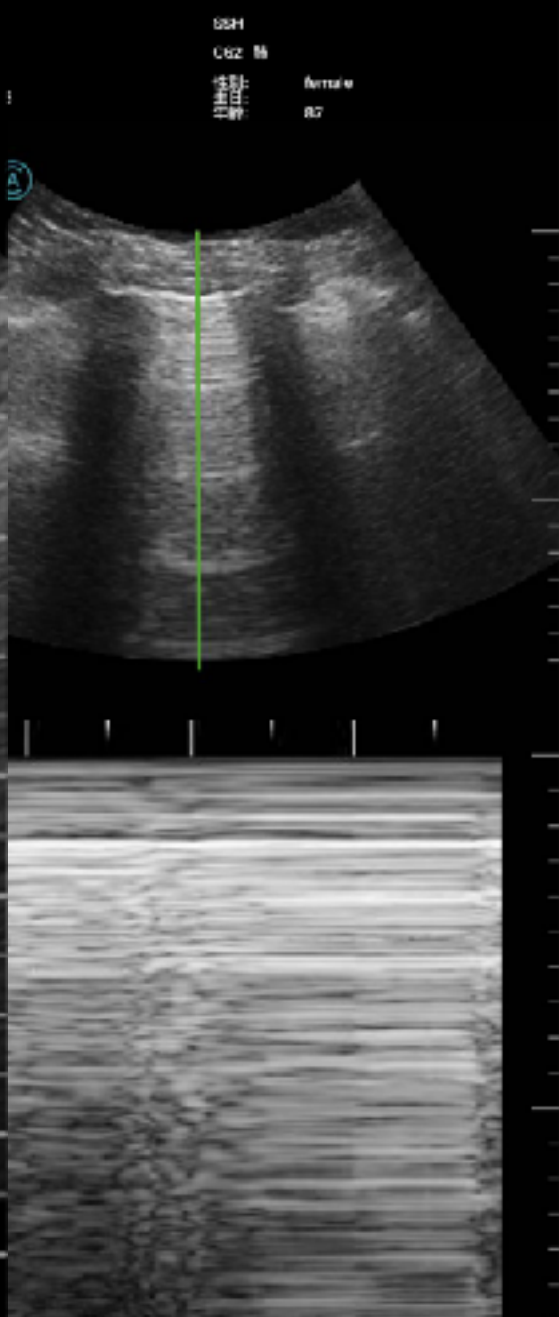
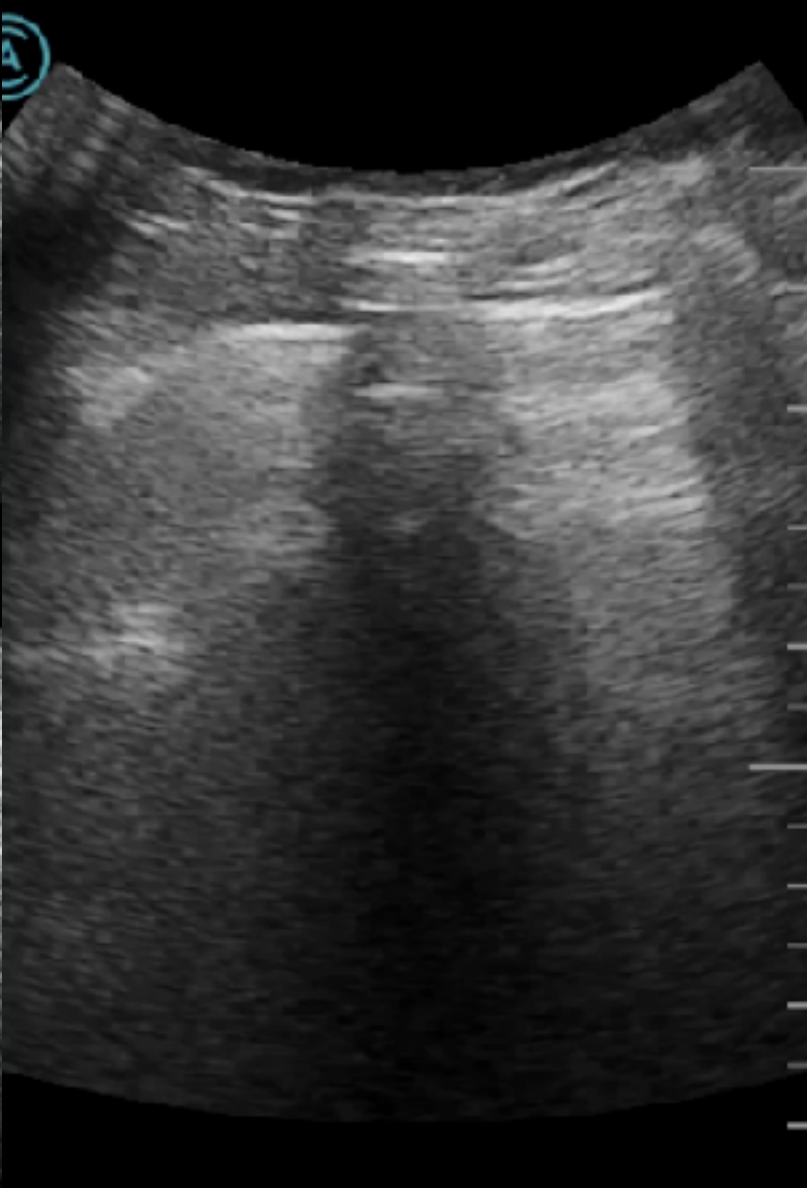
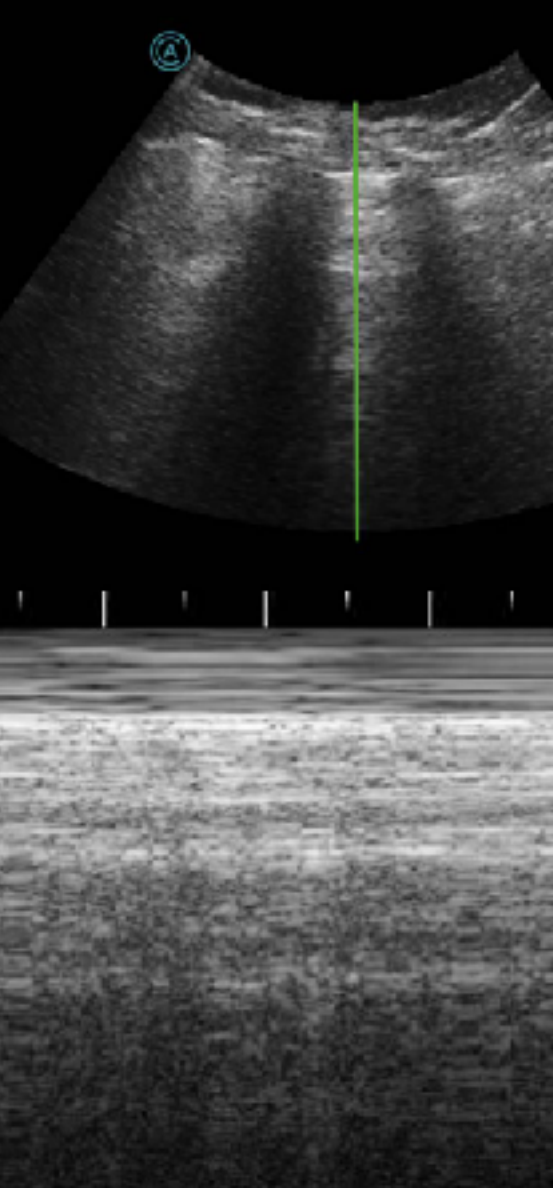


**B**



DATE: 2022-04-21 10:55:42  
Accession: 14396001  
ID: 14396001  
姓名: 梁日

DSH  
C62 林  
性别: 男性  
年龄: 67



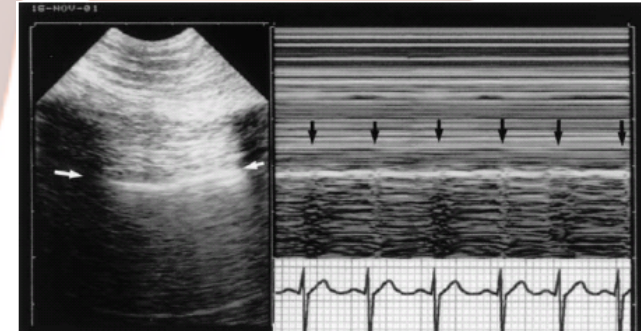
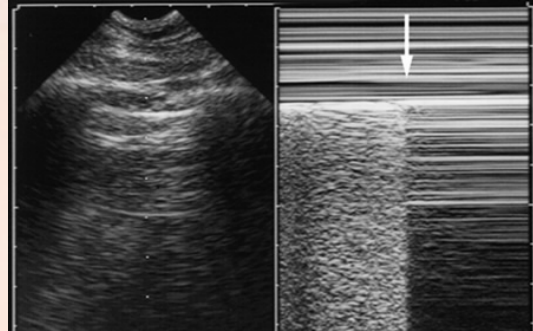
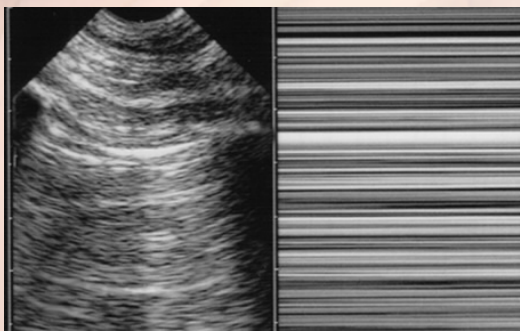
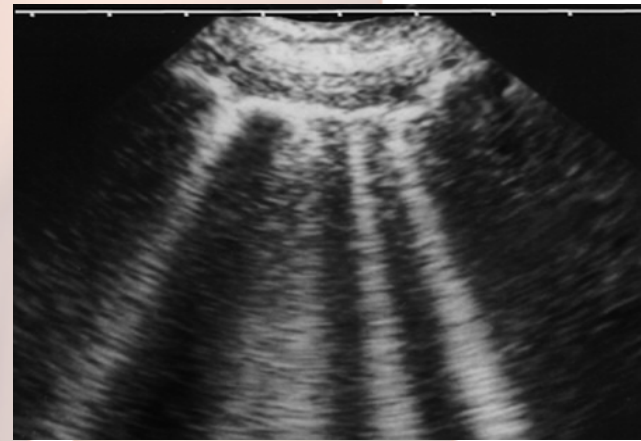
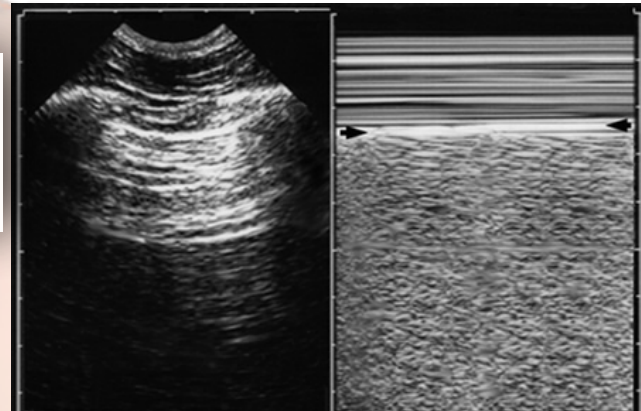
DSH  
C62 林  
性别: 男性  
年龄: 67

**PTX**

**SBP Point**

**4**

- No sliding
- No B lines
- No pulse
- Lung point



**AIS**

Point 1



**BLUE 4 points**

Point 2



Point 3



Point 4

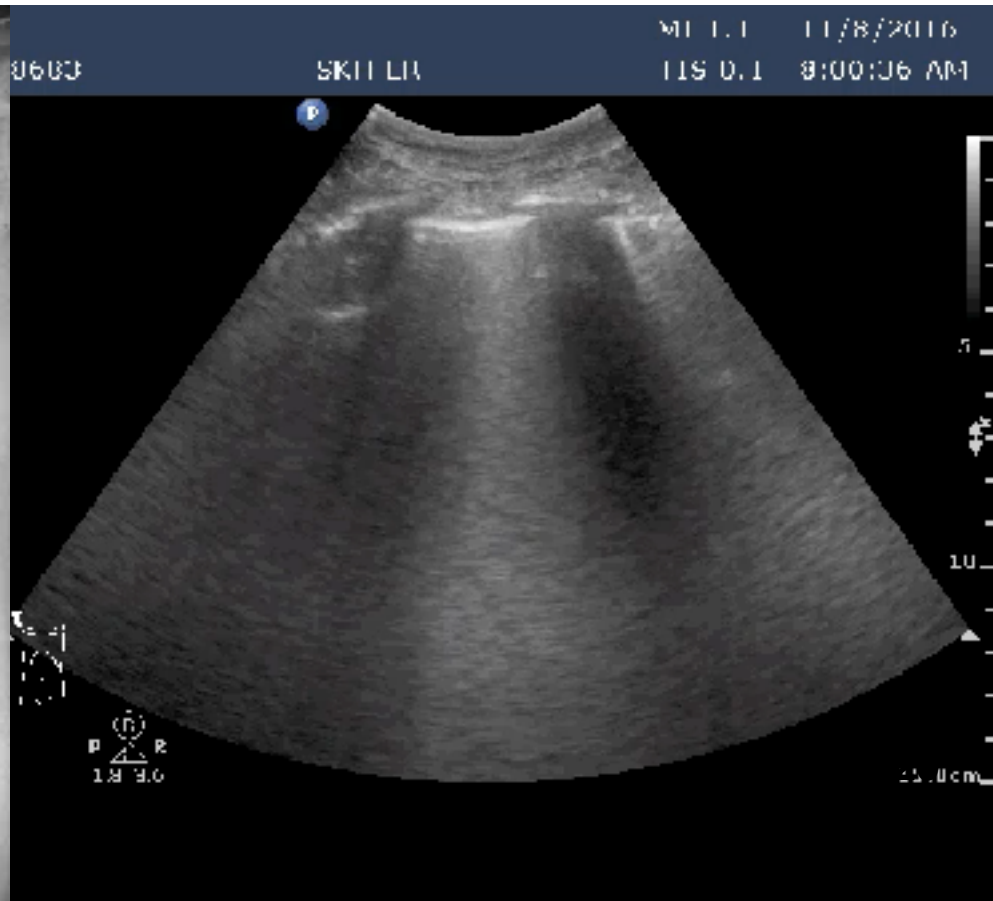
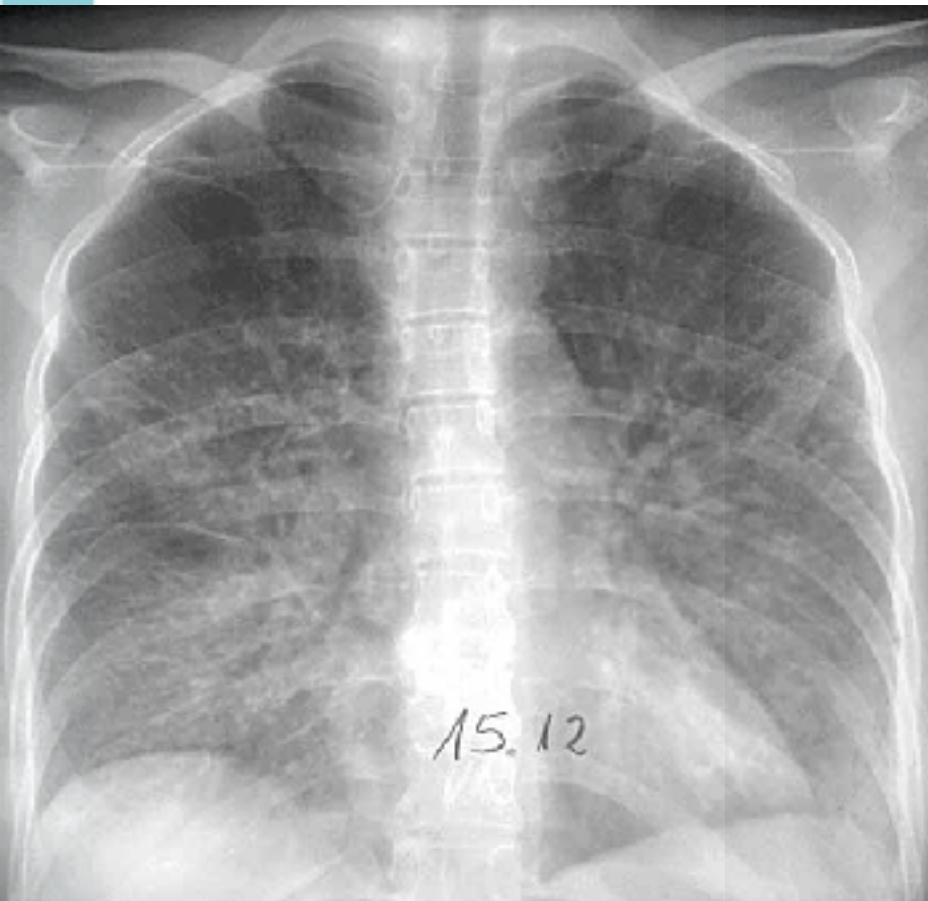


