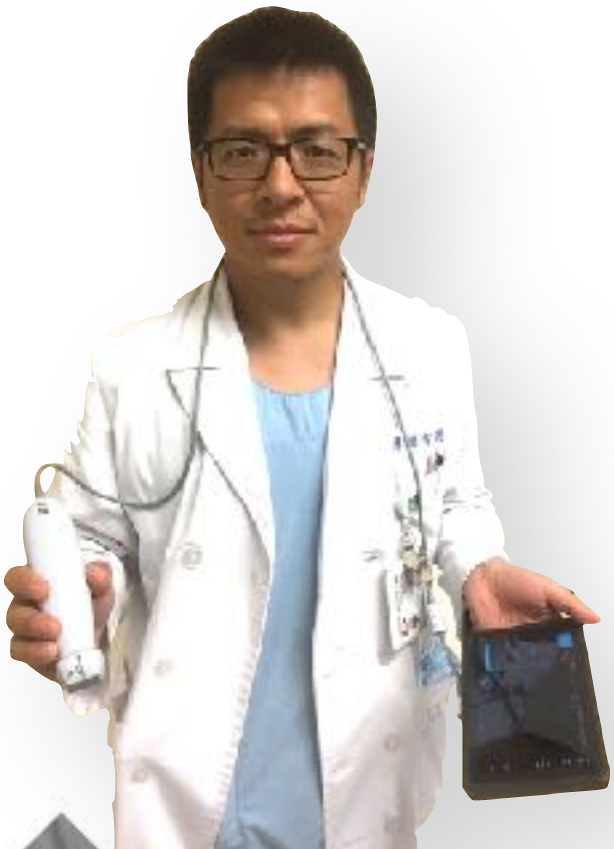
ULTRASOUND
PROGRAM

How to start CCUS in my ICU

陳國智 西園醫院急診醫學科



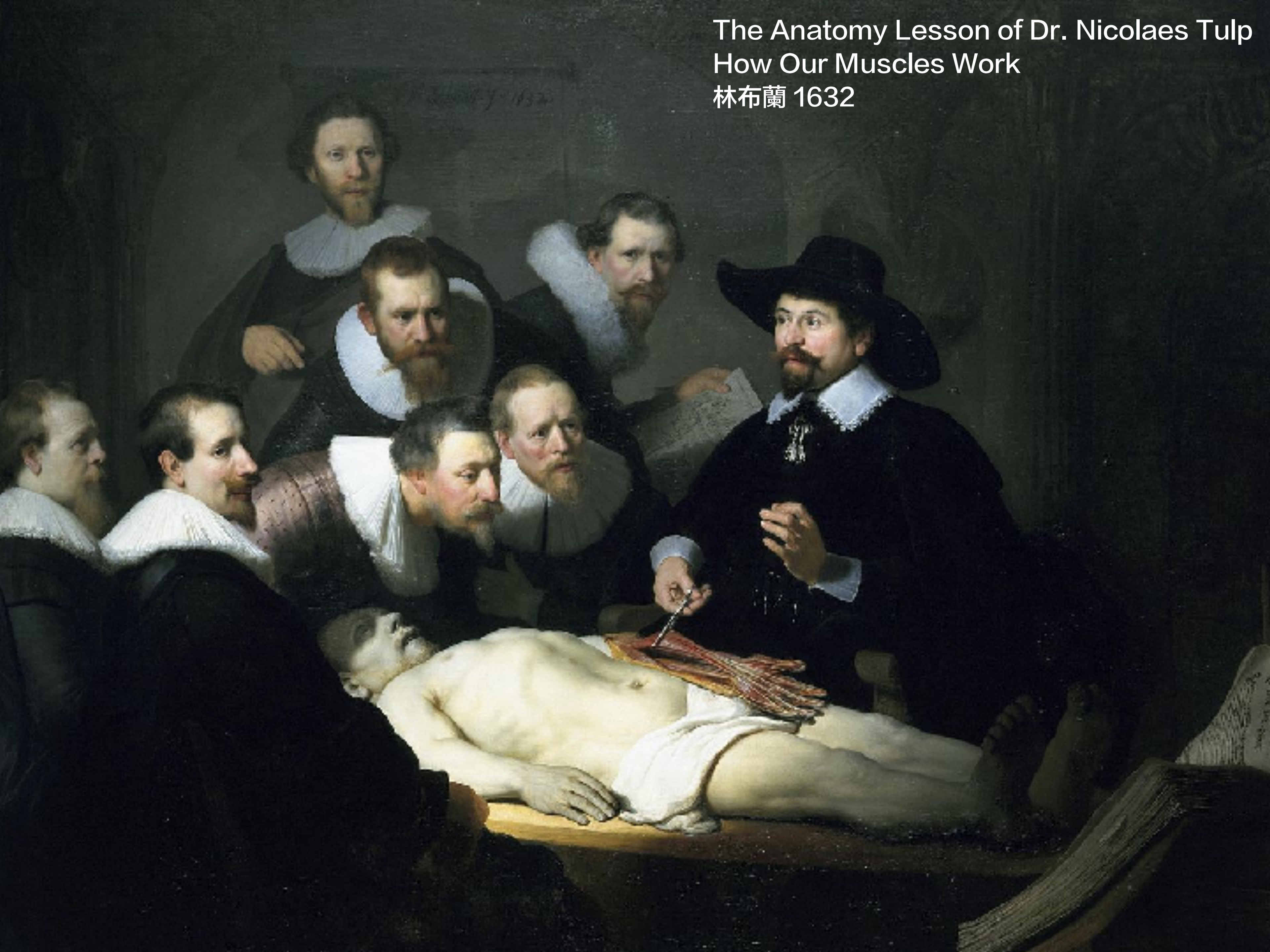
急重症超音波工作坊負責人

POCUS Academy
Emergency Ultrasound Training Center

Faculty
-WINFOCUS, PERCUSS, WFPICC
-Taiwan Pain Society

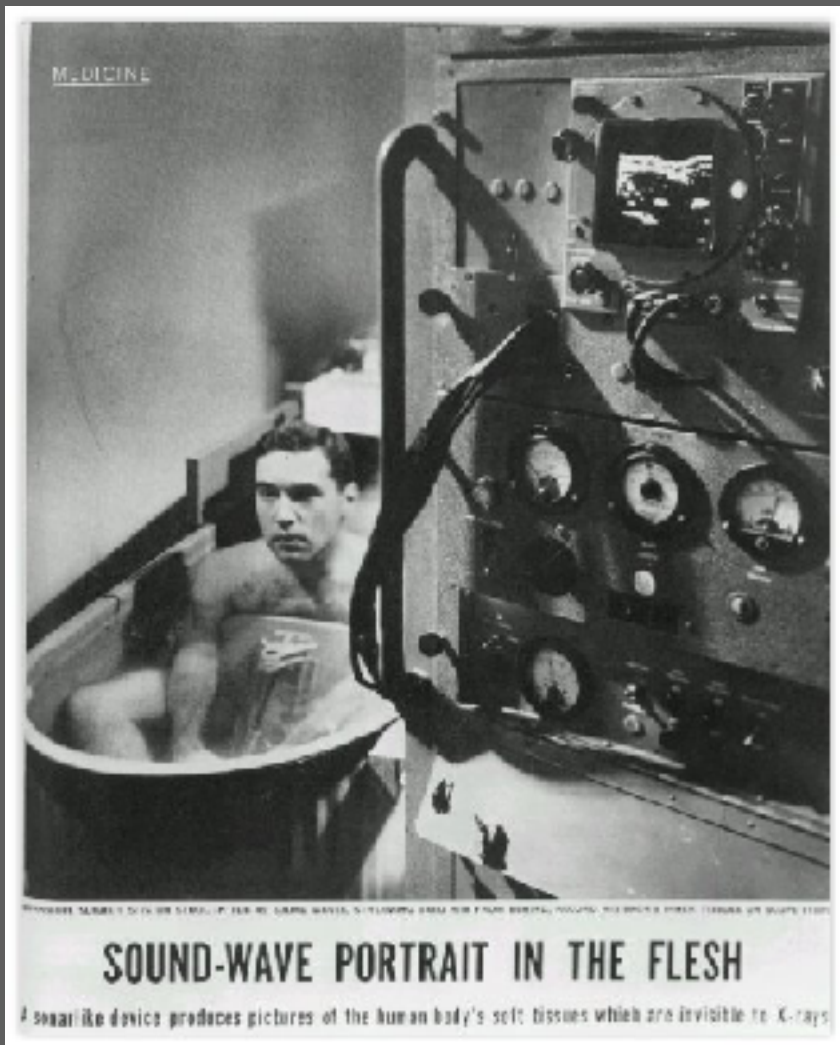
前急診超音波委員會主委

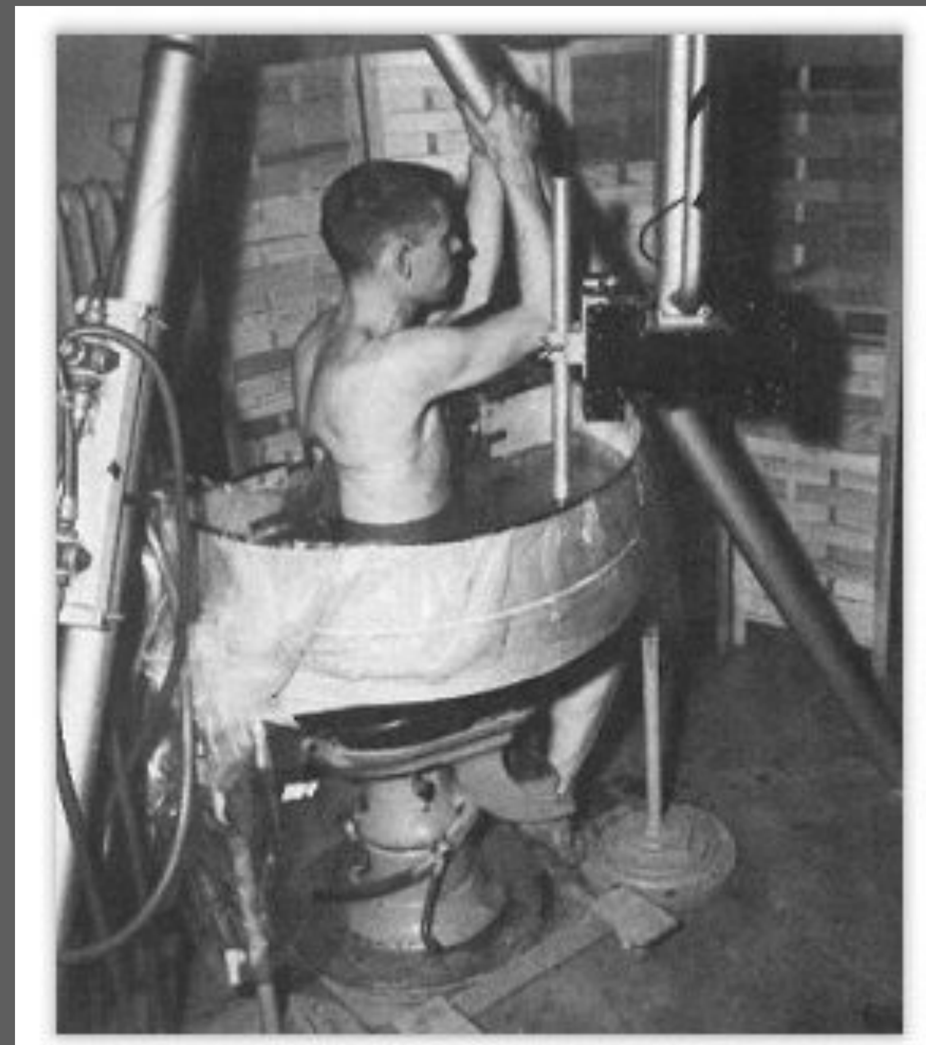
juice119@gmail.com


The Anatomy Lesson of Dr. Nicolaes Tulp
How Our Muscles Work
林布蘭 1632


現在你可以這麼做
Live

1954


MEDICINE
SOUND-WAVE PORTRAIT IN THE FLESH
A sonarlike device produces pictures of the human body's soft tissues which are invisible to X-rays




L12-3

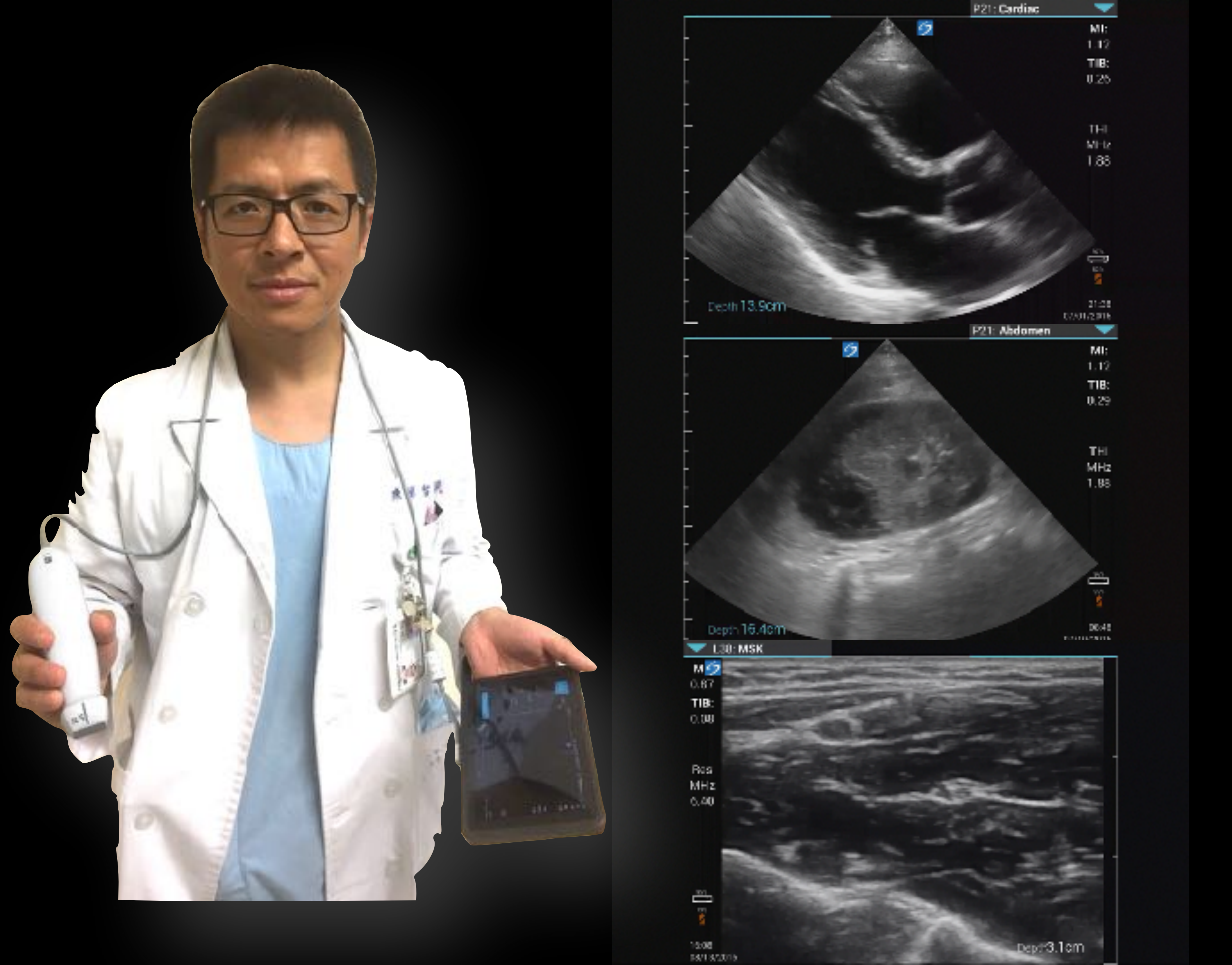

C5-1
PHILIPS


S5-1
PHILIPS


SAVING THE DAY.
EVERY DAY.
HERO SQUAD

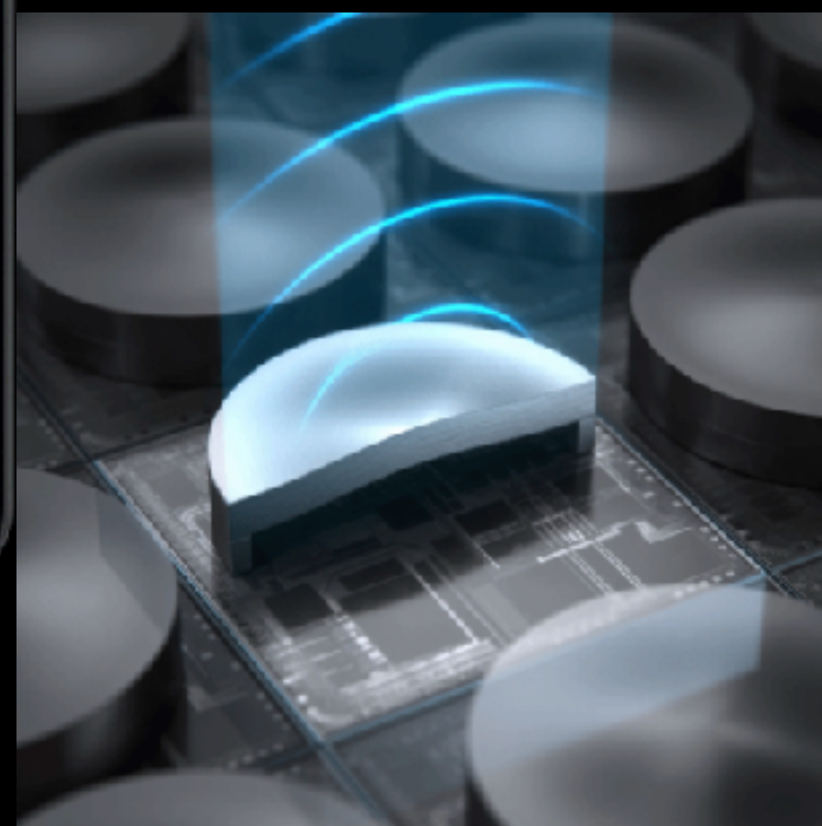

Echoscopy
GE Healthcare
Vscan

21世紀醫師的視診器



P21: Cardiac
MI:
1.12
TIB:
0.25
THI
MHz
1.88
Depth 13.9cm
P21: Abdomen
MI:
1.12
TIB:
0.29
THI
MHz
1.88
Depth 16.4cm
L38: MSK
TIB:
0.08
Res
MHz
6.40
Depth 3.1cm

Butterfly iQ
$ 2K



Victor Hugo

“There is one thing stronger than all the armies in the world, and that is an idea whose time has come”

POCUS’s time has come !!

ChenKC@POCUSAcademy

POCUS

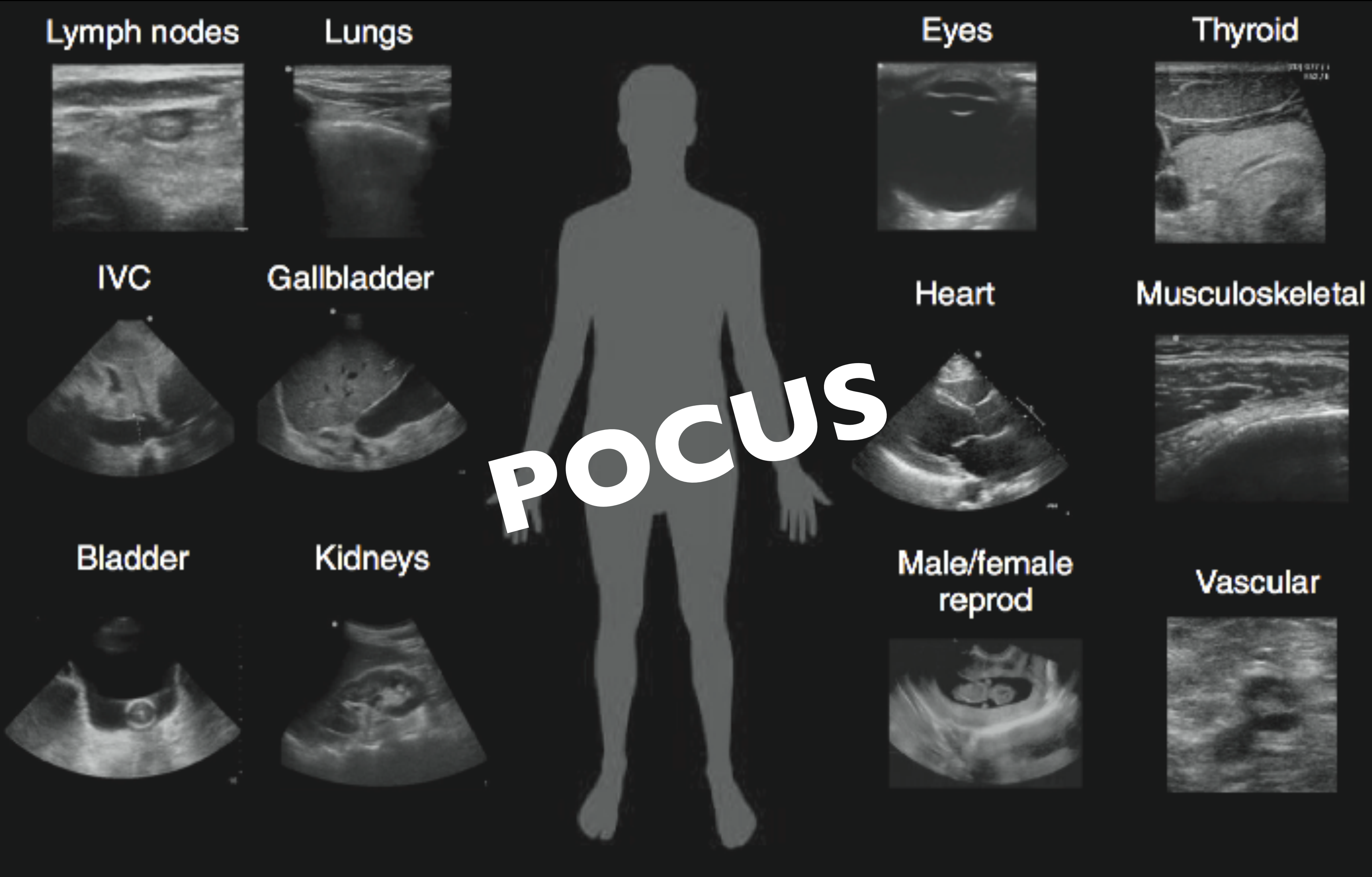
ULTRASOUND PROGRAM

POCUS

Point-of-Care Ultrasound

"ultrasonography brought to the patient and performed by the provider in real time"

Moore, C. L., & Copel, J. A. NEJM 2011


Lymph nodes
Lungs
Eyes
Thyroid
IVC
Gallbladder
Heart
Musculoskeletal
POCUS
Bladder
Kidneys
Male/female
reprod
Vascular

POCUS

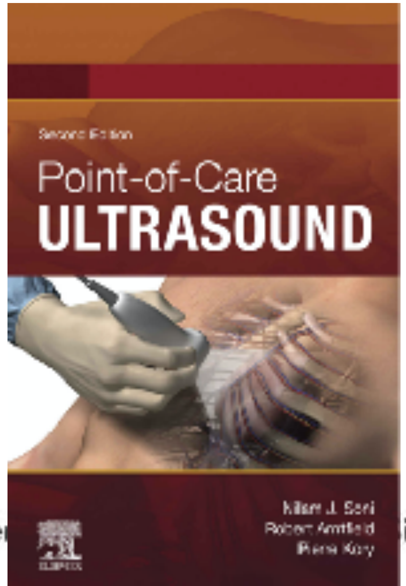
Ultrasound in Med. & Biol., Vol. ■, No. ■, pp. 1–10, 2016

0301-5629/$ - see front matter

http://dx.doi.org/10.1016/j.ultrasmedbio.2016.06.021

POINT OF CARE ULTRASOUND: A WFUMB POSITION PAPER

Christoph F. Dietrich,[*†] Adrian Goudie,[†] Liliana Chiorean,[§] Xin Wu Cui,[*†] Odd Helge Gilja,[¶]
Yi Dong,[*||] Jacques S. Abramowicz,[#] Sudhir Vinayak,[**] Susan Campbell Westerway,[††]
Christian Pállson Nolsøe,[‡‡] Yi-Hong Chou,[§§] and Michael Blaivas[¶¶]



Taipei Medical University Cent... imulation

POCUS-急診緣由

症狀
問題

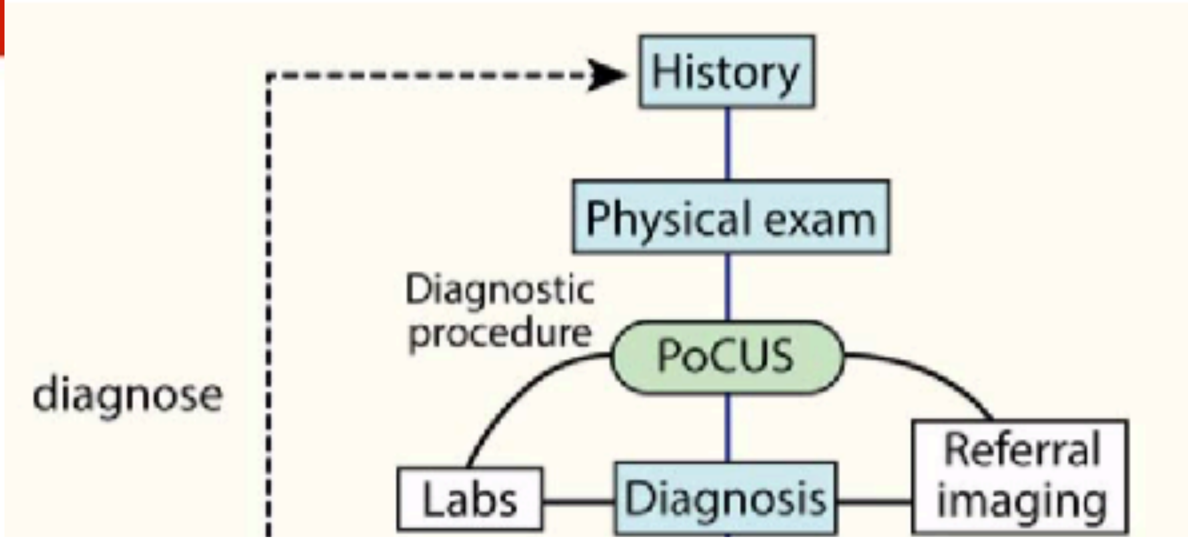
線索
時間

診斷
治療

雜

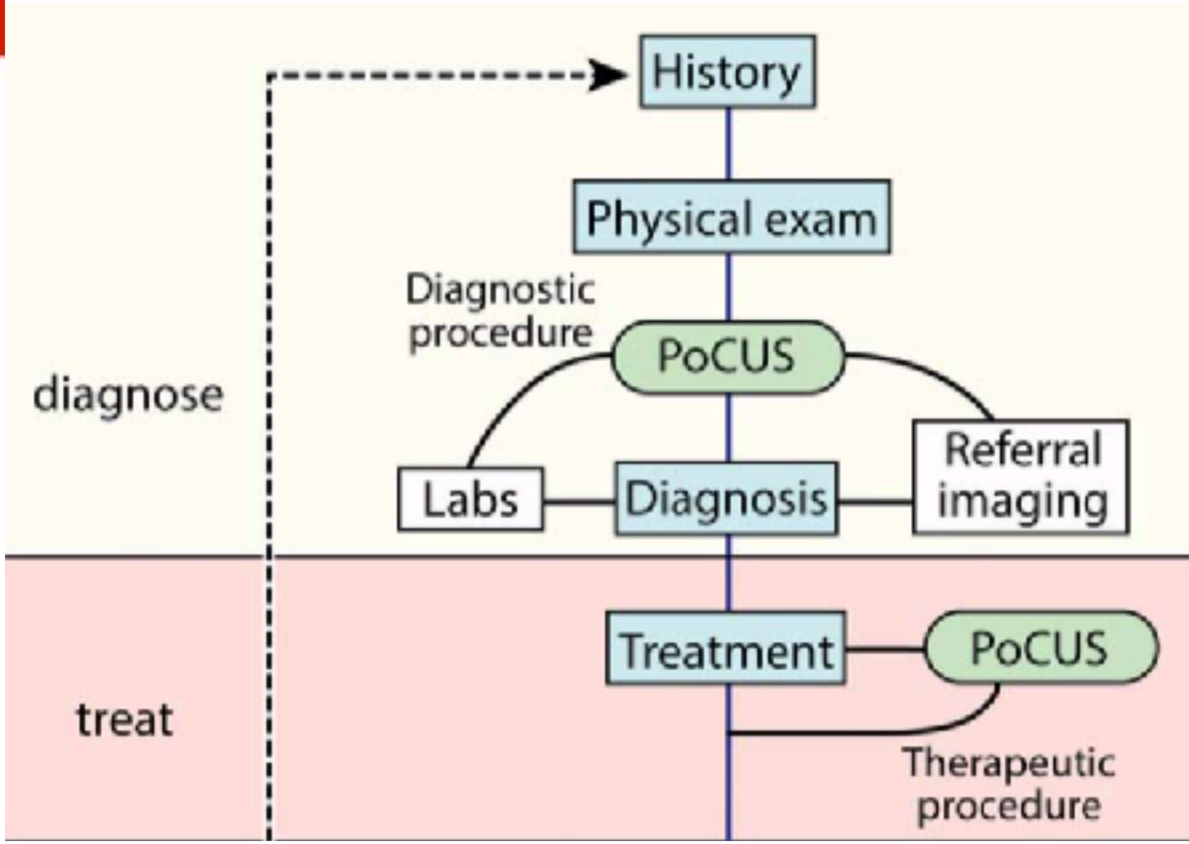
少

快


History
Physical exam
Diagnostic
procedure
PoCUS
diagnose
Labs
Diagnosis
Referral
imaging

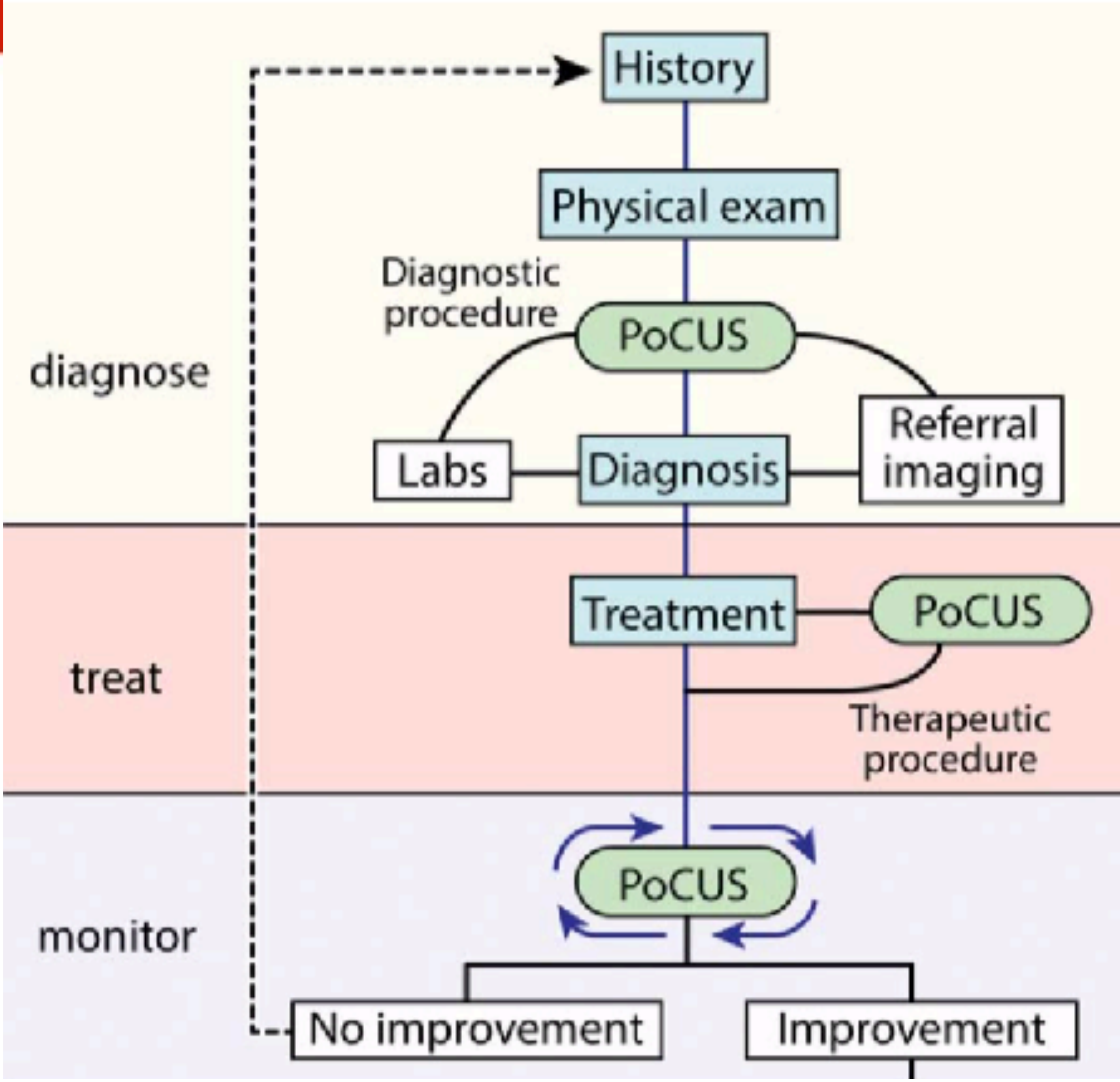
POCUS
處置流程

POCUS 處置流程

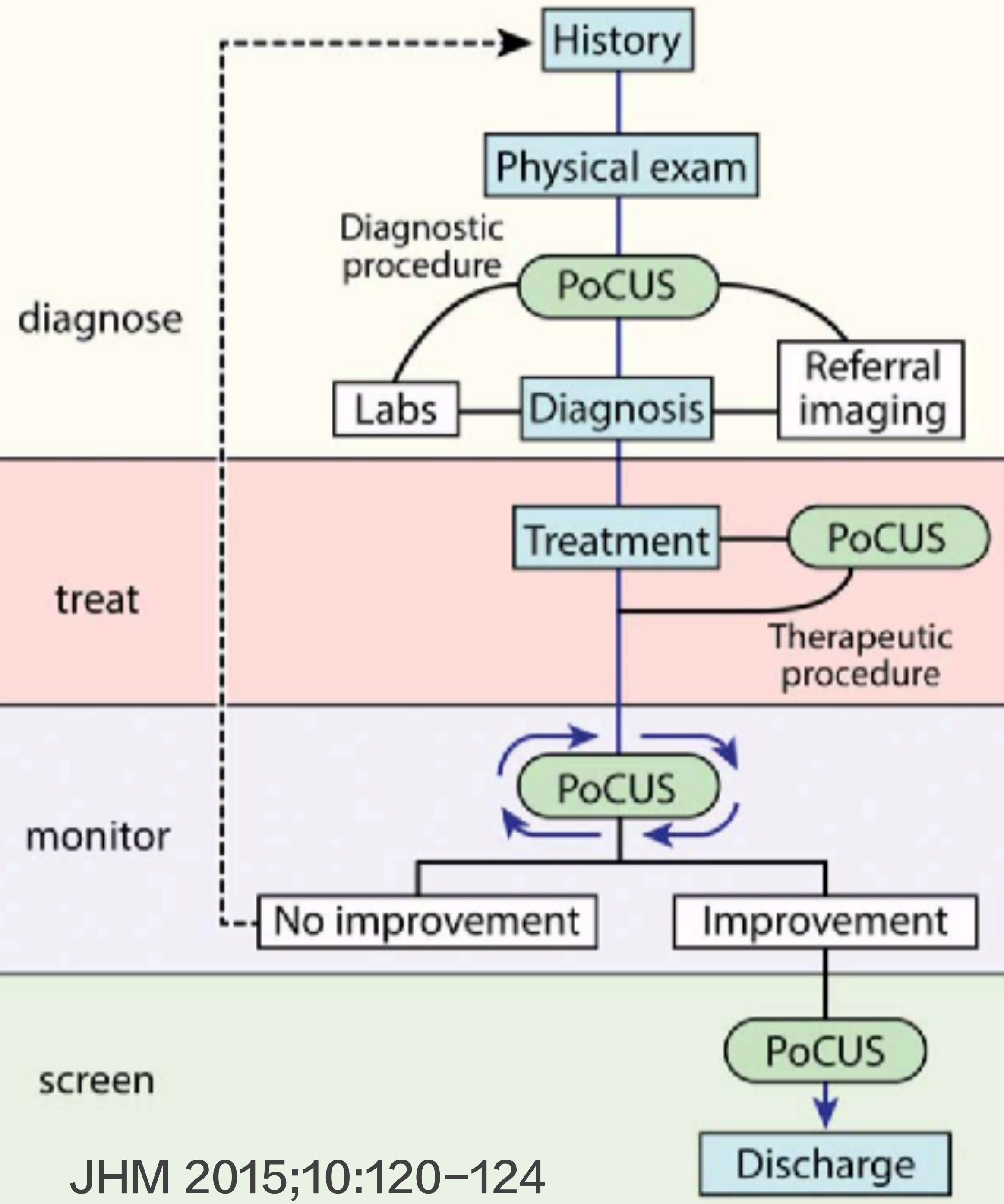

History
Physical exam
Diagnostic procedure
PoCUS
diagnose
Labs
Diagnosis
Referral imaging
treat
Treatment
PoCUS
Therapeutic procedure

ULTRASOUND PROGRAM

POCUS 處置流程

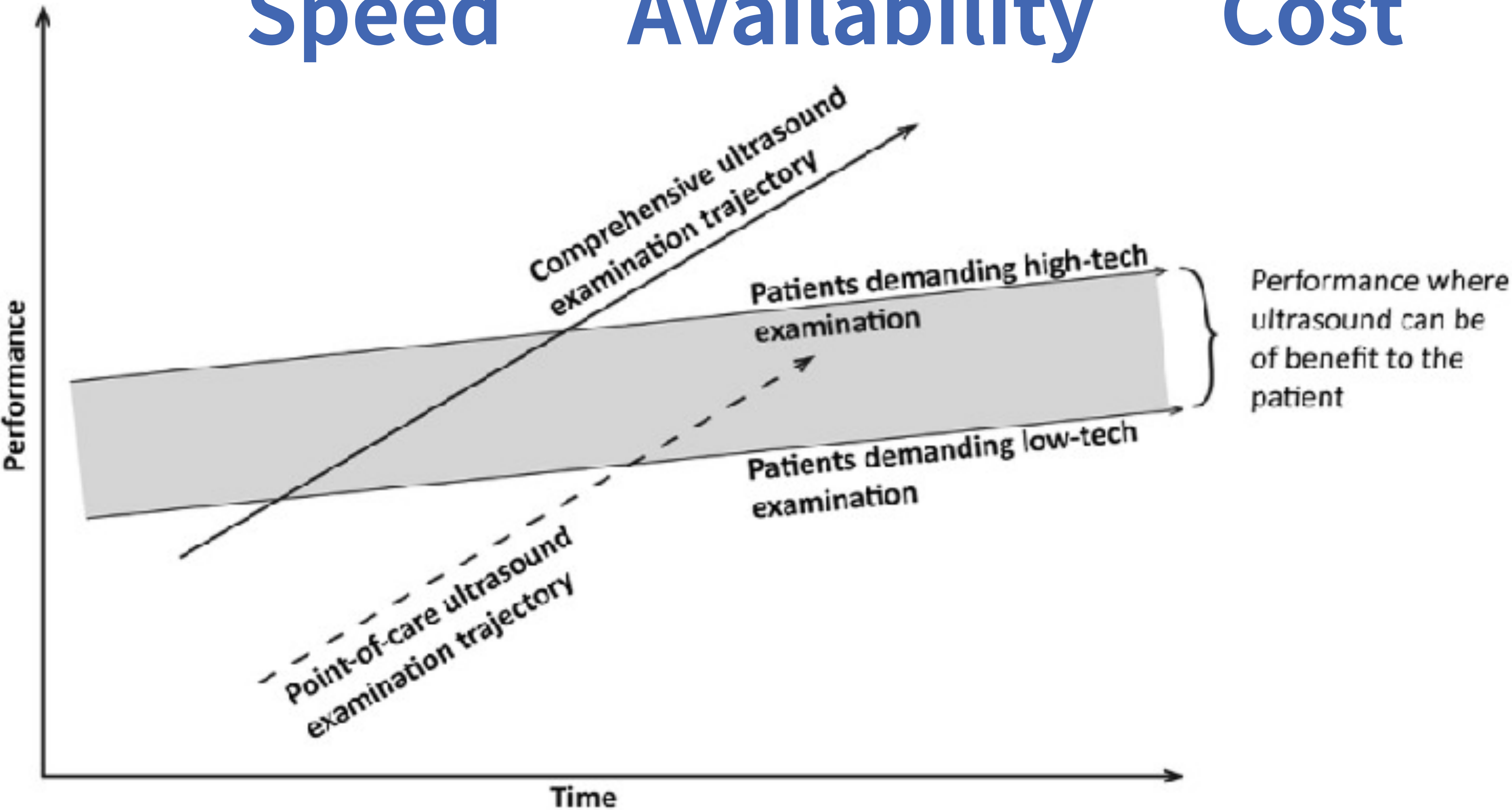


POCUS 處置流程



JHM 2015;10:120−124

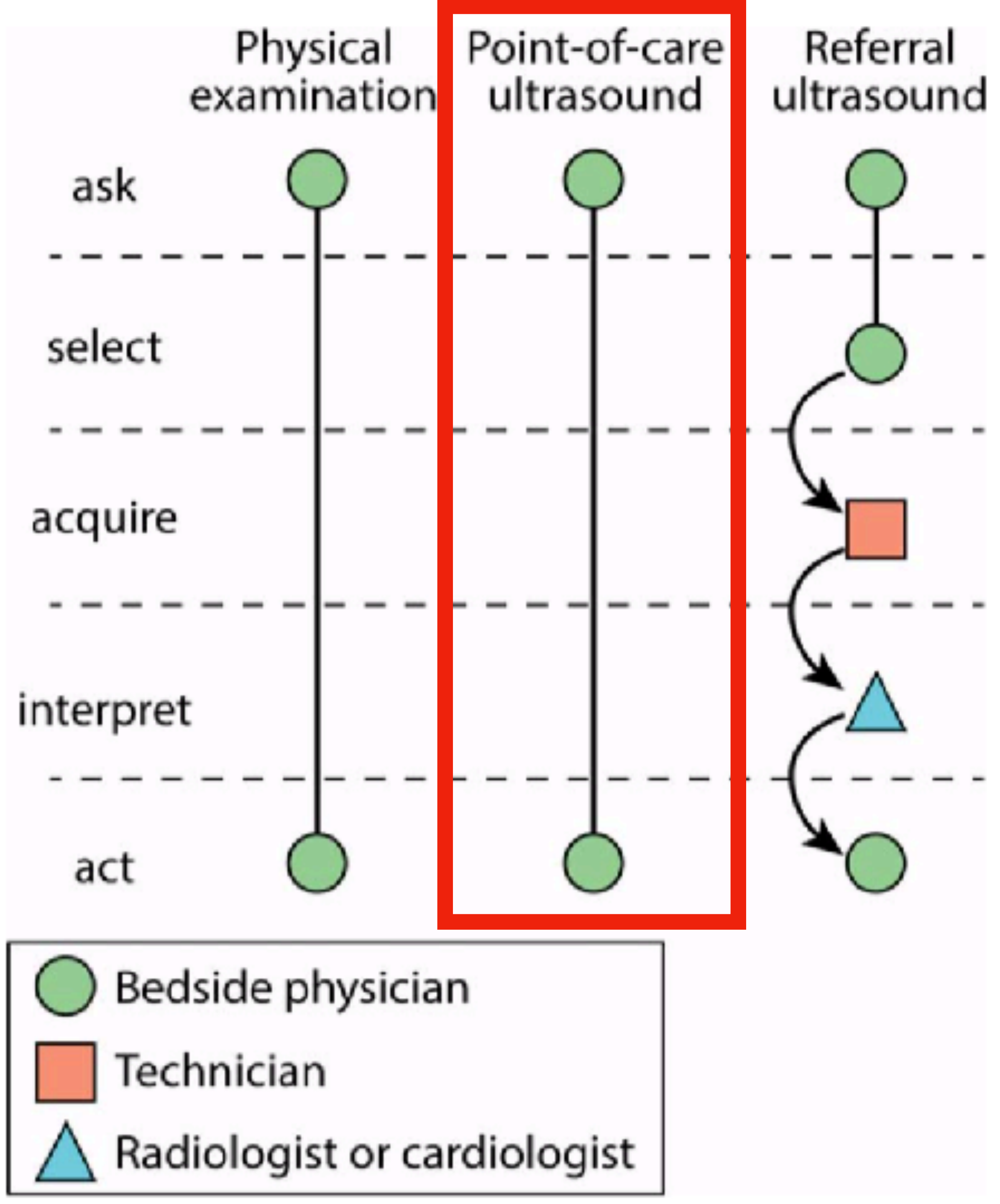
Speed Availability Cost



Crit Ultrasound J 2018;10:25

簡要

即時



Physical examination
Point-of-care ultrasound
Referral ultrasound
ask
select
acquire
interpret
act
Bedside physician
Technician
Radiologist or cardiologist

完整

耗時

ULTRASOUND
PROGRAM

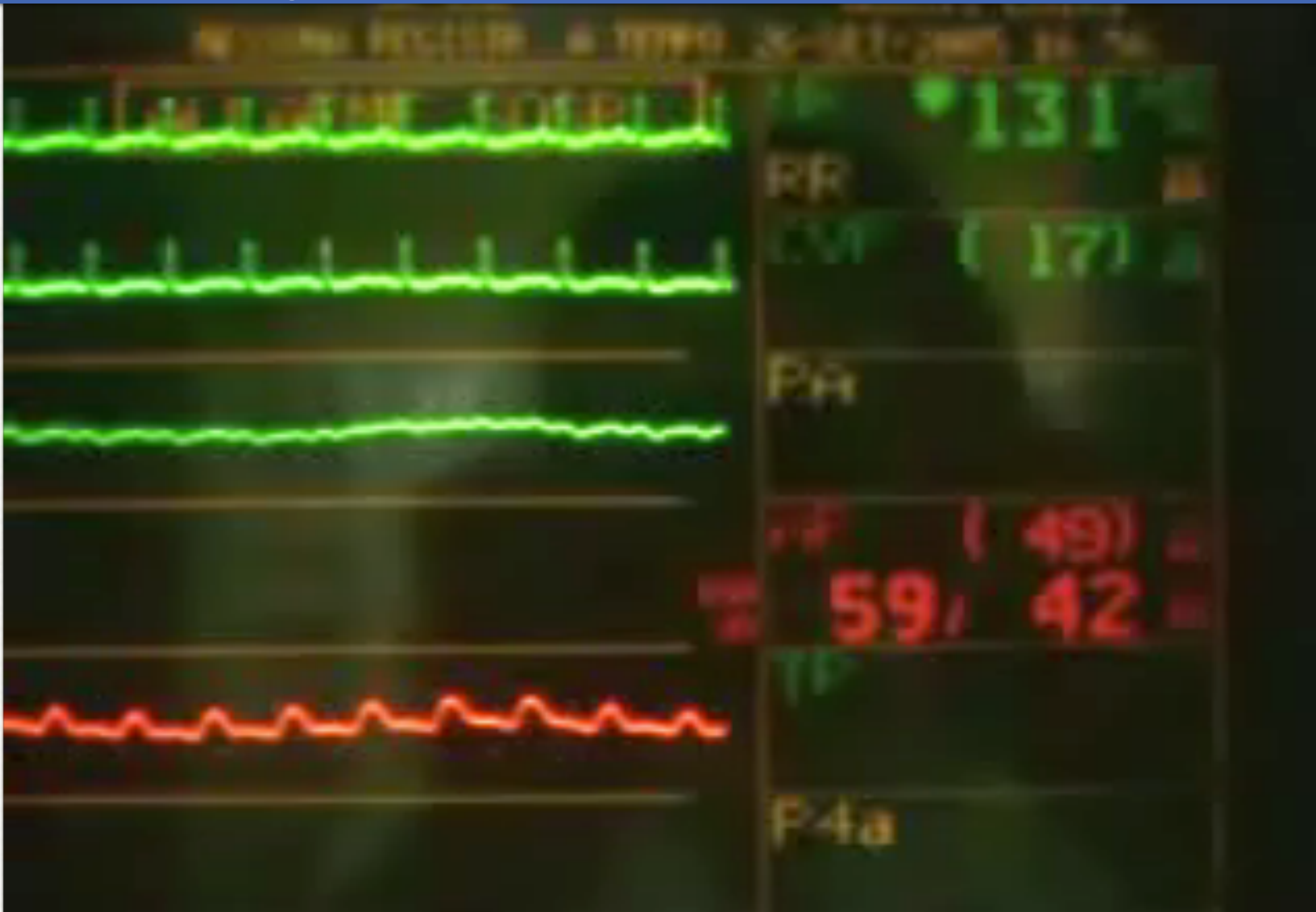
ICU POCUS

What's the point ?

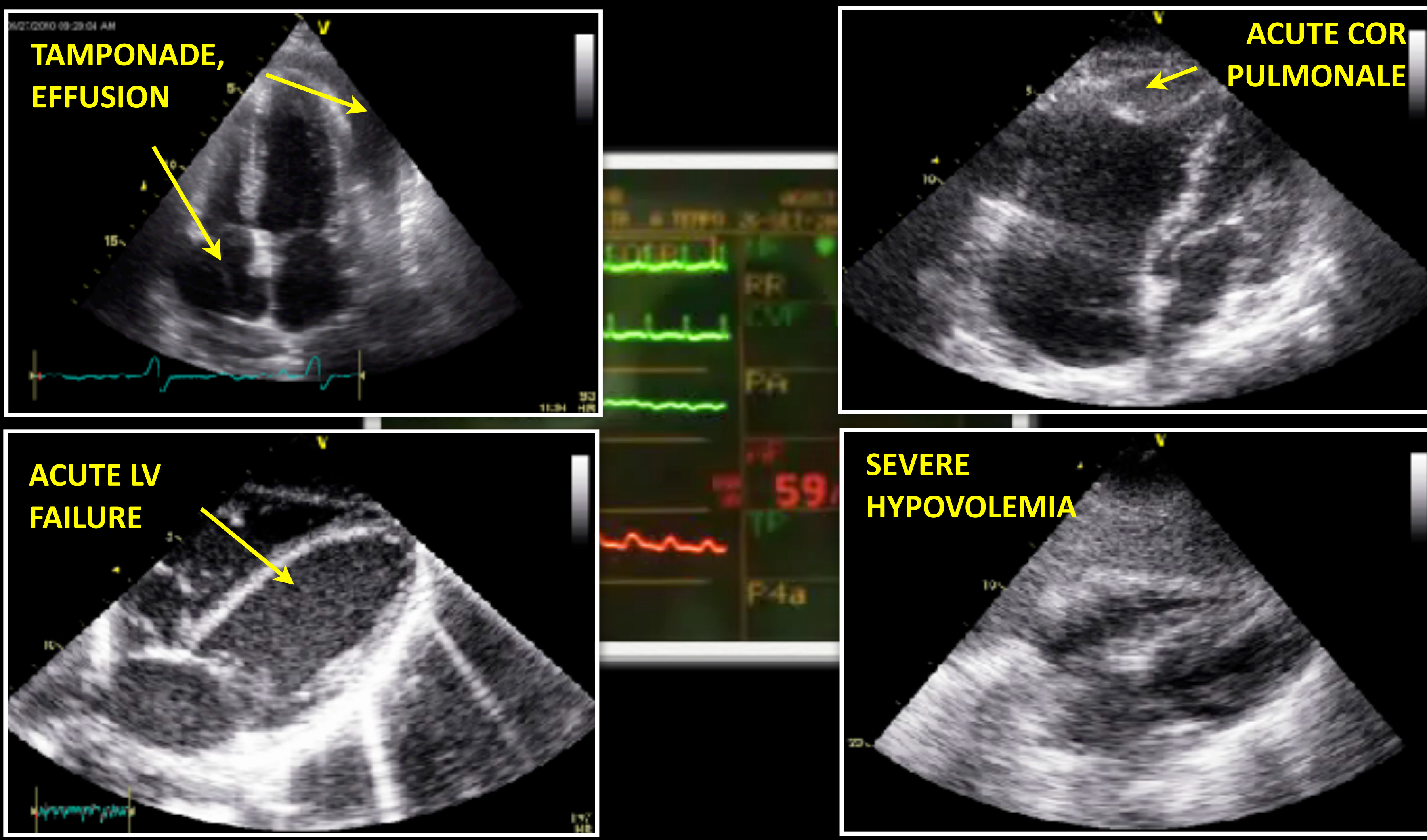
Taipei Medical University Center for Education in Medical Simulation


PATIENT
CURARISE

Critically ill, shocked patient. **Cause ??**



Critically ill, shocked patient. **Cause ??**



ULTRASOUND PROGRAM

I-AIM

Indication (Point)

Acquire | Interpret | Make decision

Taipei

Bahner DP, et al. J Ultrasound Med 2012

Acute abdomen or Shock

Internal bleeding ?

FAST | **Fluid** | **CT/TAE/OP**

Bahner DP, et al. J Ultrasound Med 2012

ST - MSK

Abscess ?

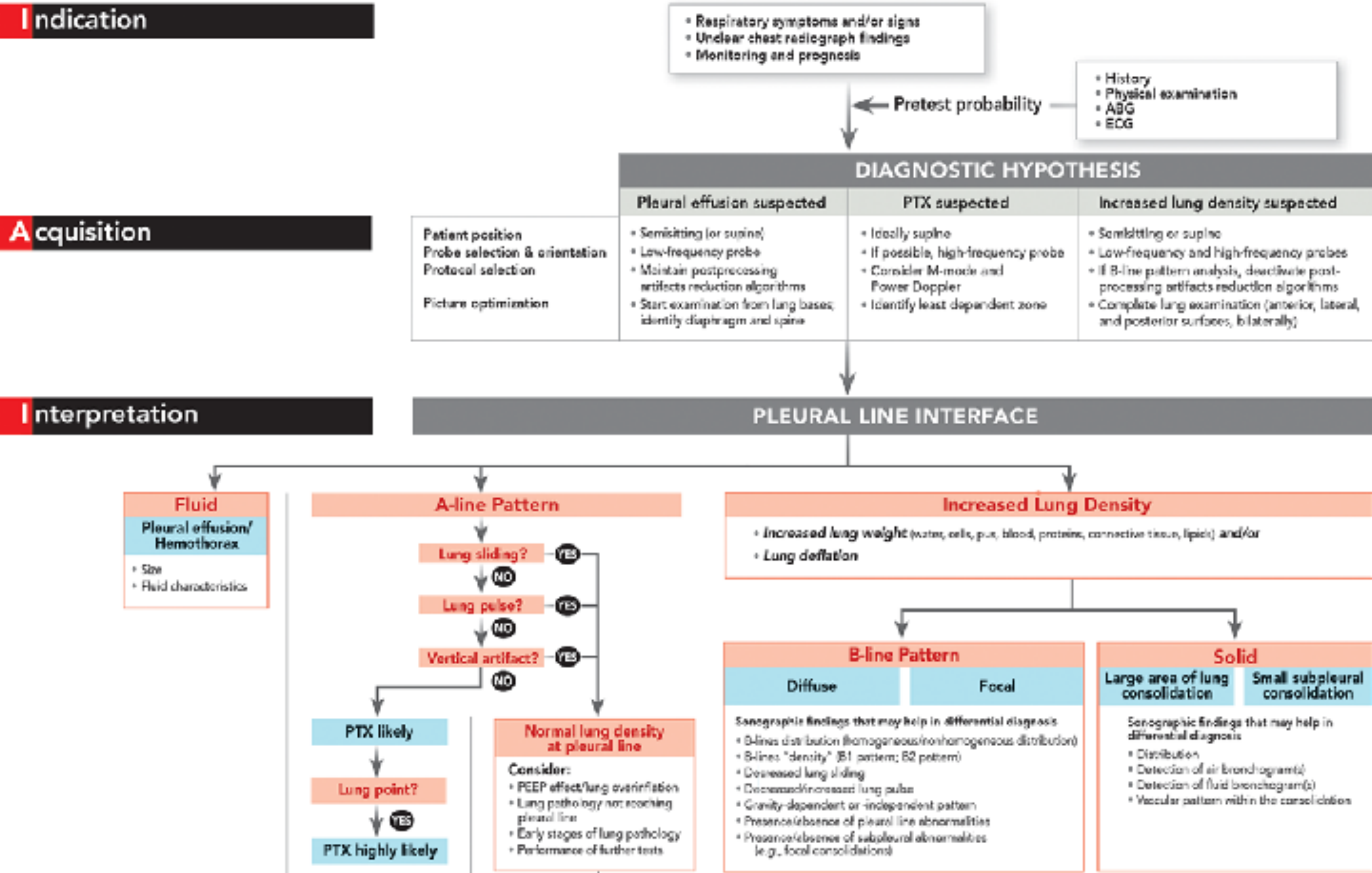
掃得到嗎

看得懂嗎

有差別嗎

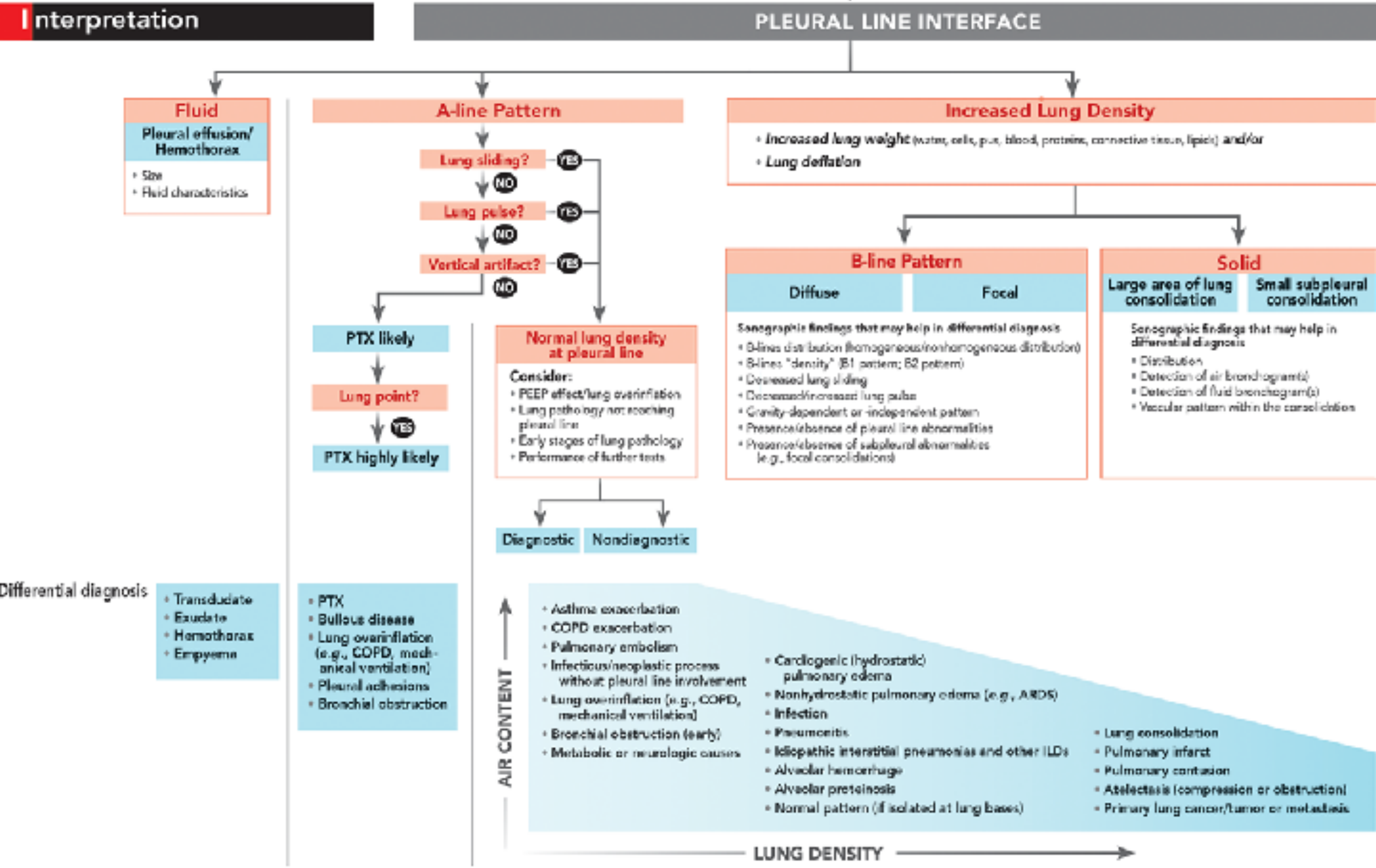
Bahner DP, et al. J Ultrasound Med 2012

I-AIM



Indication
Acquisition
Interpretation
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)
PLEURAL LINE INTERFACE
Fluid
Pleural effusion/ Hemothorax
Size
Fluid characteristics
A-line Pattern
Lung sliding?
Lung pulse?
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 pattern
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

Interpretation



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


急診
可以同步
病史詢問
理學檢查
不可省略
Y
POCUS
N

ULTRASOUND PROGRAM

重症

訊息有限

不易執行

POCUS

Fluid Sepsis Shock

DVT CVC Ileus

Dyspnea Nutrition Trauma


L12-3


C5-1
PHILIPS


S5-1
PHILIPS

The Only Limitation Is Your **Imagination**

Fluid

Shock

CVC

Dyspnea

Trauma

Fluid

Shock

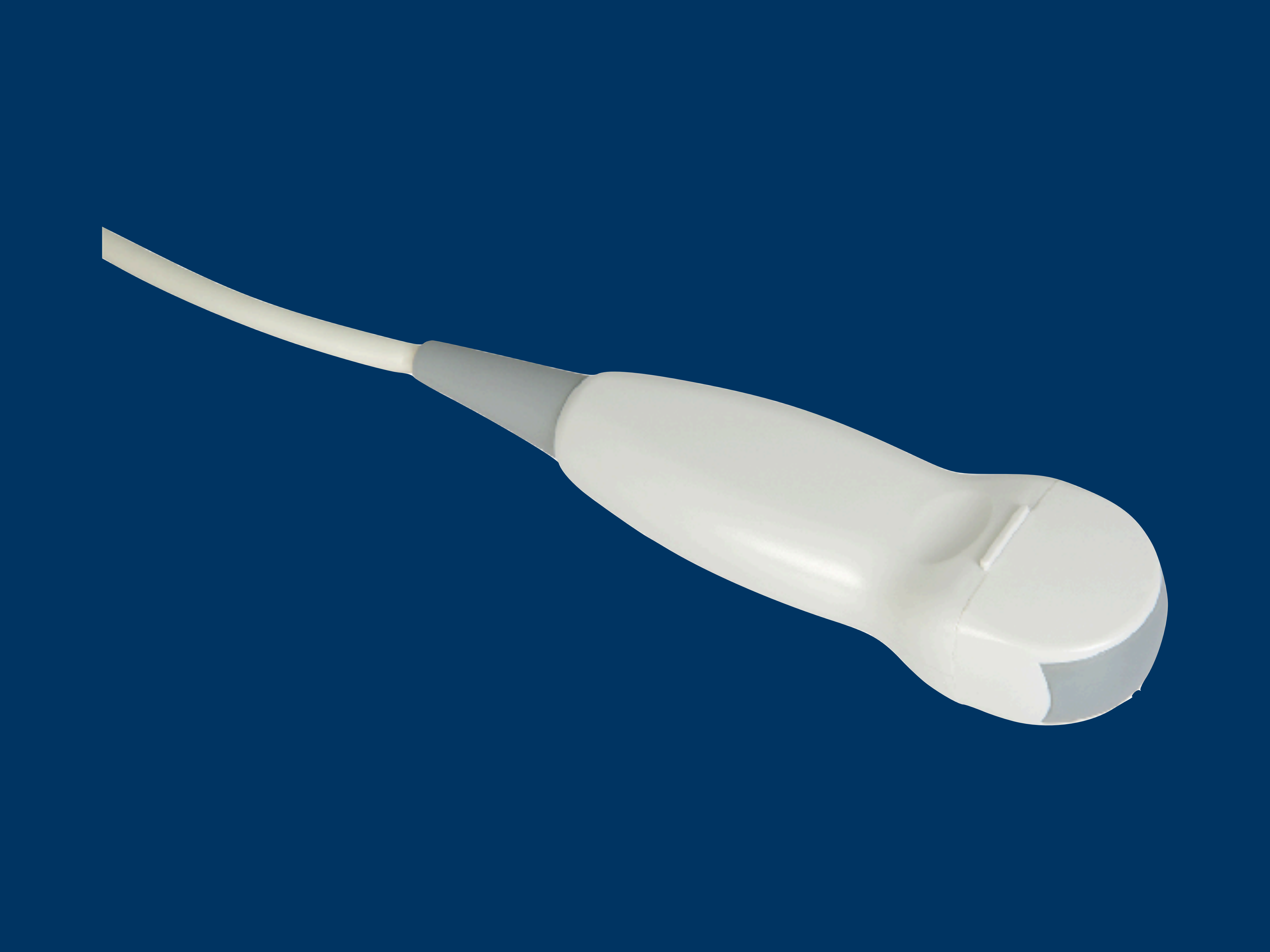
CVC

Dyspnea

Trauma

$ $ $

$ $ $




TIS: 0.02, MI: 0.48, Cardiac
B
1
2
3
4
5
6
7
8
9
10
11
13
14
15
16
10:25
0
Presets
Modes

POCUS

診斷

監測

處置

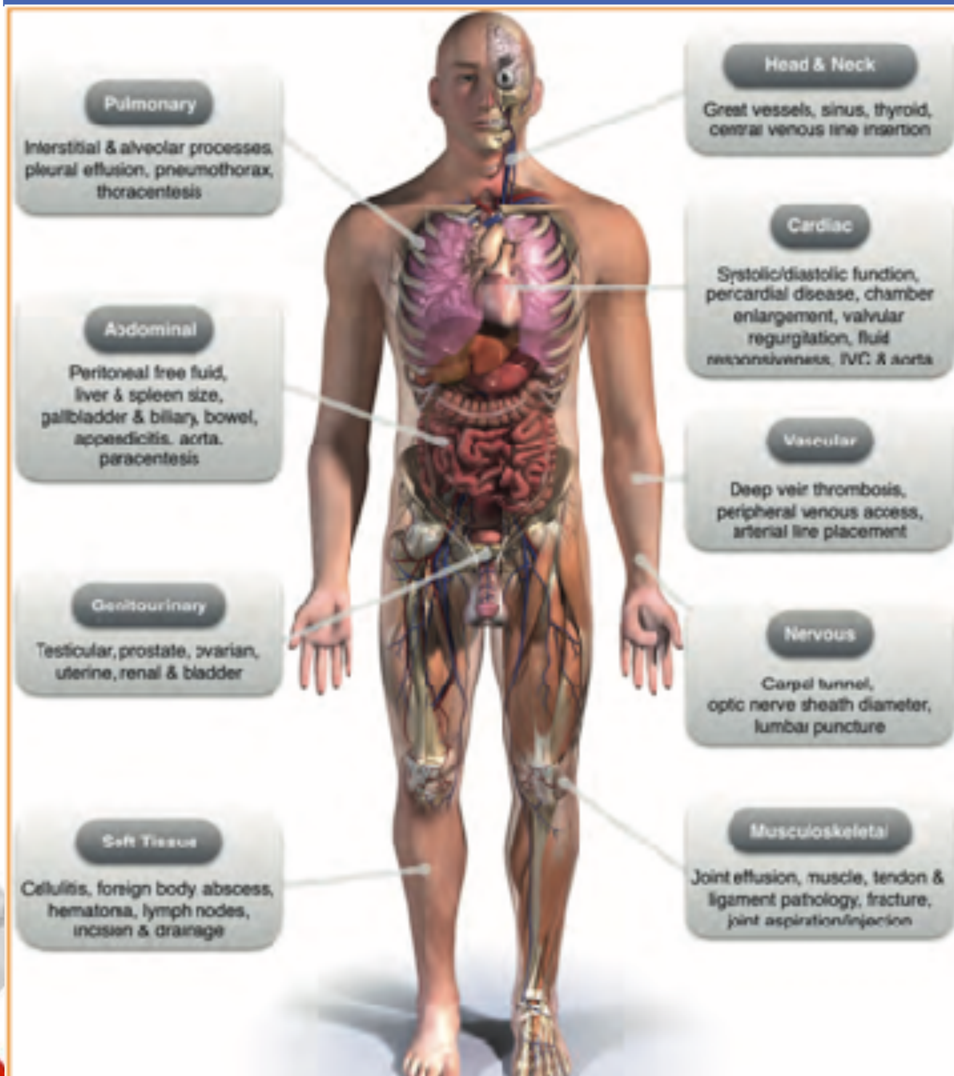
急診

住院

重症

ULTRASOUND PROGRAM

Holistic approach



處置

監測

診斷

tion

20170813 CCUS


great


B


mindray

ULTRASOUND PROGRAM

Resuscitative

Diagnostic

Procedural Guidance

Symptom- or Sign-Based

Therapeutic

Nerve block
TEE
NeuroSono

Endocavity
Contrast

ACEP 2016

Core Applications
Trauma
Intrauterine Pregnancy
AAA
Cardiac/HD Assessment
Biliary
Urinary Tract
DVT
Soft-tissue/Musculoskeletal
Thoracic/Airway
Ocular
Bowel
Procedural Guidance

12 核心

5大應用

ANNALS FOR HOSPITALISTS

Annals of Internal Medicine

Inpatient Notes: Why Should Hospitalists Use Point-of-Care Ultrasound?