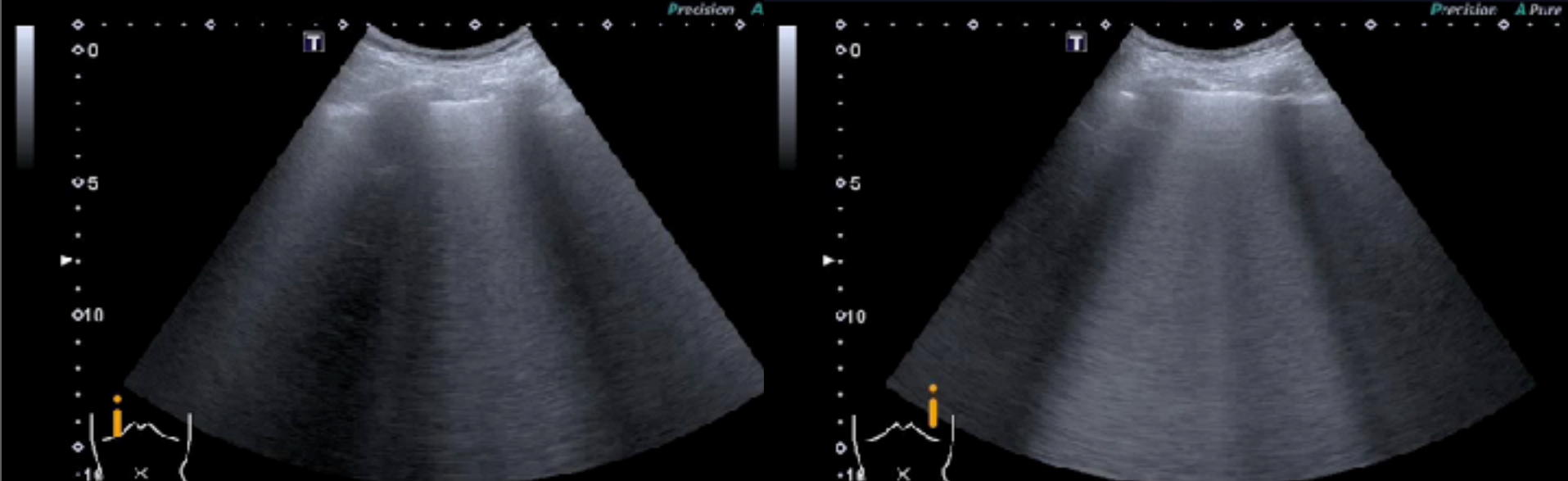
**3x2**

**Alveolar Interstitial Syndrome**

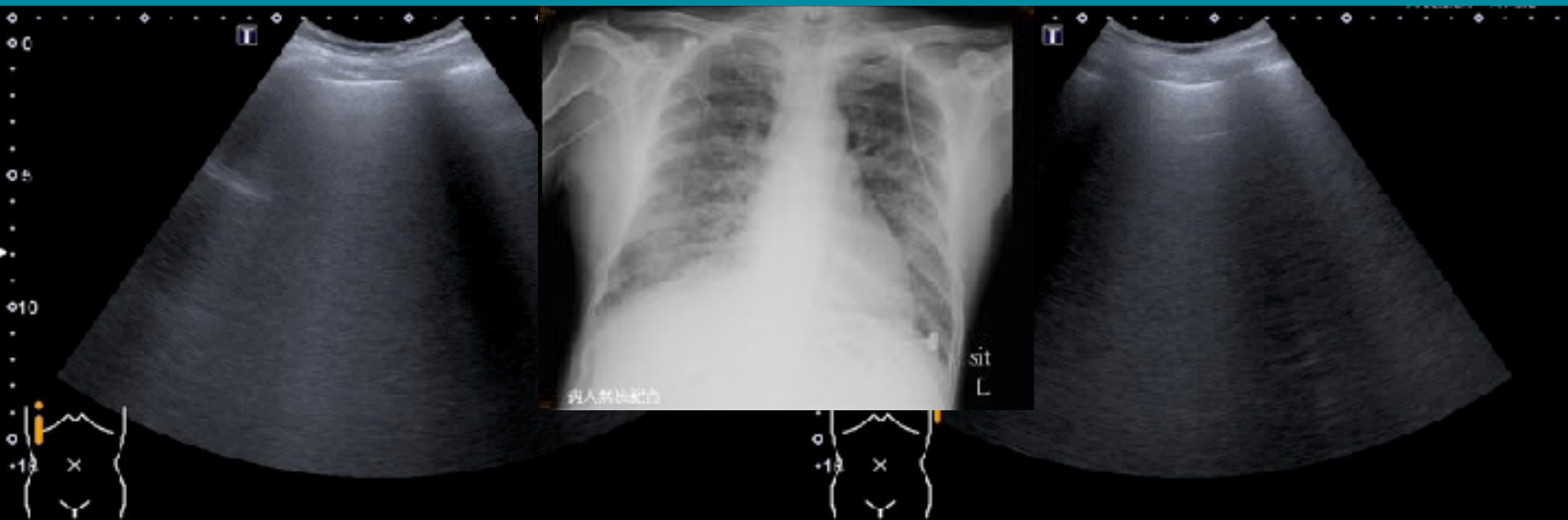
# LUNG ROCKETS

ICS > 3 B lines

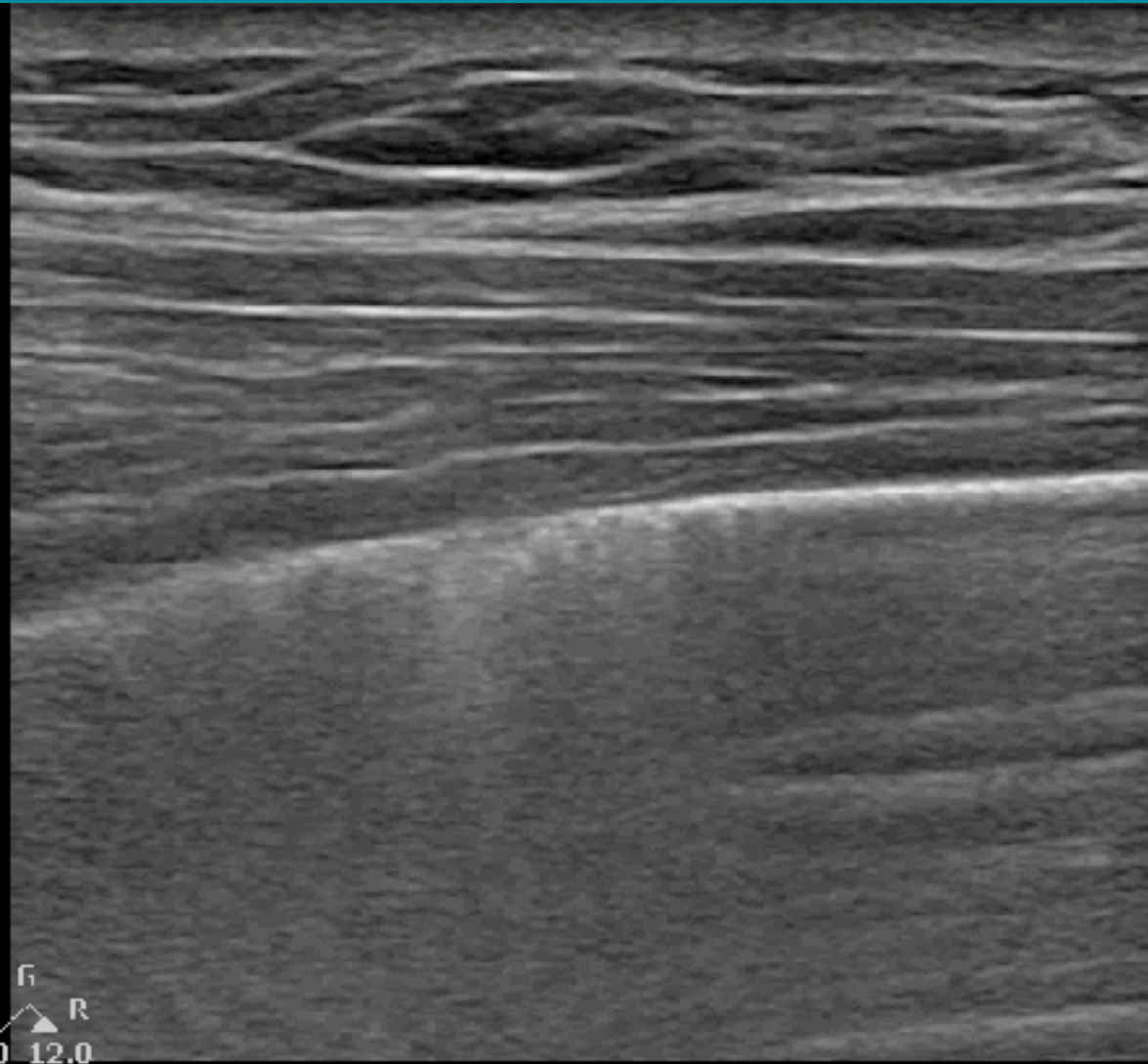




# ALEVOLAR INTERSTITIAL SYNDROME



# AIS: Localized



**Pneumonia**

Pneumonitis

Atelectasis

Contusion

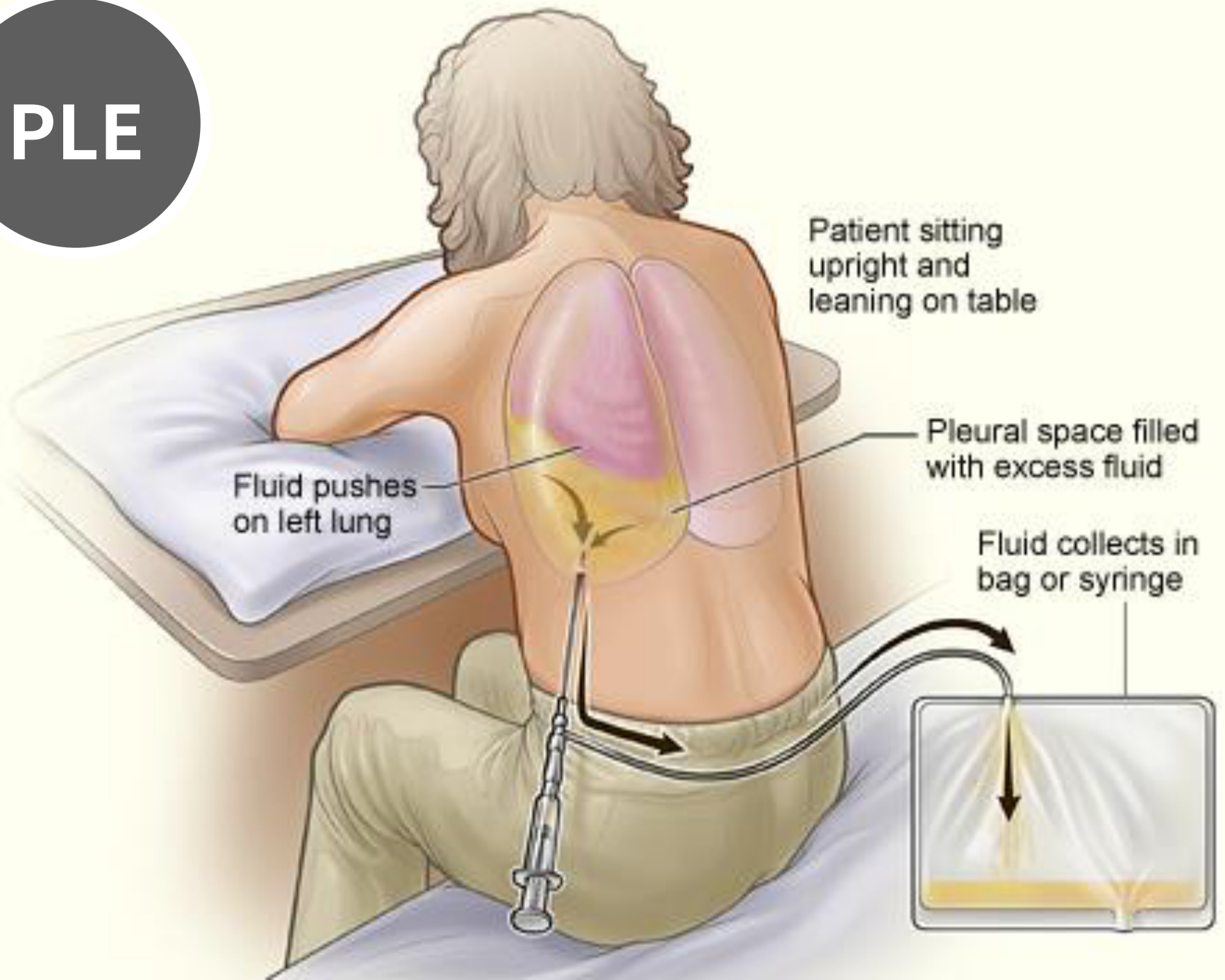
Infarction

Pleural disease

Neoplasia

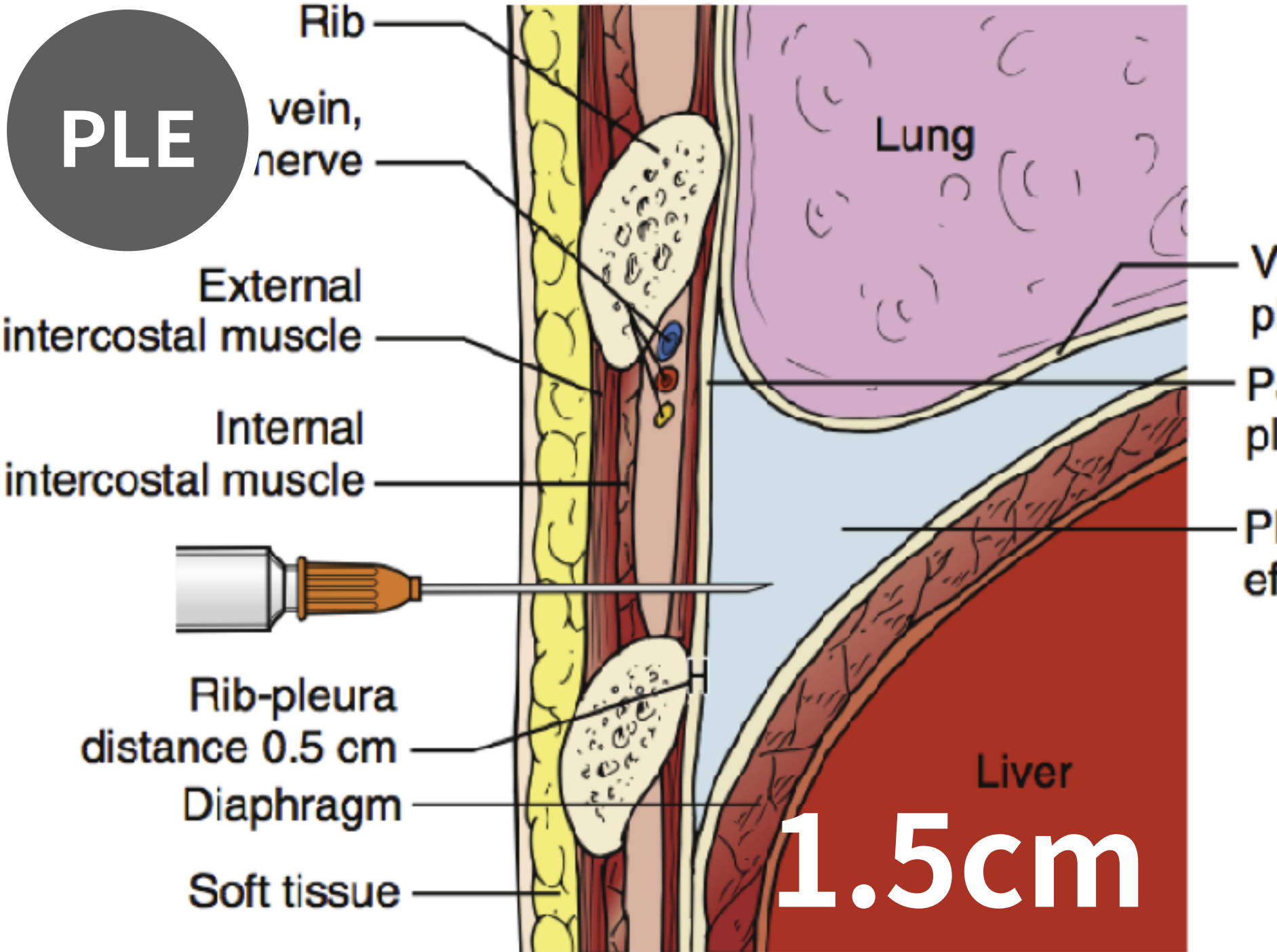
Normal lung

# PLE





**PLE**

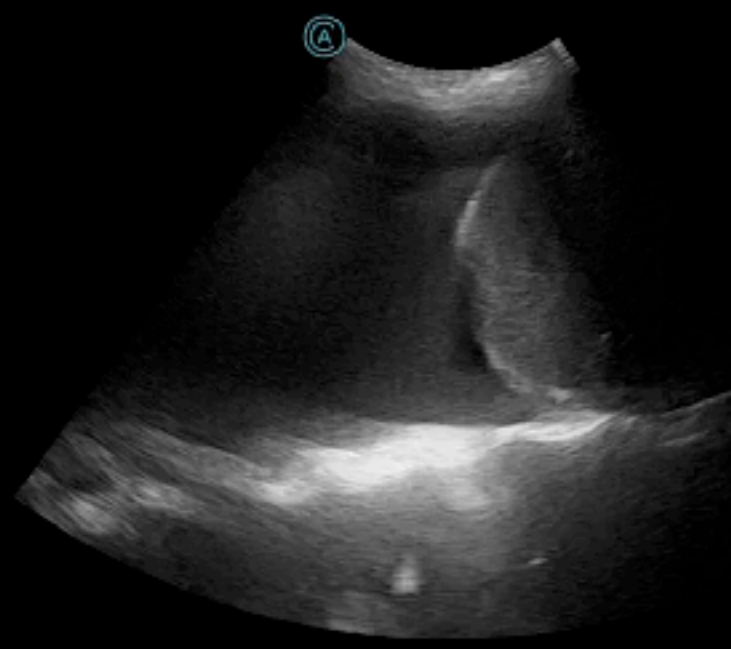
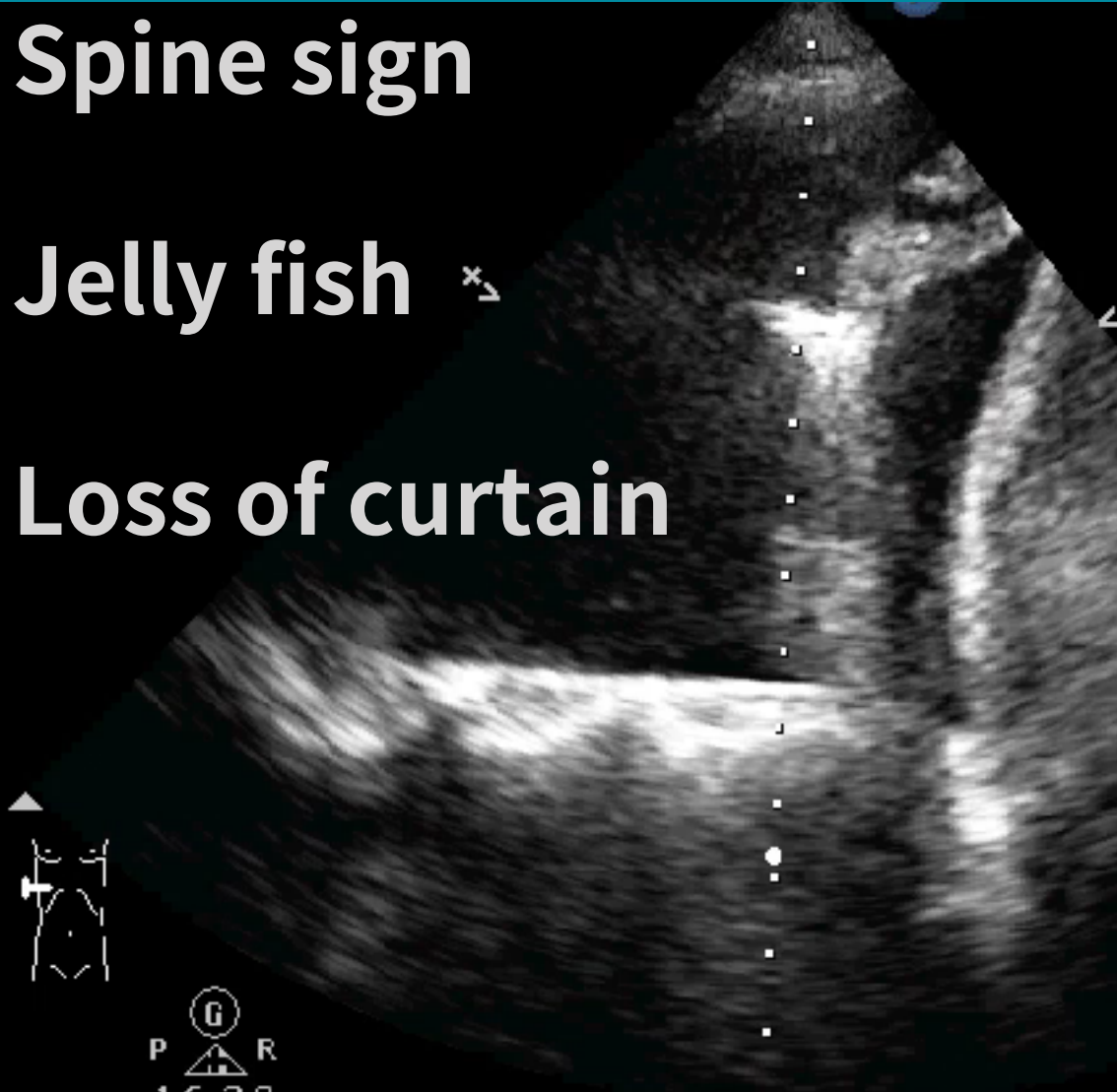