Anna M. Maw, MD, MS, and Nilam J. Soni, MD, MSc

Improved evaluation accuracy

Better resource utilization

Strengthened relationship

Ann Intern Med. 2018;168:HO2-HO3

Point-of-care ultrasound: its growing application in hospital medicine

Table 1. Current clinical scenarios where point-of-care ultrasound is regularly used

System	Applications
Central nervous system	1. Intracranial pressure monitoring: optic nerve sheath diameter 2. Cerebral blood flow: transcranial Doppler flow (this has been particularly helpful in the post subarachnoid haemorrhage population), regional blood flow post craniectomy
Cardiovascular system	1. Assessment of the shocked patient: basic echocardiography, inferior vena cava dimensions 2. Vascular access and deep venous thrombosis screening of the lower limbs
Respiratory system	1. Point-of-care assessment of the breathless patient (usually done in combination with point-of-care echocardiography) 2. Assessment of extravascular lung water: this is already being suggested as a monitor of therapeutic effectiveness in heart failure patients 3. National guidelines exist for the use of ultrasound for invasive pleural procedures
Abdomen	1. The FAST protocol in trauma: this is the mainstay in most emergency departments when deciding if shock in trauma is the result of an intra-abdominal bleed 2. Hydronephrosis or blocked urinary catheters are easily excluded by point-of-care ultrasound

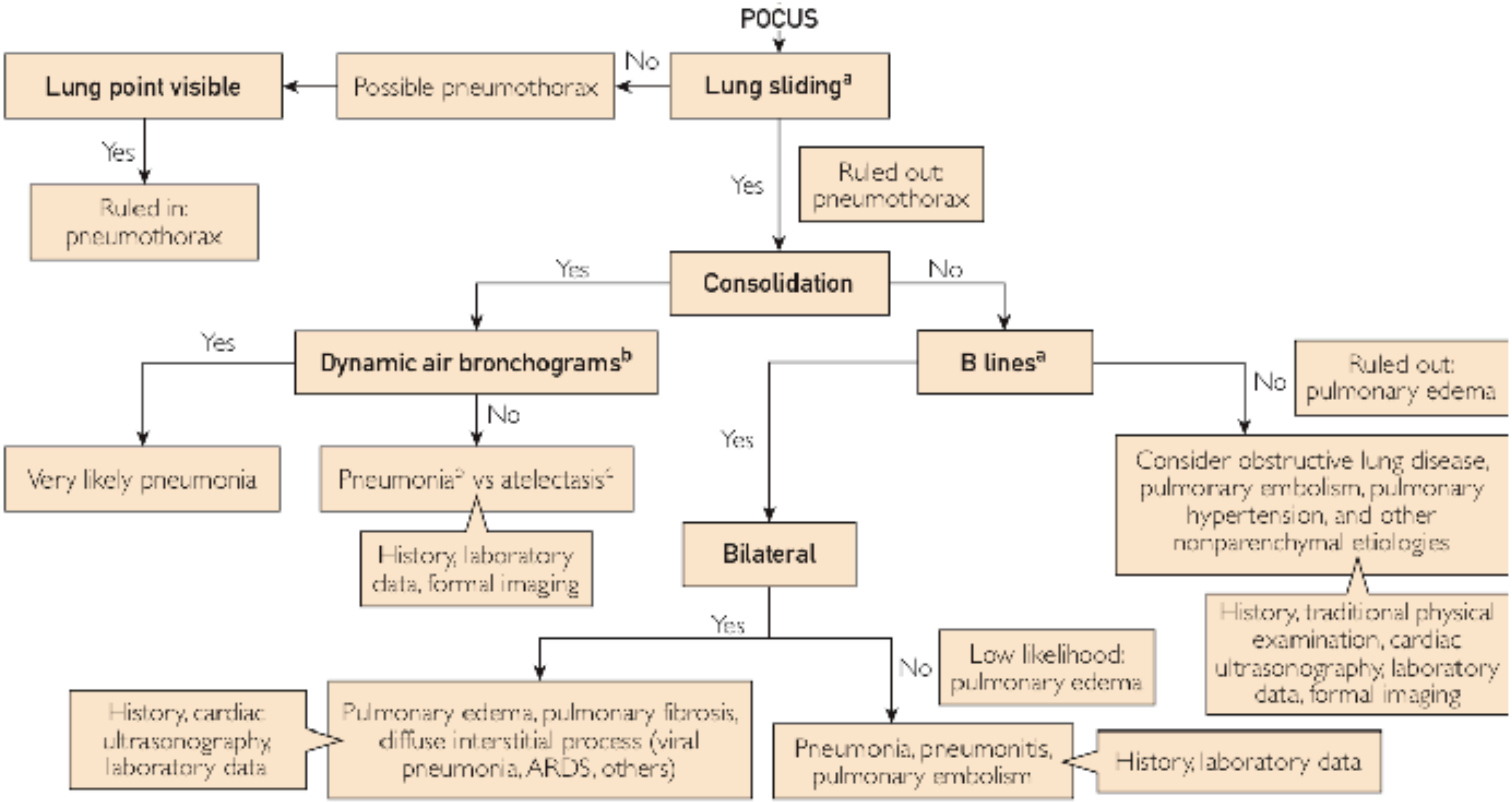
British Journal of Hospital Medicine.2017;78:492-496

Procedures

Procedure	Role of Ultrasonography
Peripheral IV insertion	Increases success rate. Reduces need for central line placement
Central line placement	Increases success rate Reduces pneumothorax and arterial puncture
Thoracentesis	Increases success rate. Reduces pneumothorax and hemothorax. Decreases cost and length of stay
Paracentesis	Increases success rate. Decreases bleeding complications, cost, and length of stay
Joint aspiration and injection	Increases success rate. Decreases pain
Lumbar puncture	Increases success rate, particularly in obese patients. Decreases traumatic taps and procedure time

Hospital Medicine Clinics. 2016;6:112-130

BLUE protocol



RUSH protocol

	Heart	IVC	FAST	Aorta	Pulmonary
Hypovolemic Shock	1. Hypercontractile 2. Small chamber size	Flat IVC	Peritoneal fluid	1. Aortic dissection 2. Aortic aneurysm	Pleural fluid
Cardiogenic Shock	1. Hypocontractile 2. Dilated heart	Distended IVC	Peritoneal fluid	Normal	1. Pulmonary edema 2. Pleural fluid
Obstructive Shock	1. Hypercontractile 2. Pericardial effusion 3. Tamponade 4. RV strain 5. Thrombus	Distended IVC	Normal	DVT	Absent lung sliding
Distributive Shock	1. Hypercontractile or 2. Hypocontractile	Flat or normal IVC	Peritoneal fluid (peritonitis)	Normal	Pleural fluid (empyema, pneumonia)

Little training & Great impact

Protocol	Sensitivity	Specificity	Training requirement	Time required to perform protocol
Evaluation for left ventricular systolic function (compared with expert sonography)[20,21,23]	69%-94%	91%-94%	8 hours of training or 20 practice exams	*
Evaluation of IVC to determine volume status and predict readmission for CHF[26,27]	81%	72%	4 hours of training and 20 practice exams	*
Evaluation for pleural effusion (compared with CT or expert sonography)[32,33]	94%	98%	3 hours of training	*
Evaluation for pneumonia (compared with x-ray or CT)[38,39,41]	90%-96%	88%-93%	3 hours of training	*
Evaluation for pulmonary edema (compared with final diagnosis by blinded chart review)[46,48]	86%-100%	92%-98%	5 practice exams	*
Screening exam for AAA (compared with expert sonography)[55-57]	100%	100%	50 practice exams	<4 minutes
Evaluation for proximal leg DVT (compared with expert sonography)[63-65]	95%	96%	10 minutes to 5 hours of training	<4 minutes

J Fam Prac. 2018;67:70-80

Point-of-care ultrasound: Coming soon to primary care?

With a little training, FPs can successfully use point-of-care ultrasound for various cardiac, pulmonary, and vascular assessments.

POCUS examinations*

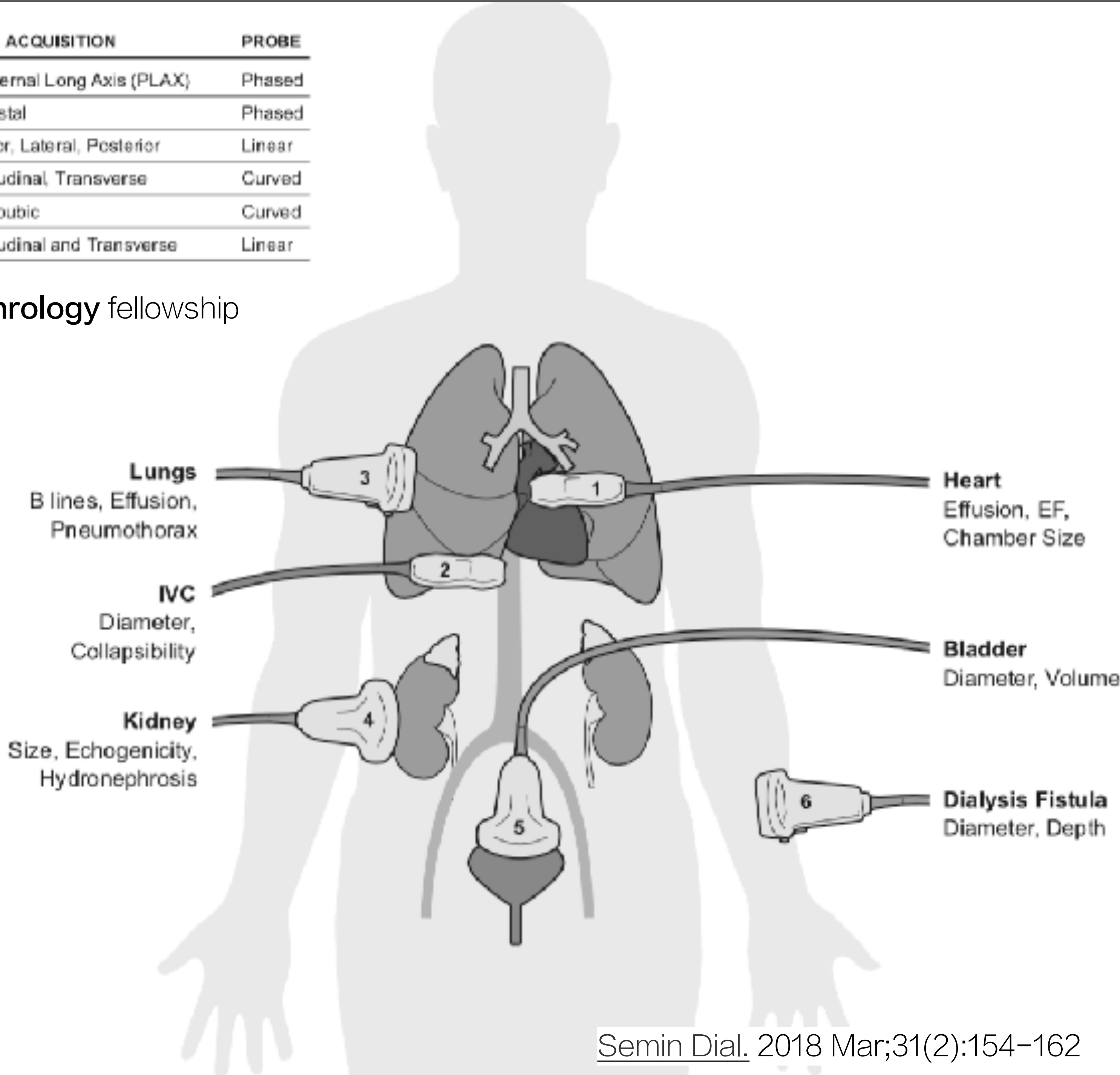
Introduction to echocardiography	https://youtu.be/JMocr_oz1Jo
Parasternal long-axis view	https://youtu.be/mZtK4PMdacE
Ultrasound of the IVC	https://youtu.be/Q6VlG3kv28Y
Overview of lung ultrasound	https://youtu.be/WOlz8-km6hE
Evaluation of the abdominal aorta	https://youtu.be/8EB0Au3l4AM
Limited examination of the lower extremity venous system for DVT	https://youtu.be/M0JmjOOg10M

J Fam Prac. 2018;67:70−80

	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

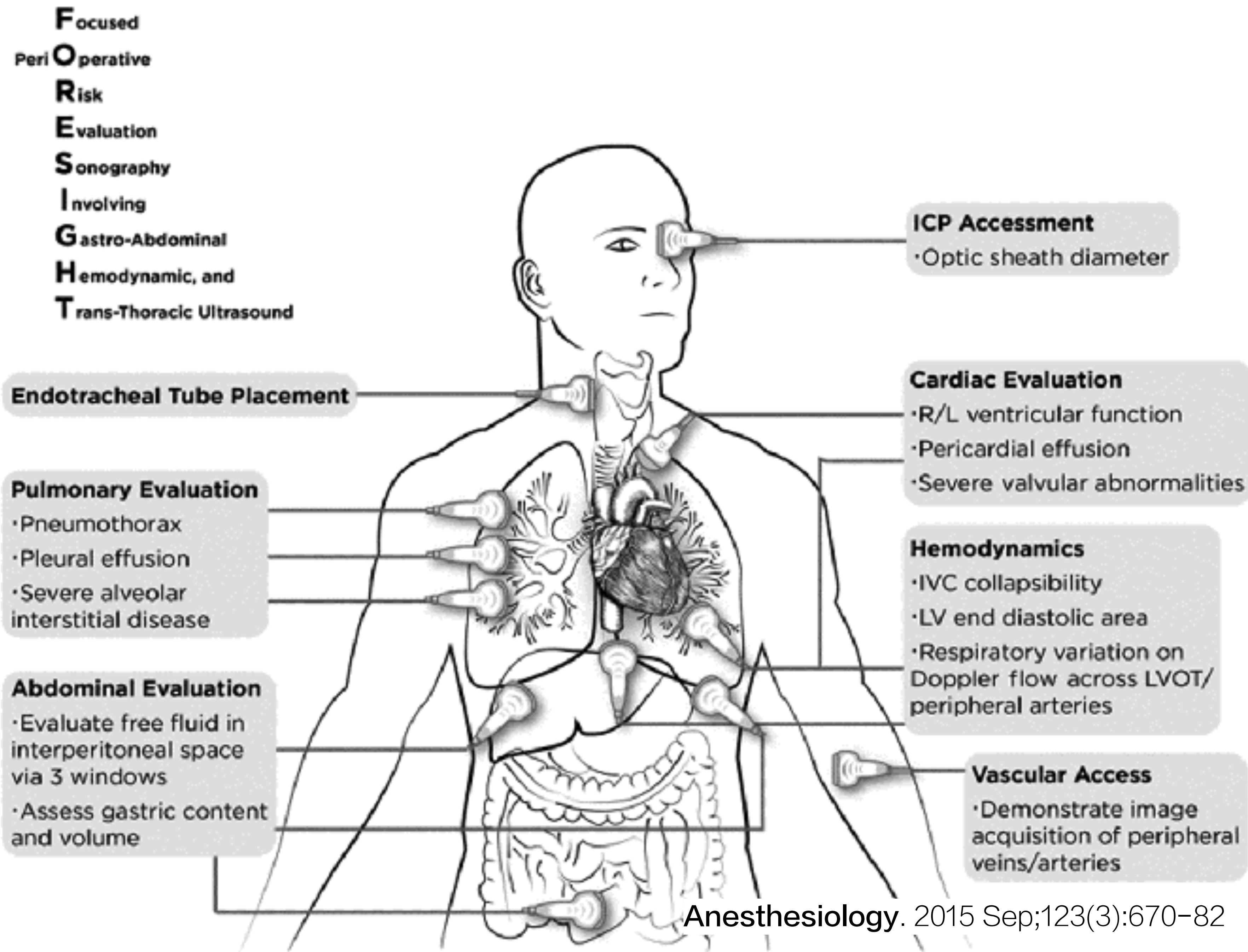
Johns Hopkins **Nephrology** fellowship

POCUS curriculum



Semin Dial. 2018 Mar;31(2):154–162

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



Anesthesiology. 2015 Sep;123(3):670–82

POCUS常用探頭

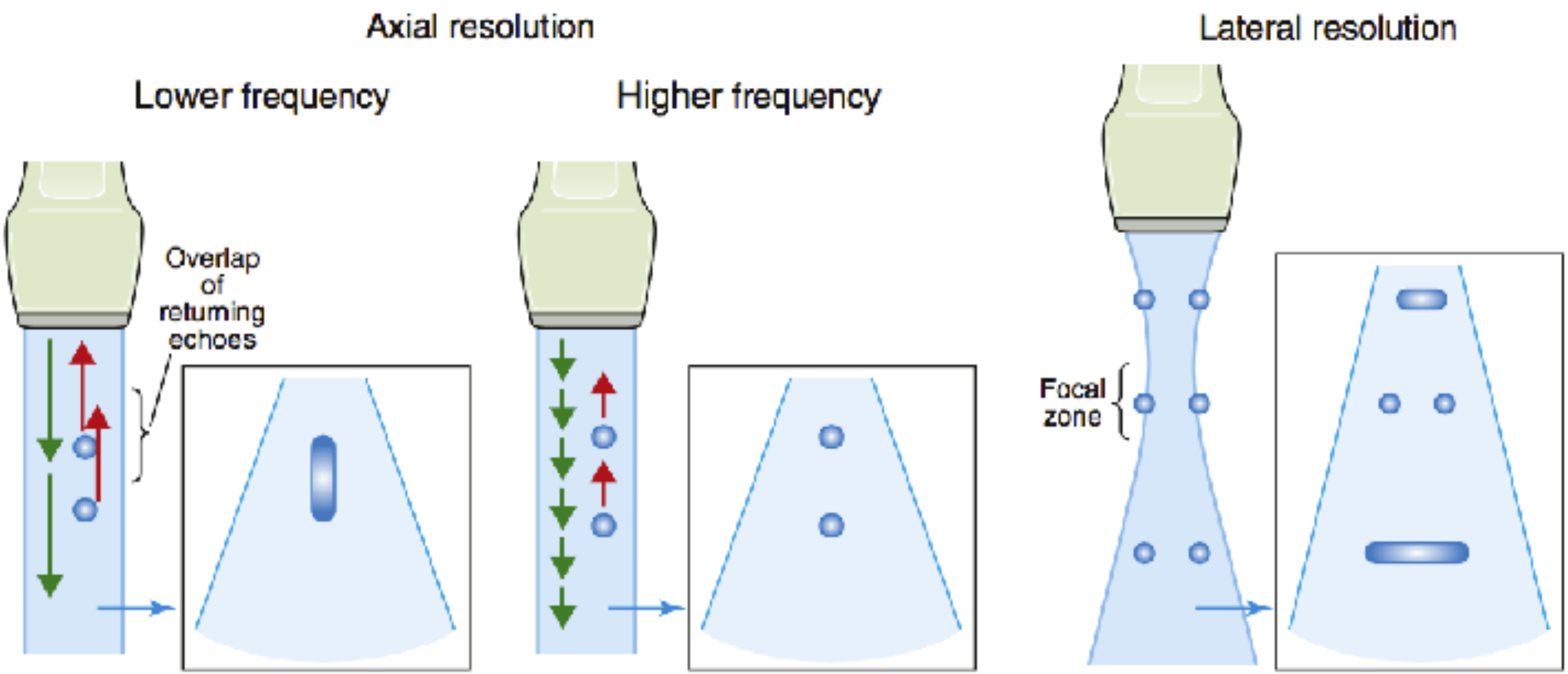
表面
目標

頻率
介面

深度
視窗

影像優化3大重點

置中　對焦　高頻



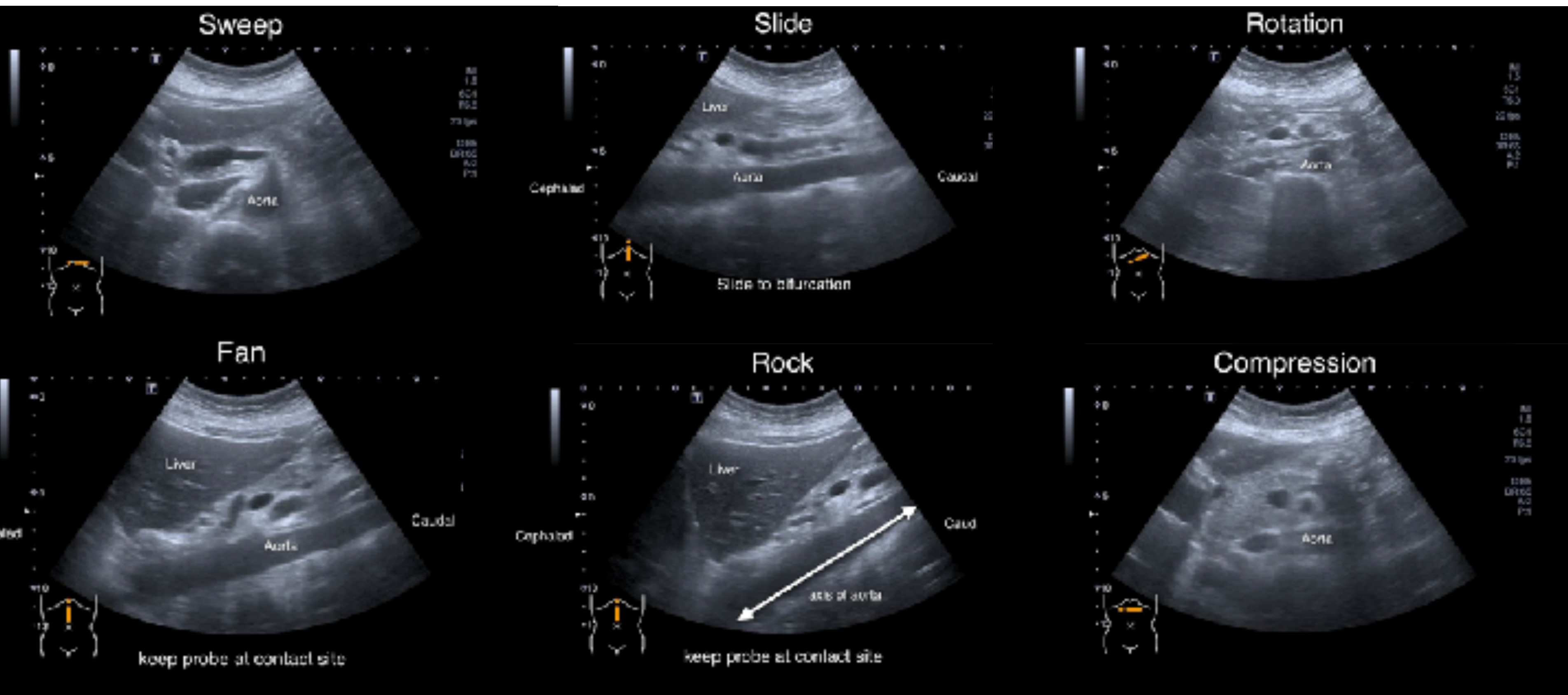
操控 6 大技巧

X	Y	Z
Sweep 掃	Slide 滑	Rotate 轉
Fan/Tilt 傾	Rock 搖	Compress 壓

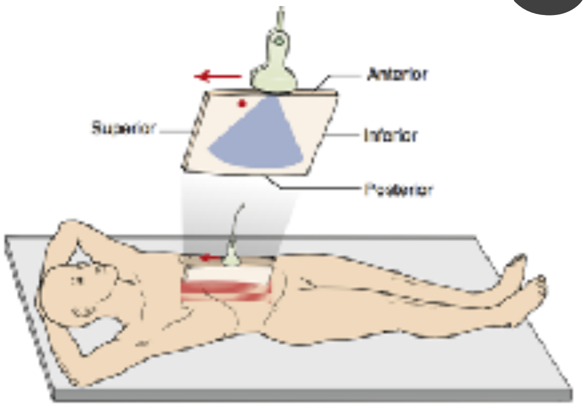
ULTRASOUND PROGRAM

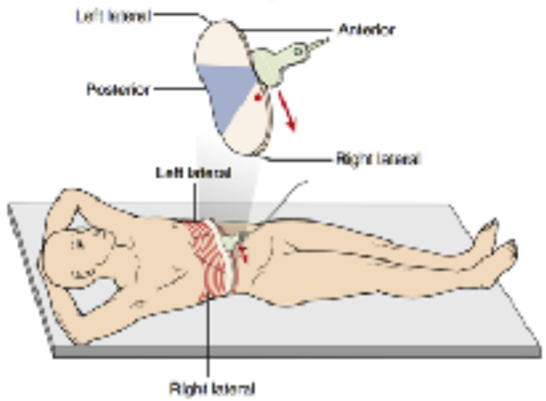
 操控 6 大技巧

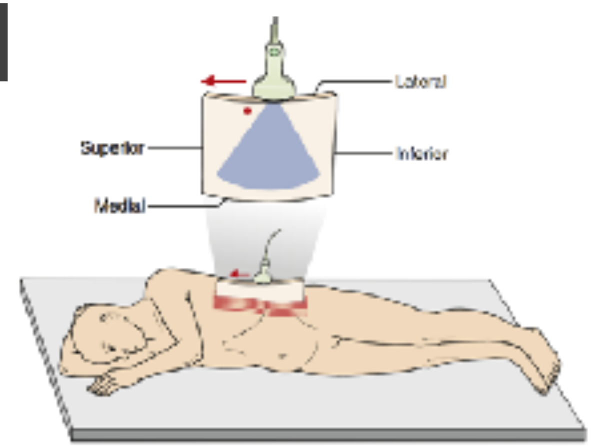
X Y Z



3D 立體掃描



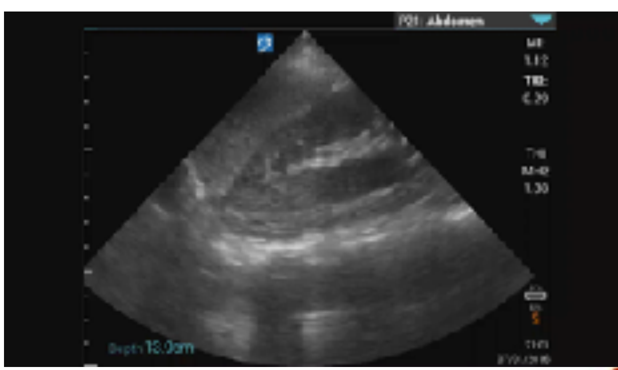




Sagittal 縱

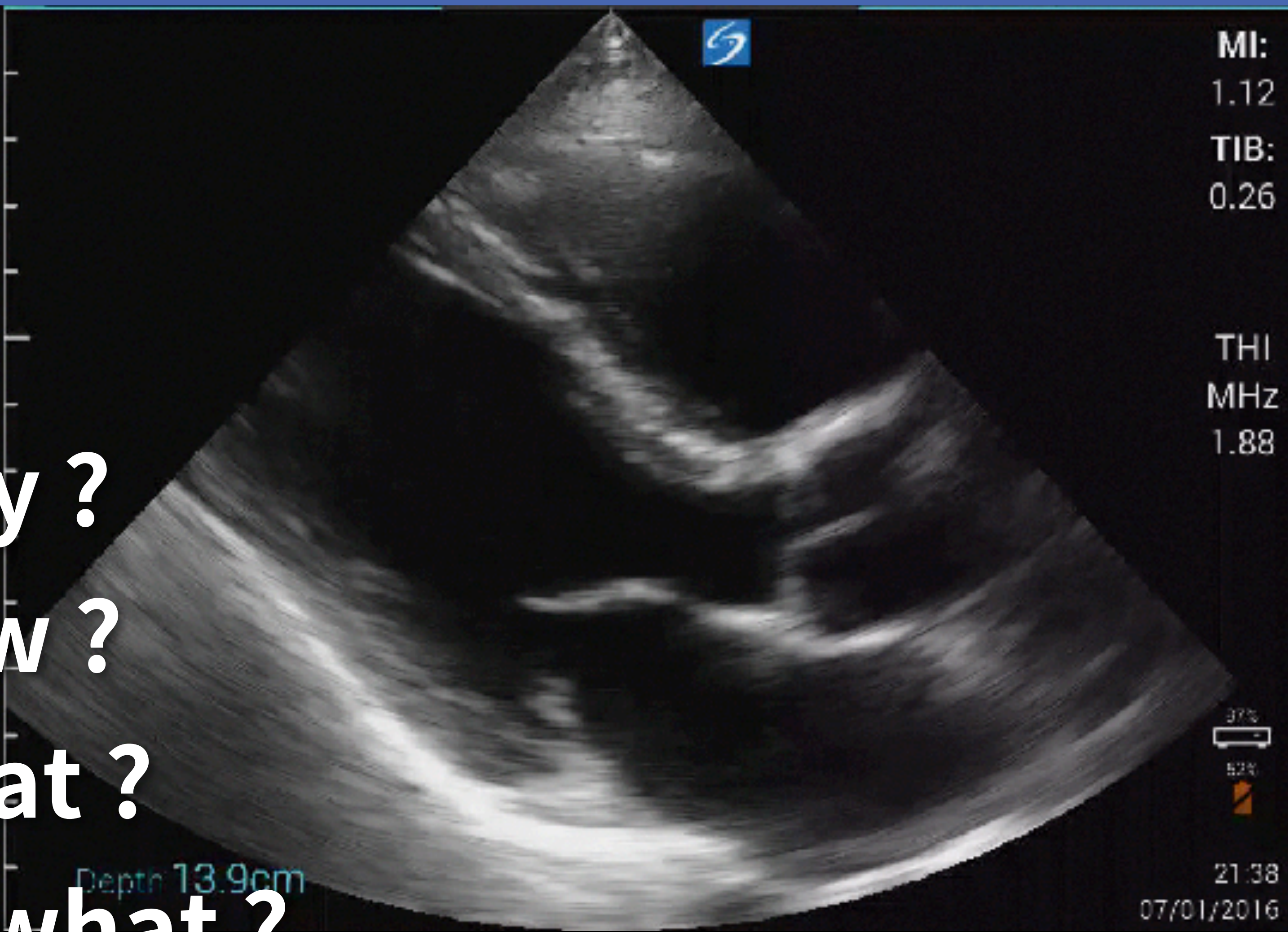
Transverse 橫

Coronal 側




Why ?
How ?
What ?
So what ?

Cardiogenic shock ?



Why ?

How ?

What ?

So what ?

Pneumothorax ?

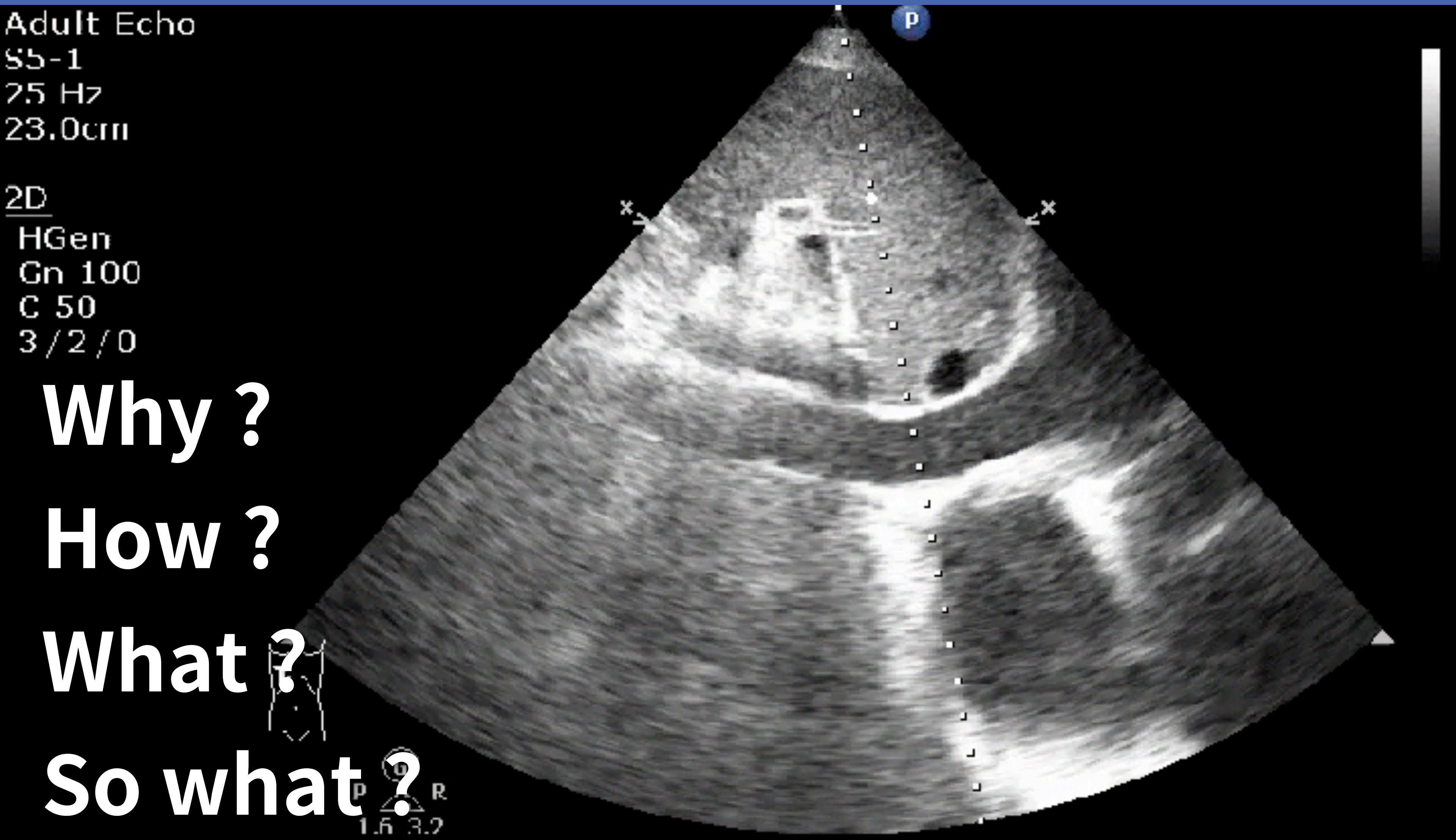
Why ?

How ?

What ?

So what ?

Fluid responder ?