# PLEURAL EFFUSION

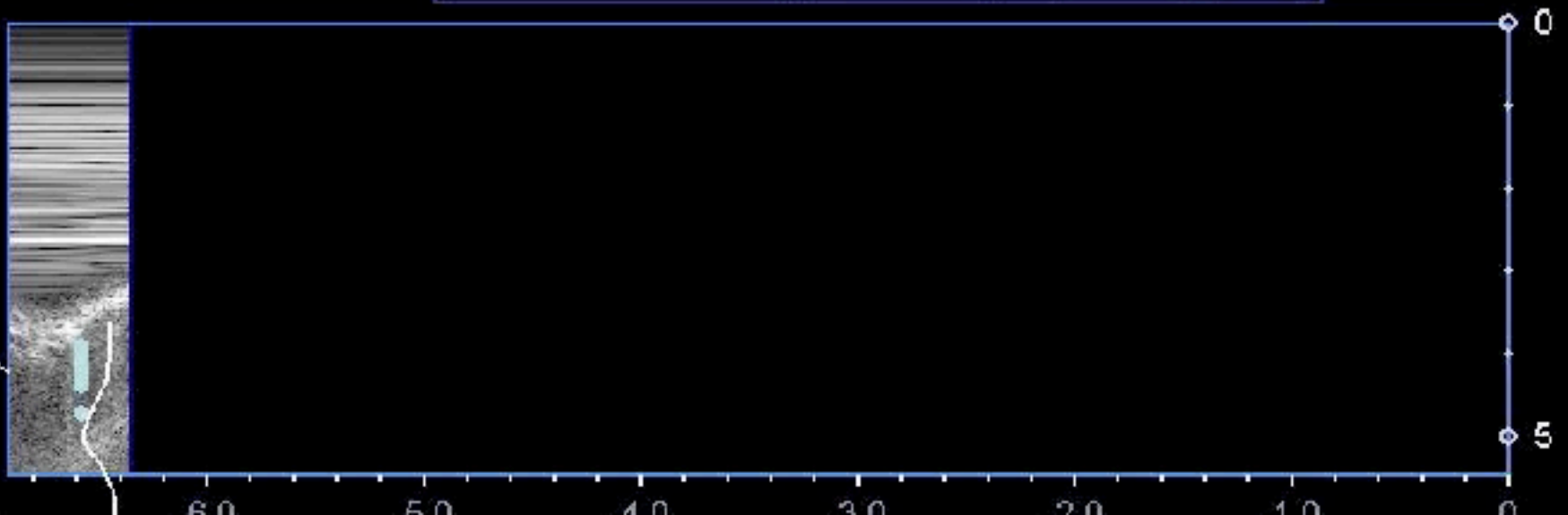
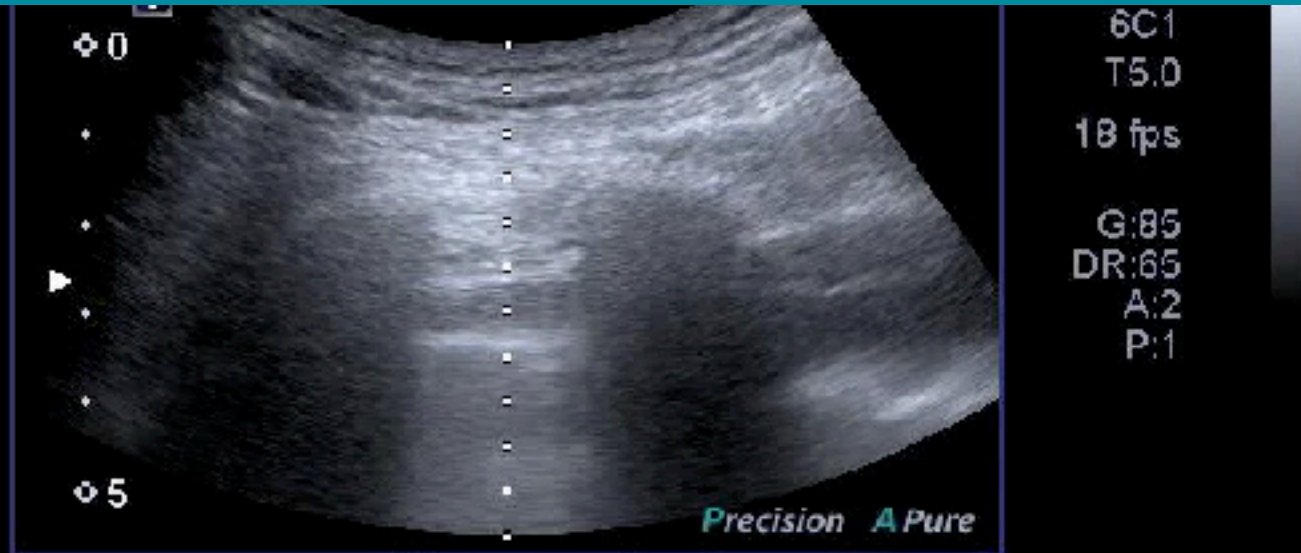
Spine sign

Jelly fish <sup>\*</sup>

Loss of curtain



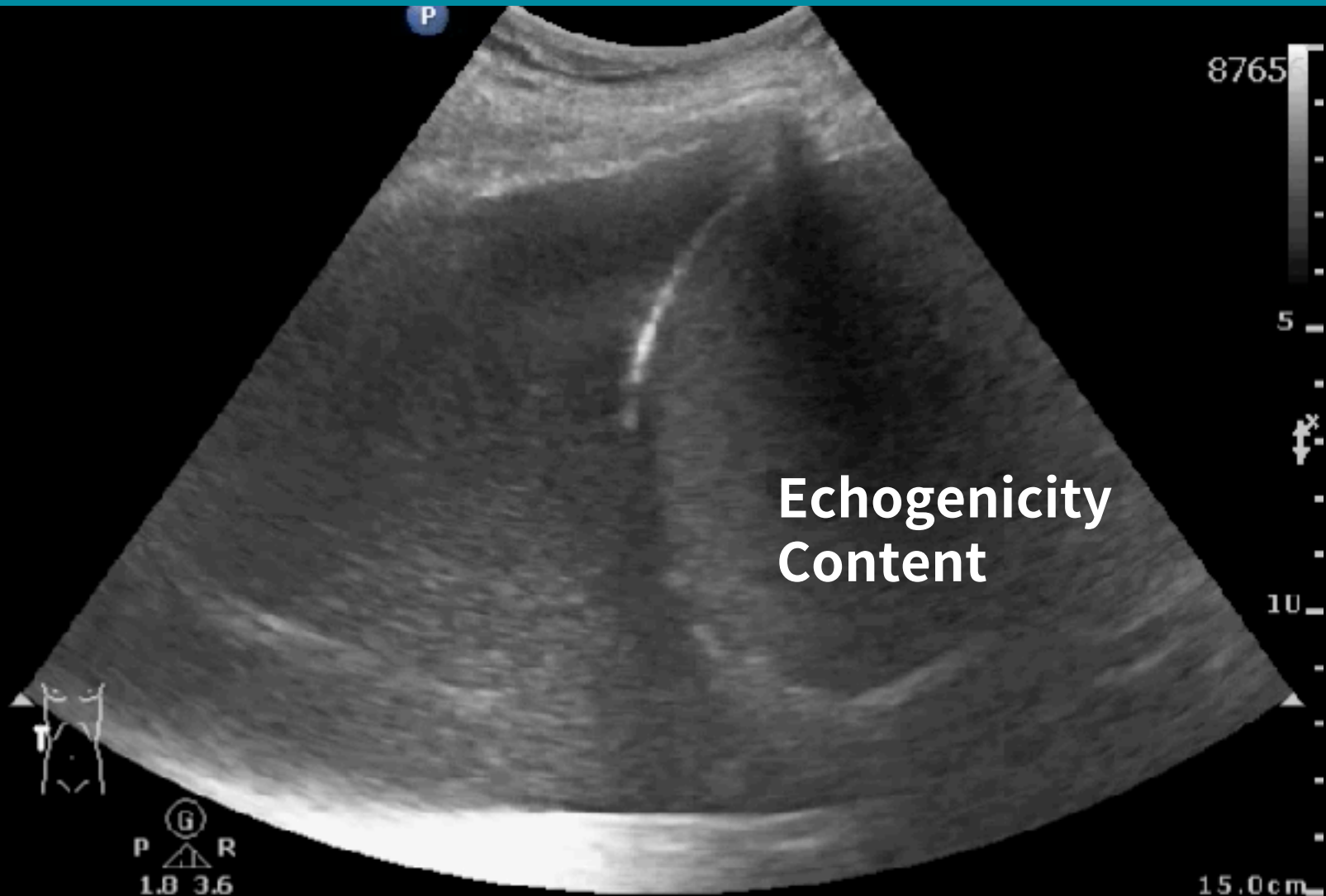
# Sharp sign / Sinusoid sign



# Plankton sign

Abd Gen2  
C5-1  
34 Hz  
15.0cm

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



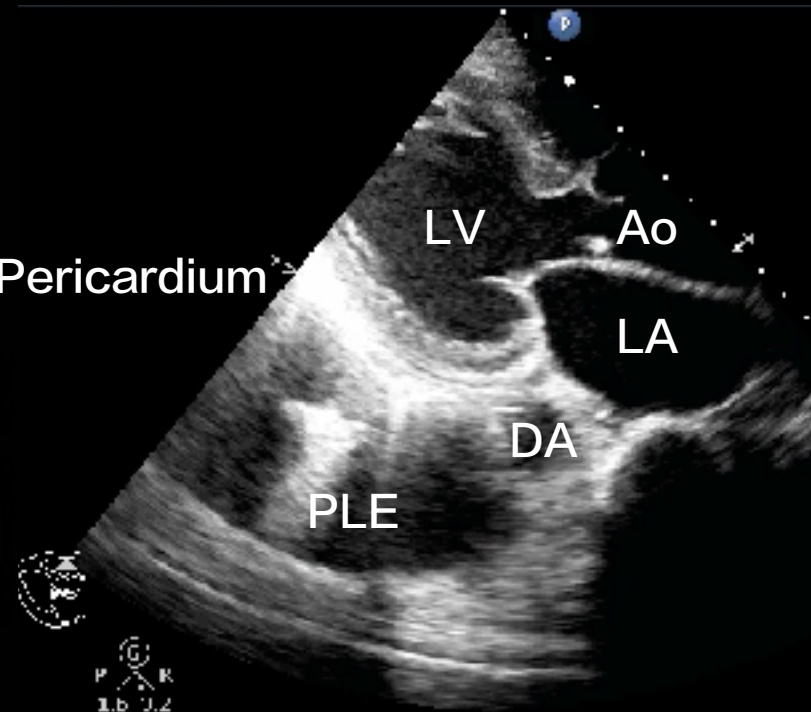




# D aorta

## Pericardial vs Pleural

Pericardium



LV

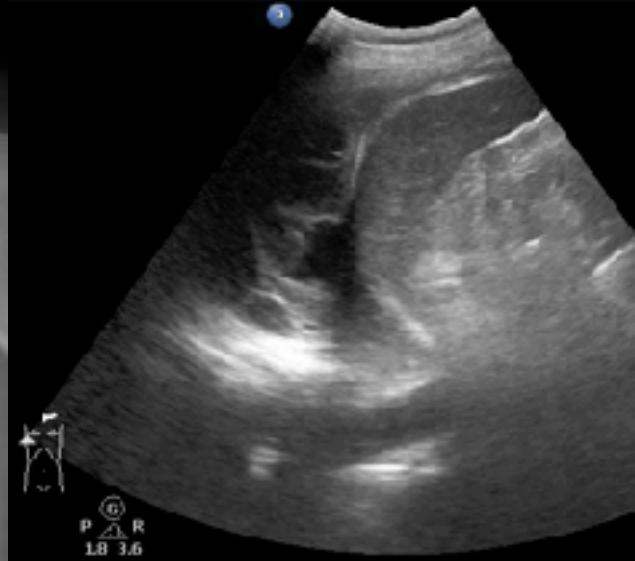
Ao

LA

DA

PLE

©  
1b 202



**Empyema**

**Septation  
Fibrin  
Particles**

# 73M, F & Dyspnea



**Empyema**





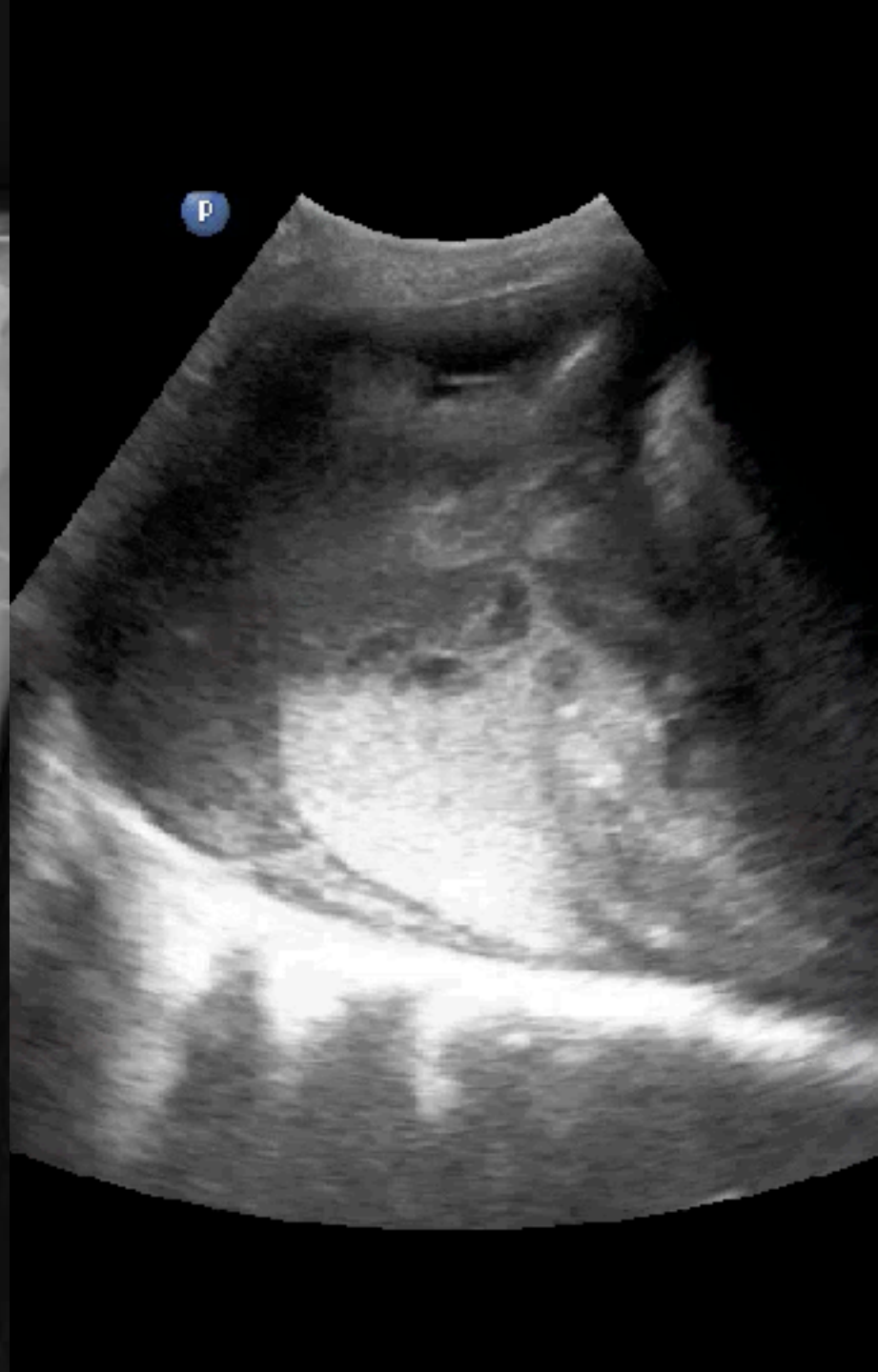
# What do you see ?

Abd Gen  
C5-1  
31 Hz  
17.0cm

2D

HGen  
Gn 90  
C. 56  
3 / 3 / 3







# US for PLE

**Detection**

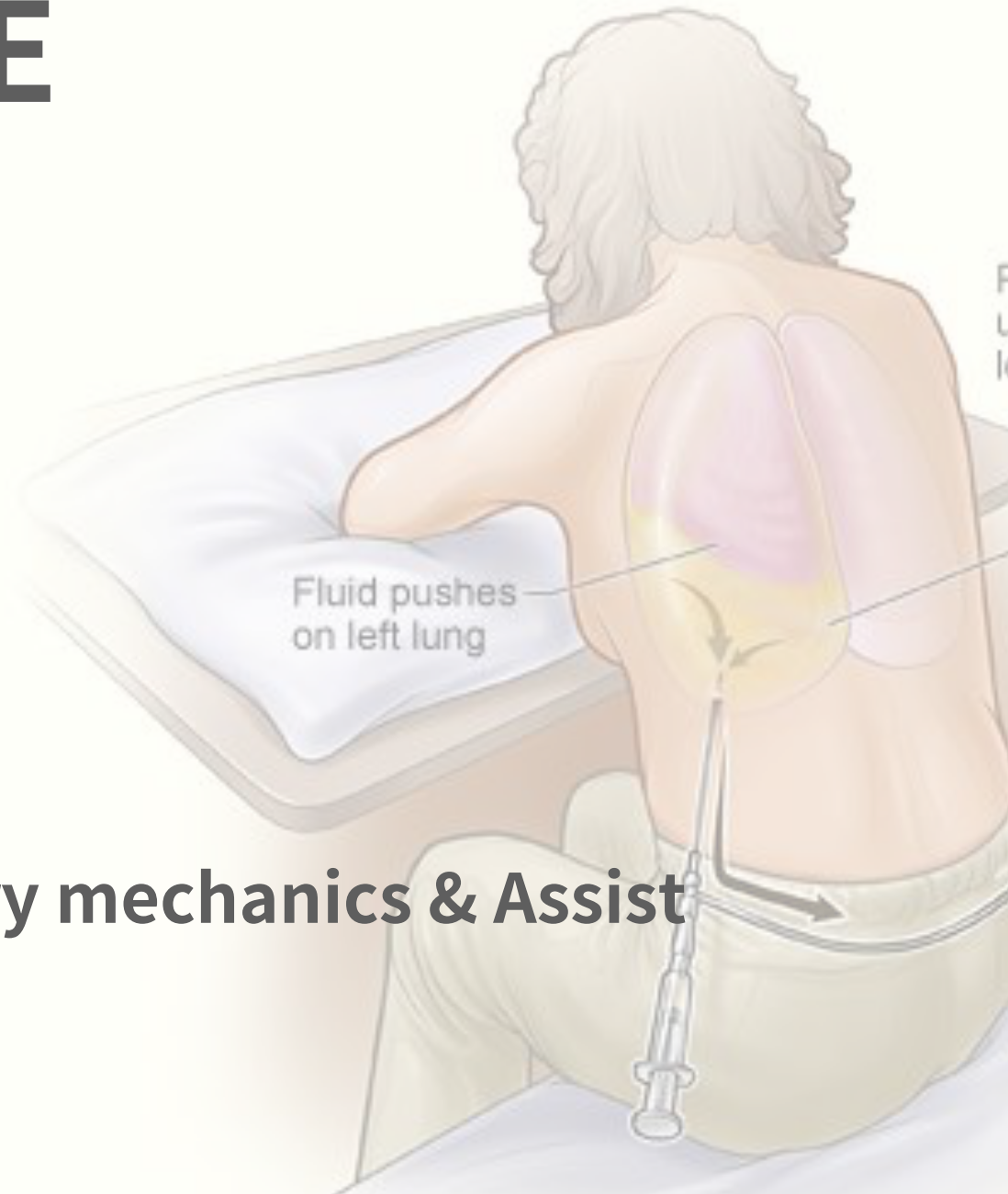
**Volume**

**Nature**

**Safety**

**Drainage**

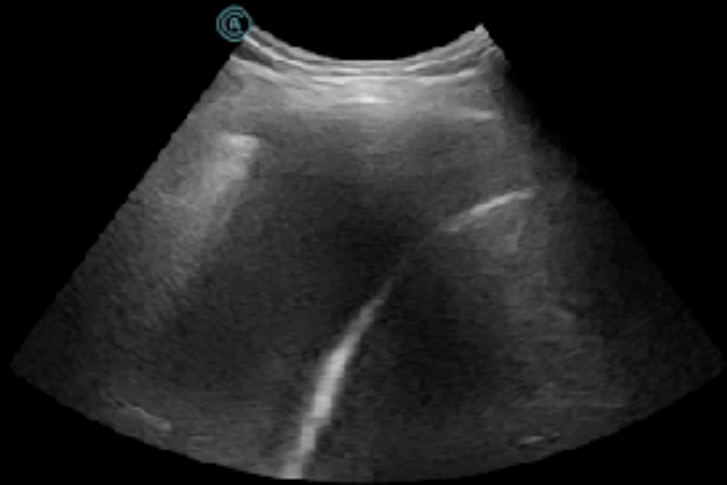
**Improve ventilatory mechanics & Assist weaning**