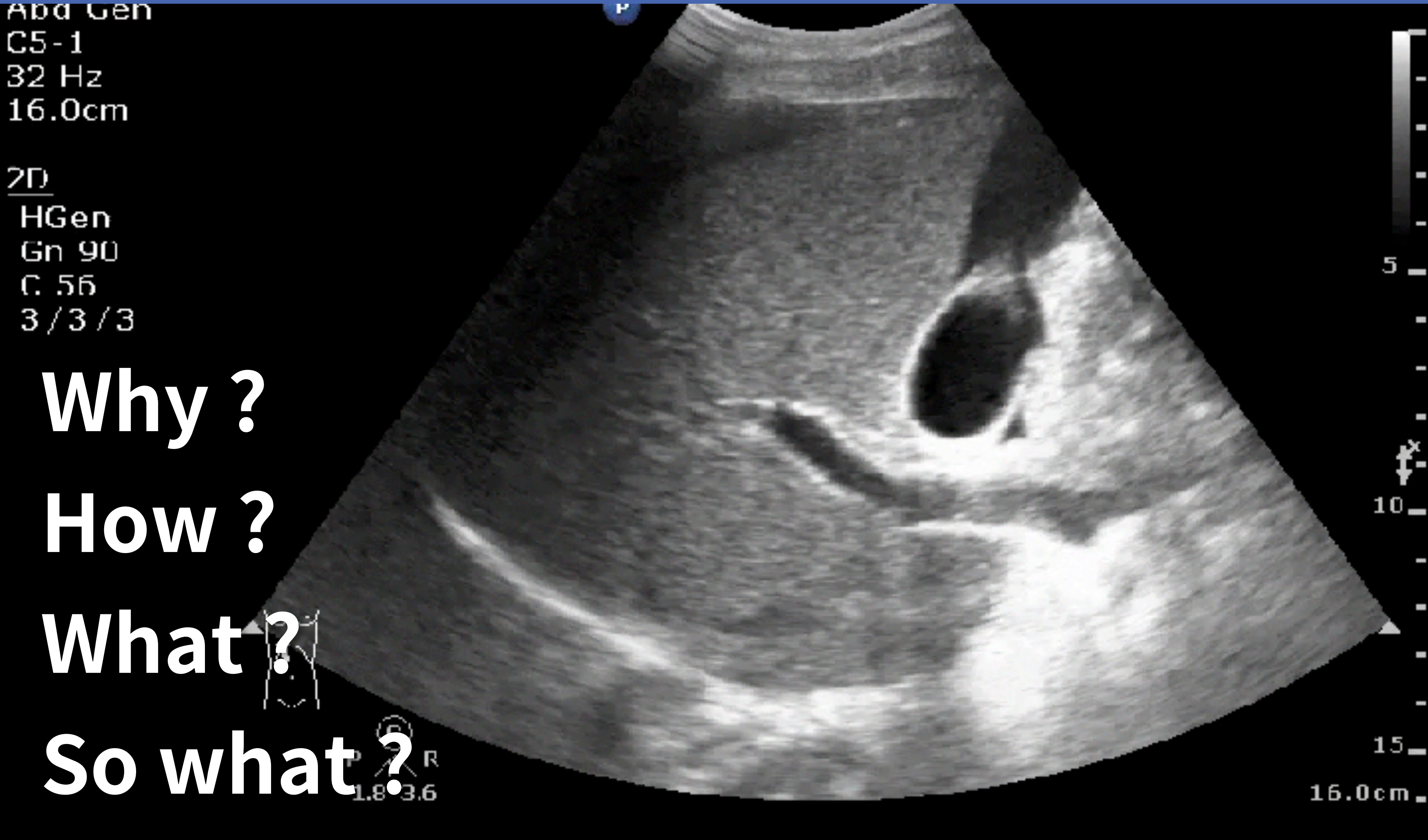
Why ?

How ?

What ?

So what ?

Shock, then ?

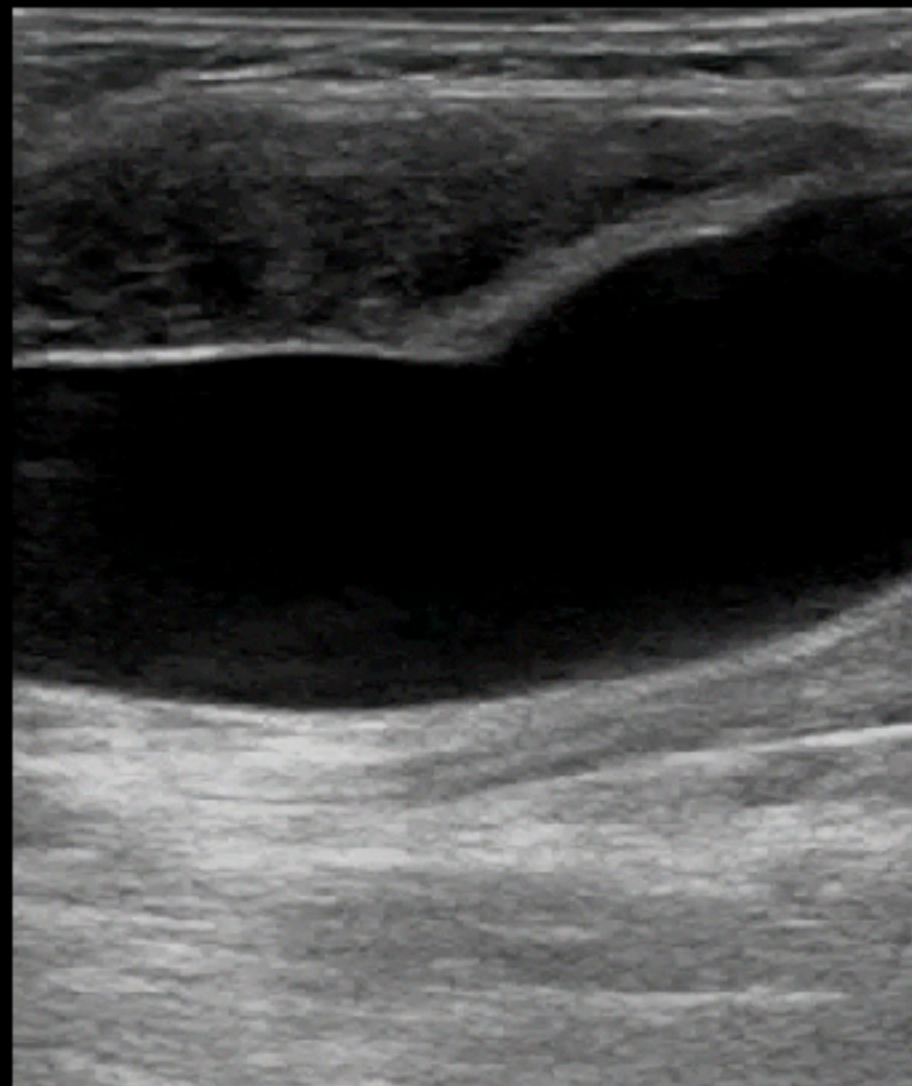


Why ?

How ?

What ?

So what ?



Why ?

How ?

What ?

So what ?

Special Article

Guidelines for the Appropriate Use of Bedside General and Cardiac Ultrasonography in the Evaluation of Critically Ill Patients—Part I: General Ultrasonography

Crit Care Med 2015; 43:2479–2502

Special Article

Guidelines for the Appropriate Use of Bedside General and Cardiac Ultrasonography in the Evaluation of Critically Ill Patients—Part II: Cardiac Ultrasonography

Crit Care Med 2016; 44:1206–1227

ICU POCUS

CVC

用針的藝術

Success rates ↑
Mechanical complications ↓

We Recommend That in Most Patients, the Use of Real-Time Ultrasound Is Preferred Over Static Preprocedure Marking. Grade 1B (56, 57)								
Quality Assessment								
Outcomes: no. of punctures, success rate, time, and complications								
No. of Studies	Design	Risk of Bias	Inconsistency	Indirectness	Imprecision	Other	Overall Quality of Evidence	Summary of Findings
(56)	RCT	No	No	Yes	No	No	⊕⊕⊕⊕ High	
(57)	RCT	No	No	Yes	No	No	⊕⊕⊕⊕ High	

RCT = randomized controlled trial.

Outcomes	Illustrative Comparative		(95% CI) p	Quality of the Evidence
	Real Time	Static		
Success rate				
(56)	53	3	< 0.006	High
(57)	100%	74%		

Effect expressed in odds ratio (OR). Large effect (OR = 53) qualifies for upgrading: (56) (adults); success defined as less than 3 punctures: (57) (infants). Overall quality was downgraded for indirectness as (56) was only for internal jugular cannulation and (57) was in infants.

Dynamic v.s. Static

Although There Are Benefits to Visualizing the Vasculature in Both Short- and Long-Axis Images by Ultrasound, We Recommend That the Short-Axis View Be Used During Insertion to Improve Success Rate. Grade 1B (58–61)

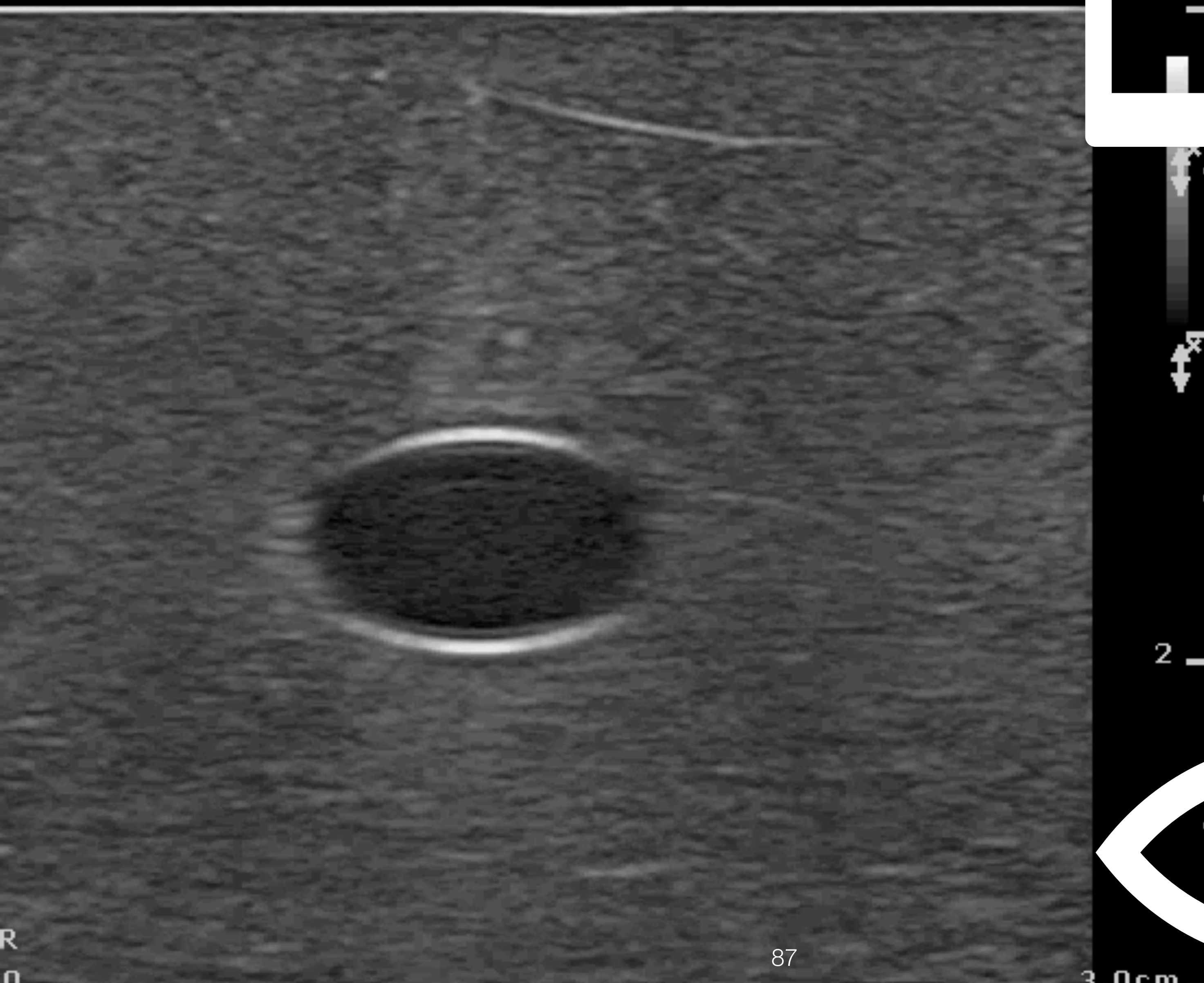
Quality Assessment								
No of Studies	Design	Risk of Bias	Inconsistency	Indirectness	Imprecision	Other	Overall Quality of Evidence	Summary of Findings
Outcomes: no. of punctures, success rate, time, and complications								
(58)	RCT	No	No	Yes	No	No	High	
(59)	RCT	No	No	Yes	No	No	Moderate	
(60)	RCT (models)	No	No	Yes	No	No	Moderate	
(61)	RCT (models)	No	No	Yes	No	No	Moderate	

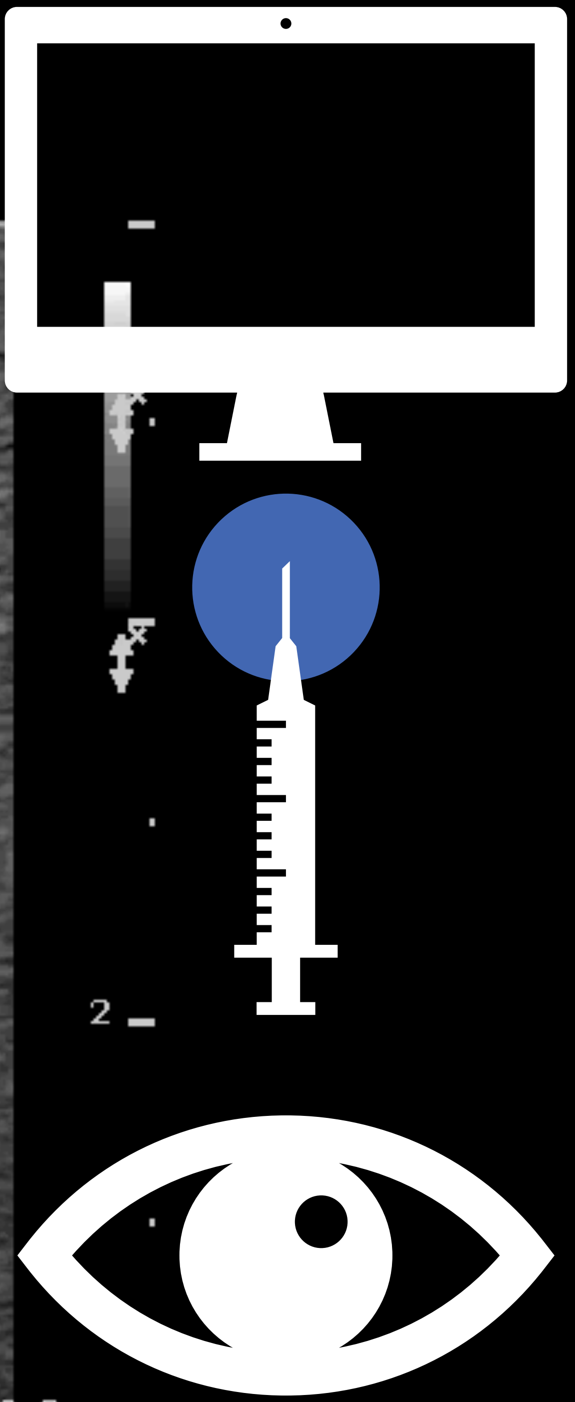
	Illustrative Comparative			
Outcomes	Short Axis	Long Axis	(95% CI) p	Quality of the Evidence
Success				
(58)	98%	78%	< 0.006	High
(59)	95%	85%	95% CI, 95–100 vs 85–100	
			Pooled $p < 0.05$	
Time	39	46	$p > 0.05$	High
	34	91	$p = 0.02$	
			Pooled $p < 0.05$	
Complication	1	0	Pooled $p > 0.05$	Moderate
	3	3		

Short v.s. Long axis


Off-plane
Trace the tip

Tilt & Sweep

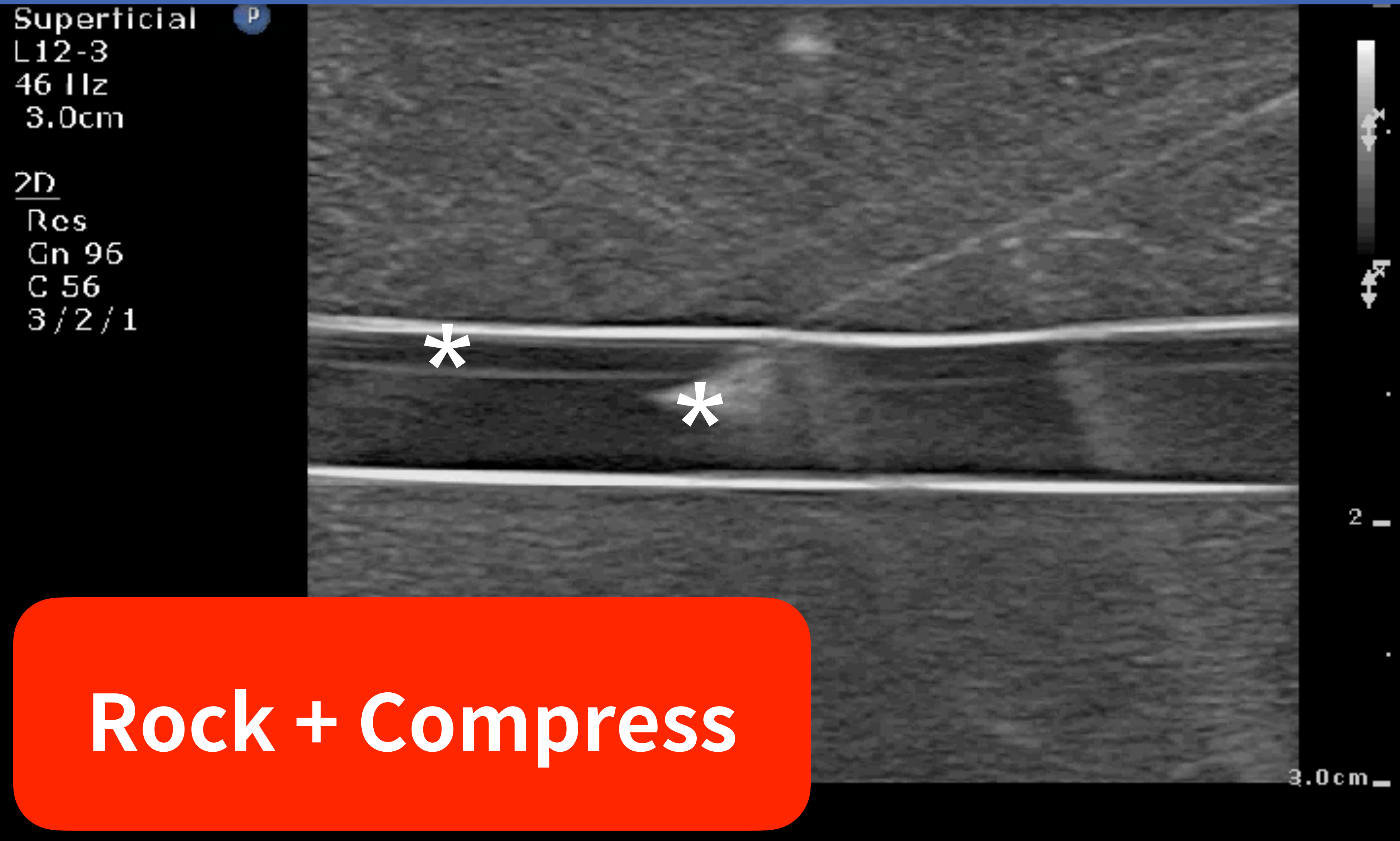




In-plane

See the needle shaft

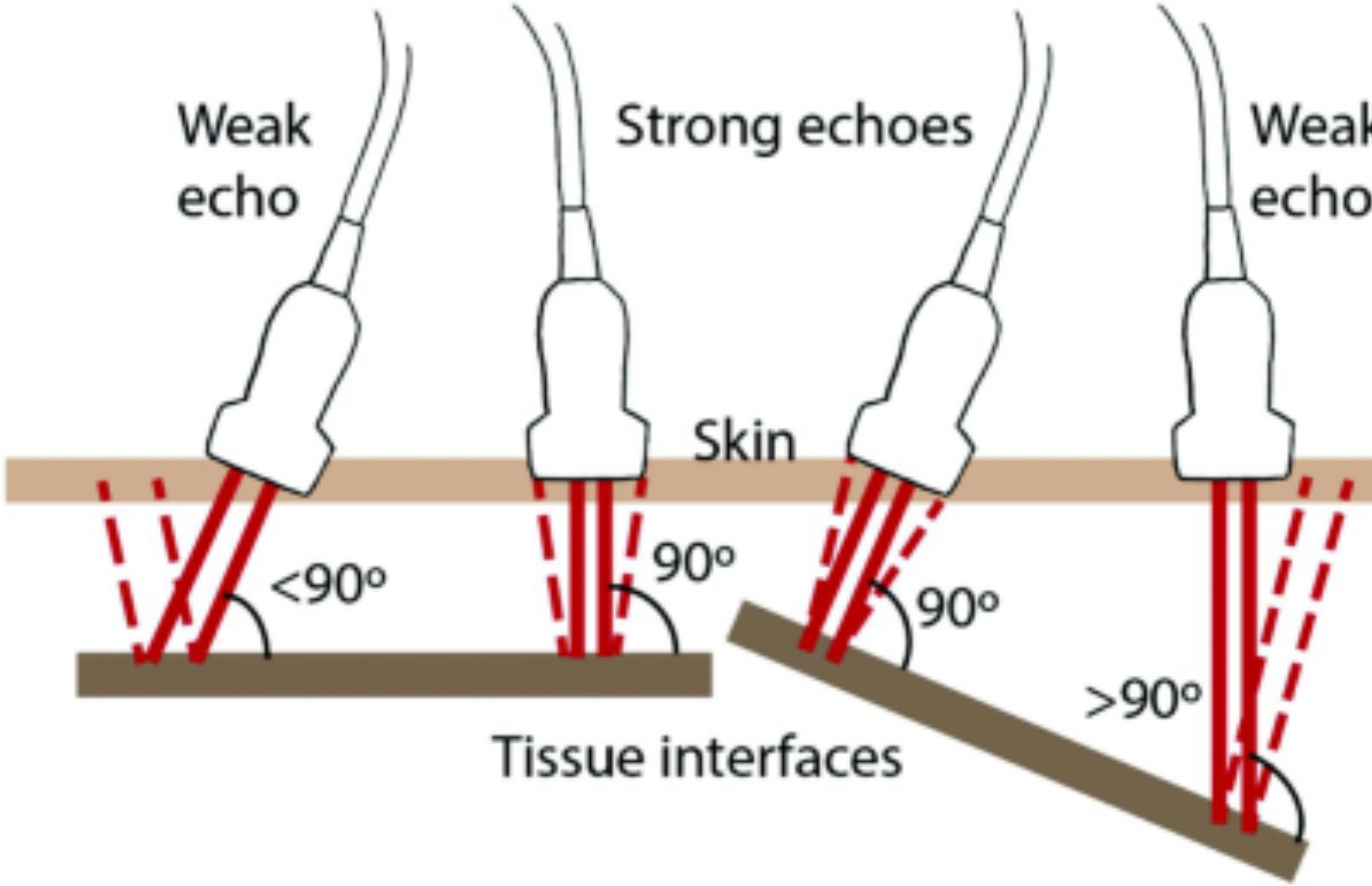
Needle optimisation



Rock + Compress


PHILIPS

探頭垂直於掃描的目標物



We Suggest That a Detailed Postcannulation Ultrasound Examination May Be Used (vs Conventional Chest Radiography) to Confirm Catheter Location and Exclude a Pneumothorax. Grade 2B (63, 64)									
Quality Assessment							Summary of Findings		
Two Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Study Result		Accuracy
Diagnostic accuracy									
(63)	No risk of bias	No serious inconsistency	Indirectness	No imprecision	Undetected	⊕⊕⊕⊖ Moderate	Positive predictive value, 83%	Negative predictive value, 91%	74–93%
(64)	No risk of bias	No serious inconsistency	Indirectness	No imprecision	Undetected	⊕⊕⊕⊖ Moderate	Sensitivity, 96% %	Specificity, 93%	

Post-cannulation US
Confirm catheter
Exclude PTX

We Recommend That Ultrasound-Guided Internal Jugular Venous Cannulation Should Be Used (vs Landmark Technique) to Improve Success Rate, Shorten Procedure Time and Reduce the Risk of Procedure-Related Complications in Adult Patients. Grade 1A (65–76)							
Quality Assessment							Summary of Findings
12 Randomized Controlled Trials and Meta-Analysis	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Relative Risk (95% CI)
Success rate (important outcome)	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High	0.14 (0.06–0.33)
Time	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High	Ultrasound 17.1 ± 16.5 min vs no ultrasound 44 ± 95.4 min; $p < 0.001$
Complication	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High (1)	0.43 (0.22–0.87)

Dynamic US-guided IJ venous cannulation

We Recommend That Ultrasound Guidance (vs Landmark Technique) Be Used to Improve the Success Rate and Reduce Complications for Femoral Venous Cannulation. Grade 1A (77–80)							
Quality Assessment							Summary of Findings
Randomized Controlled Trials and Observational	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Effect (95% CI)
Success rate (important outcome)	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High	RR, 0.14 (0.06–0.33)
Time	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High	Ultrasound 17.1 ± 16.5 min vs no ultrasound 44 ± 95.4 min; $p < 0.001$
Complication	No serious risk of bias	No inconsistency	No indirectness	No serious imprecision	Undetected	⊕⊕⊕⊕ High	RR, 0.43 (0.22–0.87)

RR = relative risk.

High-quality randomized controlled trials. Large effect. Meta-analysis reported; benefit more for novice operators.

Dynamic US-guided FV cannulation

Taipei Medical University Center for Education in Medical Simulation

We Suggest the Use of Ultrasound Guidance (vs Landmark Technique) to Improve the Success Rate and Diminish Complications During Peripheral Venous Catheterization. Grade 2B (81–85)								
Quality Assessment							Summary of Findings	
							Study Result	
Five Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Ultrasound	Without Ultrasound
Outcomes: no. of punctures, success rate, time, and complications								
Five randomized controlled trial	No risk of bias	No serious inconsistency	No indirectness	No imprecision	Undetected	⊕⊕⊕⊕ High (1)	All in favor of ultrasound with significant difference in reported outcomes	

Outcomes (80)	Illustrative Comparative: Ultrasound	Illustrative Comparative: No Ultrasound	(95% CI) p
Success	97%	33%	< 0.05
Time (s)	13	30	< 0.05
Trials (no. of attempts)	1.7	3.7	< 0.05

Downgraded for indirectness as the technique is mostly useful in difficult patients such as infants, obese, and hemodynamically unstable patients and/or when previous unsuccessful attempts have been performed.

PIV catheterization Conditional

We Suggest the Use of Ultrasound Guidance (vs Landmark Technique) to Improve the Success Rate and Diminish Complications During Arterial Catheterization. Grade 2B (86–91)								
Quality Assessment							Summary of Findings	
							Study Result	
Six Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Ultrasound	Without Ultrasound
Nine randomized controlled trial 5+4 in meta-analysis	No risk of bias	No serious inconsistency	No indirectness	No imprecision	Undetected	⊕⊕⊕⊕ High	All in favor of ultrasound with significant difference in reported outcomes	

Outcomes	Illustrative Comparative		(95% CI)
	Ultrasound	No Ultrasound	*p*
Success	Adult: 87%	62%	< 0.05
	Ped: 67%	14%	
Time (s)	136	148	< 0.05
First attempt	71% improvement over control (relative risk, 1.7)		< 0.05

Arterial catheterization Conditional

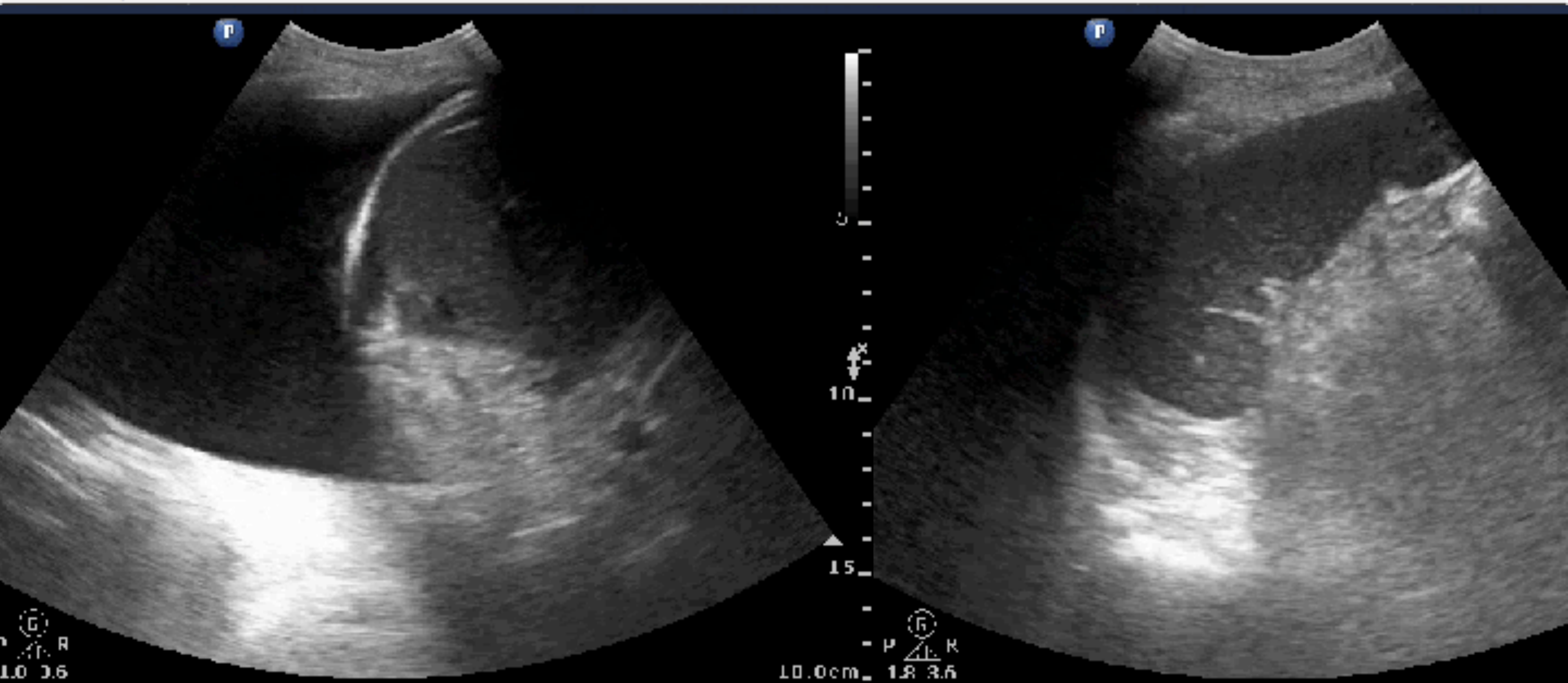
ICU POCUS

CVC

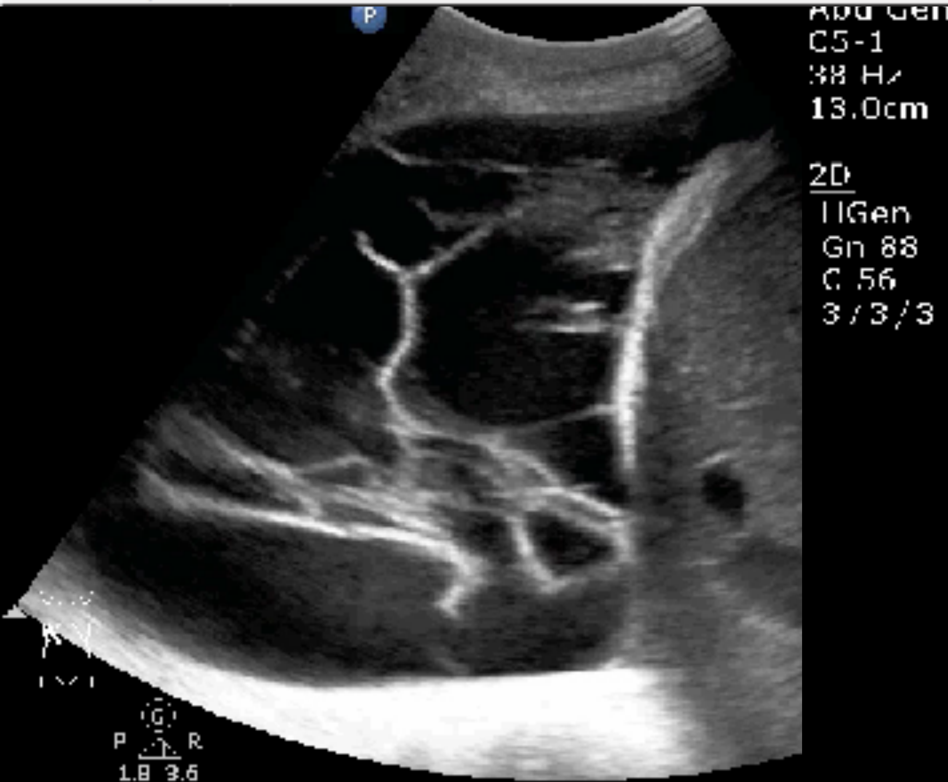
Lung

We Recommend That Ultrasound Be Used to Complement Physical Examination and Conventional Chest Radiography to Rules In Pleural Effusion. Grade 1A (16–27)

Quality Assessment							Summary of Findings		
							Study Result		
Participants	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity	Diagnostic Accuracy
Diagnostic accuracy									
140 exam cross-sectional study	No serious risk of bias	No serious inconsistency	No serious indirectness	Imprecision	Undetected	⊕⊕⊕⊕ High	83.6%	100%	94%



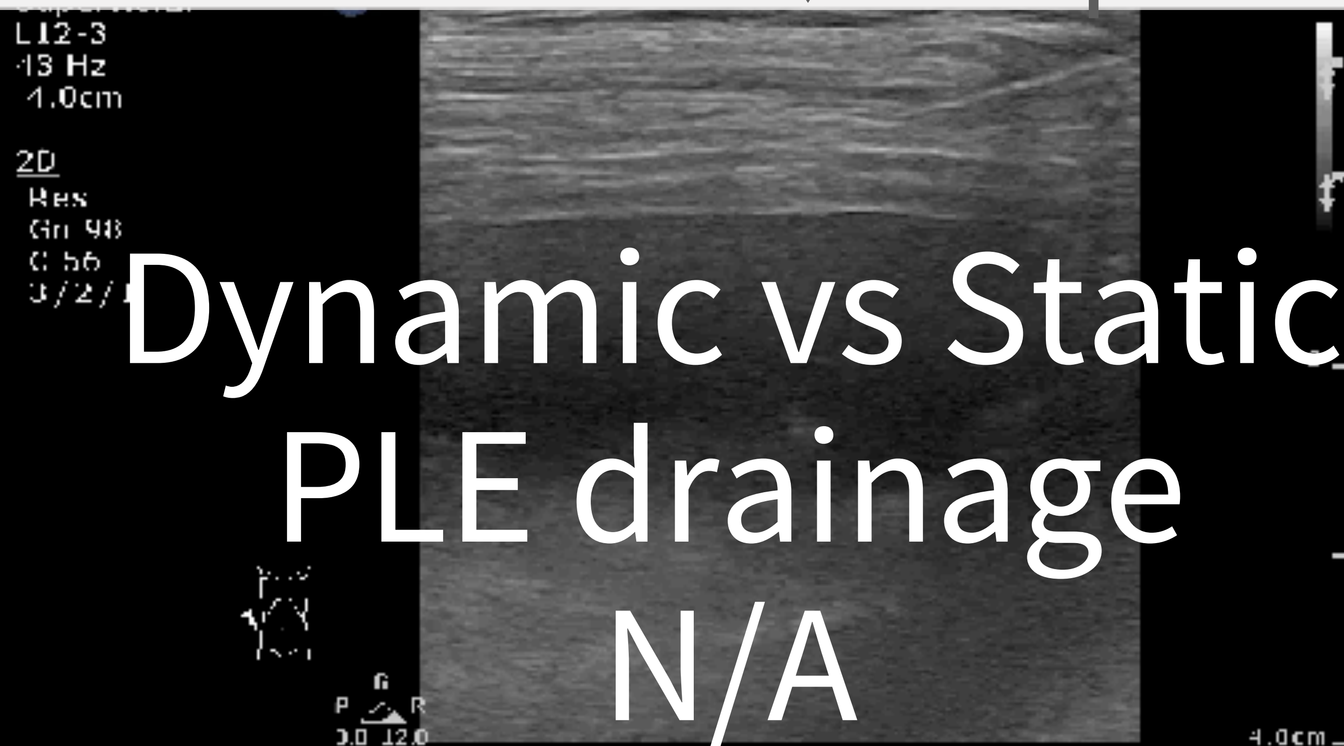
We Recommend That Ultrasound Be Used to Complement Physical Examination and Conventional Chest Radiography to Rules In Pleural Effusion. Grade 1A (16–27)									
Quality Assessment							Summary of Findings		
							Study Result		
Participants	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity	Diagnostic Accuracy
Diagnostic accuracy									
140 exam cross-sectional study	No serious risk of bias	No serious inconsistency	No serious indirectness	Imprecision	Undetected	⊕⊕⊕⊕ High	83.6%	100%	94%



We Recommend That Ultrasound-Guidance Be Used to Assist in Drainage (Including Needle Guidance), Particularly for Identification of Small or Loculated Effusions Compared With Landmark Technique. Grade 1B (16–27)

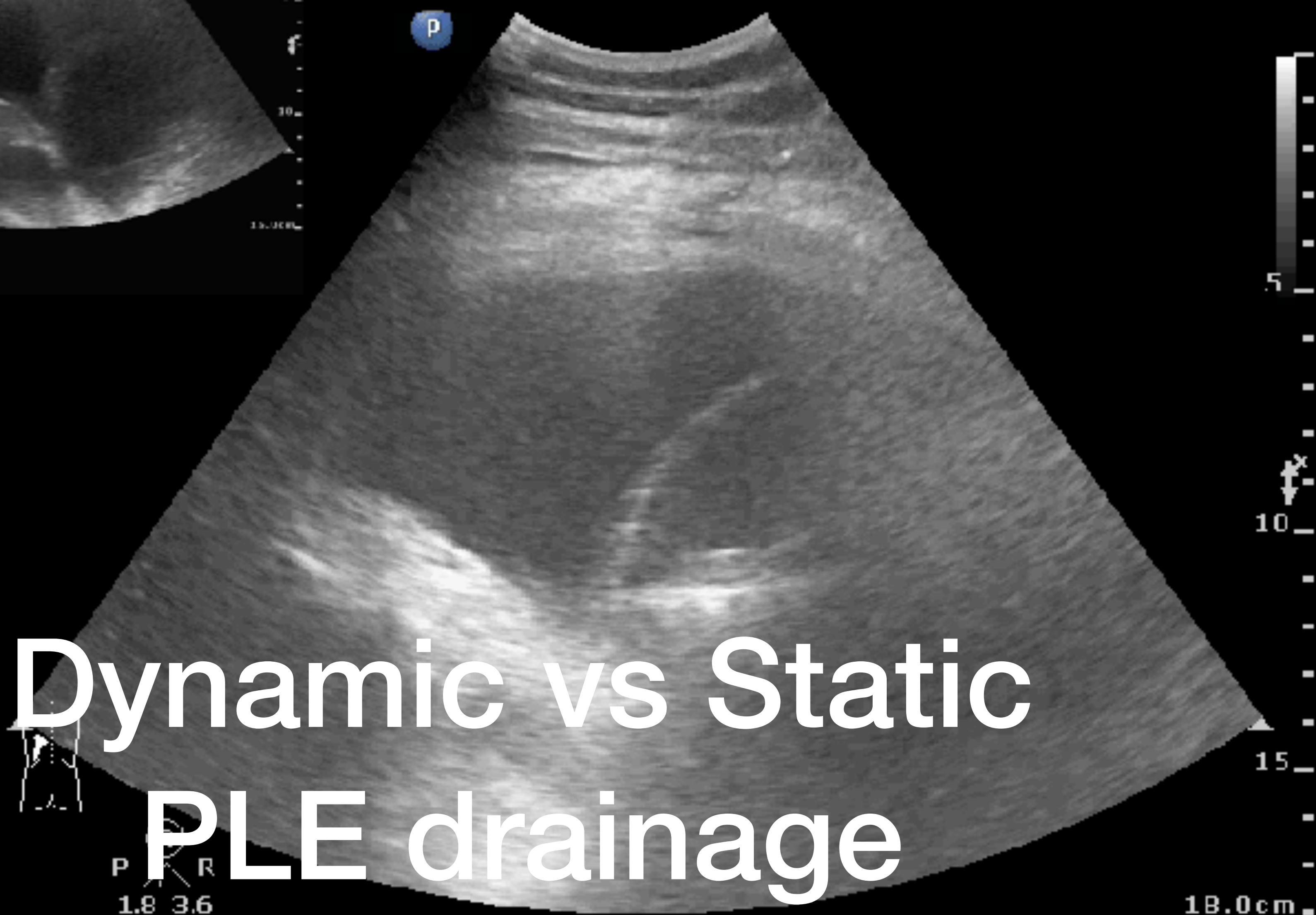
Quality Assessment							Summary of Findings	
							Study Result	
12 Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Ultrasound	Without Ultrasound
Complications								
52 procedures randomized controlled trial	No serious risk of bias	No serious inconsistency	Indirectness	Imprecision	Undetected	⊕⊕⊕◯ Moderate	0/19 (0%)	14/33 (24%)
Rest observational								

↓complications



Dynamic vs Static
PLE drainage
N/A

Catheter insertion



Dynamic vs Static PLE drainage

N/A

We Recommend That Ultrasound Be Used to Complement or Replace Conventional Chest Radiography to Diagnose a Pneumothorax, Depending on the Clinical Setting and Need for Rapid Results. Grade 1A (29–39)

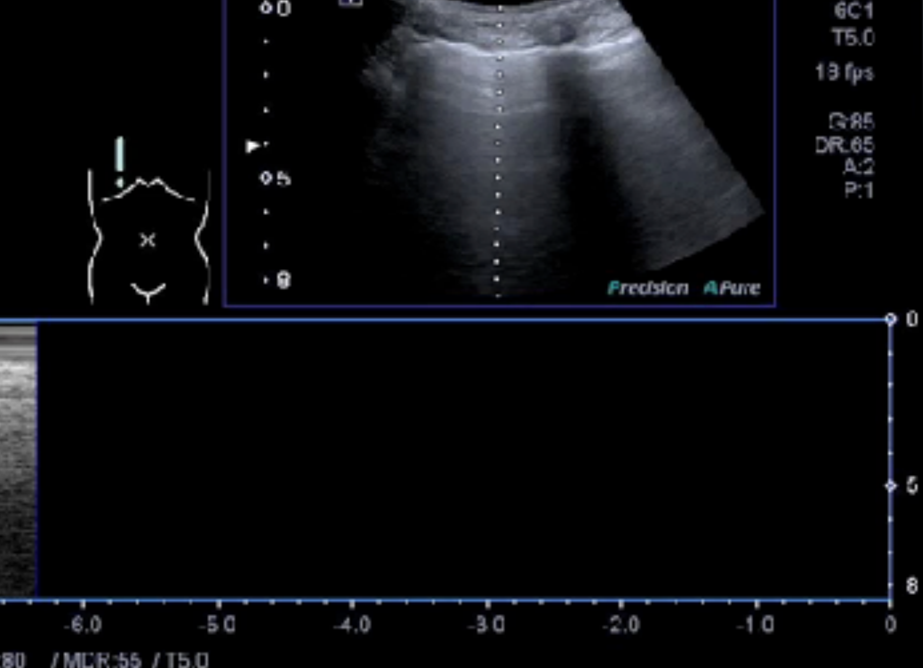
Quality Assessment							Summary of Findings		
							Study Result		
Eight Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity	
Diagnostic accuracy									
Randomized controlled trial for strategy Cross sectional for diagnostic accuracy Misanalysis	No risk of bias	No serious inconsistency	No indirectness	No imprecision	Undetected	⊕⊕⊕⊕ High	89% 70%	99% ultrasound vs 96% chest radiograph	Ultrasound has LR 36–153

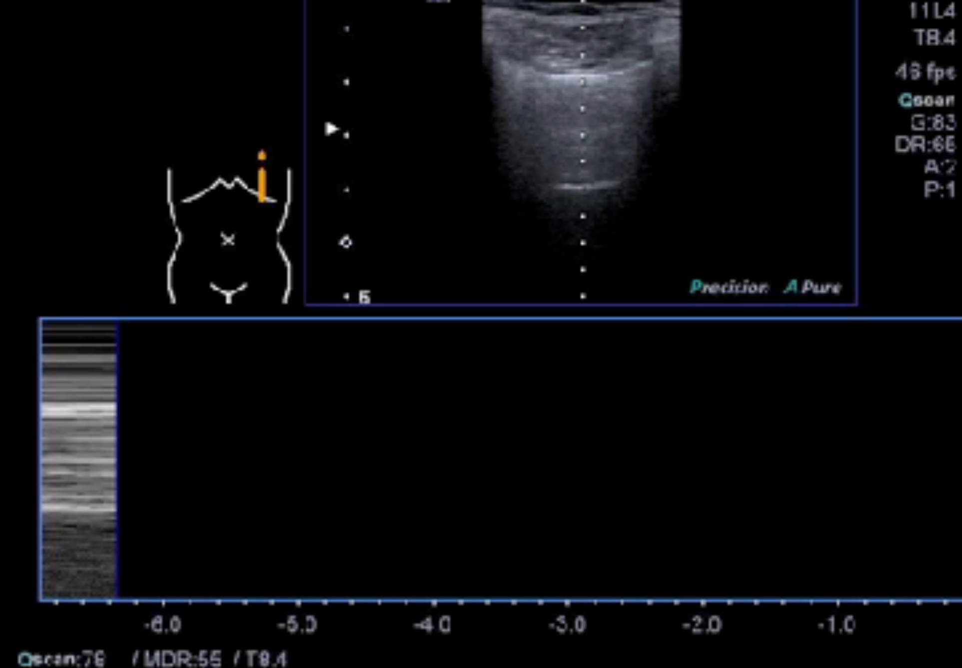
Sliding — **Rule out**

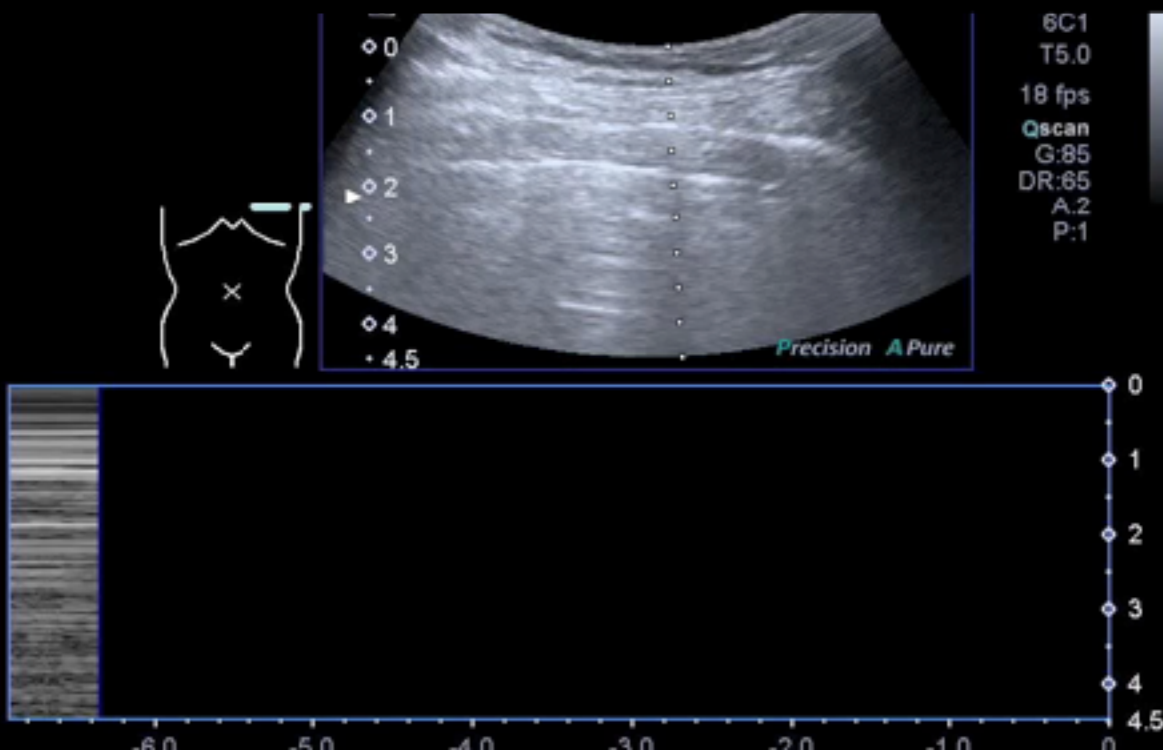
Comet-tail artifact — **Rule out**

Lung pulse — **Rule out**

Lung point — **Rule in**

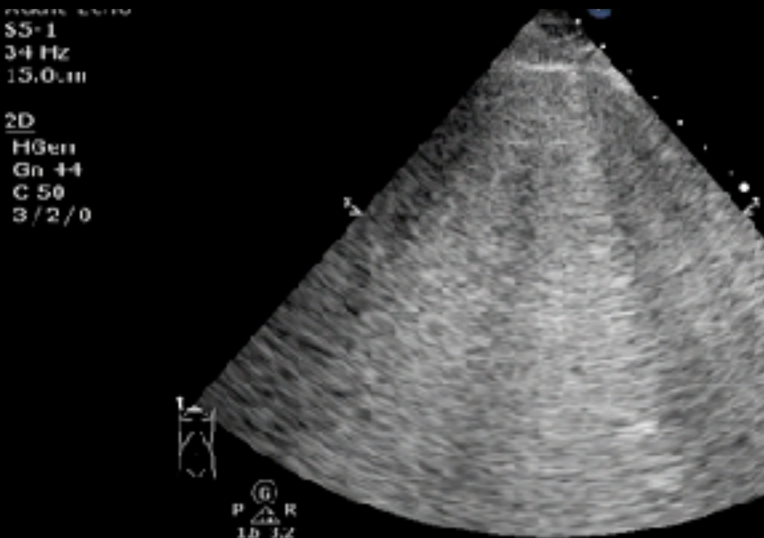

6C1
T5.0
18 fps
G:85
DR:65
A:2
P:1
Precision APure
/ MDR:55 / T5.0

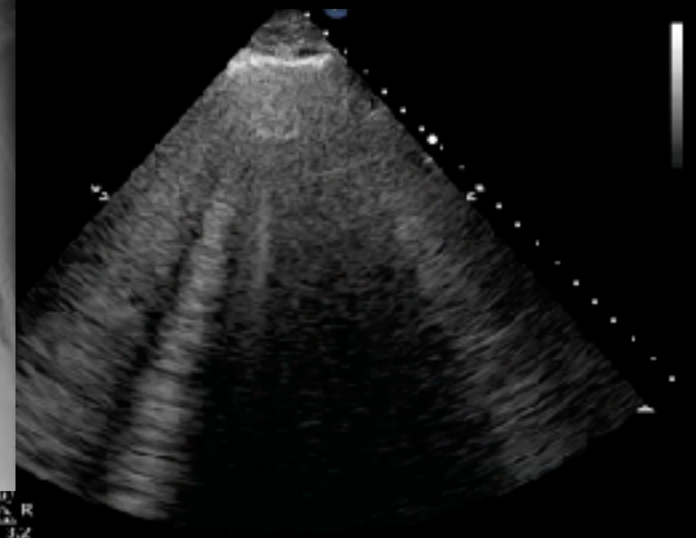

T8.4
Qscan
Precision APure
Qscan:76 / MDR:55 / T8.4


6C1
T5.0
18 fps
Qscan
G:85
DR:65
A:2
P:1
Precision APure

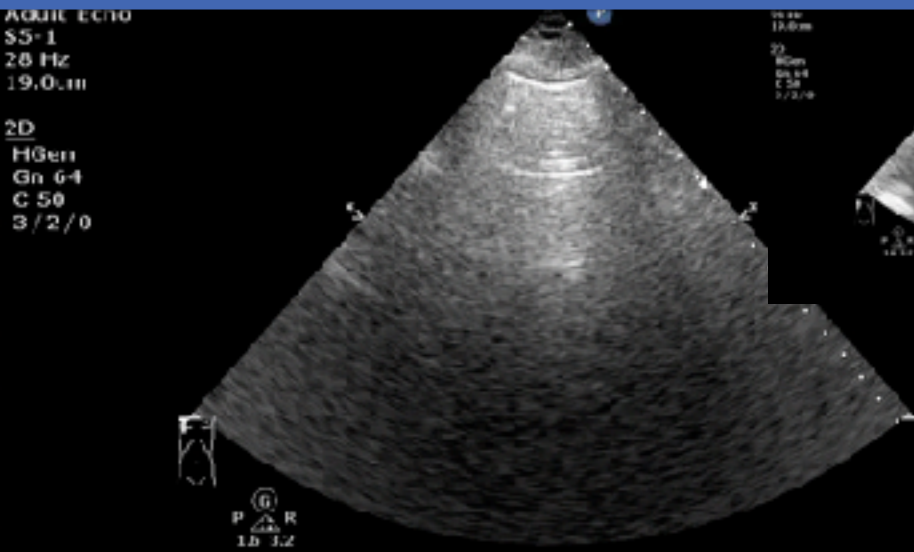
We Suggest That a Systematic Approach Incorporating Bedside Ultrasound May Be a Primary Diagnostic Modality for the ICU Patient With Respiratory Failure. Grade 2B (40–46)									
Quality Assessment							Summary of Findings		
							Study Result		
Seven Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity	Accuracy
Diagnostic accuracy									
Cross sectional for diagnostic accuracy	No risk of bias	No serious inconsistency	Potential indirectness	No imprecision	Potential	⊕⊕⊕⊝ Moderate	90%	98%	90.5%

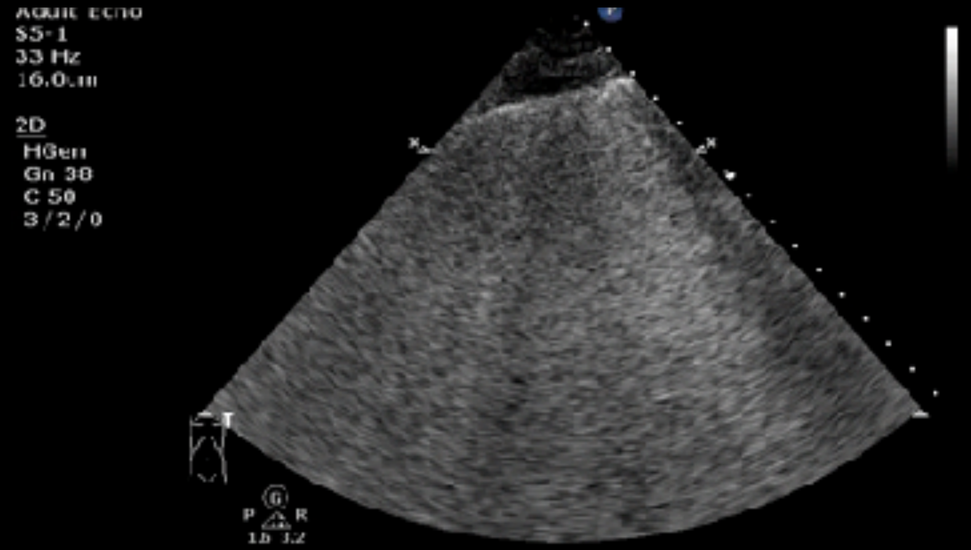
Interstitial & **Parenchymal**
Lung pathology



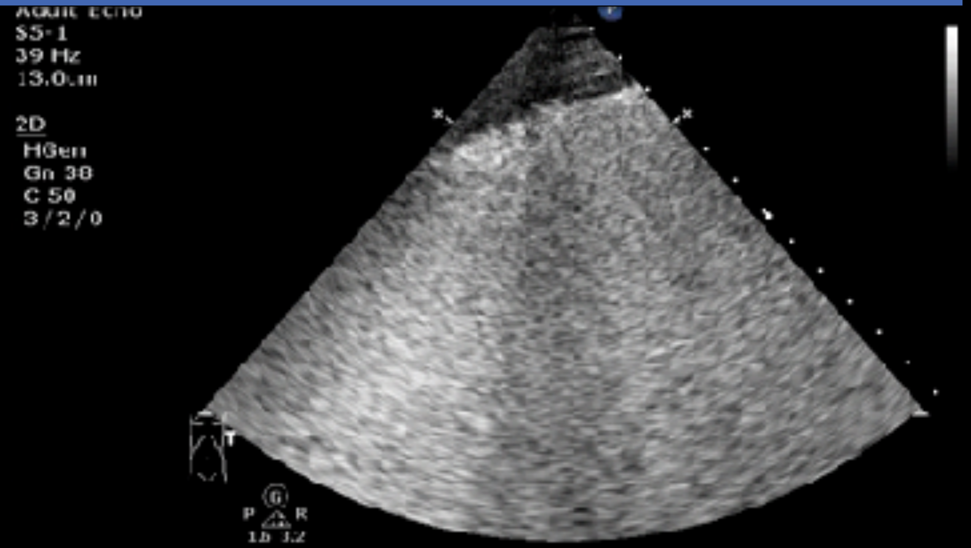


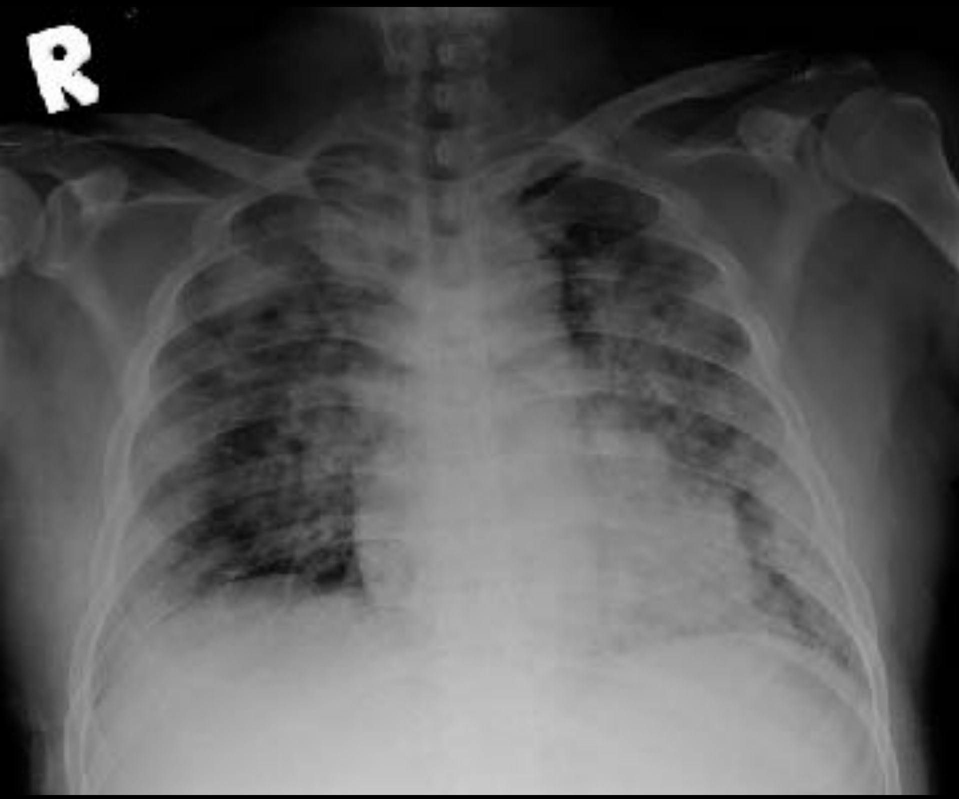
APE with improvement



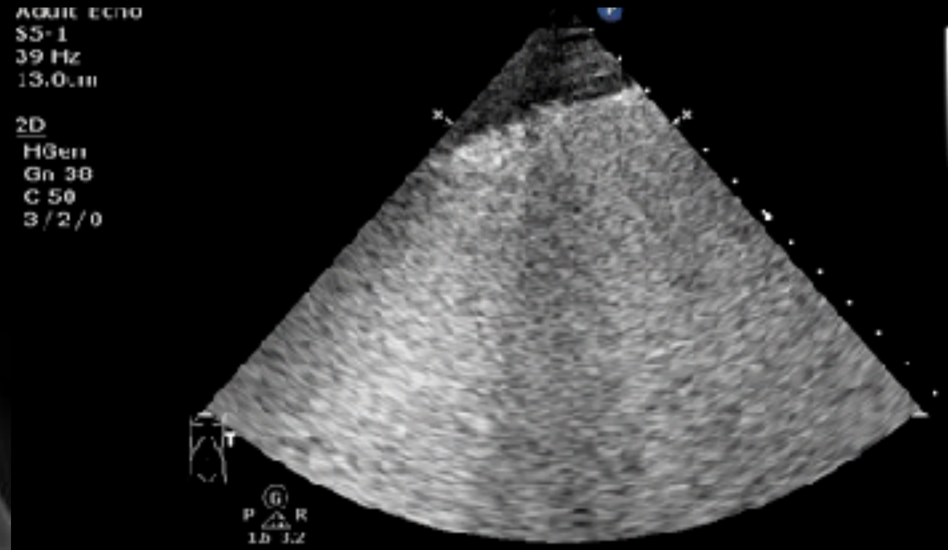


B lines & Consolidation

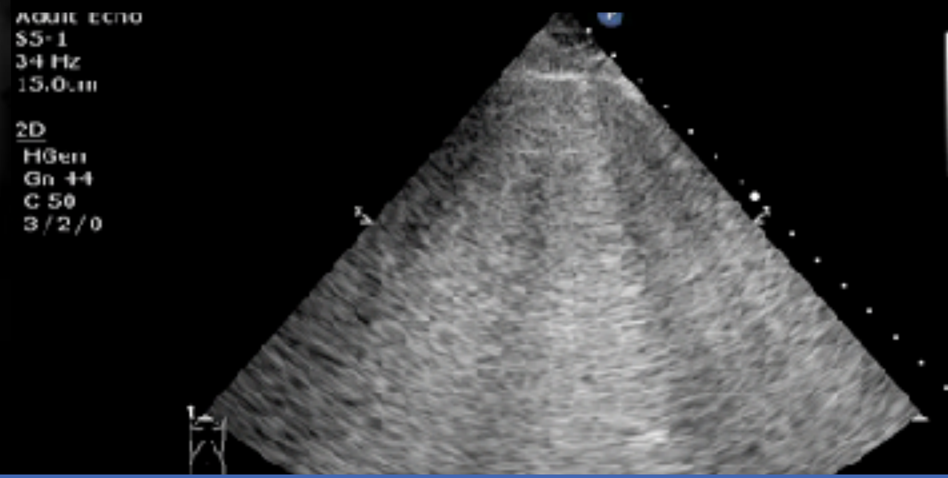




ARDS

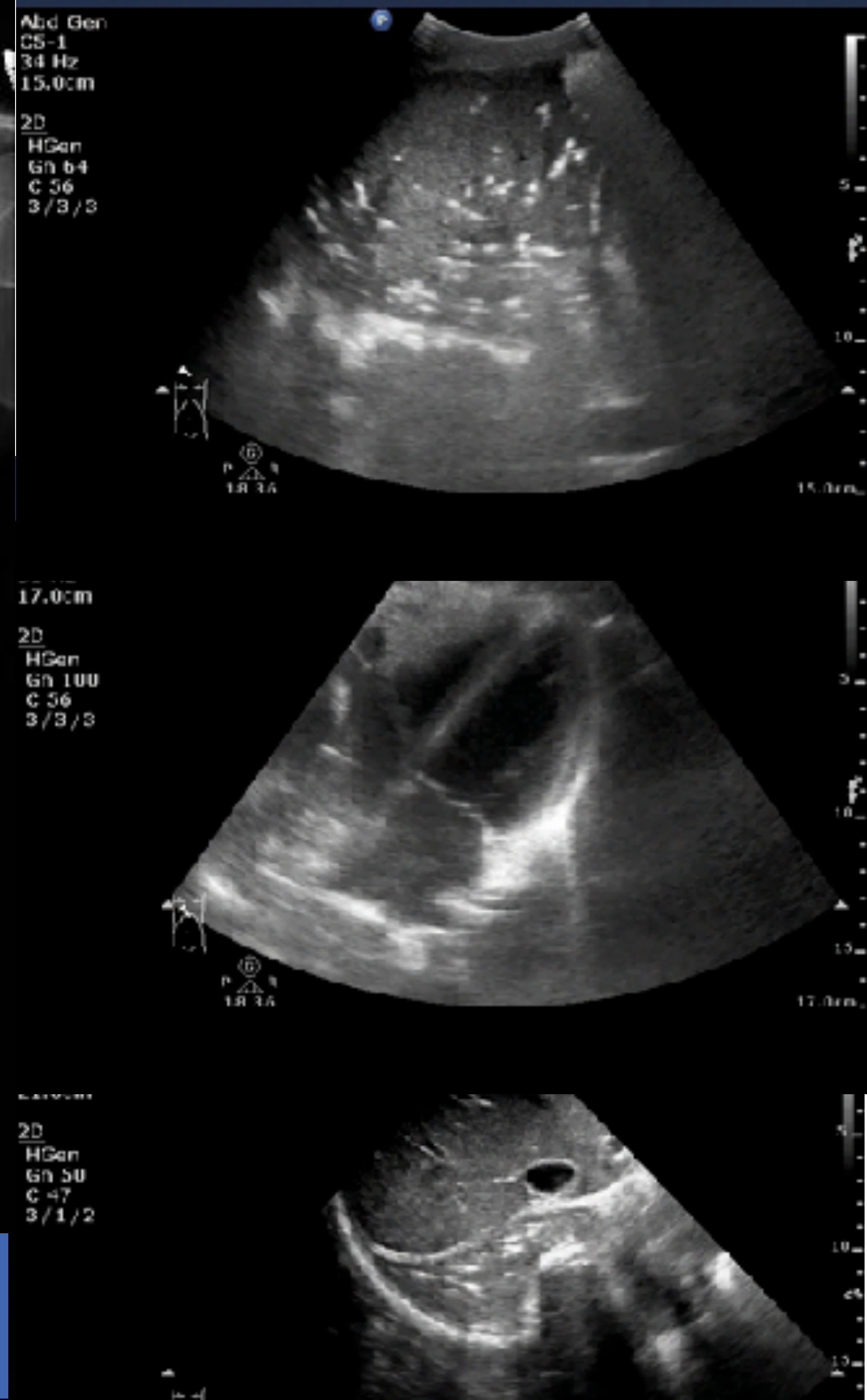


APE



ARDS (APE as comparison)


R


Abd Gen
C5-1
34 Hz
15.0cm
2D
HGen
Gn 64
C 56
3/3/3
17.0cm
2D
HGen
Gn 100
C 56
3/3/3
2D
HGen
Gn 50
C 47
3/1/2

PN & Sepsis

ICU POCUS

CVC

Lung

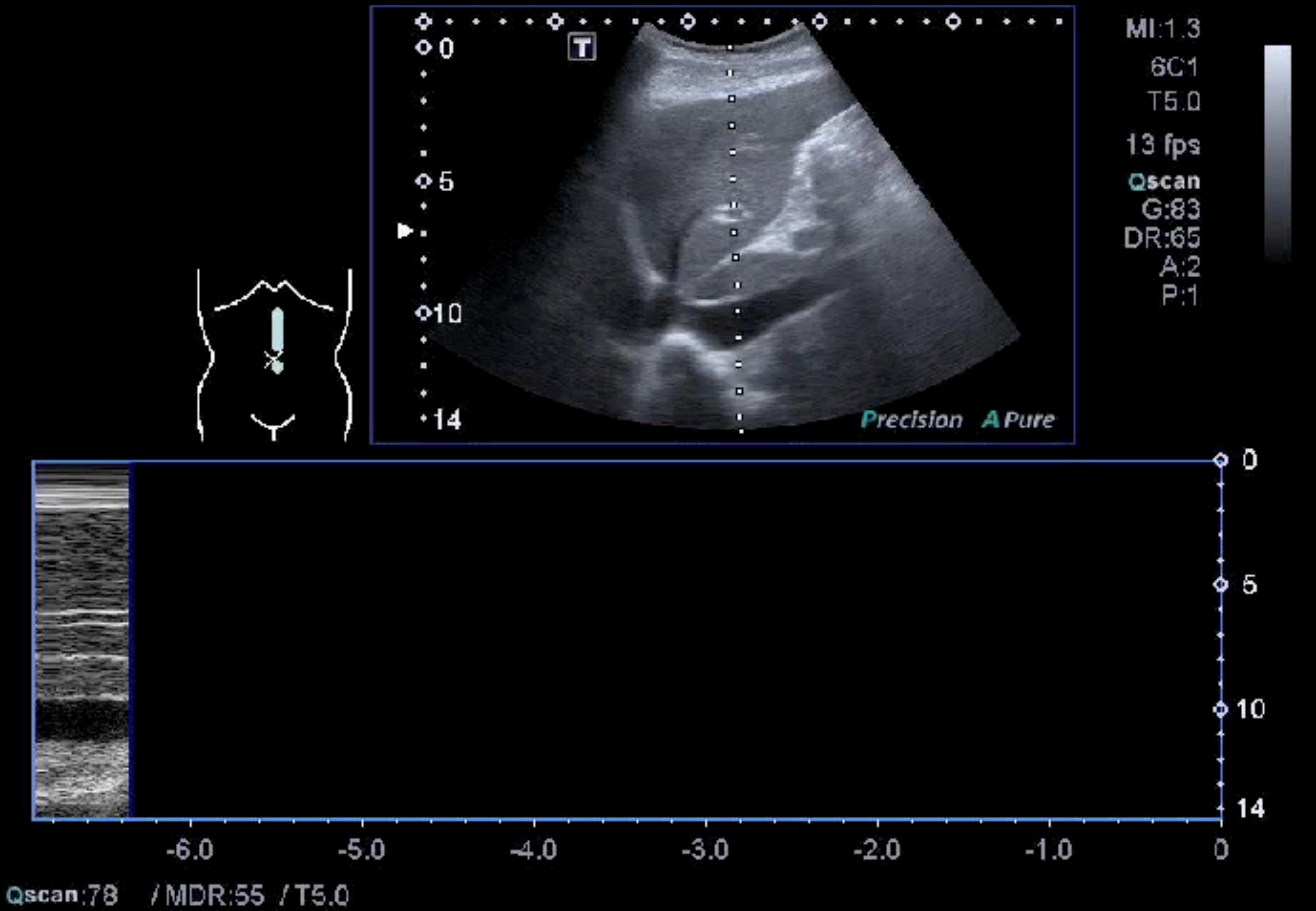
IVC

We recommend intensivists consider measuring inferior vena cava (IVC) collapsibility in patients on positive pressure ventilation, by Bedside cardiac ultrasound to assess fluid responsiveness prior to undergoing large volume fluid resuscitation. Any patient who has >15% change in vena caval diameter should be considered preload responsive. Patients with a smaller change in IVC diameter may not respond favorably to volume resuscitation. **Grade 1B**