# 28F, 來抽肋膜積液吧!?

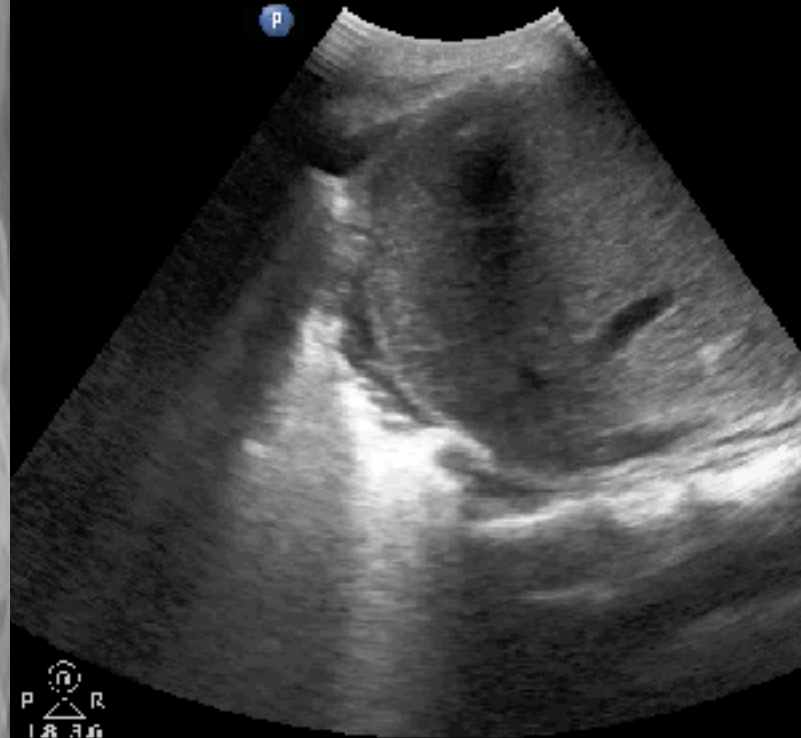


# 28F, 來抽肋膜積液吧!?

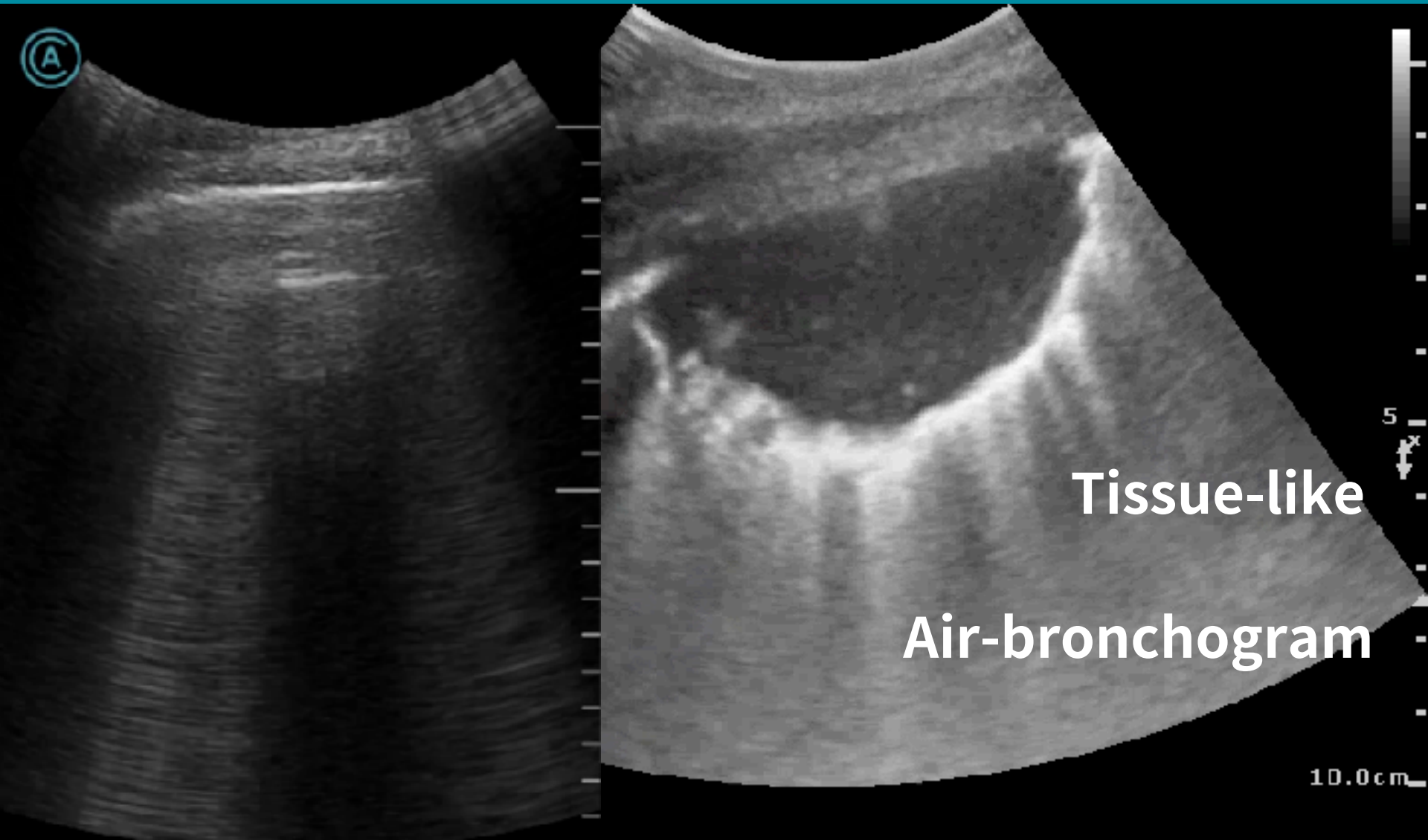


# Pneumonia

**Consolidation**  
**Air-bronchogram**

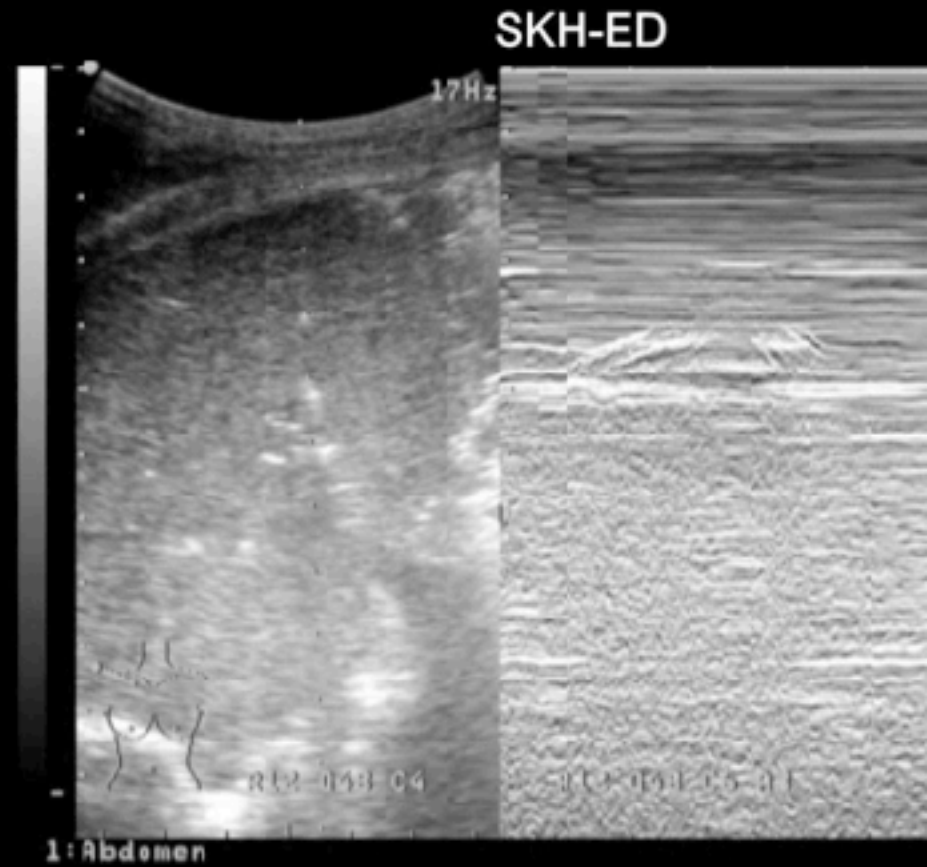


# C profile



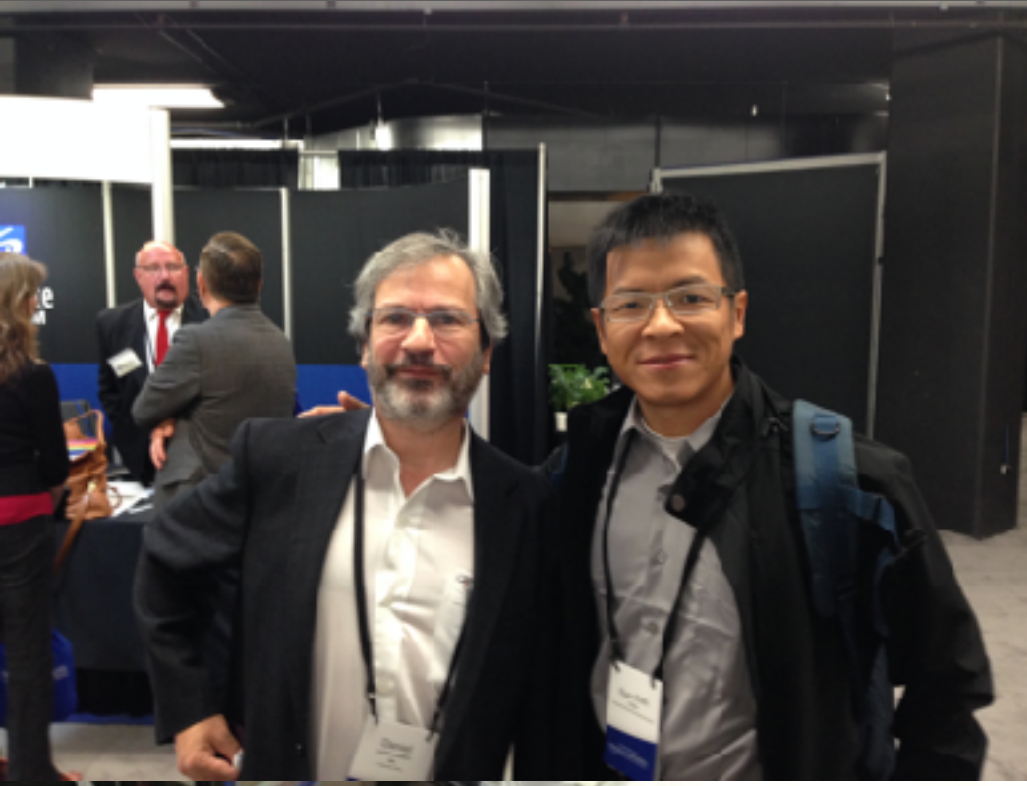


# Dynamic air-bronchogram



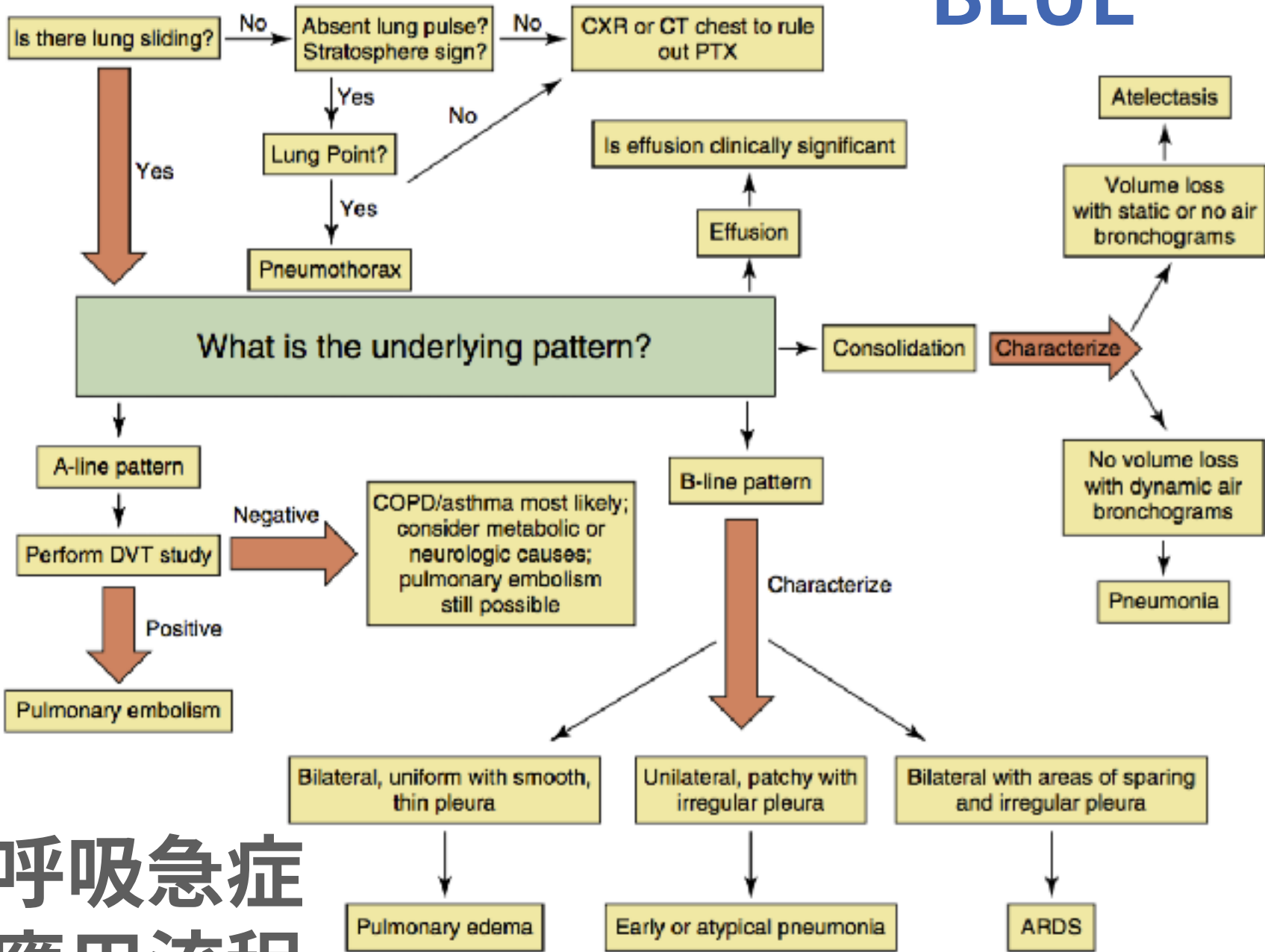
# BLUE Protocol

(Bedside Lung Ultrasound in Emergency Protocol)



Daniel Lichtenstein

# BLUE



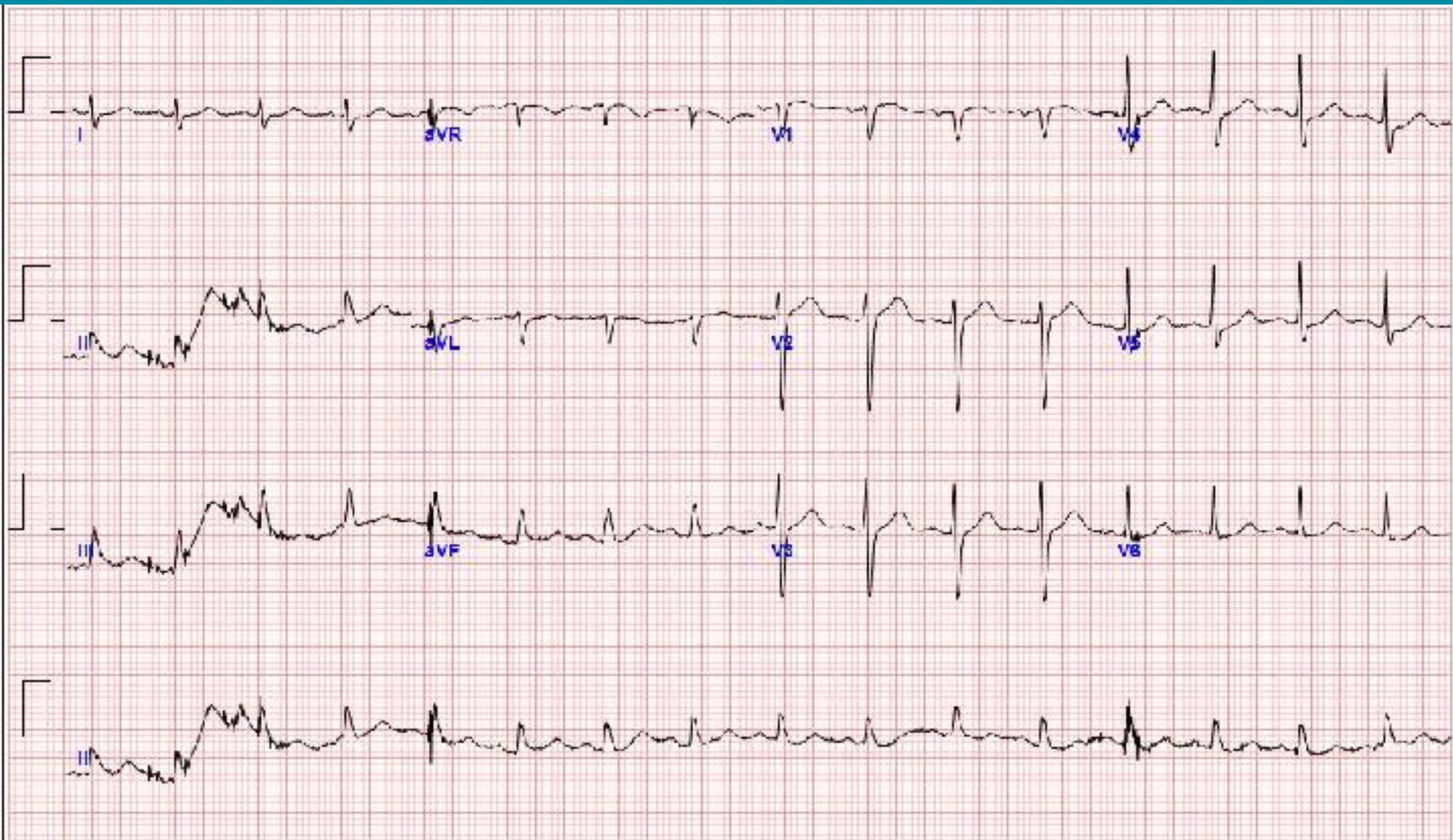
S  
A  
B  
E  
C

## 呼吸急症 應用流程

# 76M, Dyspnea & desaturation



# 76M, Dyspnea & desaturation



# 76M, Dyspnea & desaturation



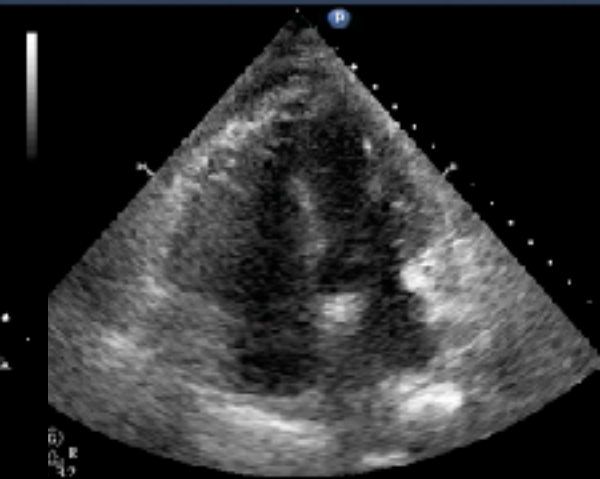
# 76M, Dyspnea & desaturation



PSLA

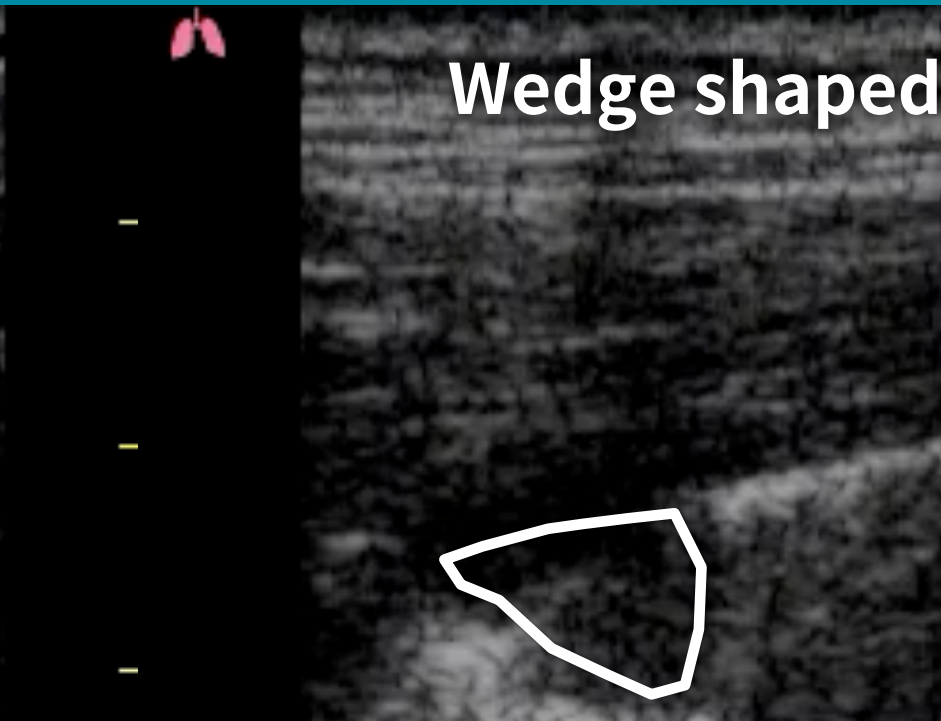
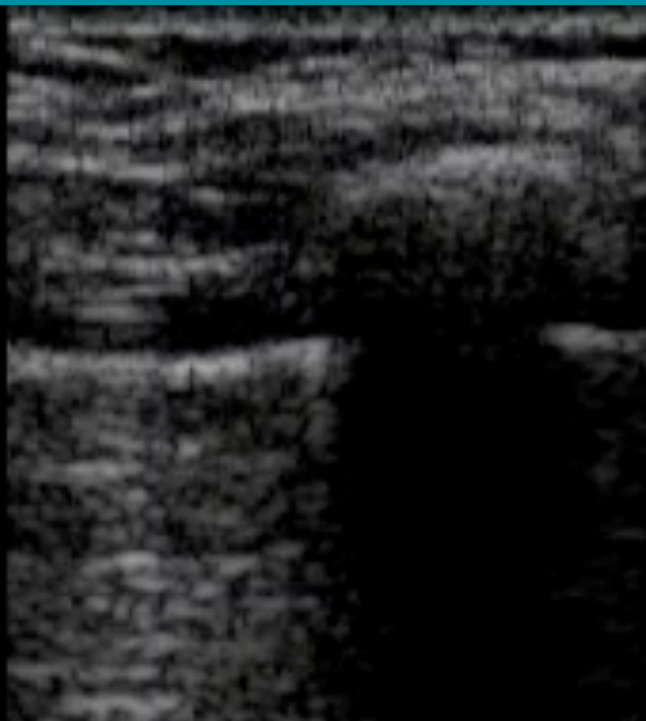