Bibliography: Ref 14-20

Quality assessment							Summary of Findings	
(7 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	Studies result range	
							sensitivity	specificity
Diagnostic accuracy								
observational studies	serious risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊕⊖ **MODERATE**	90-100%	70-90%

MV patient
Fluid responder
IVC diameter chang > 15%



MI:1.3
6C1
T5.0
13 fps
Qscan
G:83
DR:65
A:2
P:1
0
5
10
14
Precision A Pure
-6.0
-5.0
-4.0
-3.0
-2.0
-1.0
0
Qscan:78 / MDR:55 / T5.0

ICU POCUS

CVC

ECHO

Lung

IVC

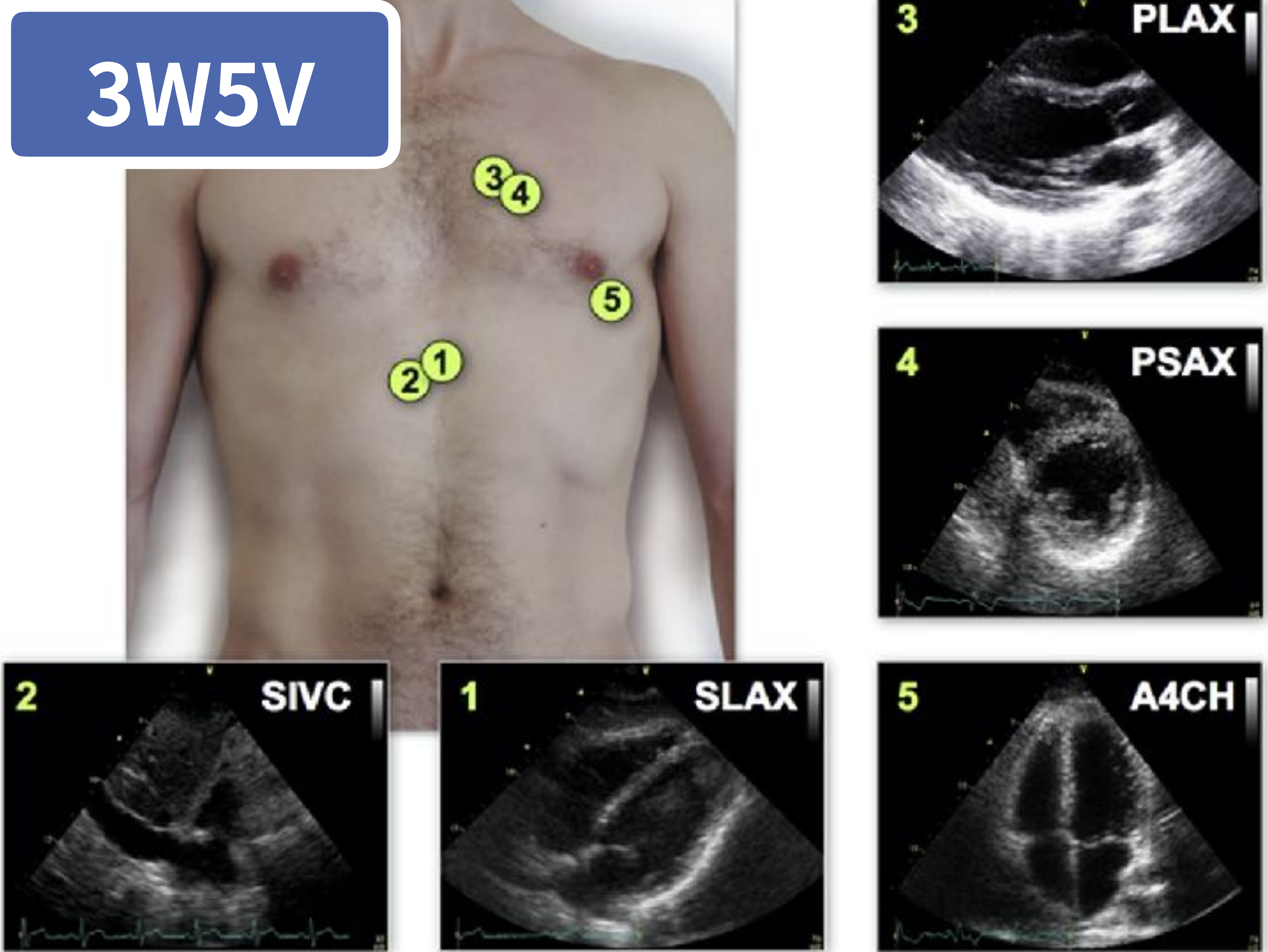
AMERICAN SOCIETY OF ECHOCARDIOGRAPHY CONSENSUS STATEMENT

Focused Cardiac Ultrasound in the Emergent Setting: A Consensus Statement of the American Society of Echocardiography and American College of Emergency Physicians

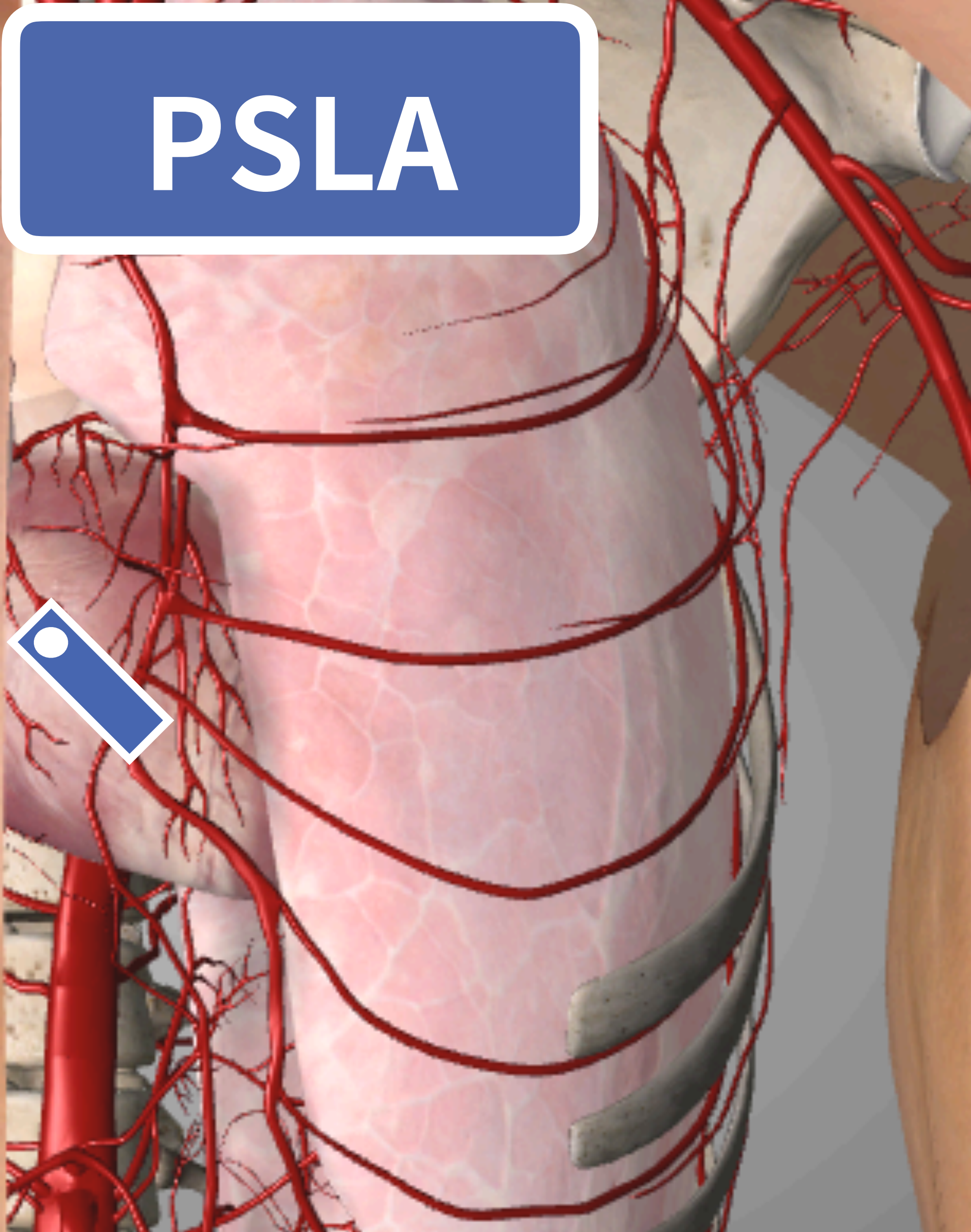
2010

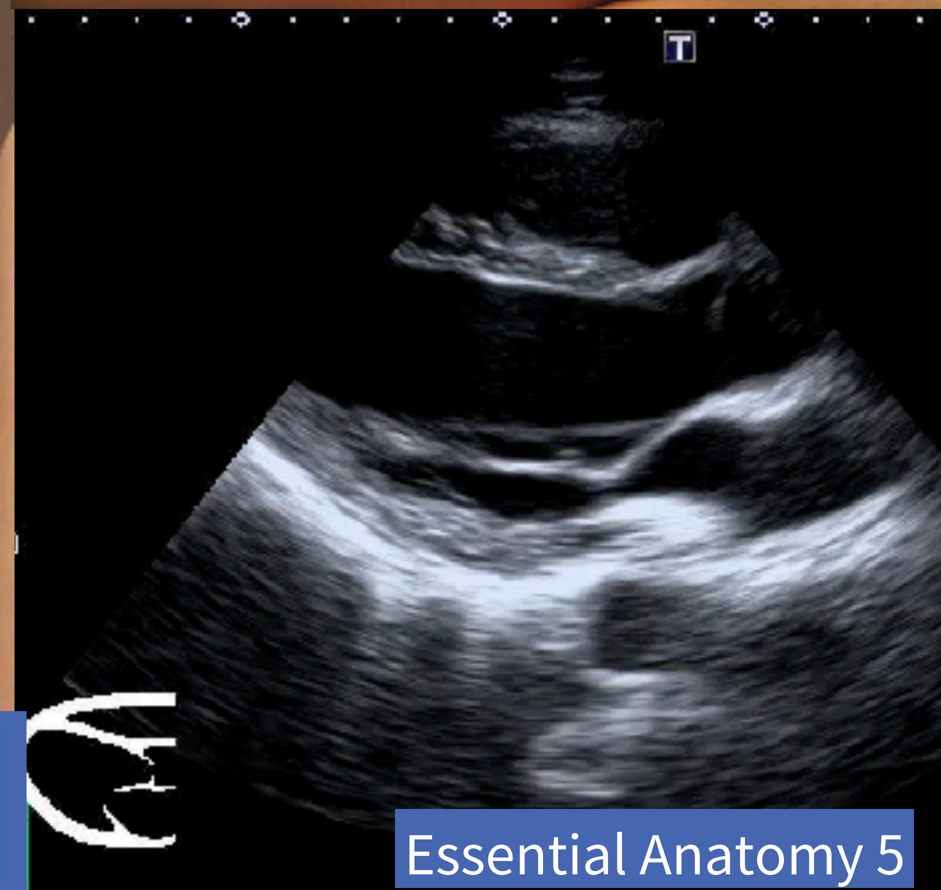
Pericardial effusion
Global systolic function
Marked RV & LV enlargement
Volume assessment
Pericardiocentesis
TVP wire confirmation