D sign



McConnell's sign

# Pulmonary infarction



Wedge shaped



呼吸喘看肺—心—靜

肺栓塞看靜—心—肺

4.9cm





**Diagnostician**

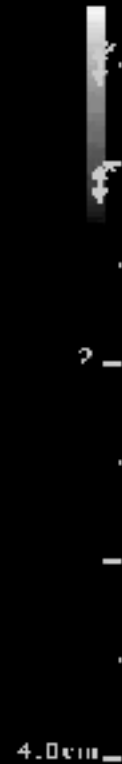
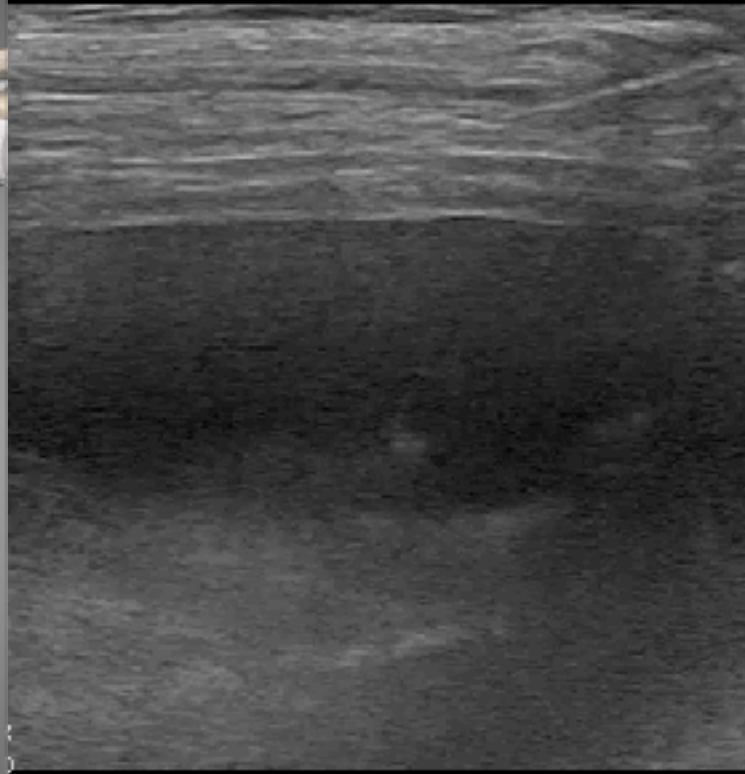
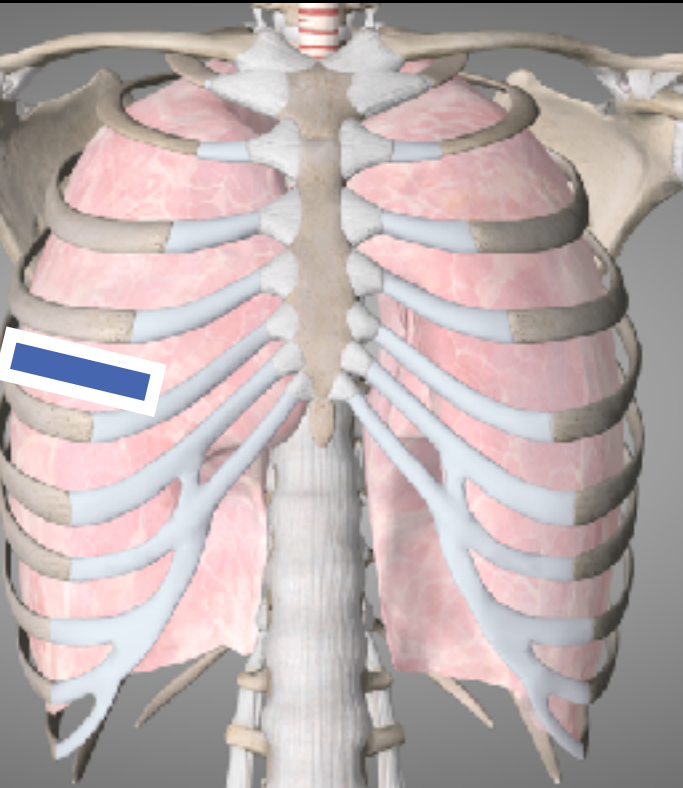


**Interventionist**

# In-plane drainage



SKH-EUTC©ChenKC



Catheter insertion

# Off-plane drainage



Superficial

L 12-3

43 Hz

4.5cm

2D

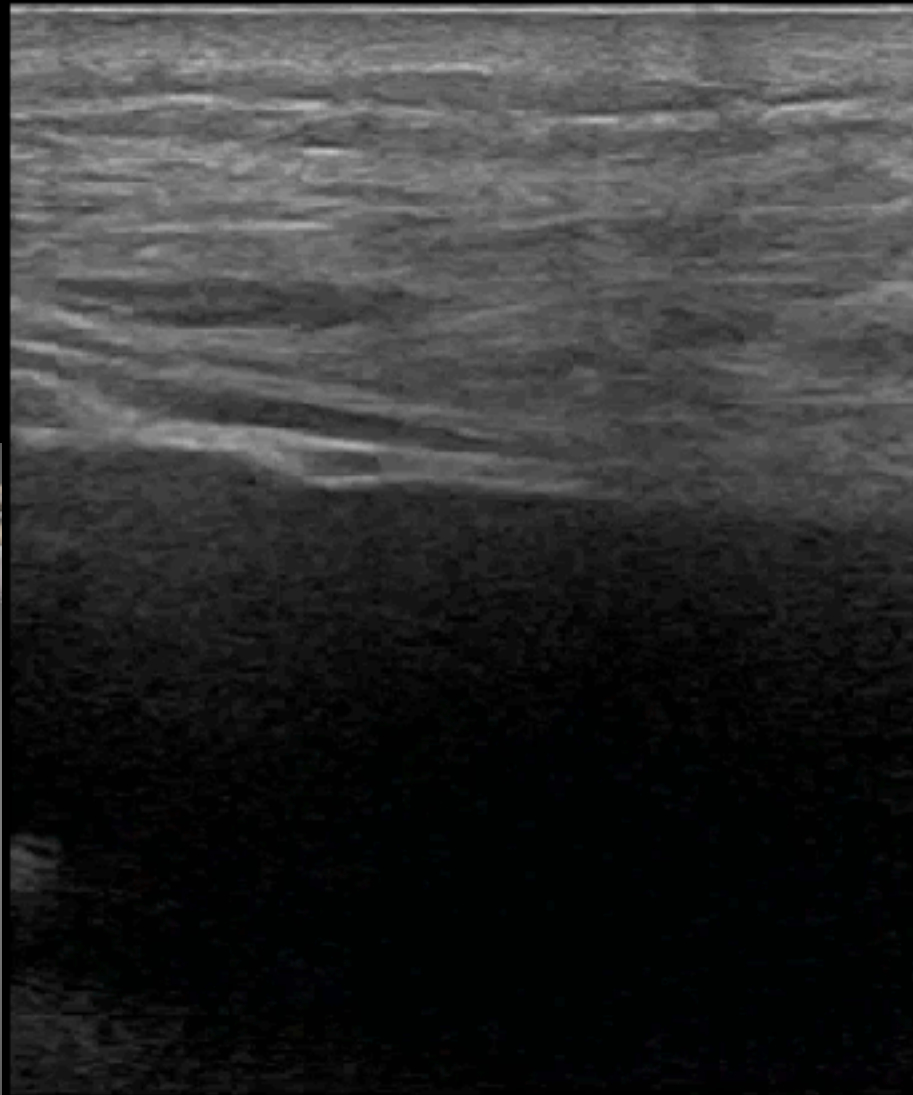
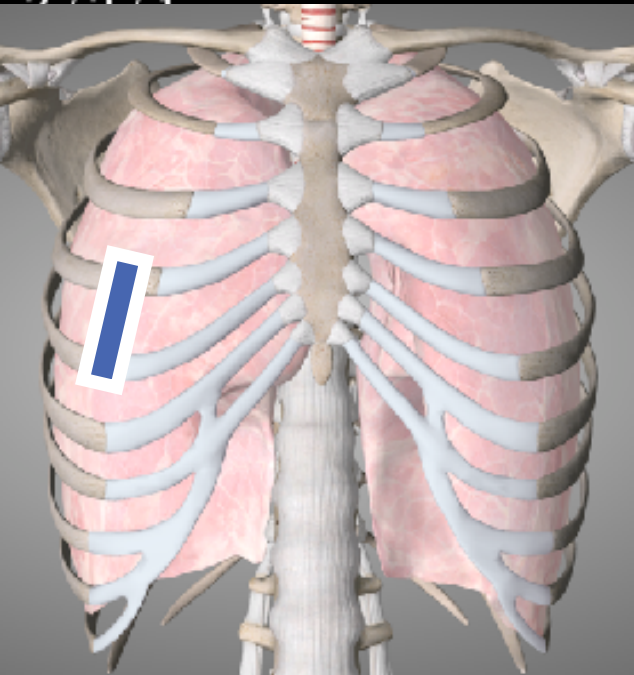
Res

Gn 100

C 56

2 / 2 / 1

P



4.5cm

# Pigtail drainage with stylet

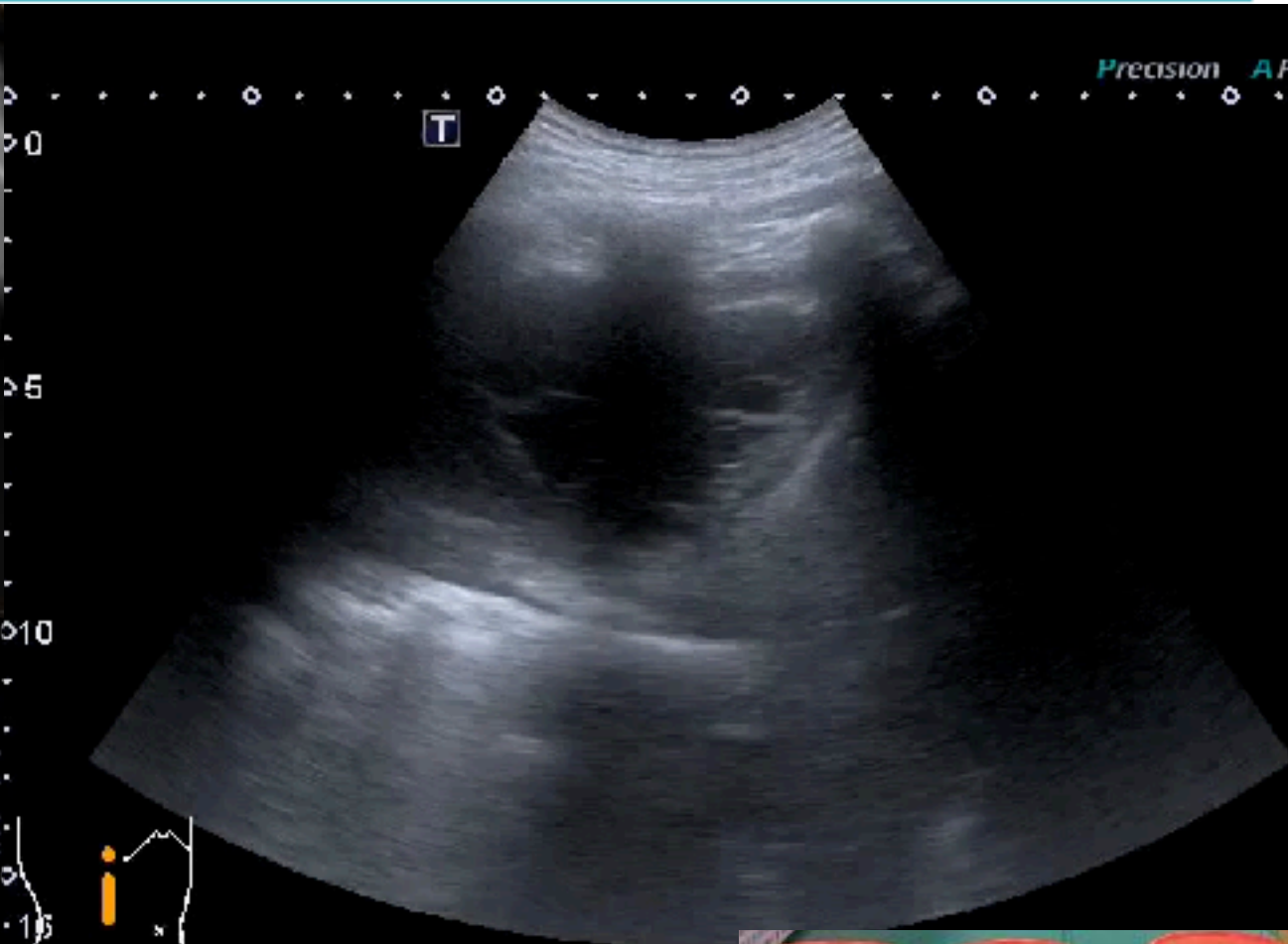


Abd Gen2  
C5-1  
30 Hz  
18.0cm

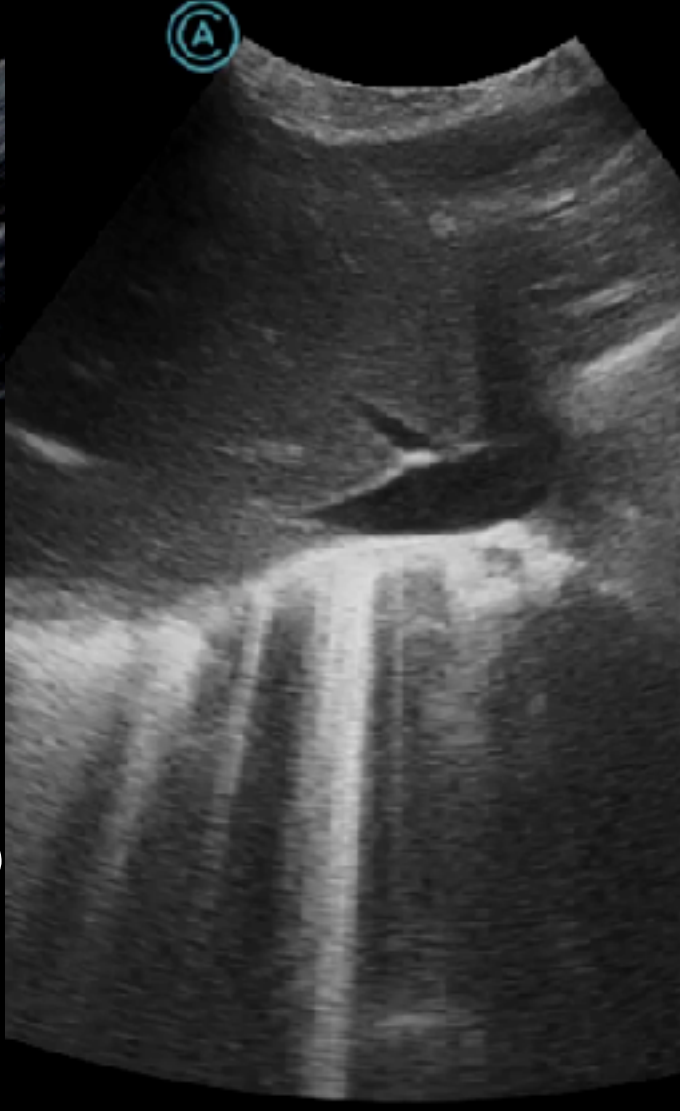
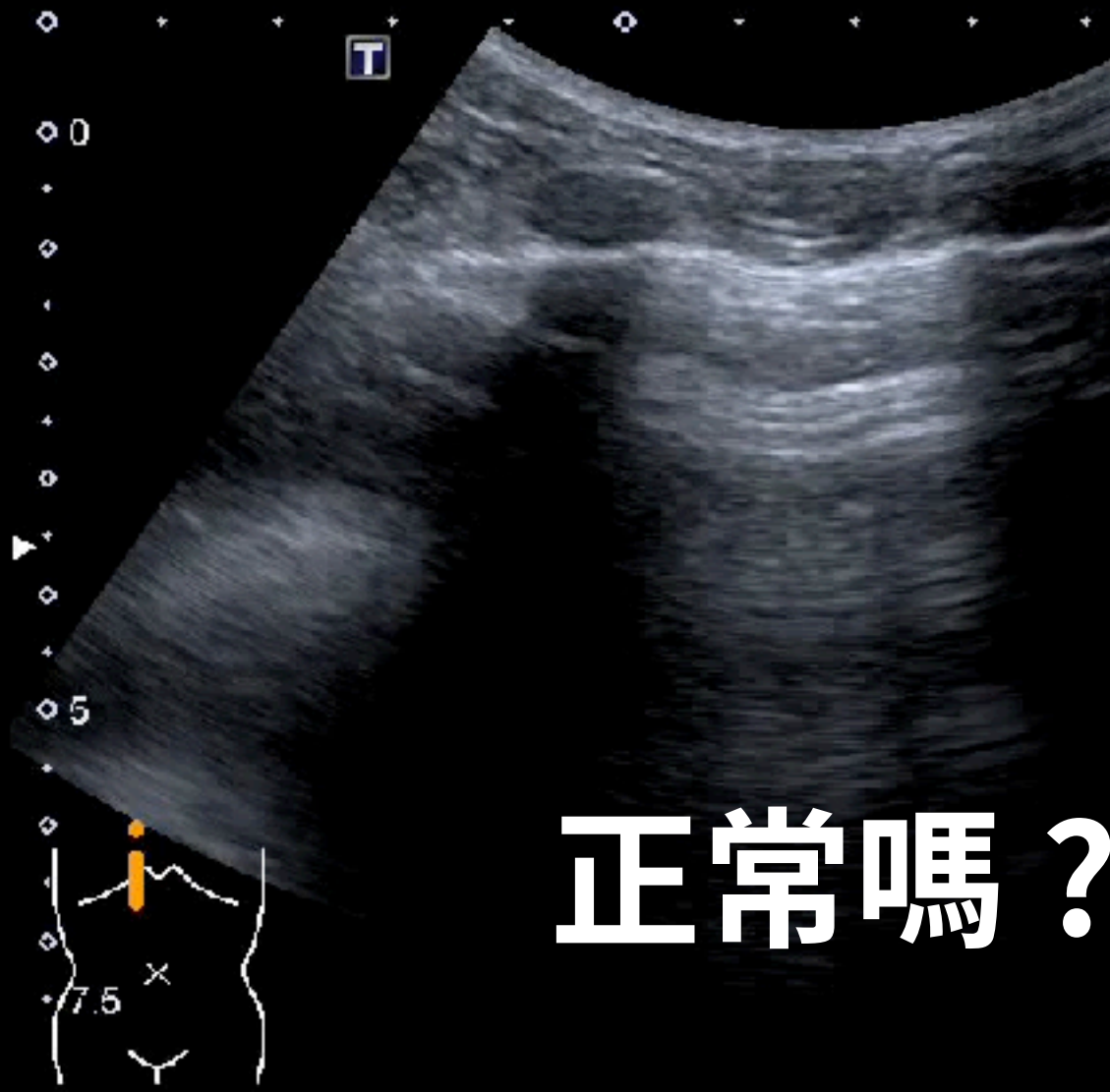
2D  
HGen  
Gn 100  
C 56  
3 / 3 / 3



# Pigtail drainage with guidewire



# LUNG USG : S - ABCDE



正常嗎？

# LUNG USG : S - ABCDE



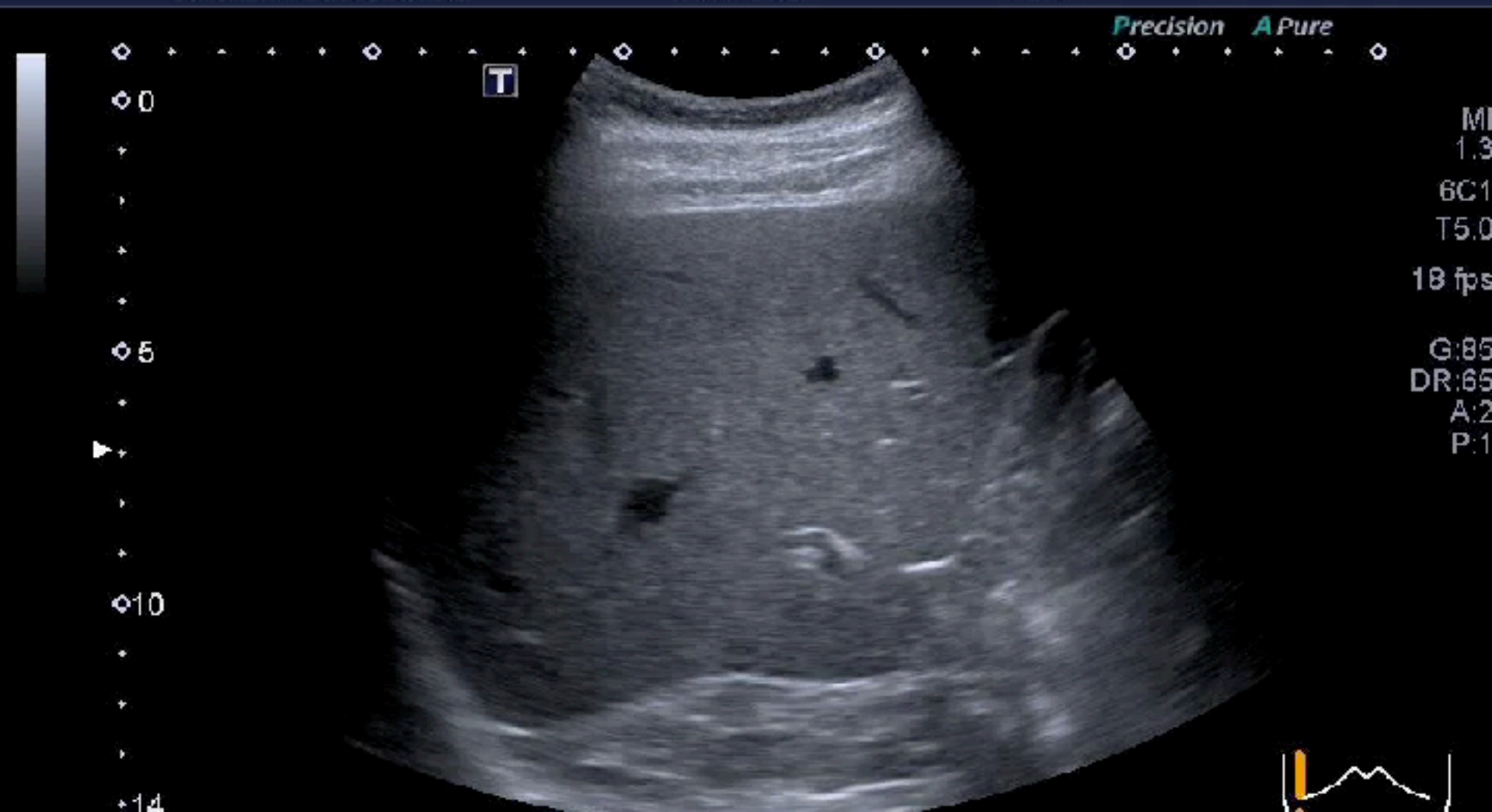
Dyspnea  
Chest pain  
Infections

**PTX**  
**AIS**  
**PLE**  
**Consolidation**  
**DVT**

# Curtain sign & Diaphragm movement



TOSHIBA Xario 200 West Garden Hospital Abdomen 3158 2017/05/09 9:17:06 AM

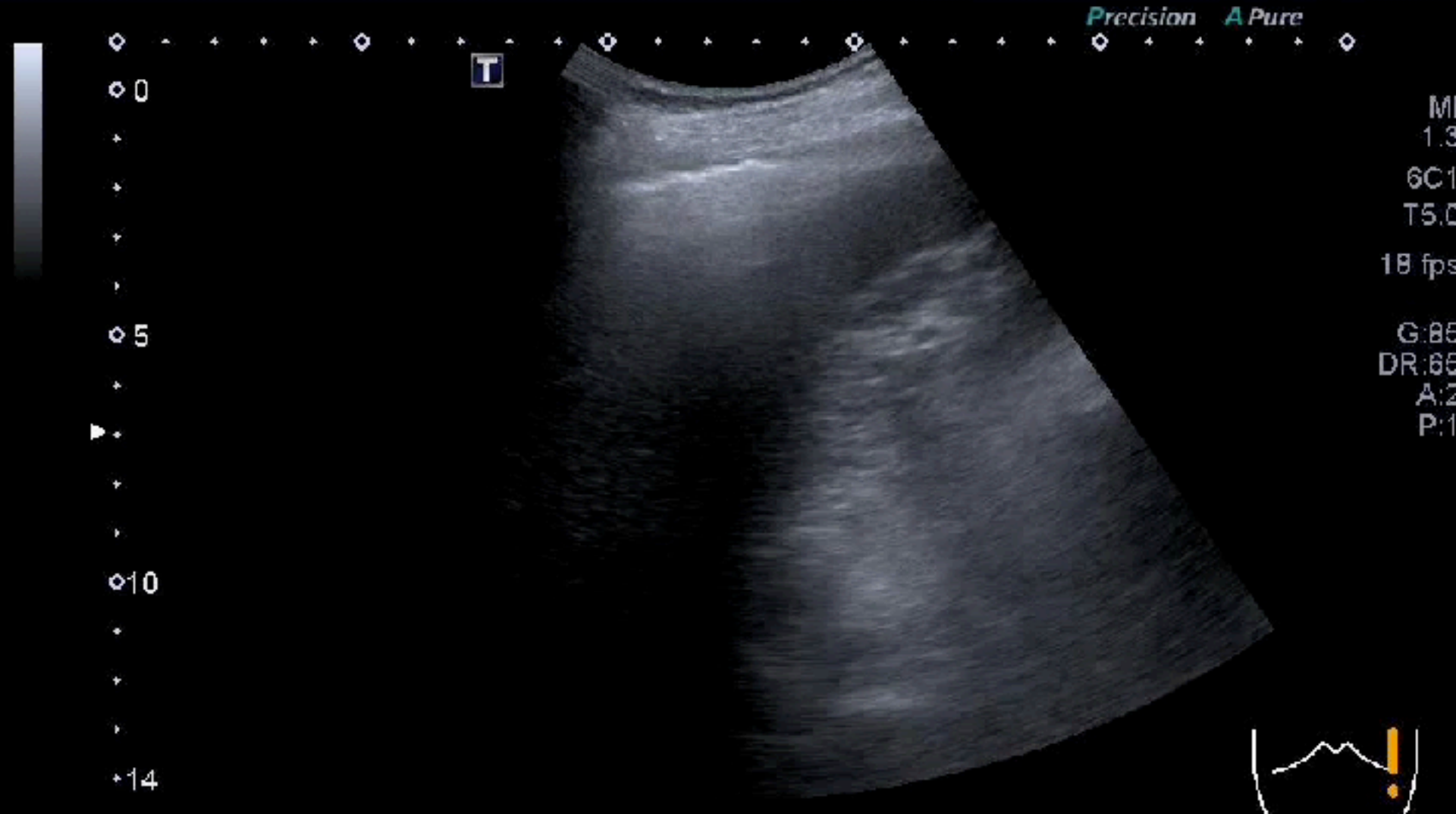




# Greatest motion of sliding



TOSHIBA Xario 200 West Garden Hospital Abdomen 3158 2017/05/09 9:17:41 AM



# Respiratory drive



2017/05/09

9:20:39 AM

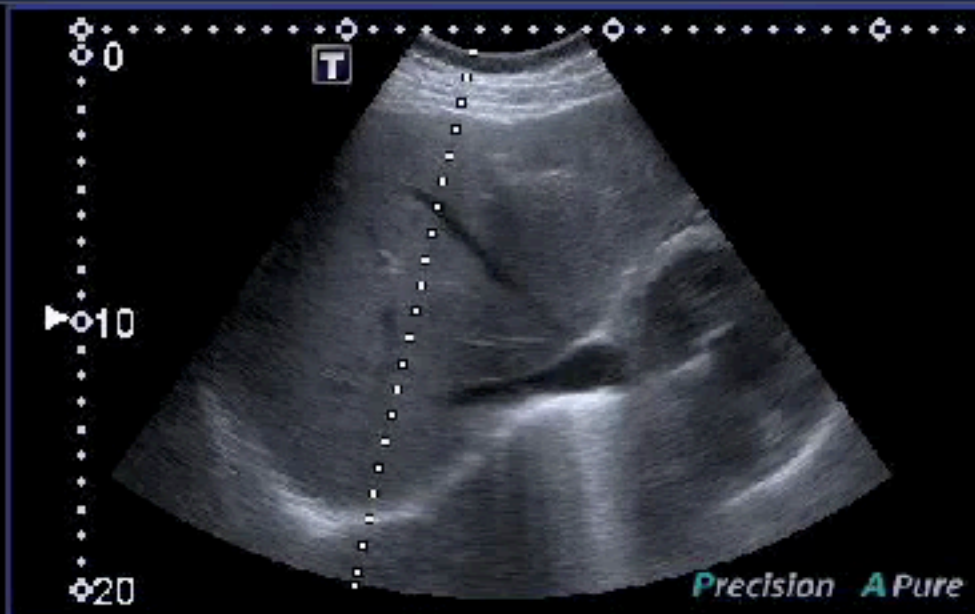
TOSHIBA

Xario 200

West Garden Hospital

Abdomen

3158



MI:1.3

6C1

T5.0

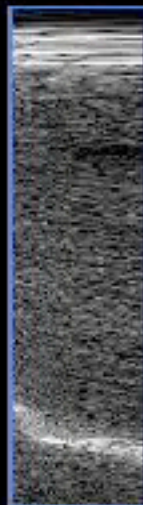
11 fps

G:85

DR:65

A:2

P:1



**Diaphragm excursion**  
**Diaphragm velocity**



# Respiratory drive



TOSHIBA

Xario 200

West Garden Hospital

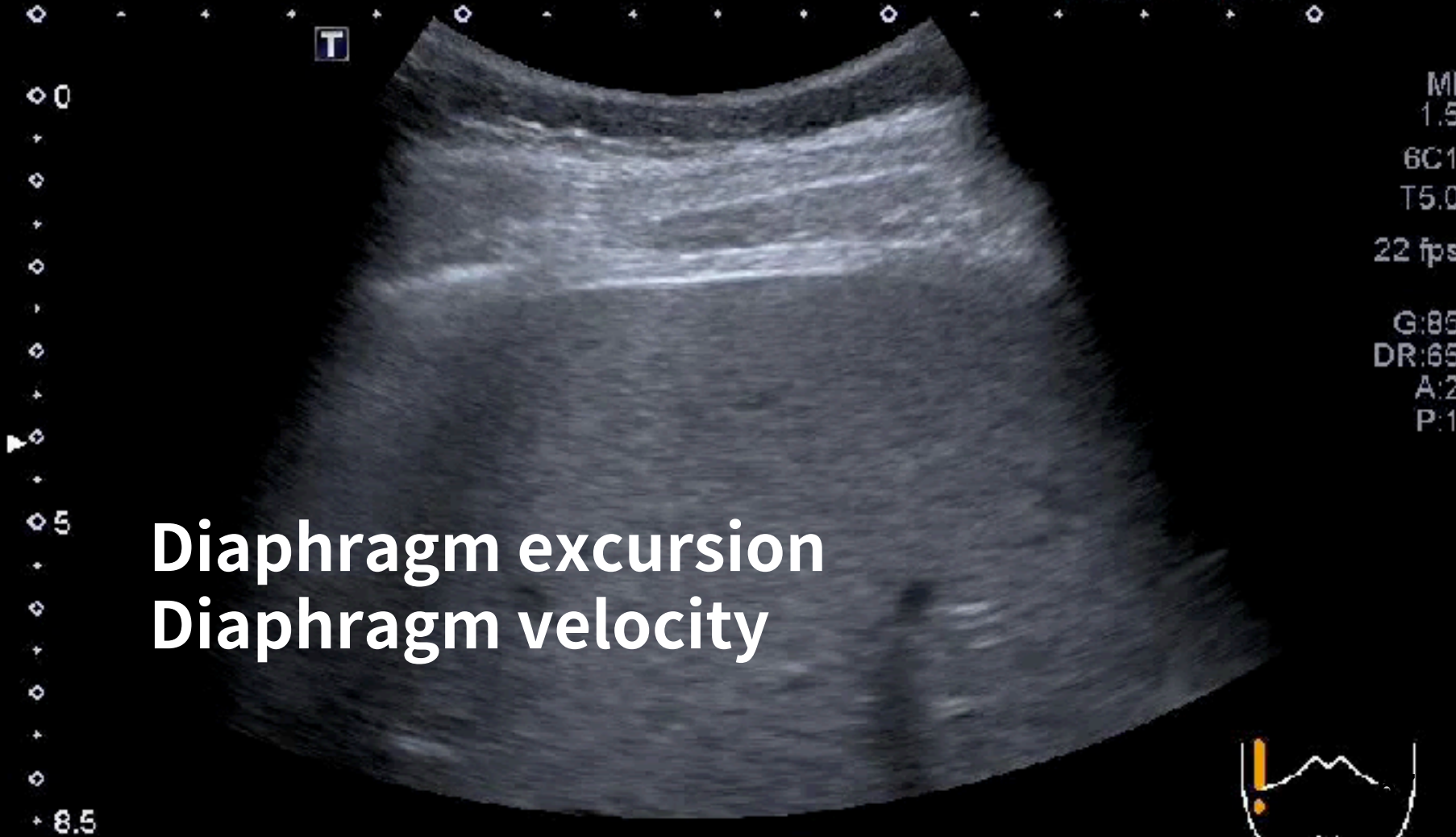
Abdomen

3158

2017/05/09

9:16:47 AM

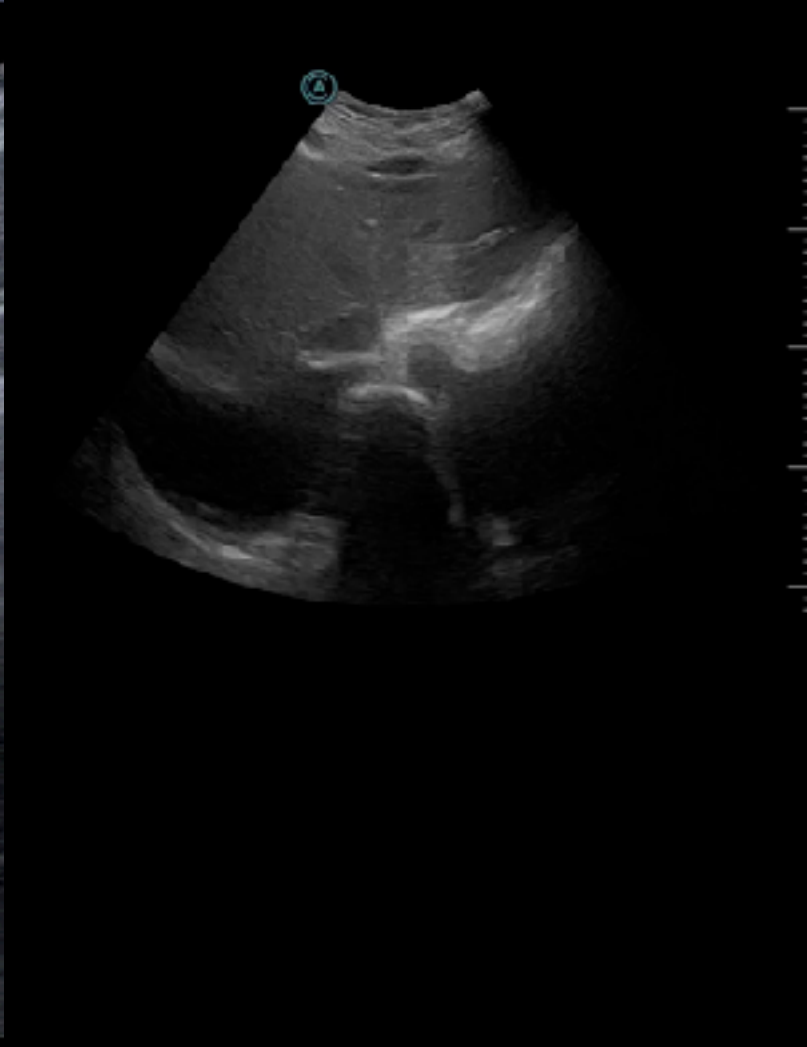
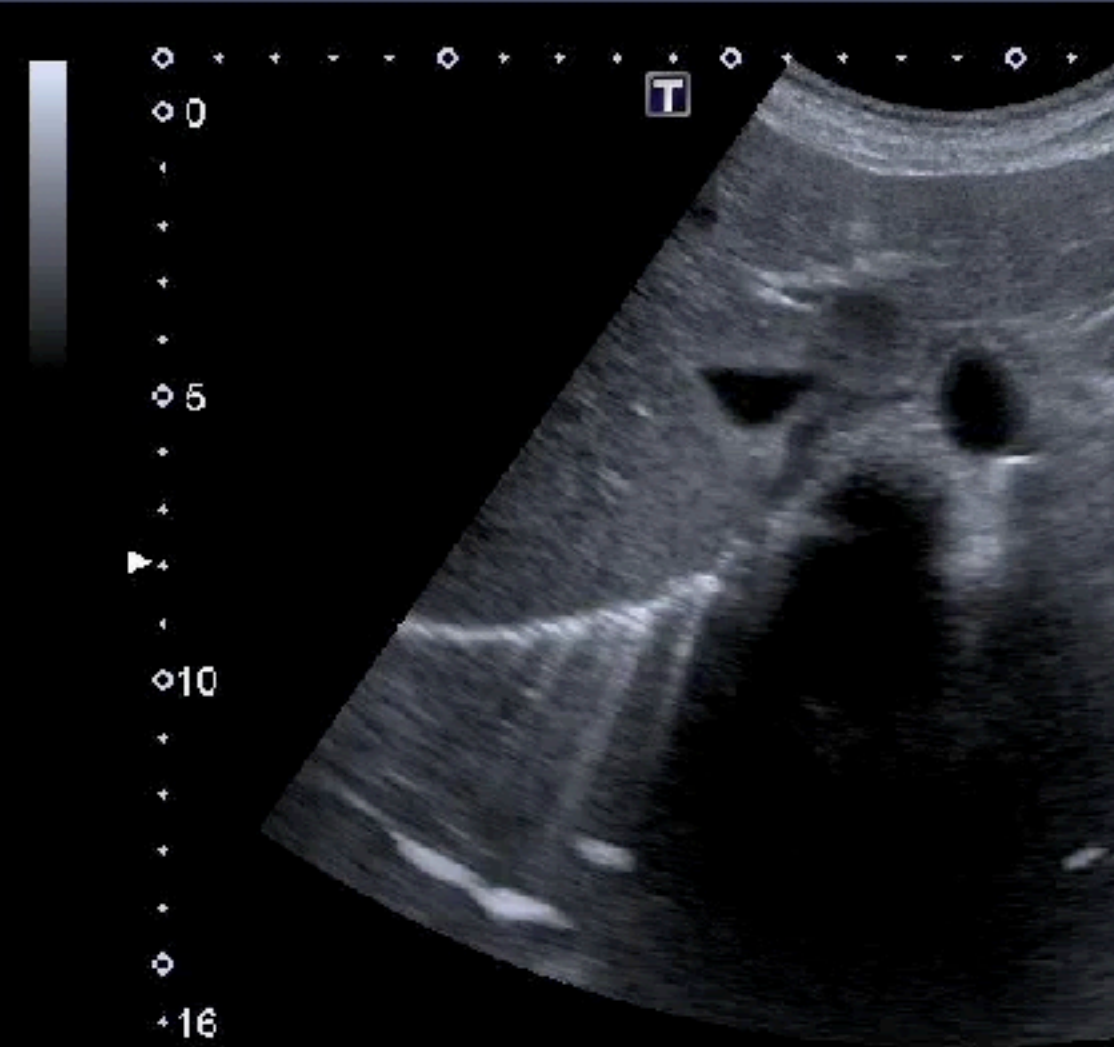
Precision A Pure