3W5V

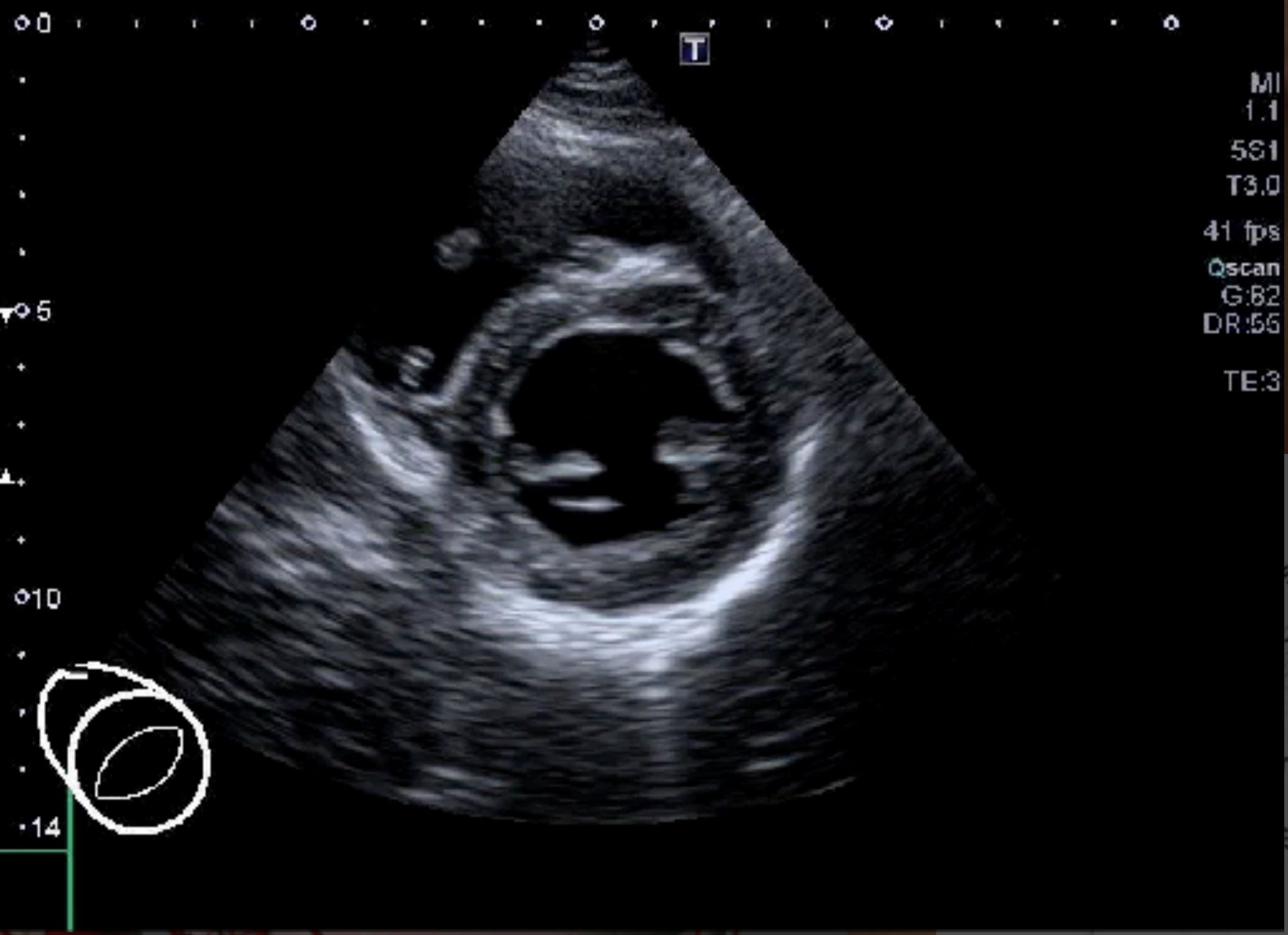


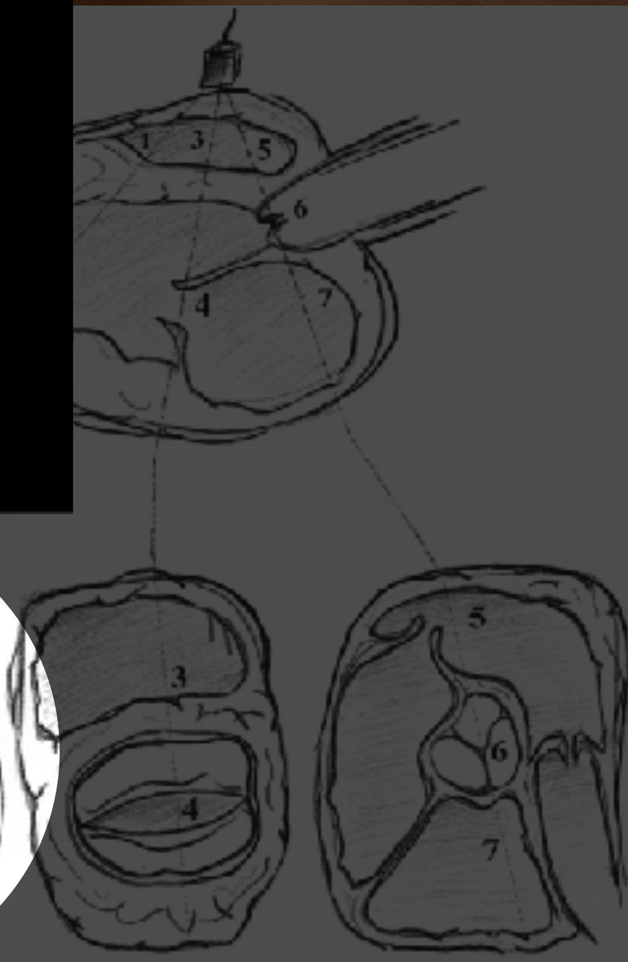
PSLA





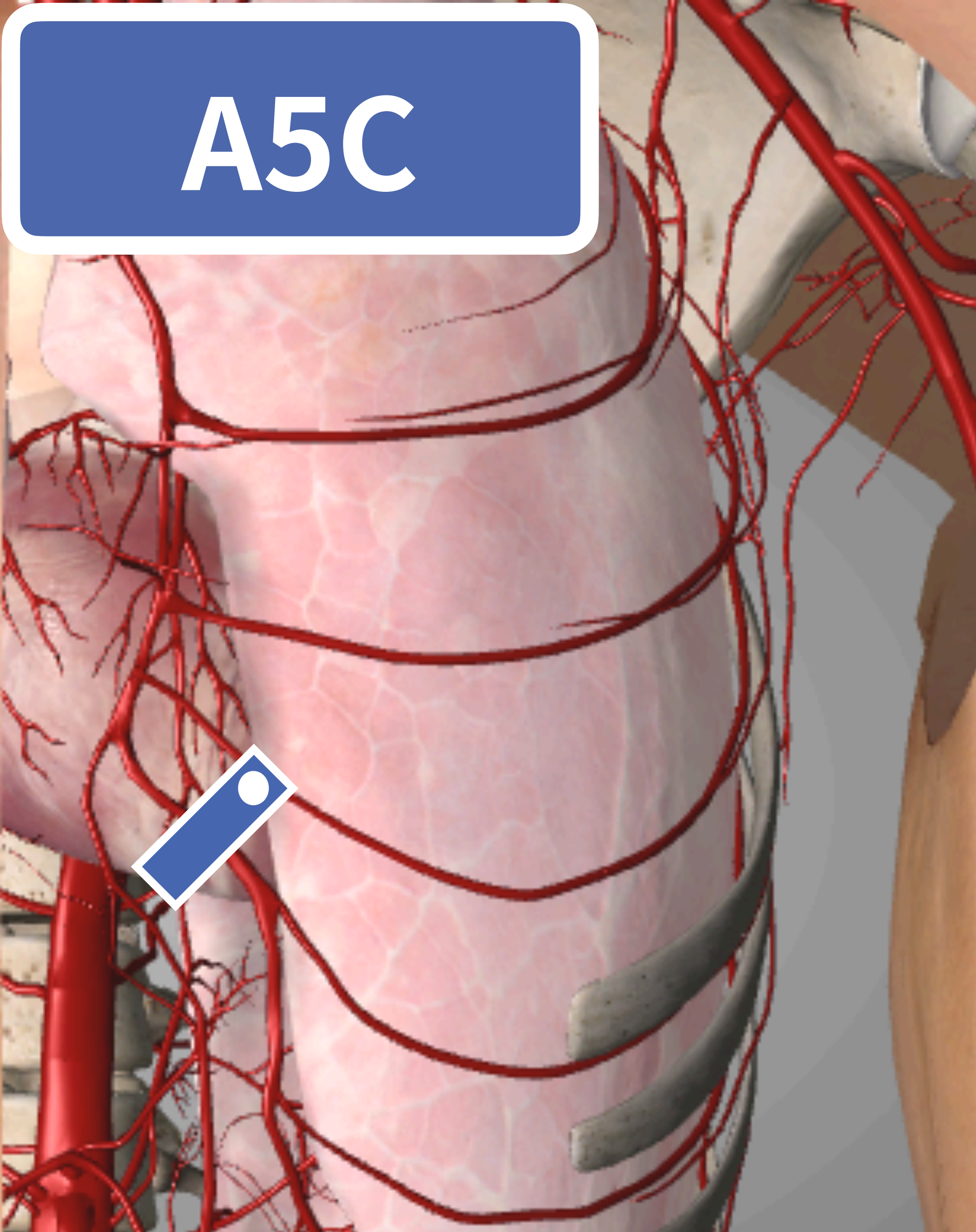
Parasternal long axis

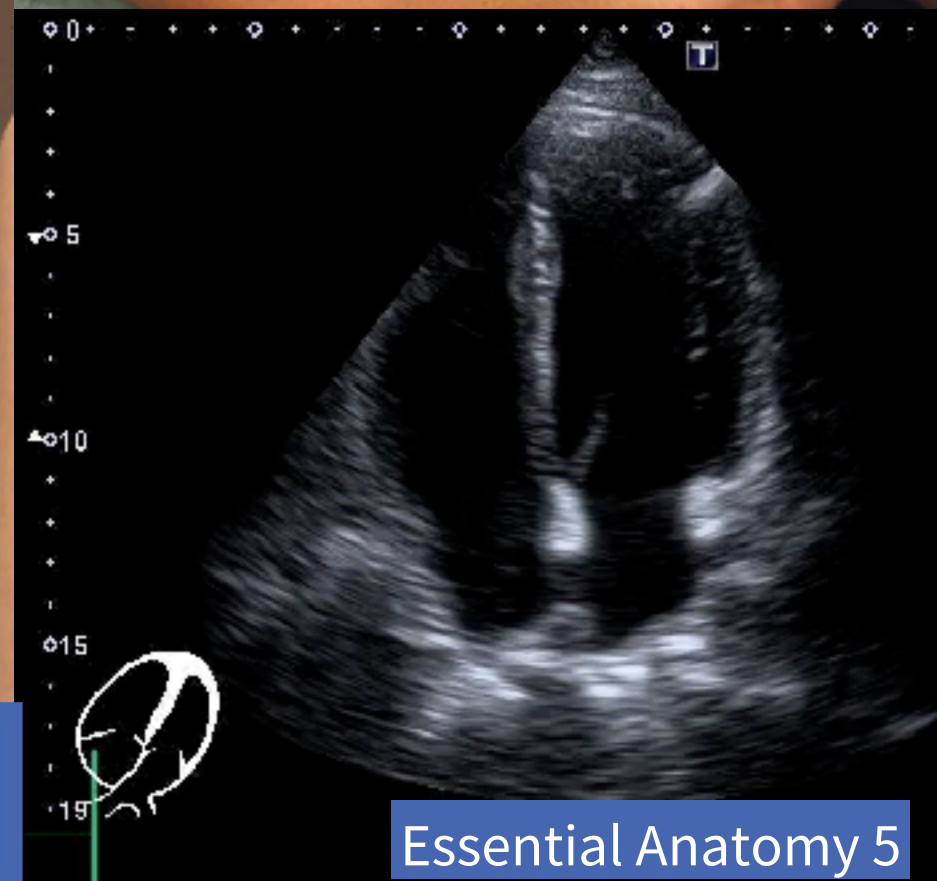




Parasternal short axis

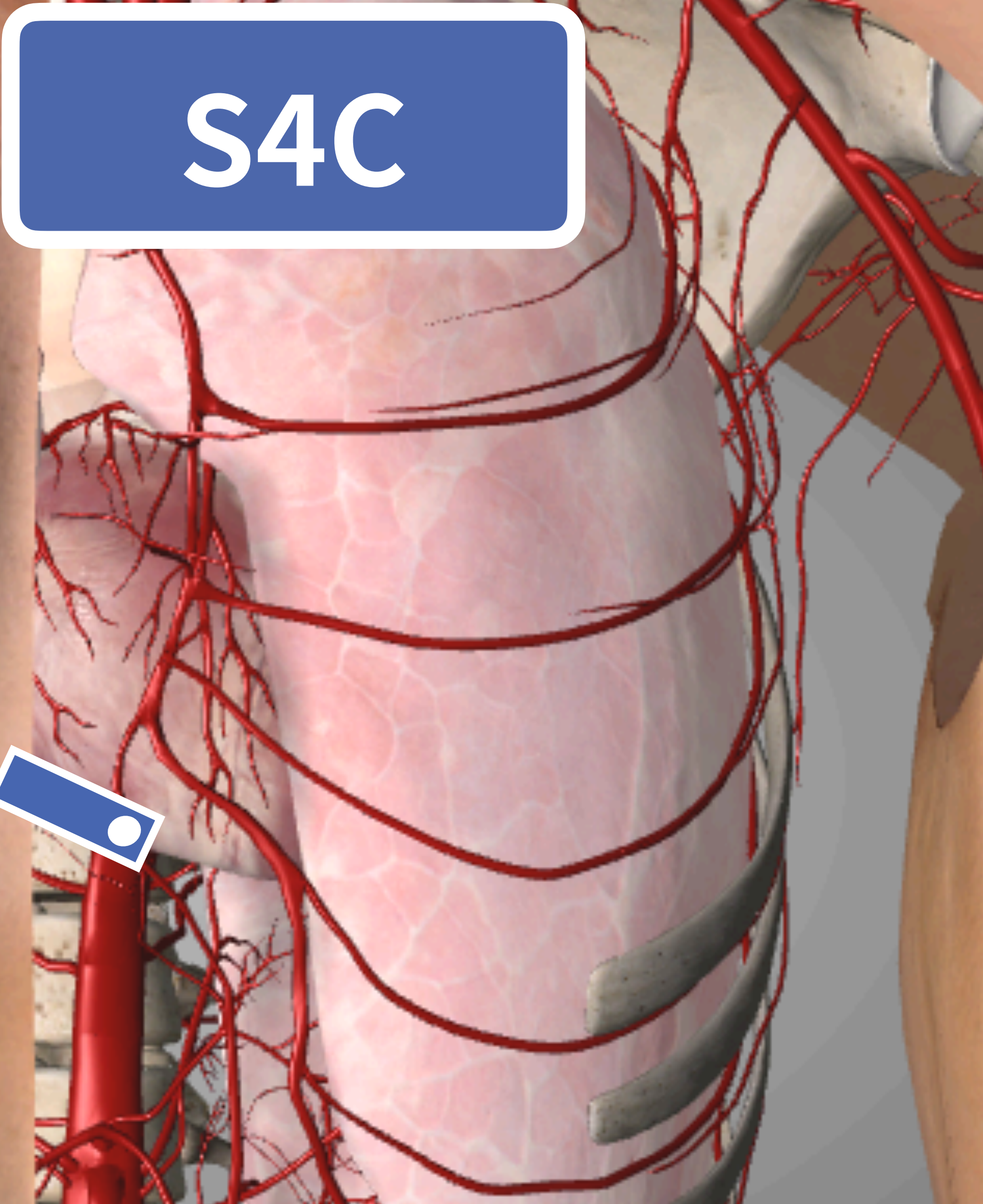
A5C

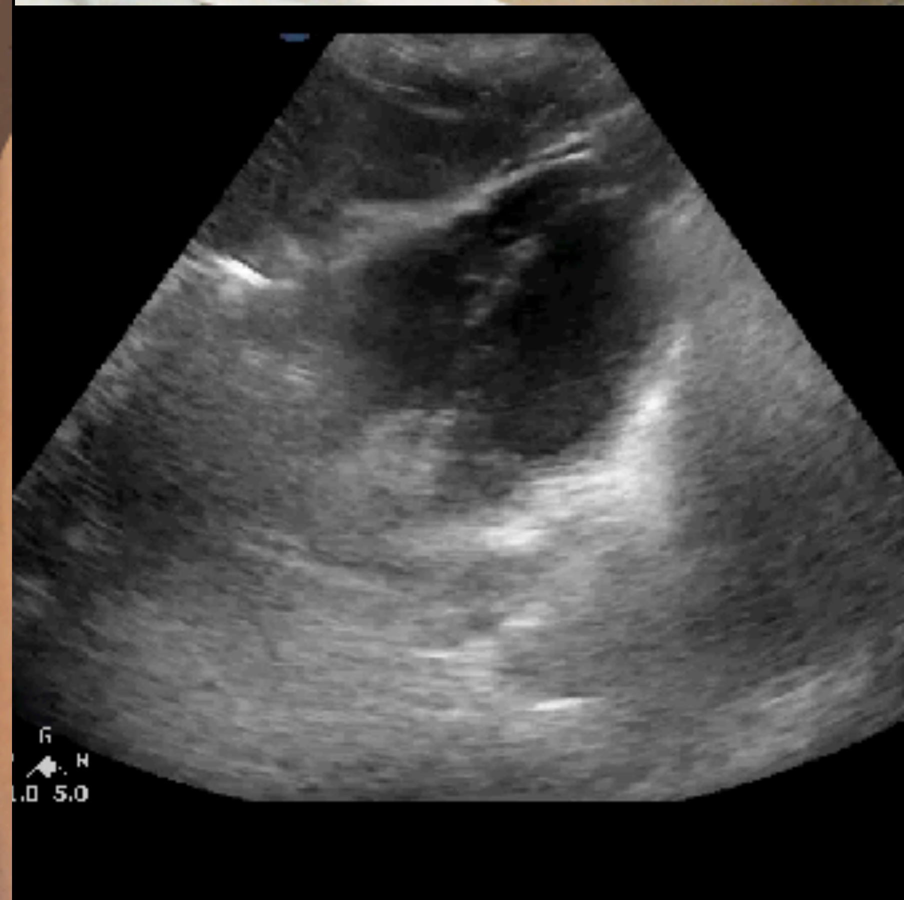




Apical 5 Chambers

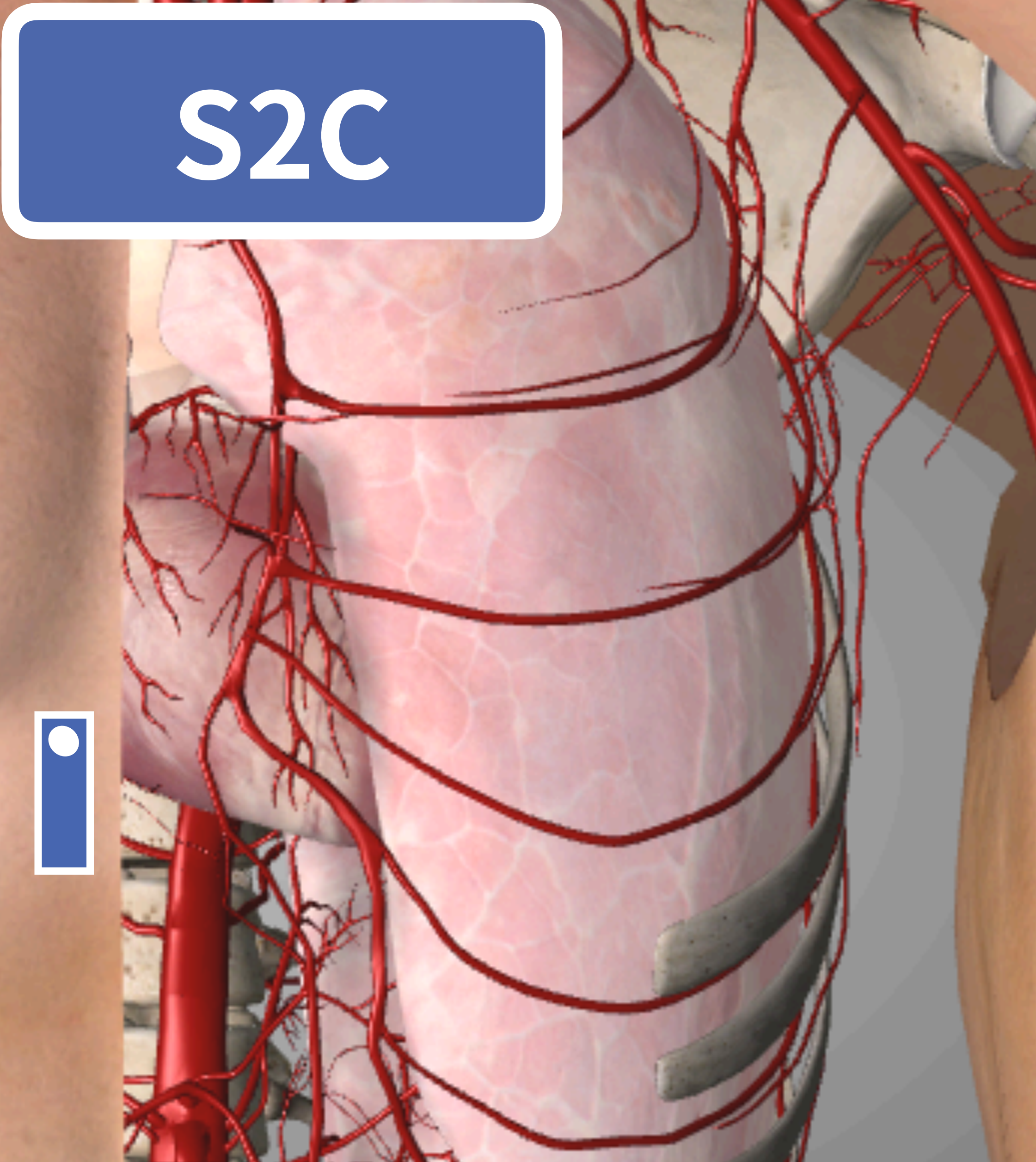
S4C

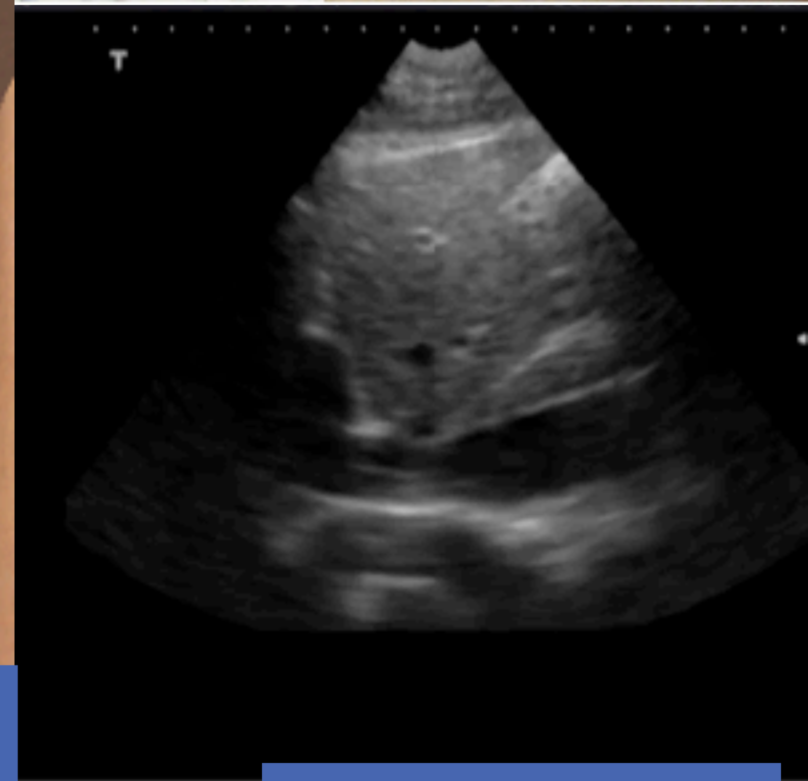




Subcostal 4 Chambers

S2C





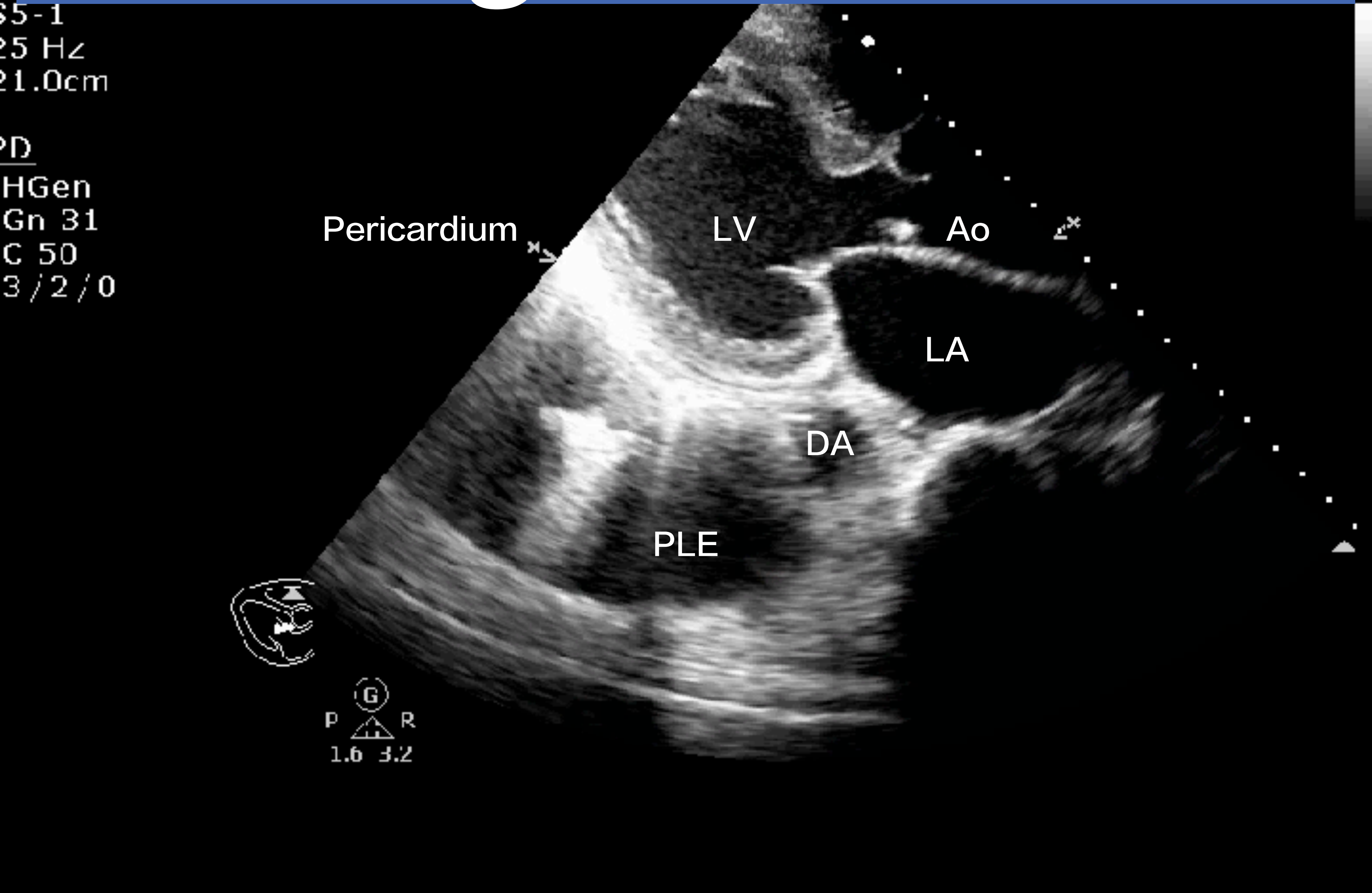
Subcostal 2 Chambers

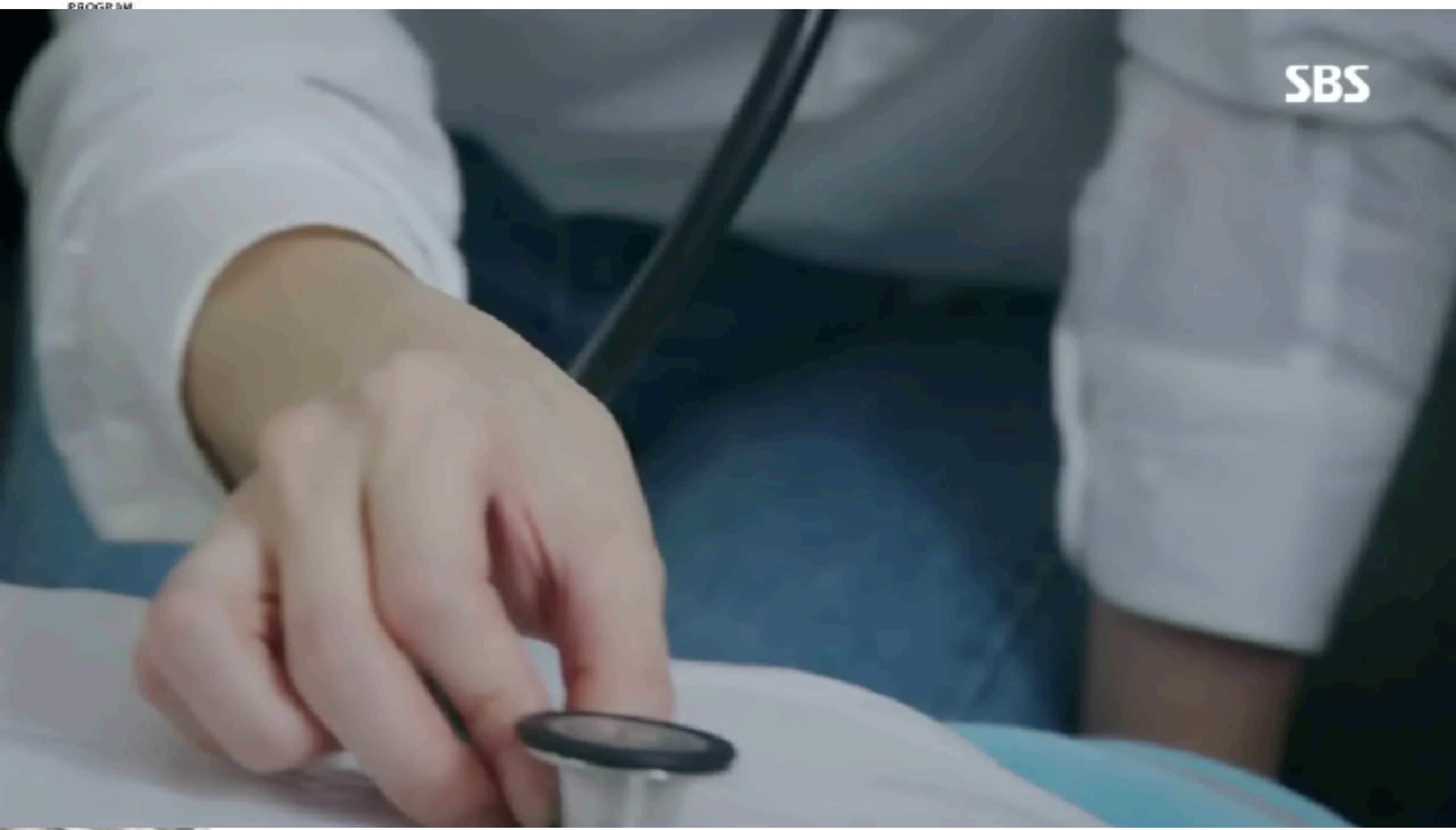
Pericardial effusion

1 ~ 2 cm

Che

DA as a good reference

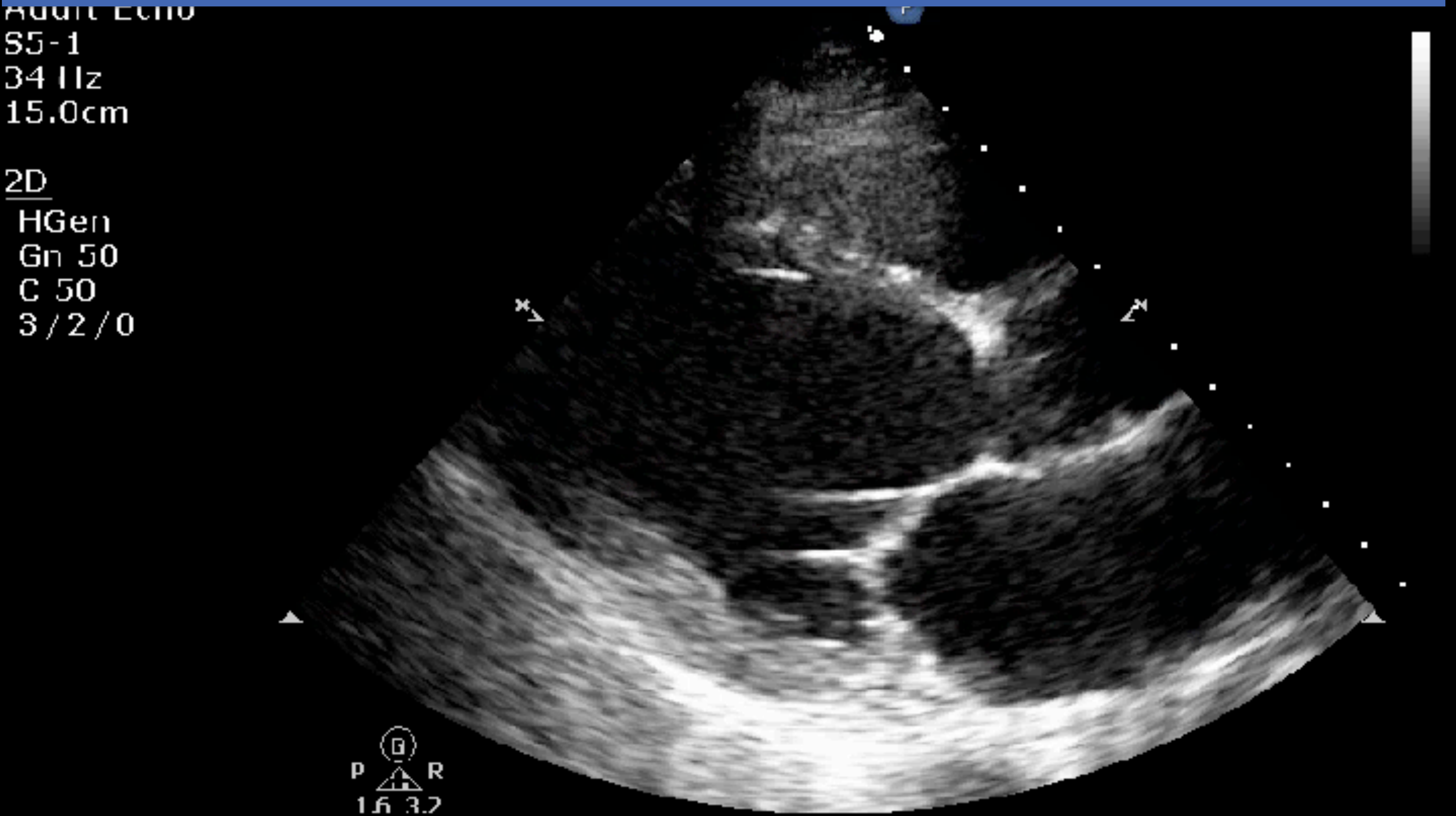



SBS

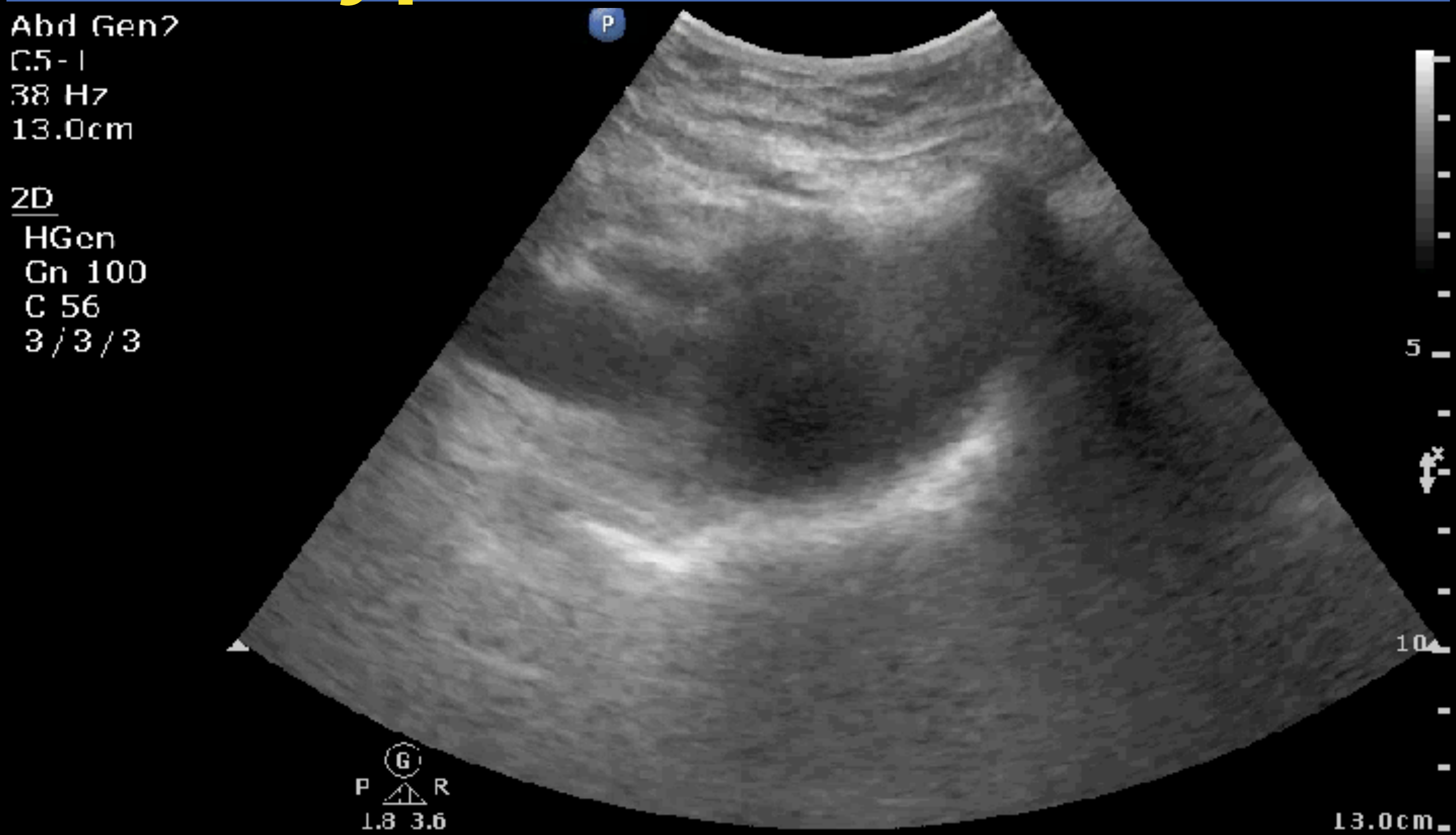
Assessment of LV systolic function
Therapeutic decision making
Fluid & Inotropic/Vasoactive agents

Assessment of LV diastolic function
Advanced
Fluid & Inotropic/Vasoactive agents

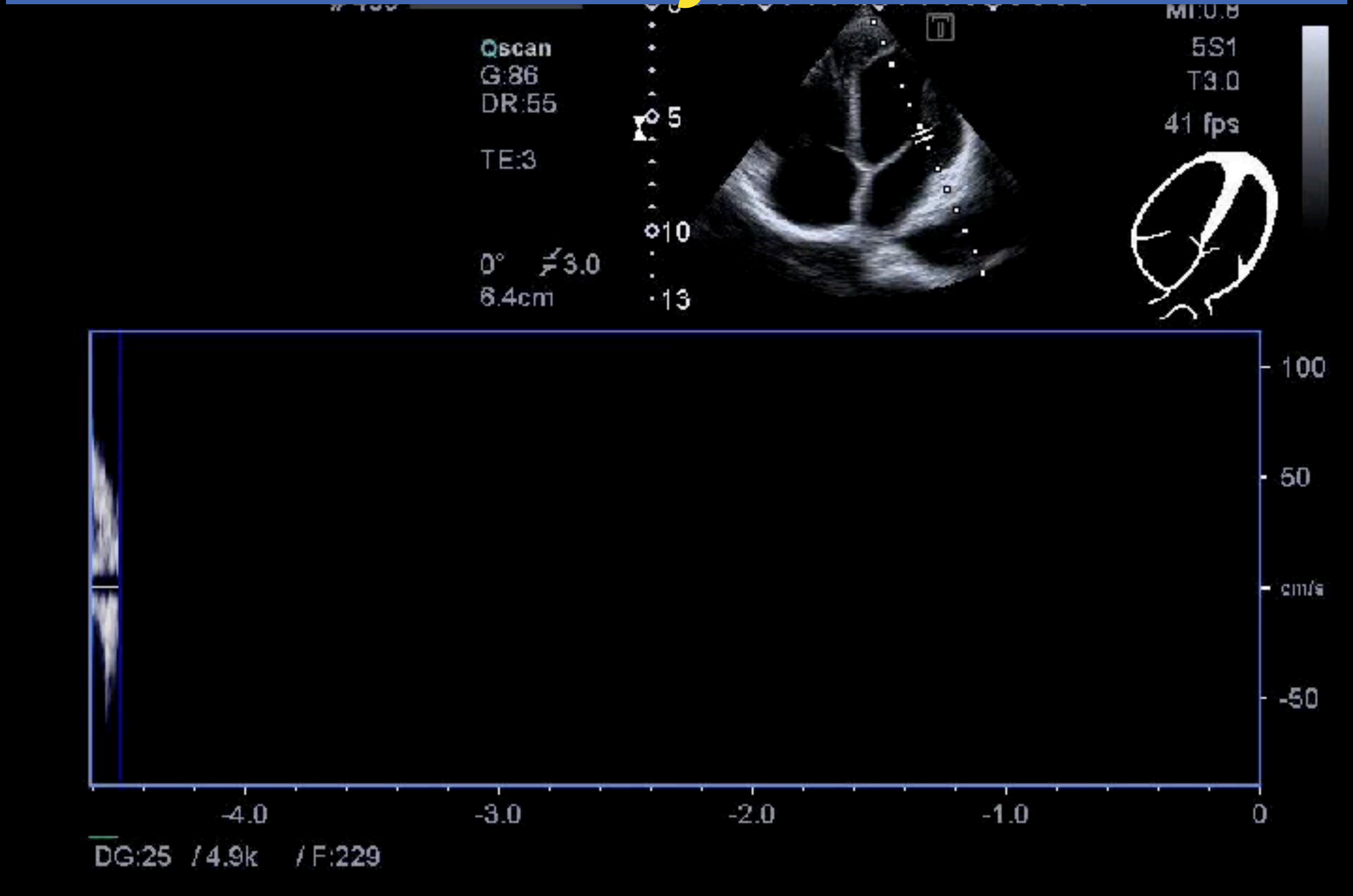
DCM with heart failure



Hypovolemic shock



Diastolic dysfunction



Acute Cor Pulmonale

Acute RV failure

Pressure or Volume overload

Systole: septal flattening, paradoxical motion

Diastole: ratio of RVEDA to LVEDA

We recommend bedside cardiac ultrasonography should be used to measure pulmonary arterial pressures in all patients with suspected primary or secondary pulmonary hypertension provided that operator has the required training for this . Grade 1B

Bibliography: Ref 35, 43-58

Quality assessment							Summary of Findings	
							Studies result range	
(17 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	sensitivity	specificity
Diagnostic accuracy								
observational studies	serious risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊕⊝ **MODERATE**	specificity	76-96%

Pulmonary HTN

Advanced

PA pressure

We recommend that bedside cardiac ultrasonography and a venous exam of the proximal bilateral lower extremities should be performed in patients with suspected pulmonary embolism and should be used prior to computed tomography in unstable patients. Grade 1C

Bibliography: Ref 50-58

Quality assessment							Summary of Findings	
(9 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	Studies result range	
							sensitivity	specificity
Diagnostic accuracy								
observational studies	serious risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊝⊝ LOW	13-76%	76-96%

Symptomatic PE
Cardiac & Venous US
Prior to CT for unstable p't
McConnell's sign

We recommend that bedside cardiac ultrasonography and a venous exam of the proximal bilateral lower extremities should be performed in patients with suspected pulmonary embolism and should be used prior to computed tomography in unstable patients. Grade 1C

Bibliography: Ref 50-58

Quality assessment							Summary of Findings	
(9 studies)	Risk of bias	Inconsistency	Indirectne ss	Imprecisi on	Publication bias	Overall quality of evidence	Studies result range	
							sensitivity	specificity
Diagnostic accuracy								
observation al studies	serious risk of bias	No serious inconsistency	No Indirectnes s	No Imprecisio n	Undetected	⊕⊕⊖⊖ LOW	13-76%	76-96%

ICU POCUS

CVC

ECHO

Lung

DVT

IVC

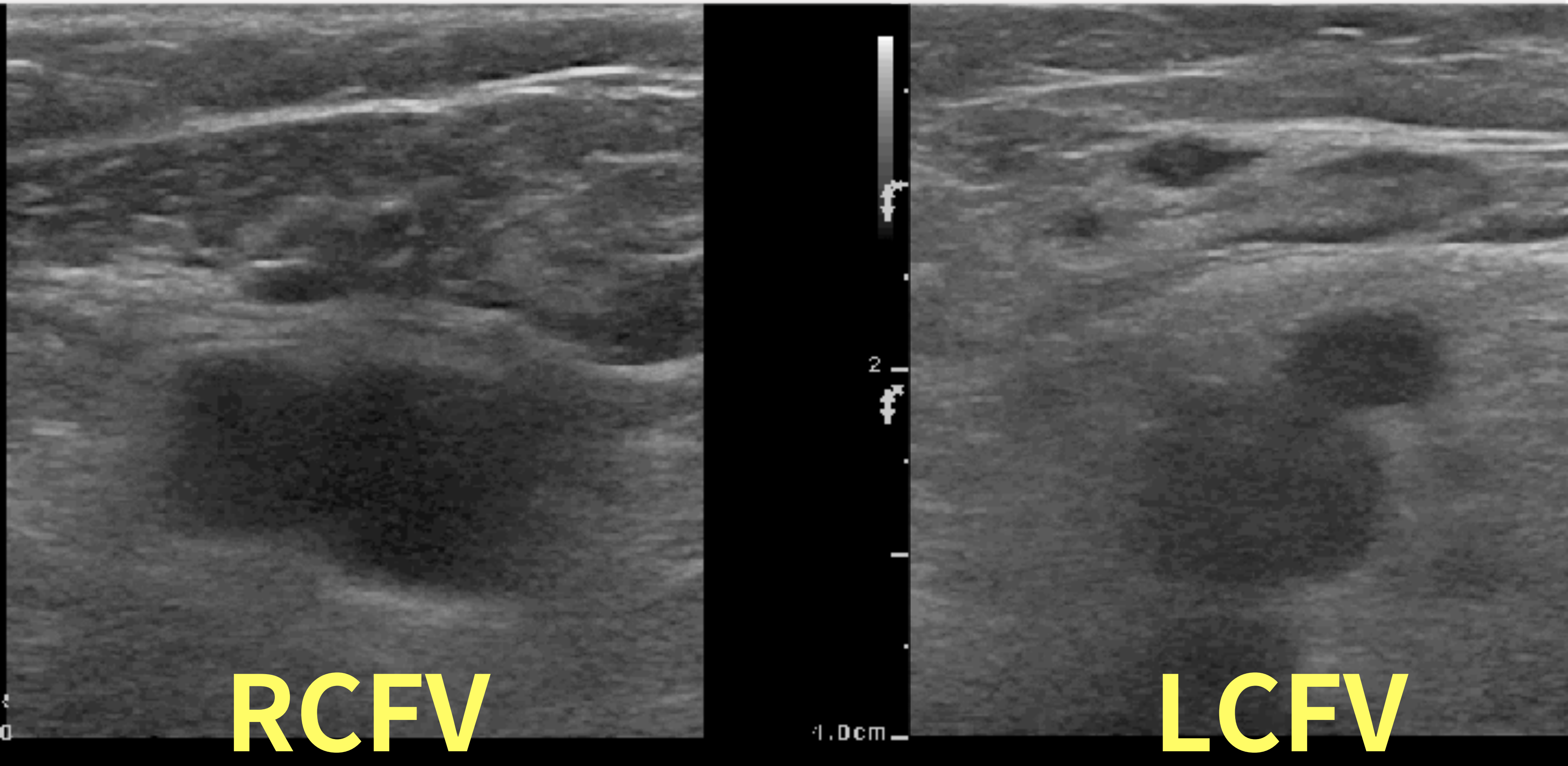
We Recommend That a Focused Ultrasound Technique Using Gray Scale Imaging to Evaluate Vein Compression at the Common Femoral and Popliteal Veins Is Sufficient to Diagnose Most Proximal Deep Venous Thrombosis (Compared With Contrast Venography). Grade 1B (54)								
Quality Assessment							Summary of Findings	
							Study Result	
	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity
Diagnostic accuracy								
Cross sectional	No risk of bias	No serious inconsistency	Indirectness	Imprecision	Potential	⊕⊕⊕⊖ Moderate	91%	99%

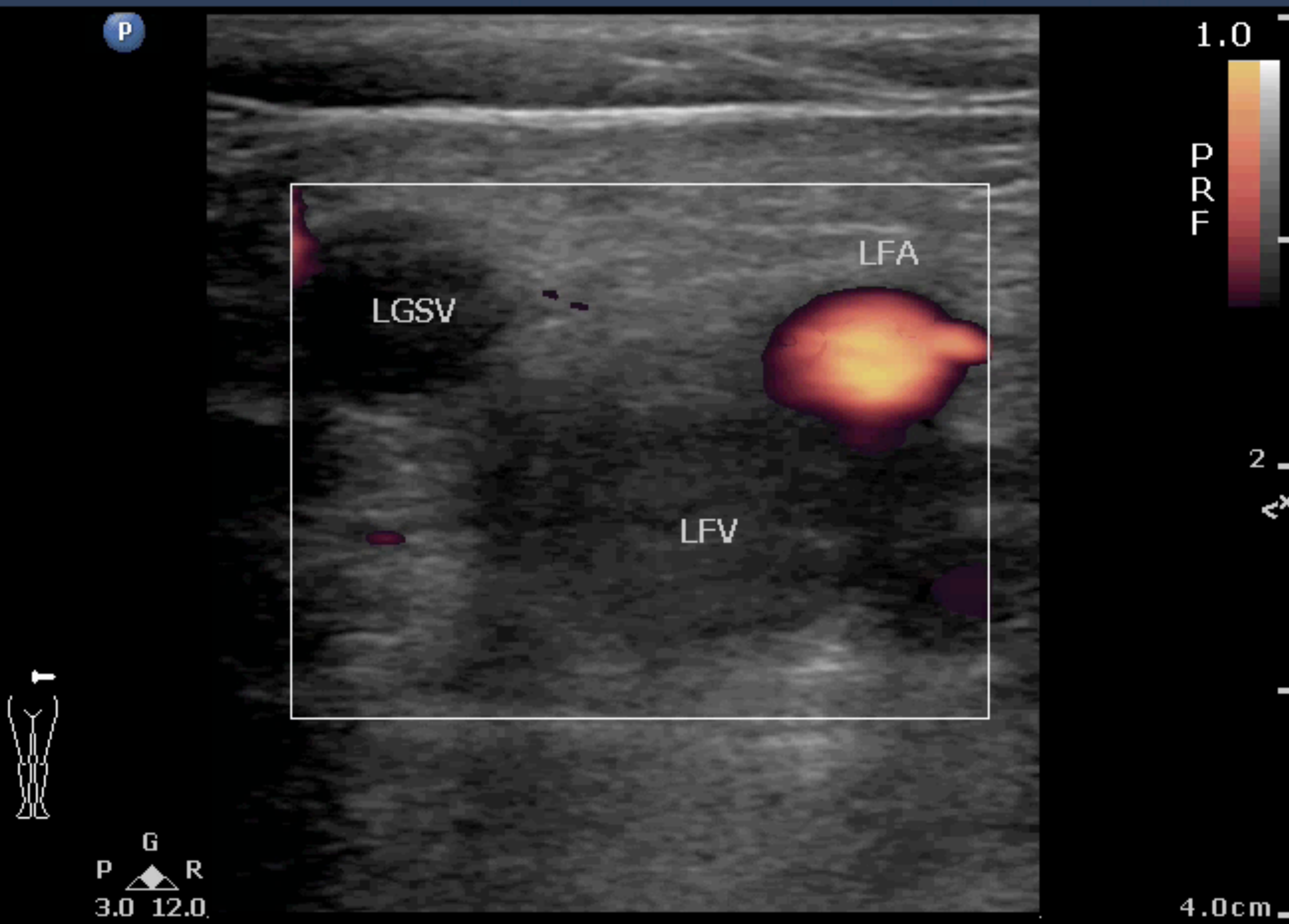
DVT screening & detection
High accuracy

We Recommend That Intensivists Can Reliably Perform a Focused Screening Examination by Ultrasound to Diagnose Lower Extremity Proximal deep venous thrombosis. Grade 1B (55)								
Quality Assessment							Summary of Findings	
							Study Result	
	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity
Diagnostic accuracy								
Cross-sectional intensivist vs radiologist	No risk of bias	No serious inconsistency	Indirectness	Imprecision	Potential	⊕⊕⊕⊖ Moderate	86%	96%

We Recommend That Intensivists Can Reliably Perform a Focused Screening Examination by Ultrasound to Diagnose Lower Extremity Proximal deep venous thrombosis. Grade 1B (55)

	Quality Assessment						Summary of Findings	
							Study Result	
	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	Specificity
Diagnostic accuracy								
Cross-sectional intensivist vs radiologist	No risk of bias	No serious inconsistency	Indirectness	Imprecision	Potential	⊕⊕⊕⊝ Moderate	86%	96%





P
1.0
PRF
LFA
LGSV
LFV
2
G
P
R
3.0 12.0
4.0cm

ICU POCUS

CVC

ECHO

Lung

DVT

IVC

Shock

Undifferentiated shock

Narrow D/D

Faster diagnosis

Guide resuscitation

Goal-directed protocol

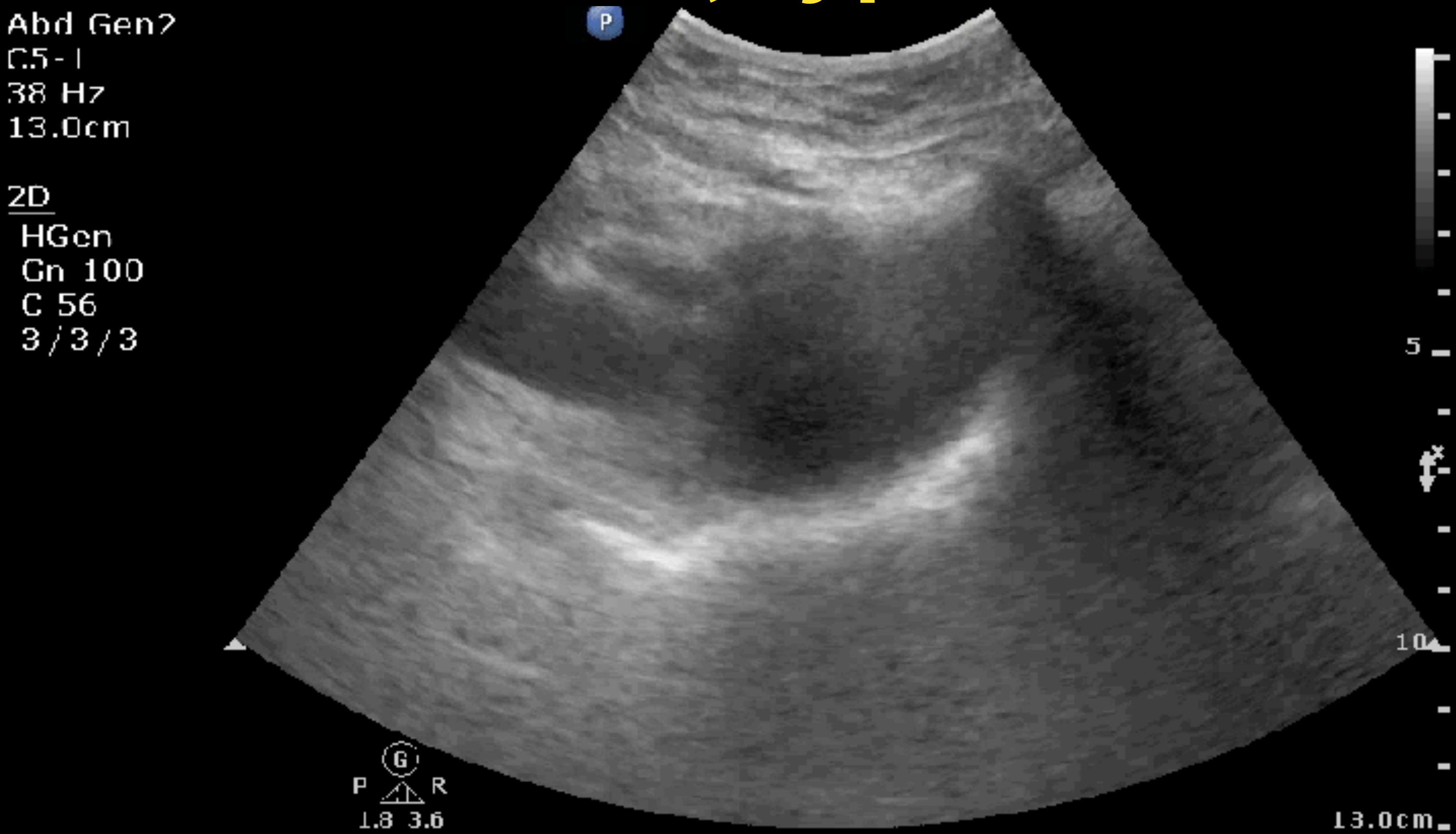

Abd Gen2
C5-1
36 Hz
2D
HGen
Gn 60
8.0cm
2D
Gn 57

We recommend that bedside cardiac ultrasonography should be performed to diagnose cardiac tamponade and to increase the effectiveness and safety of pericardiocentesis and guide performance of the procedure. Grade 1B
Bibliography: Ref 123-134 plus 2 studies*

Quality assessment							Summary of Findings	
(14 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	Studies result range	
							sensitivity	specificity
Diagnostic accuracy								
observational studies	No risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊕⊖ **MODERATE**	96%	98%
Success and Complication rate								
observational studies	serious risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊖⊖ **LOW**	Success rate Complication rate	97% 4.7%

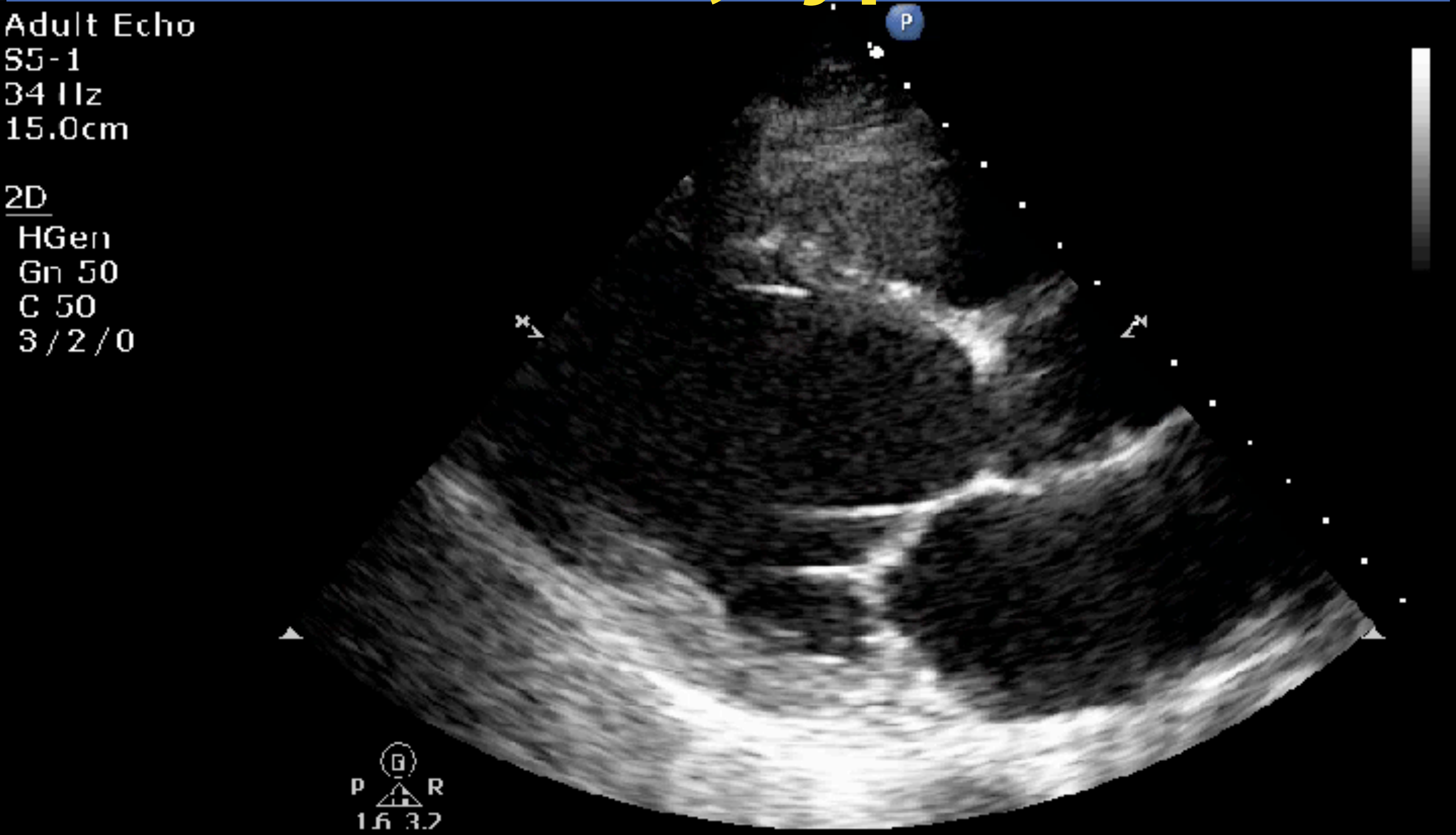
Diagnosis & Intervention

Shock, type ?