Diaphragm excursion  
Diaphragm velocity

# PED & Thin

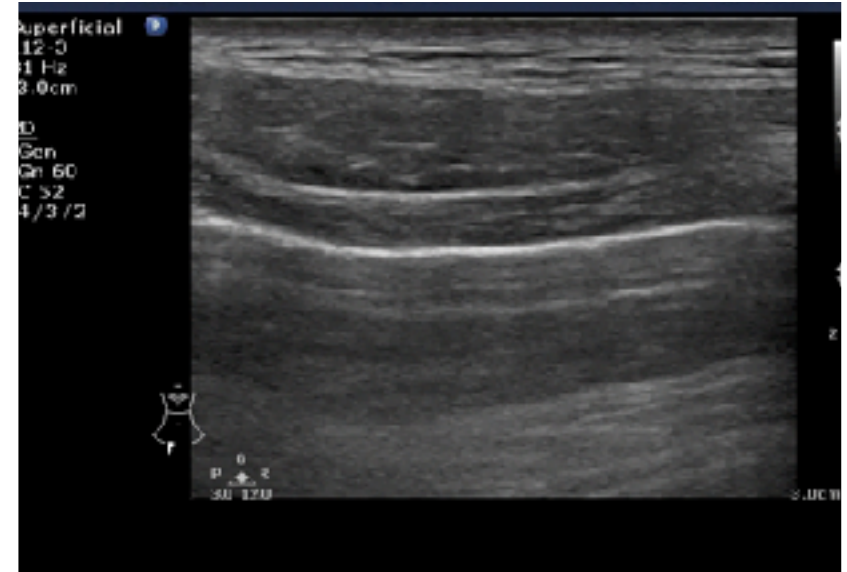
**TOSHIBA**  
Xario 200 West Garden Hospital Abdomen



# 那一段影片正常？

A

B

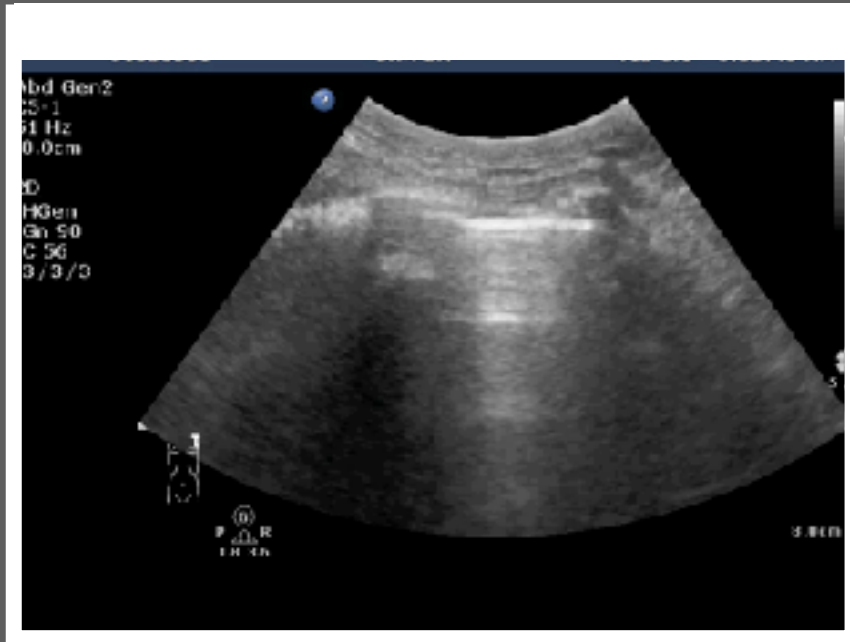


Empyema

Normal lung

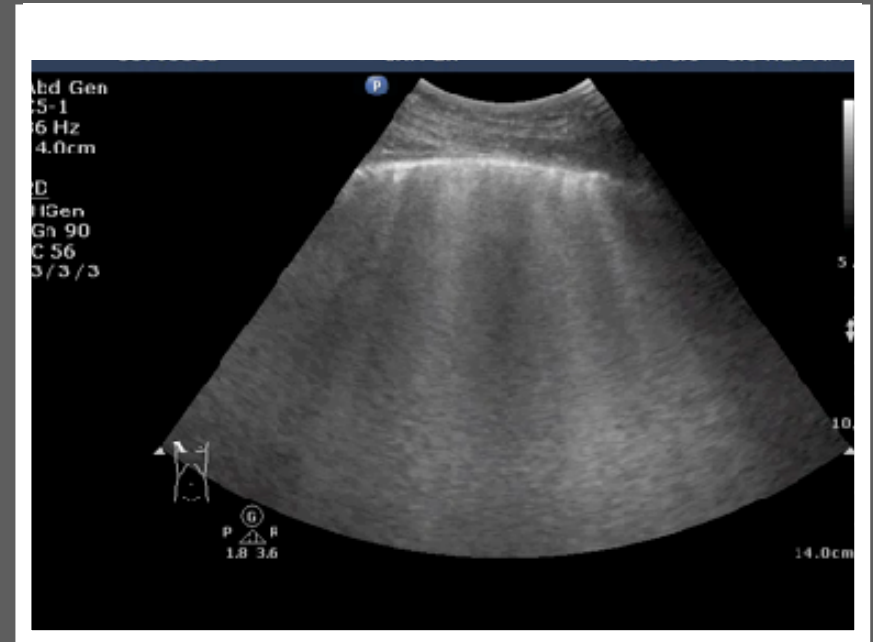
# 那一段影片正常？

A



No sliding

B



Lung rockets

# 18M, MBA Victim



# Back !!!



Abd Gen2  
C5-1  
39 Hz  
12.0cm

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



F R  
1.8 3.6

10.0cm

Abd Gen2  
C5-1  
39 Hz  
12.0cm

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

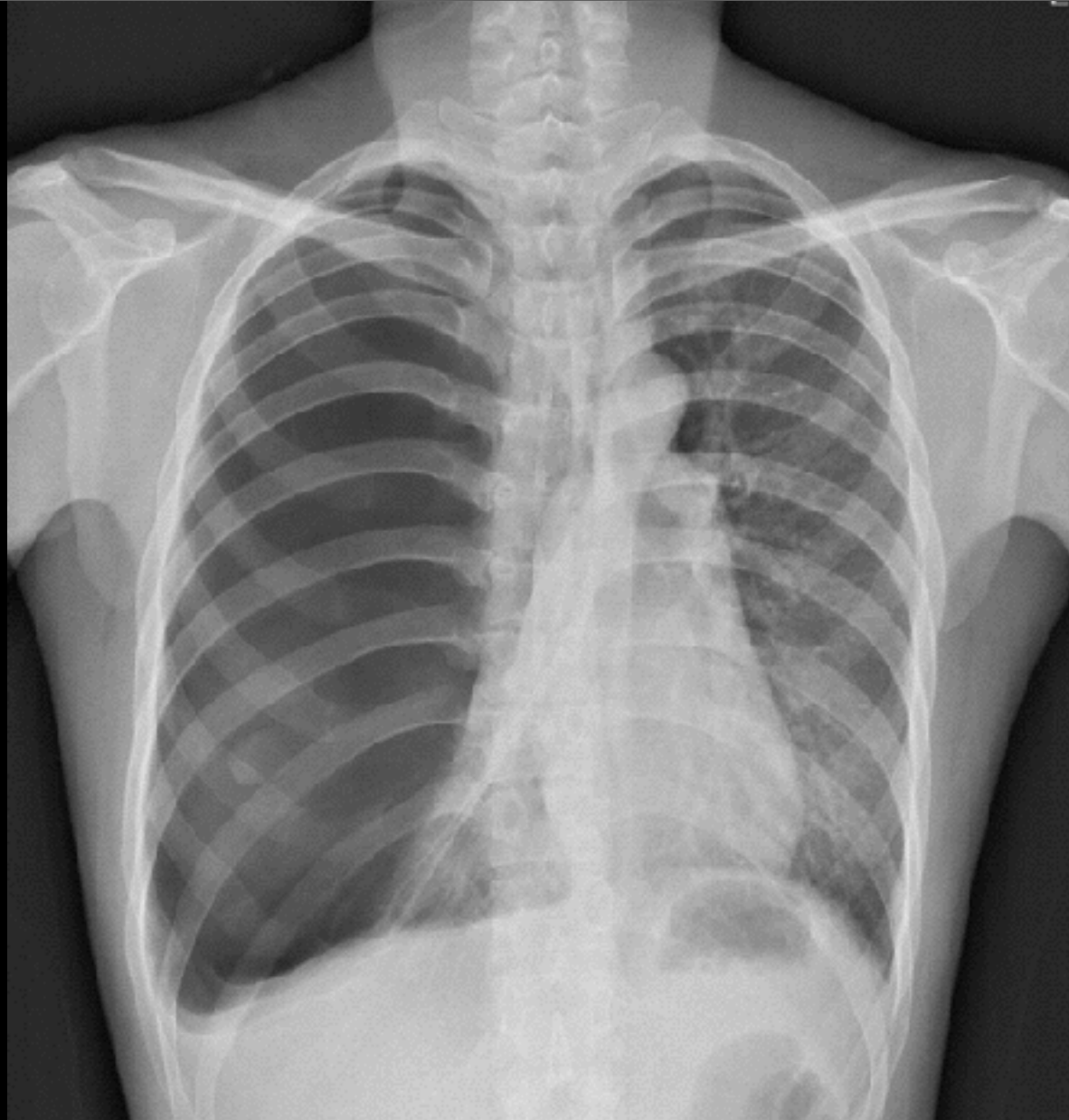


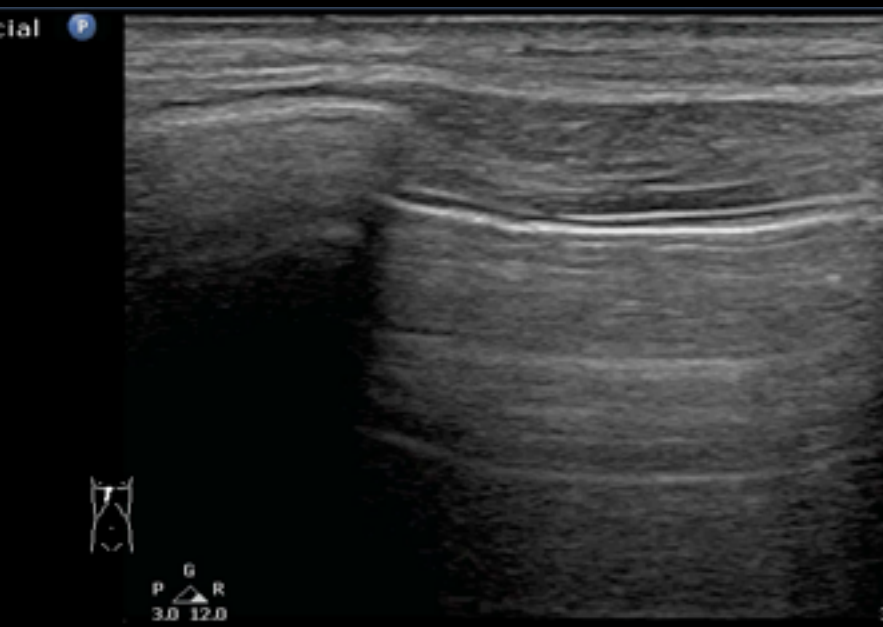
F R  
1.8 3.6

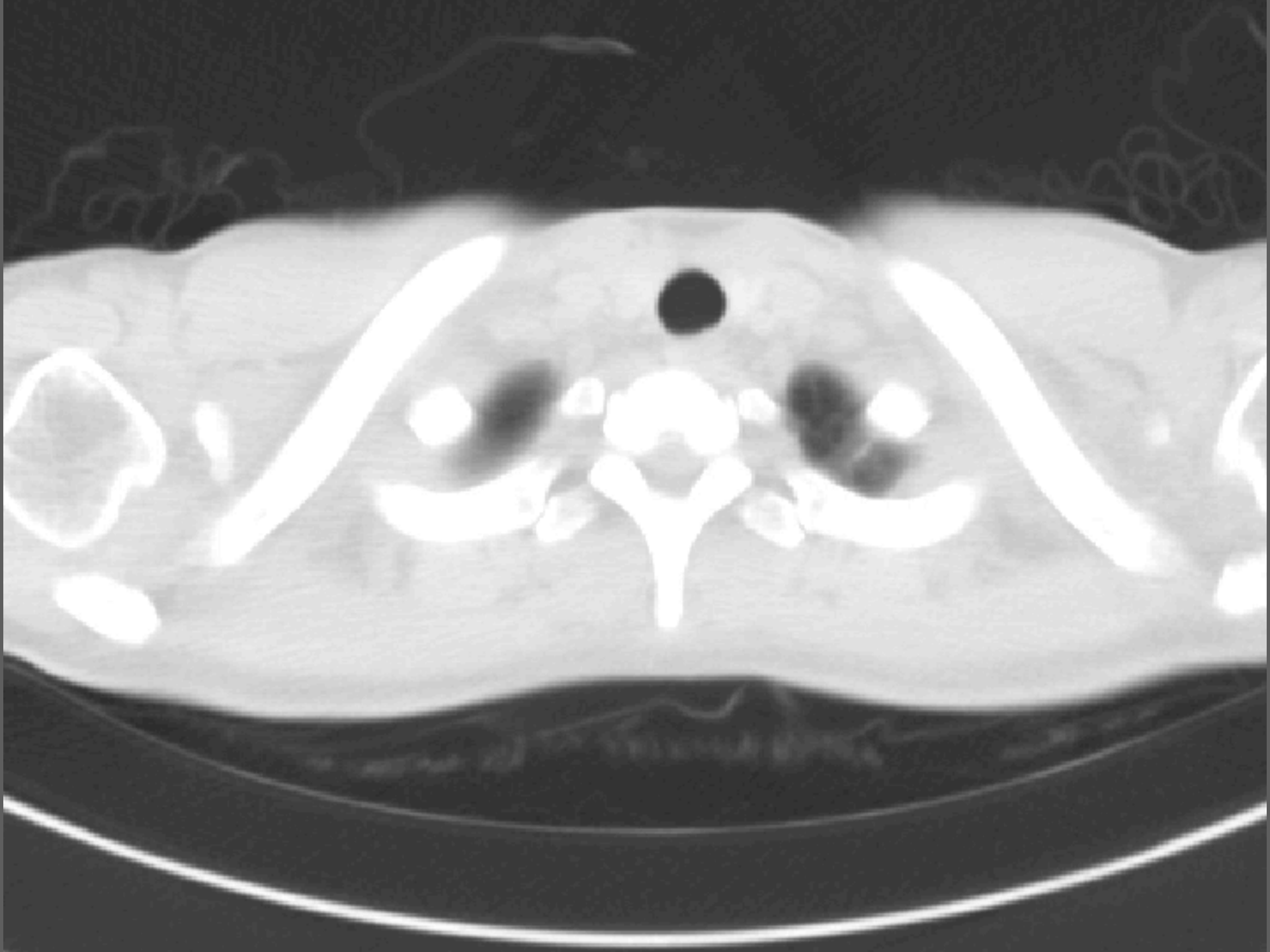
10.0cm



**30F, CS referred for pigtail**



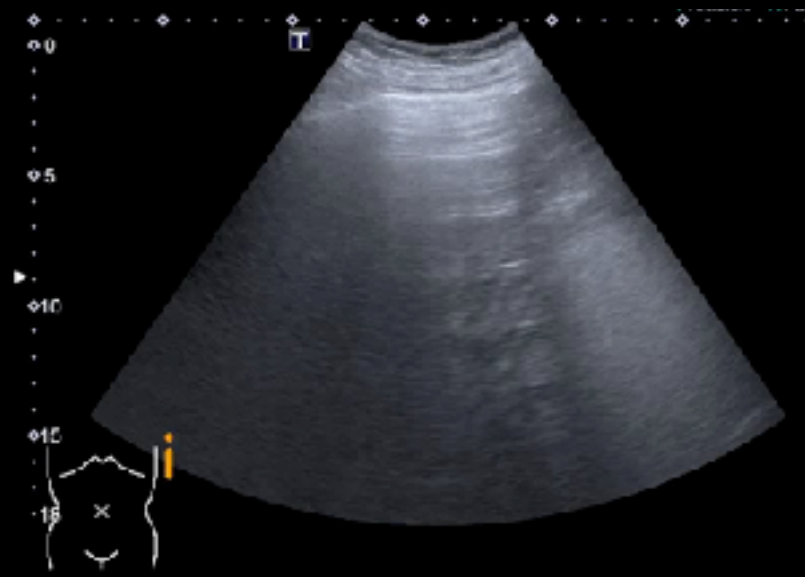
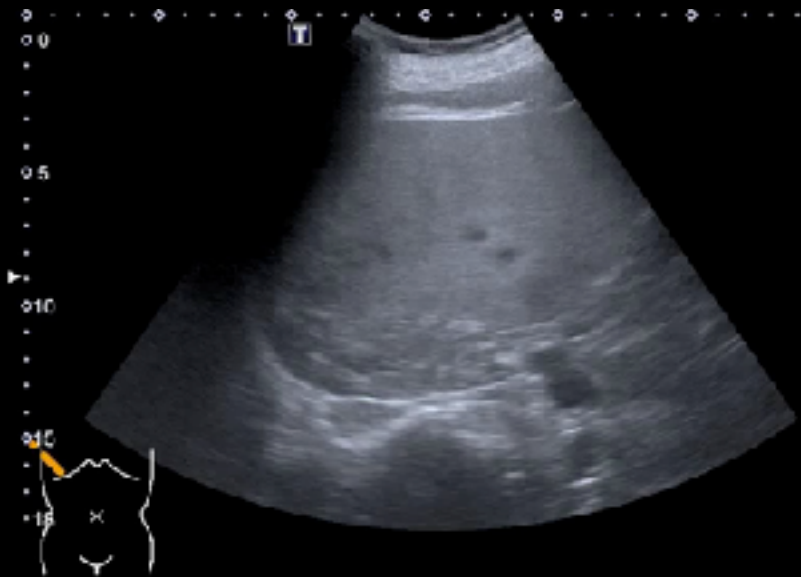
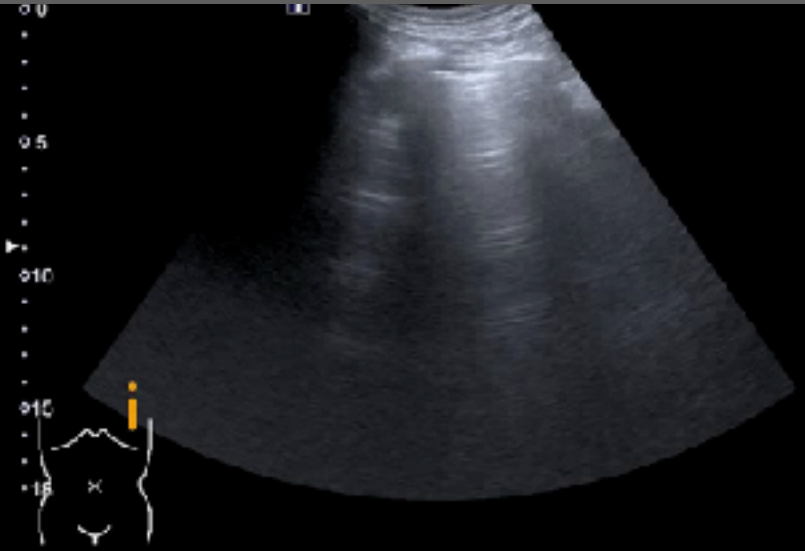
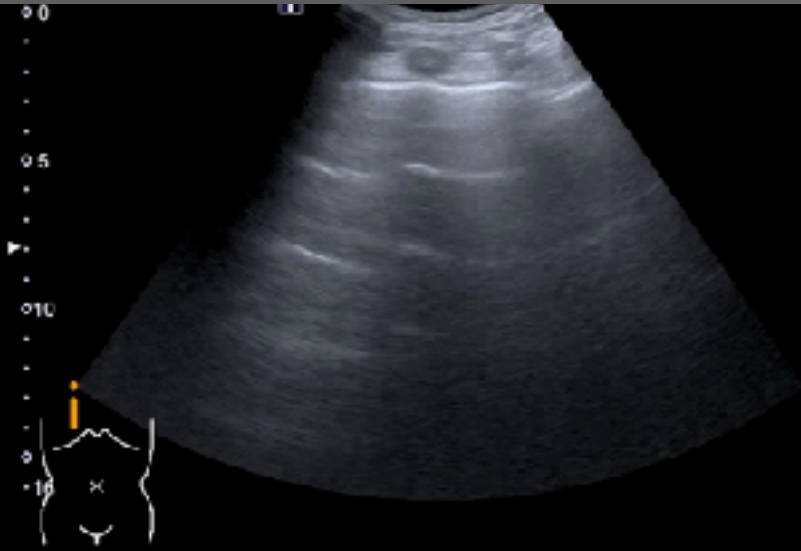




# 67M, left upper chest pain



# 54M, COPD & CHF, Dyspnea



# Indication

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

- History
- Physical examination
- ABG
- ECG

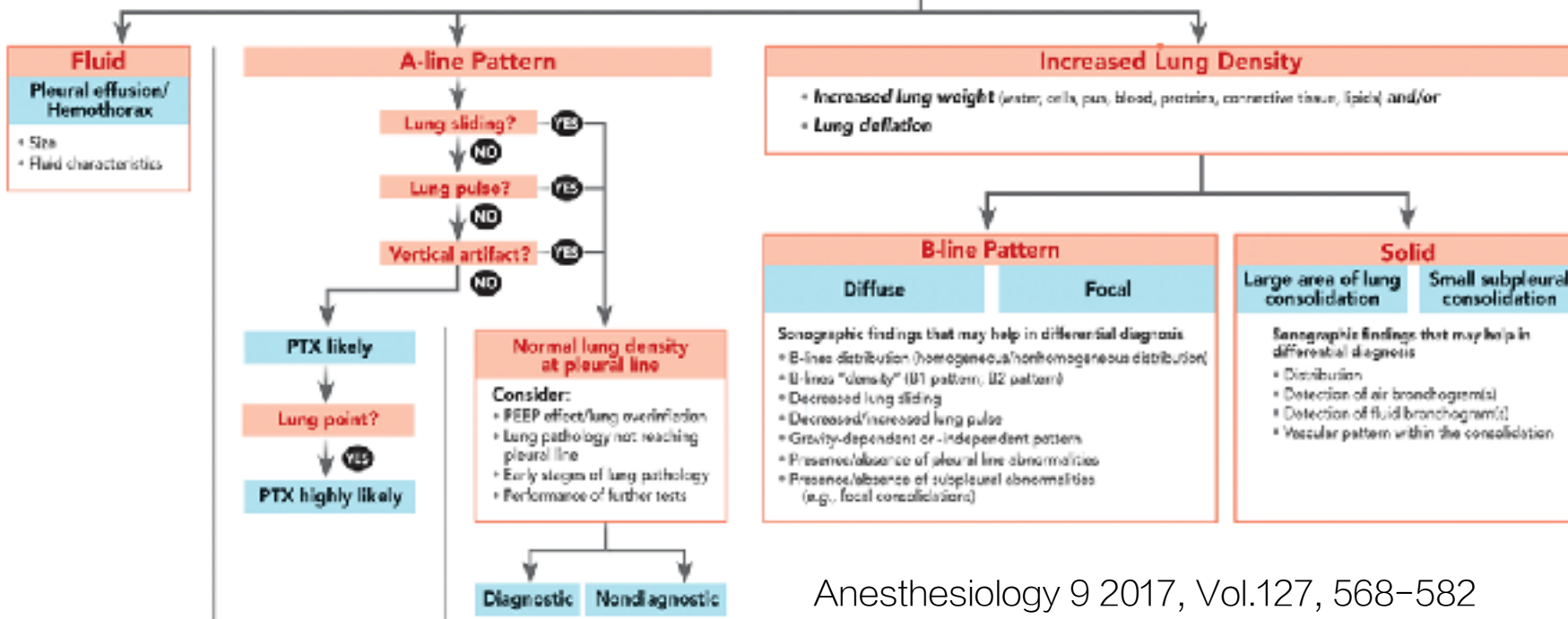
← Pretest probability

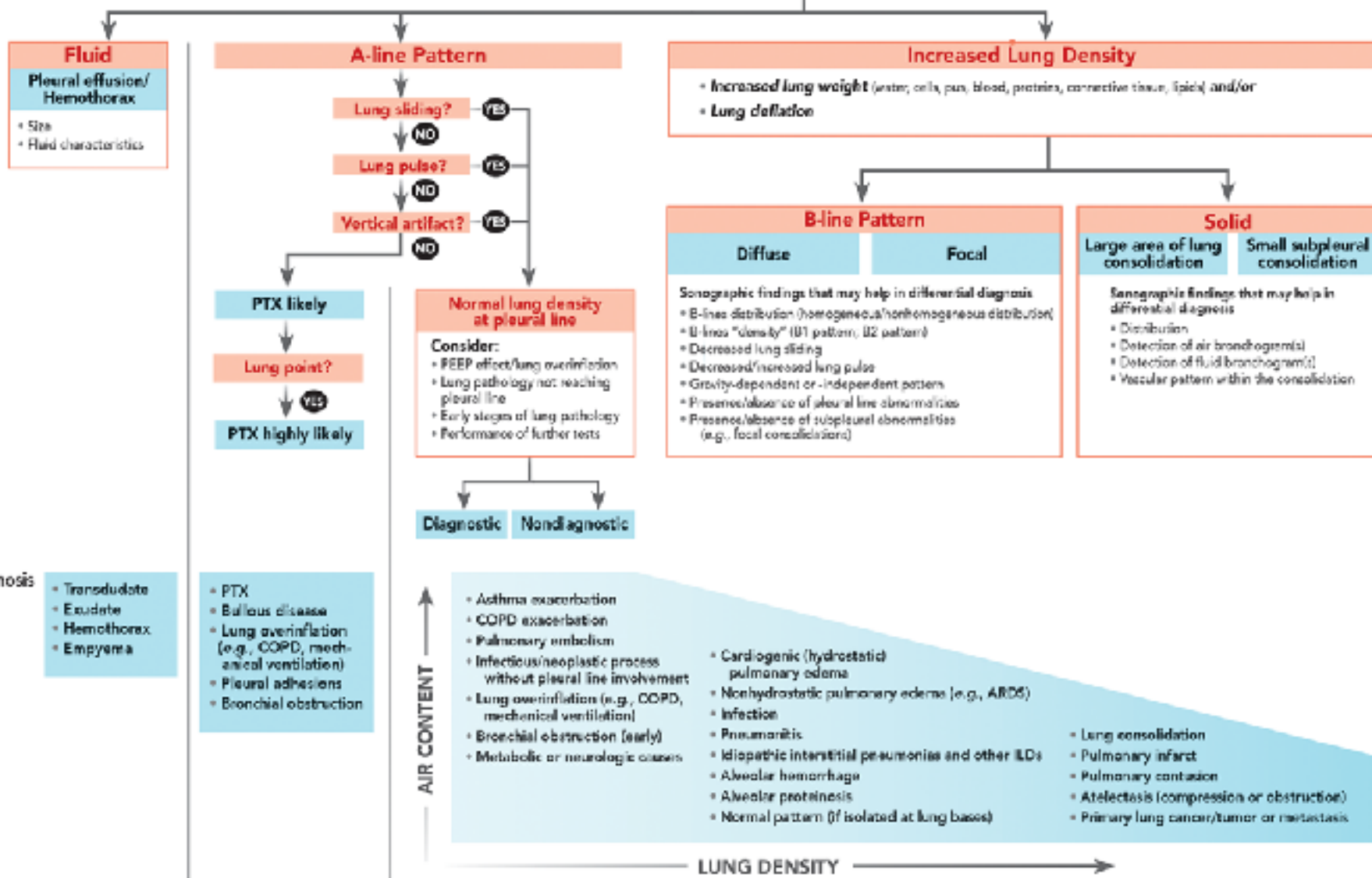
# Acquisition

	DIAGNOSTIC HYPOTHESIS		
	Pleural effusion suspected	PTX suspected	Increased lung density suspected
Patient position Probe selection & orientation Protocol selection Picture optimization	<ul style="list-style-type: none"> <li>• Semi-erect (or supine)</li> <li>• Low-frequency probe</li> <li>• Maintain post-processing artifacts reduction algorithms</li> <li>• Start examination from lung bases; identify diaphragm and spine</li> </ul>	<ul style="list-style-type: none"> <li>• Ideally supine</li> <li>• If possible, high-frequency probe</li> <li>• Consider M-mode and Power Doppler</li> <li>• Identify least dependent zone</li> </ul>	<ul style="list-style-type: none"> <li>• Semi-erect or supine</li> <li>• Low-frequency and high-frequency probes</li> <li>• If B-line pattern analysis, deactivate post-processing artifacts reduction algorithms</li> <li>• Complete lung examination (anterior, lateral, and posterior surfaces, bilaterally)</li> </ul>

# Interpretation

## PLEURAL LINE INTERFACE





- 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

# LUS for critically ill patients

ARJCCM 2018

## ACUTE RESPIRATORY FAILURE – DIFFERENTIAL DIAGNOSIS

Start with anterior fields examination

A-lines

B-lines<sup>#</sup>

Consolidations

No sliding

Sliding

Focal

Diffuse

Subpleural consolidations

Thin regular pleura  
Normal sliding

Subpleural consolidation  
Irregular and thickened pleura  
Reduced sliding

Move to postero-lateral fields or other point-of-care ultrasound techniques

Lung point

Eventual consolidations

Subpleural consolidations  
DVT+

Eventual consolidations

Eventual consolidation &  
eventual pleural effusion

Eventual consolidation

Pneumothorax

COPD

Pulmonary Embolism

Pneumonia

Cardiogenic edema

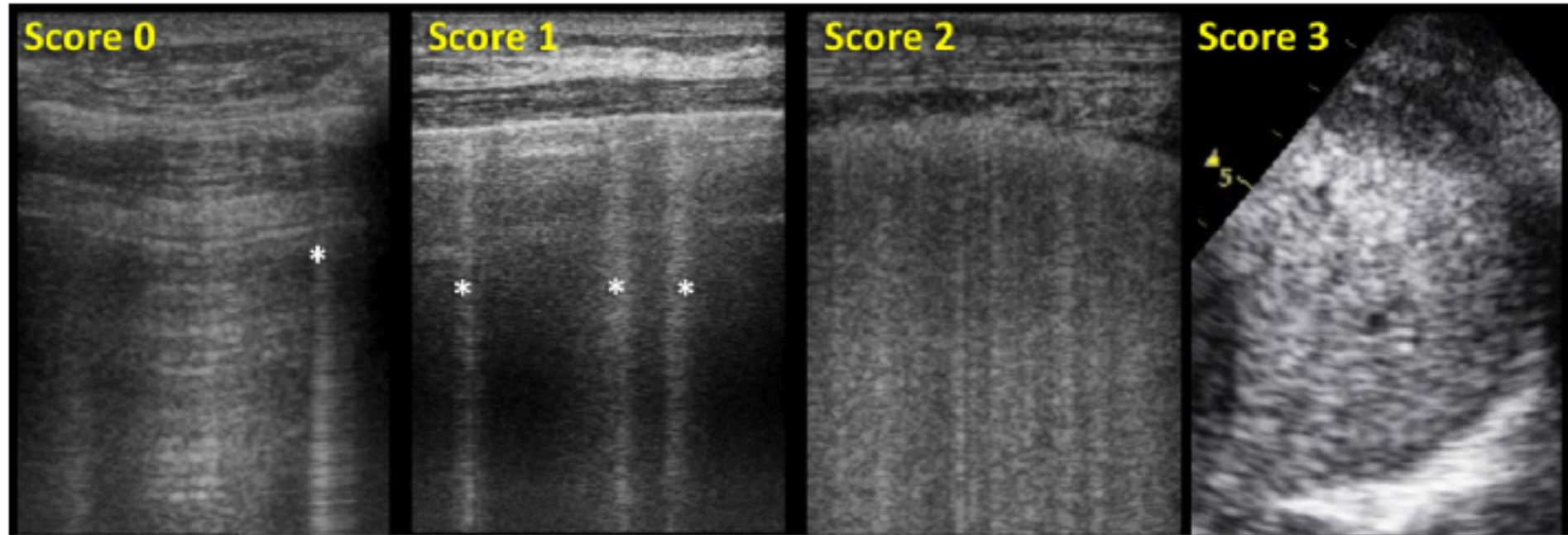
Interstitial disease

ARDS  
Pneumonia



# Lung Aeration Score

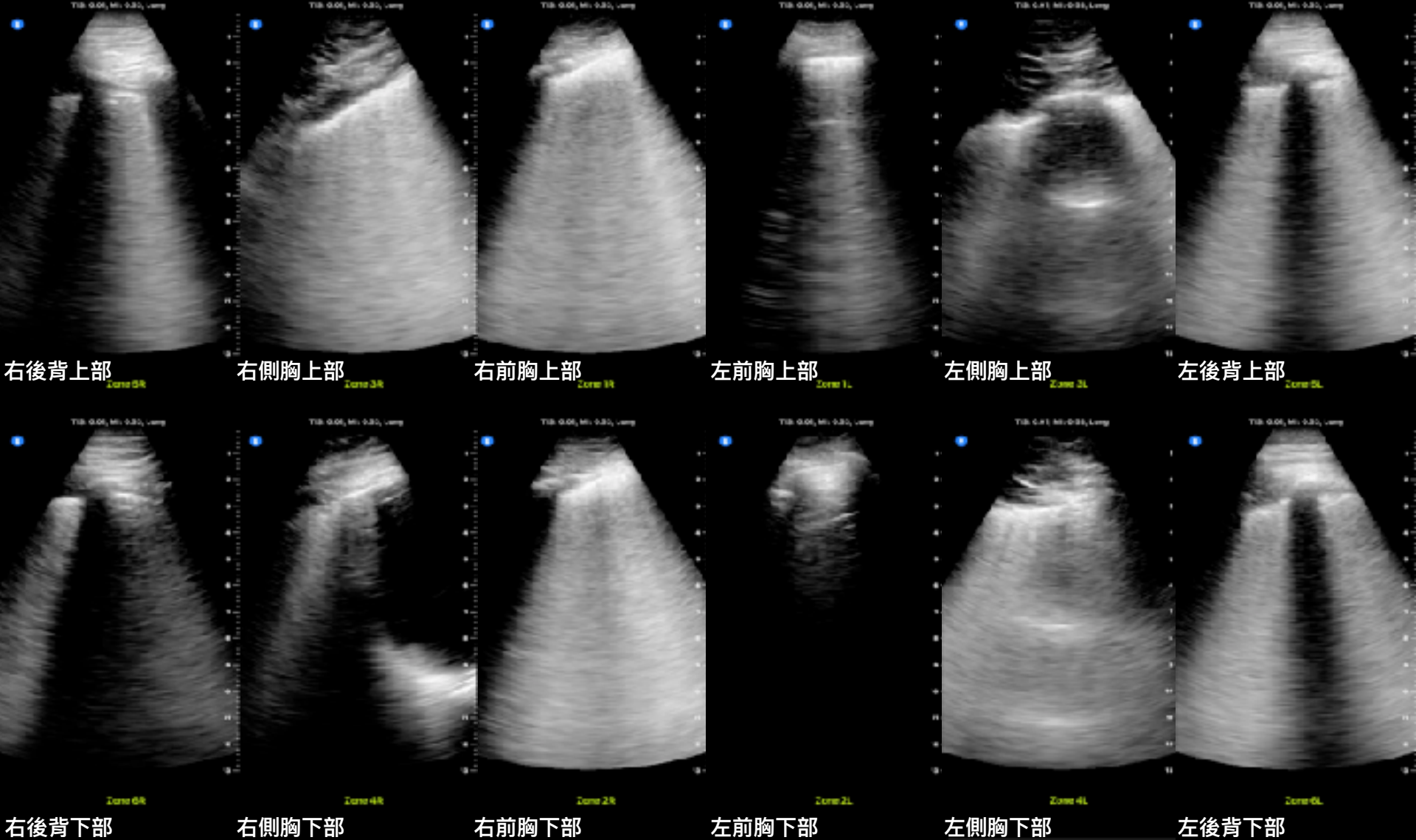
12 regions: 0 ~ 36



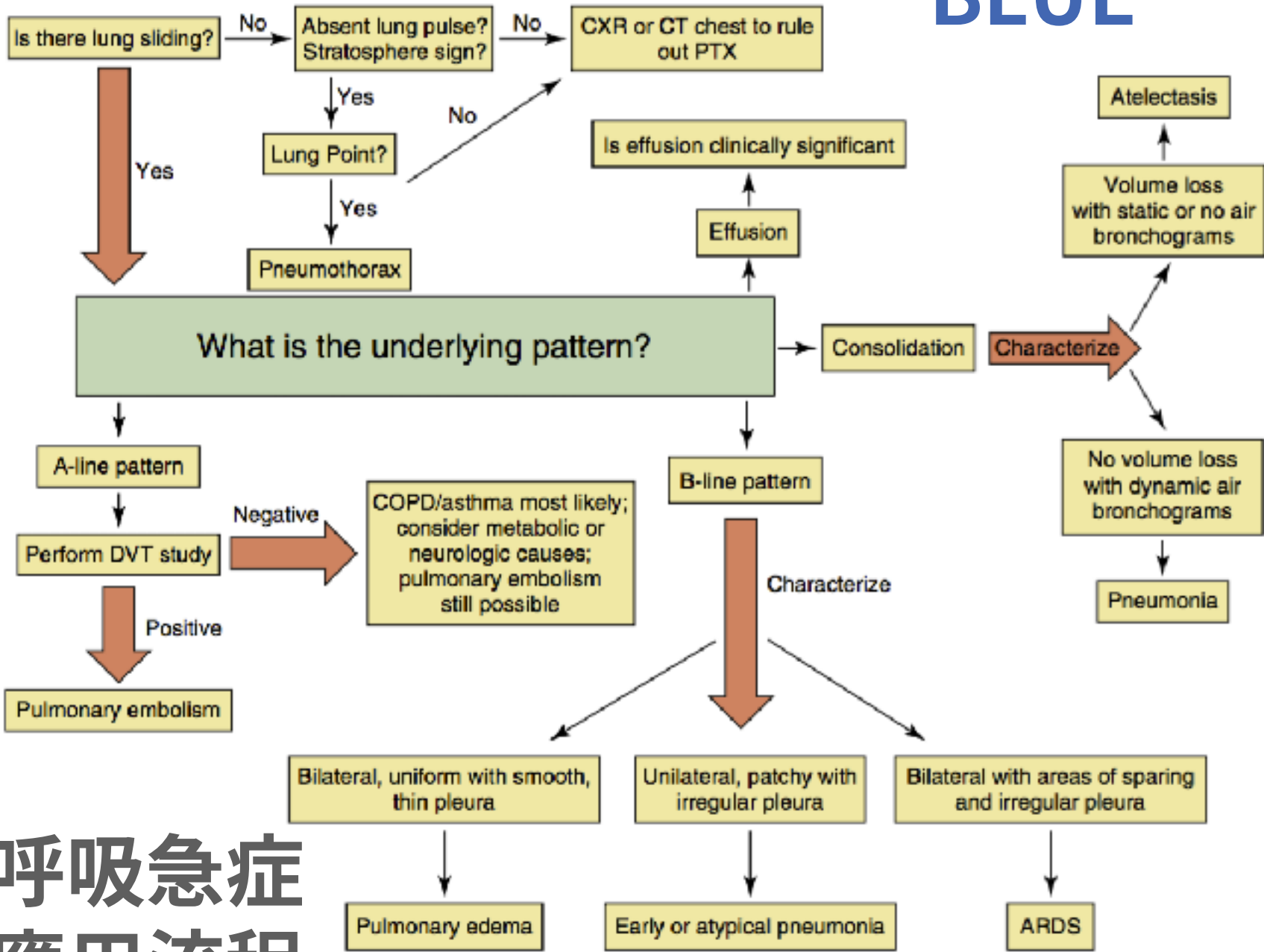
Reaeration score	Score 0	Score 1	Score 2	Score 3
+1	←	←	←	←
+3	←	←	←	←
+5	←	←	←	←
-1	→	→	→	→
-3	→	→	→	→
-5	→	→	→	→



57歲女性，就診時SpO2 64%，主訴咳和喘約5天  
BT 38.2°C; PR 86; RR 18; BP 122/70 mmHg  
Rapid test antigen: **negative**; RT-PCR on 3rd day: **positive**



BLUE



S  
A  
B  
E  
C

呼吸急症  
應用流程