Abd Gen2
C5-1
38 Hz
13.0cm
2D
HGen
Gn 100
C 56
3/3/3
P
5
10
G
P R
1.8 3.6
13.0cm

Shock, type ?



Shock, type ?


Khonkaen hospital (ER)
cardiac Ratra...
SP5-1s
03-09-2017 15:40:28
20170903-154017-ED02
AP 96.6% MI 1.4 TIS 0.9
mindray
M9
B
F PH3.4
D 15.0
G 51
FR 35
DR 145
iClear 7
Echo Boost

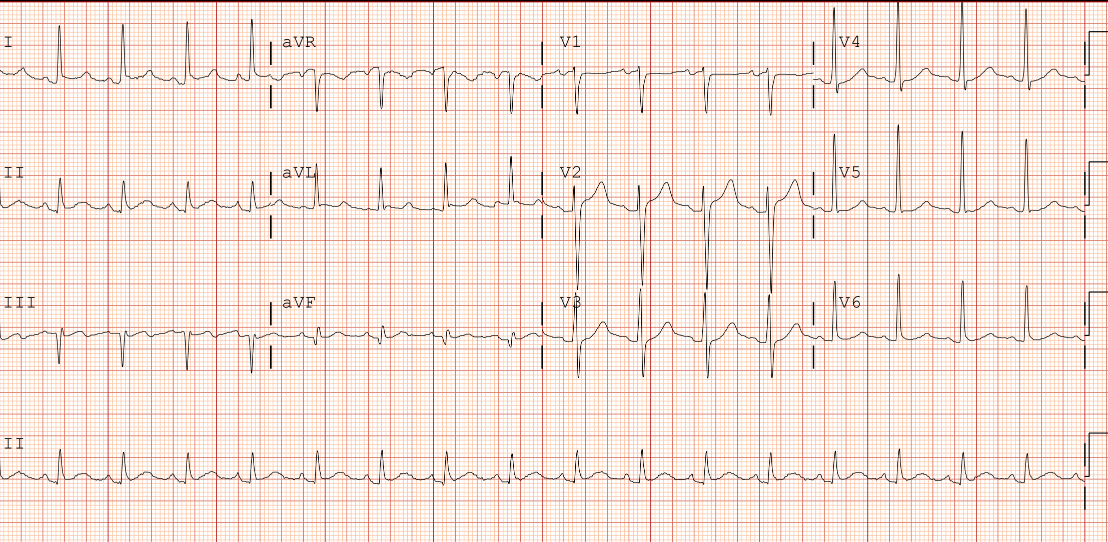
We recommend that patients with suspected ACS and AMI should receive a bedside cardiac ultrasonography. Grade 1C

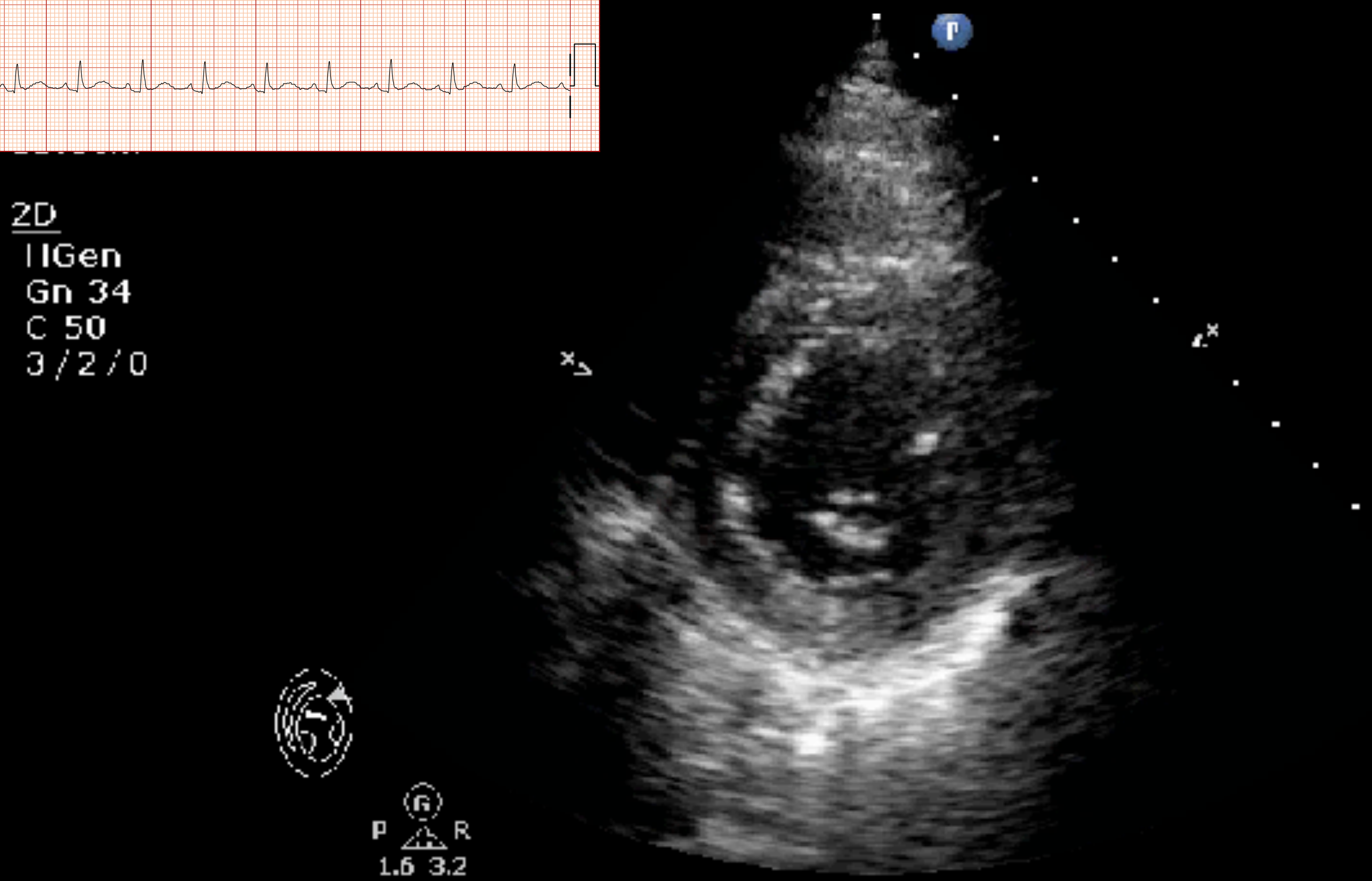
Bibliography: see table SoF-7 plus 119-122

Quality assessment							Summary of Findings	
							Studies result range	
(9 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	sensitivity	specificity
Diagnostic accuracy								
observational studies	serious risk of bias	No serious inconsistency	Serious Indirectness	No Imprecision	Undetected	⊕⊕⊖⊖ LOW	92-100%	82-93%

ACS and AMI

Advanced


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


2D
IIGen
Gn 34
C 50
3/2/0
P
R
1.6 3.2

ACS and AMI
Advanced

WM abnormality
LV function
MV dysfunction
Rule out RV involvement
Mechanical complications of AMI
Prompt diagnosis & management

Valve for all

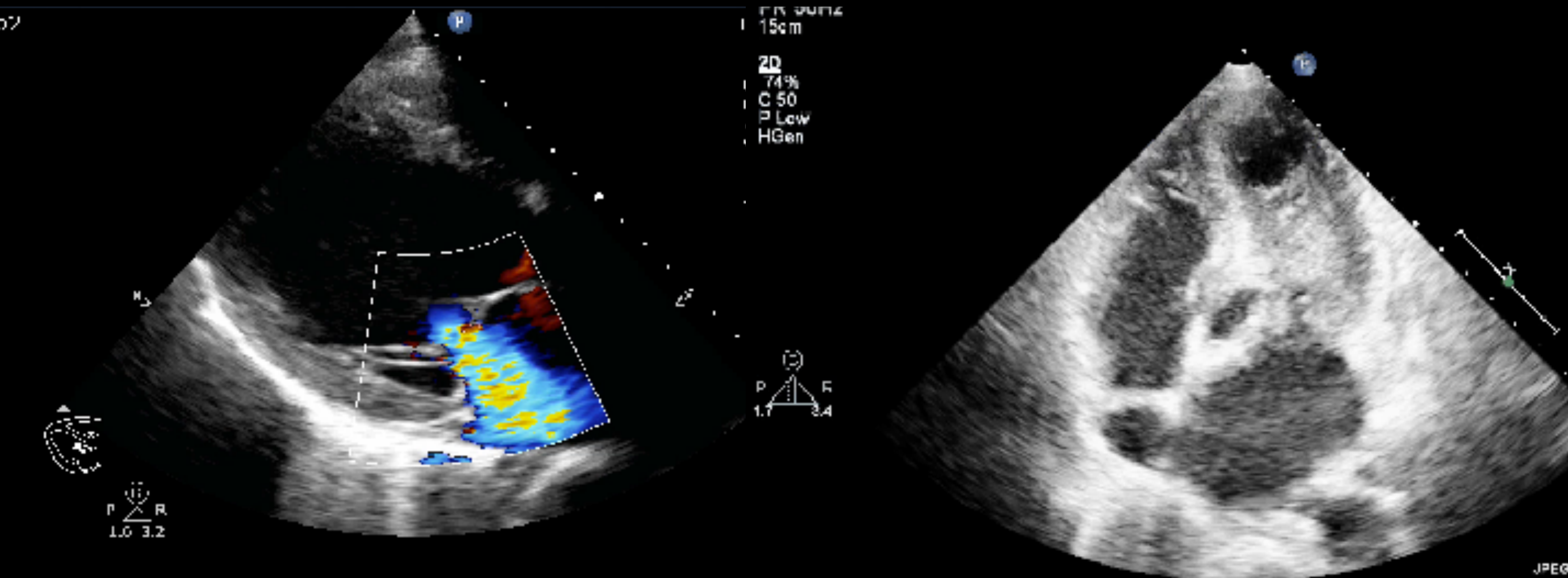
New murmur

Endocarditis

Valve for expert

Mechanical dysfunction

Prosthetic endocarditis (Advanced)



15cm
2D
74%
C 50
P Low
HGen
P R
1.0 3.2
1.7 3.4
JPEG

We suggest that all patients admitted for sepsis may receive a bedside cardiac ultrasonography to evaluate for signs of LV dysfunctions both systolic and diastolic to help guide inotropic therapy. Grade 2C

Bibliography: 66-77 plus MA$

Quality assessment							Summary of Findings
3 multi-central trials* and 1 meta-analysis$	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication bias**	**Overall quality of evidence**	**RR** (95% CI)
Early Goal Directed Therapy (EGDT) subgroups in first 6 hours							
	No serious risk of bias	No inconsistency	Very serious indirectness	No serious imprecision	Undetected	⊕⊖⊖⊖ **VERY LOW**	**0.77** **(CI 0.67-0.89)**

Sepsis resuscitation 6 hour bundle

LV dysfunction, sepsis
To guide inotropic therapy

RV dysfunction, sepsis
To guide fluid or drugs

ULTRASOUND PROGRAM

ICU POCUS

- CVC
- ECHO
- Resus
- Lung
- DVT
- IVC
- Shock

We suggest that bedside cardiac ultrasonography may be performed during asystole to guide further resuscitative efforts. Grade 2C

Bibliography: 81-111

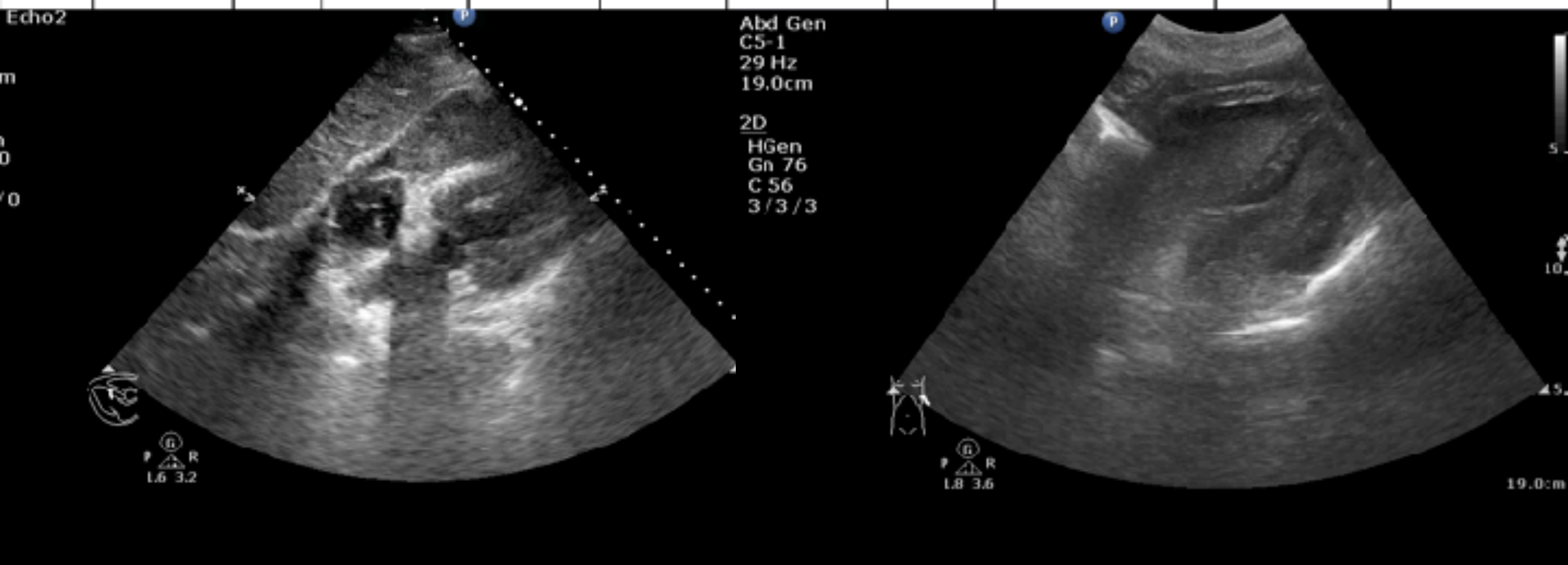
Quality assessment							Effect		Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative (95% CI)	Absolute (95% CI)		
Electrical Asystole										
11	observational studies	Very serious	No serious	serious	not serious	none	not estimable	not estimable	⊕⊝⊝⊝ VERY LOW	Critical
Pulseless Electrical Activity (PEA)										
14	observational studies	Very serious	No serious	serious	not serious	none	not estimable	not estimable)	⊕⊝⊝⊝ VERY LOW	Critical

Diagnosis
Assist resuscitation
Prognosis
Minimal interruption

We suggest that bedside cardiac ultrasonography may be performed during asystole to guide further resuscitative efforts. Grade 2C

Bibliography: 81-111

Quality assessment							Effect		Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative (95% CI)	Absolute (95% CI)		
Electrical Asystole										
11	observational studies	Very serious	No serious	serious	not serious	none	not estimable	not estimable	⊕⊖⊖⊖ VERY LOW	Critical
Pulseless Electrical Activity (PEA)										
14	observational studies	Very serious	No serious	serious	not serious	none	not estimable	not estimable)	⊕⊖⊖⊖ VERY LOW	Critical



We recommend that bedside cardiac ultrasonography should be performed in patients with ventricular tachycardia/ fibrillation arrest following return of spontaneous circulation (ROSC) to look for segmental wall motion abnormalities a a surrogate for CAD being the primary cause of cardiac arrest. Grade 1B

Bibliography: Ref 112-115 plus 1 handheld study*

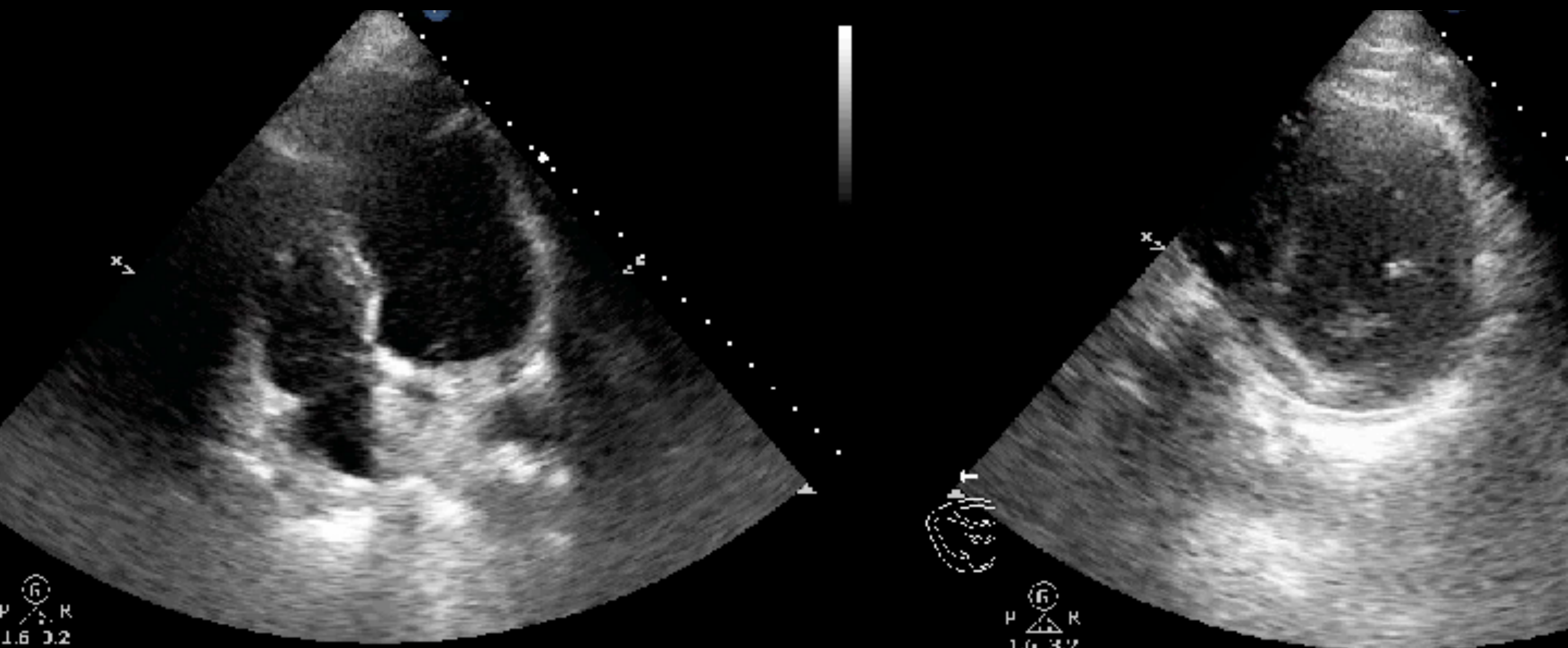
Quality assessment							Summary of Findings	
							Studies result range	
(5 studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	sensitivity	specificity
Diagnostic accuracy								
observational studies	serious risk of bias	No serious inconsistency	No Indirectness	No Imprecision	Undetected	⊕⊕⊕⊖ MODERATE	92-100%	82-93%

VT/VF arrest & ROSC

Regional WMA

We recommend that bedside cardiac ultrasonography should be performed in patients with ventricular tachycardia/fibrillation arrest following return of spontaneous circulation (ROSC) to look for segmental wall motion abnormalities a surrogate for CAD being the primary cause of cardiac arrest. Grade 1B

Bibliography: Ref 112-115 plus 1 handheld study*



TEE during CPR

Advanced

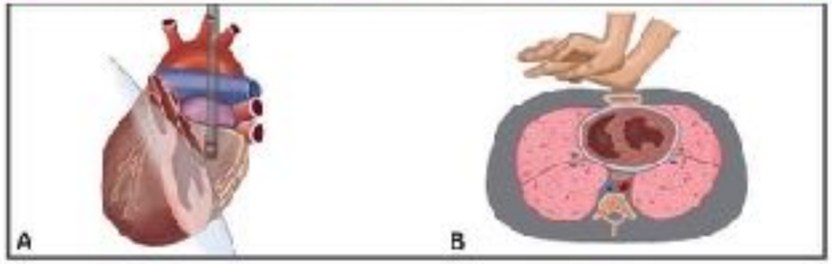
Intraoperative cardiac arrest

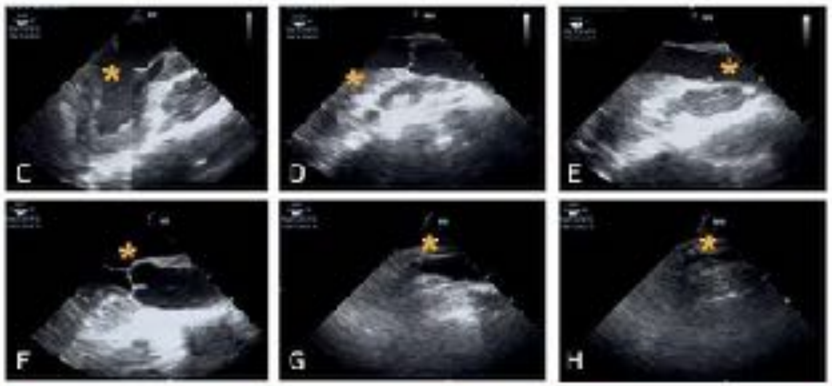
ULTRASOUND PROGRAM

CENTRAL ILLUSTRATION: Use of Focused Transesophageal Echocardiography During Cardiac Arrest Resuscitation

Enhancing Quality of CPR

- Minimize interruptions of CPR
- Allow real-time feedback of quality of chest compressions (i.e., obstruction of LVOT/Ao)





Diagnostic Role/Procedural Guidance

- Identification of potentially treatable pathologies (i.e., cardiac tamponade)
- Intra- or peri-arrest procedural guidance (i.e., ECMO)

Prognostic Role

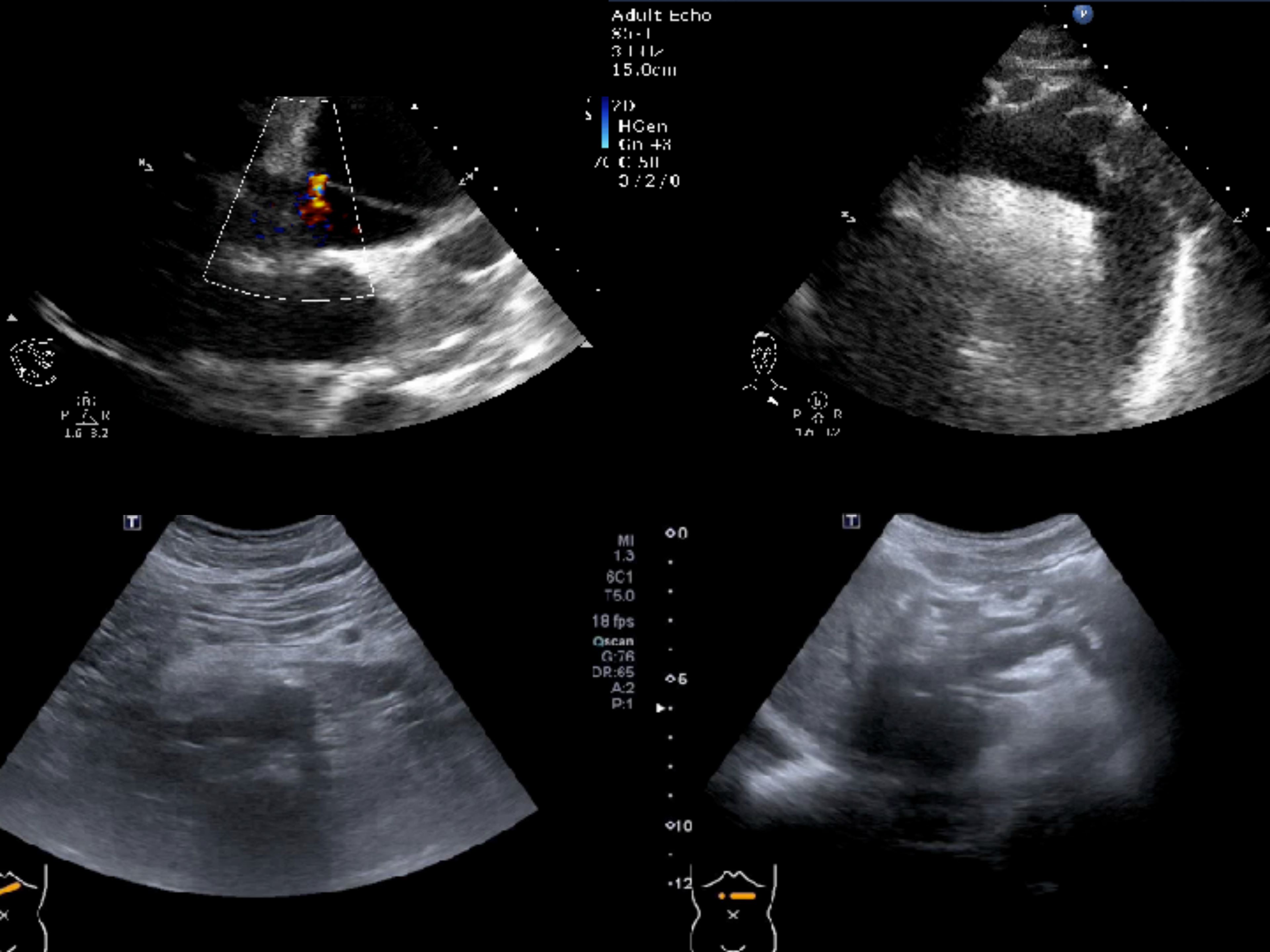
- Characterization of myocardial activity (i.e., cardiac standstill, organized vs. disorganized contractions)
- Continuous imaging of cardiac function

Taipei Mc

Teran, F. et al. J Am Coll Cardiol. 2020;76(6):745-54.

Great vessel disease & Injury
Hemodynamic unstable p't

Proximal aortic arch
Aortic aortic root
Aortic valve
Portion of thoracic descending aorta
Pericardial effusion
Pleural effusion


Adult Echo
15.0cm
2D
HGen
MI
1.3
6C1
T5.0
18 fps
Qscan
G:76
DR:65
A:2
P:1

ULTRASOUND PROGRAM

ICU POCUS

CVC

ECHO

Resus

Lung

DVT

Trauma

IVC

Shock

Blunt chest trauma

Limited value for
blunt cardiac injury

Unclear etiology & unstable
Abnormal ECG
Cardiac arrhythmia

Blunt chest trauma

Pericardial effusion

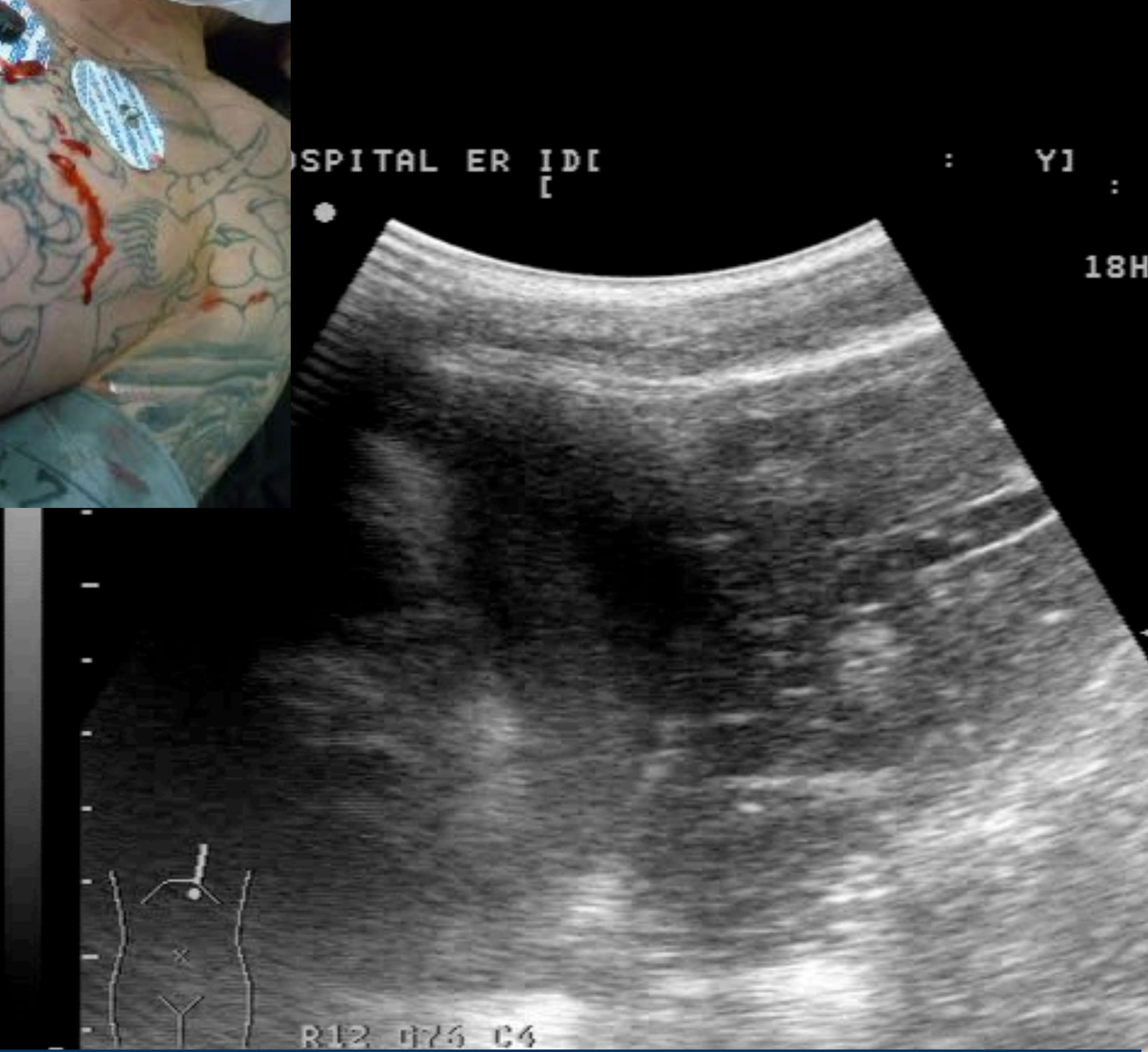
Penetrating chest trauma

Unstable → thoracotomy

Stable

↓

free fluid & free air

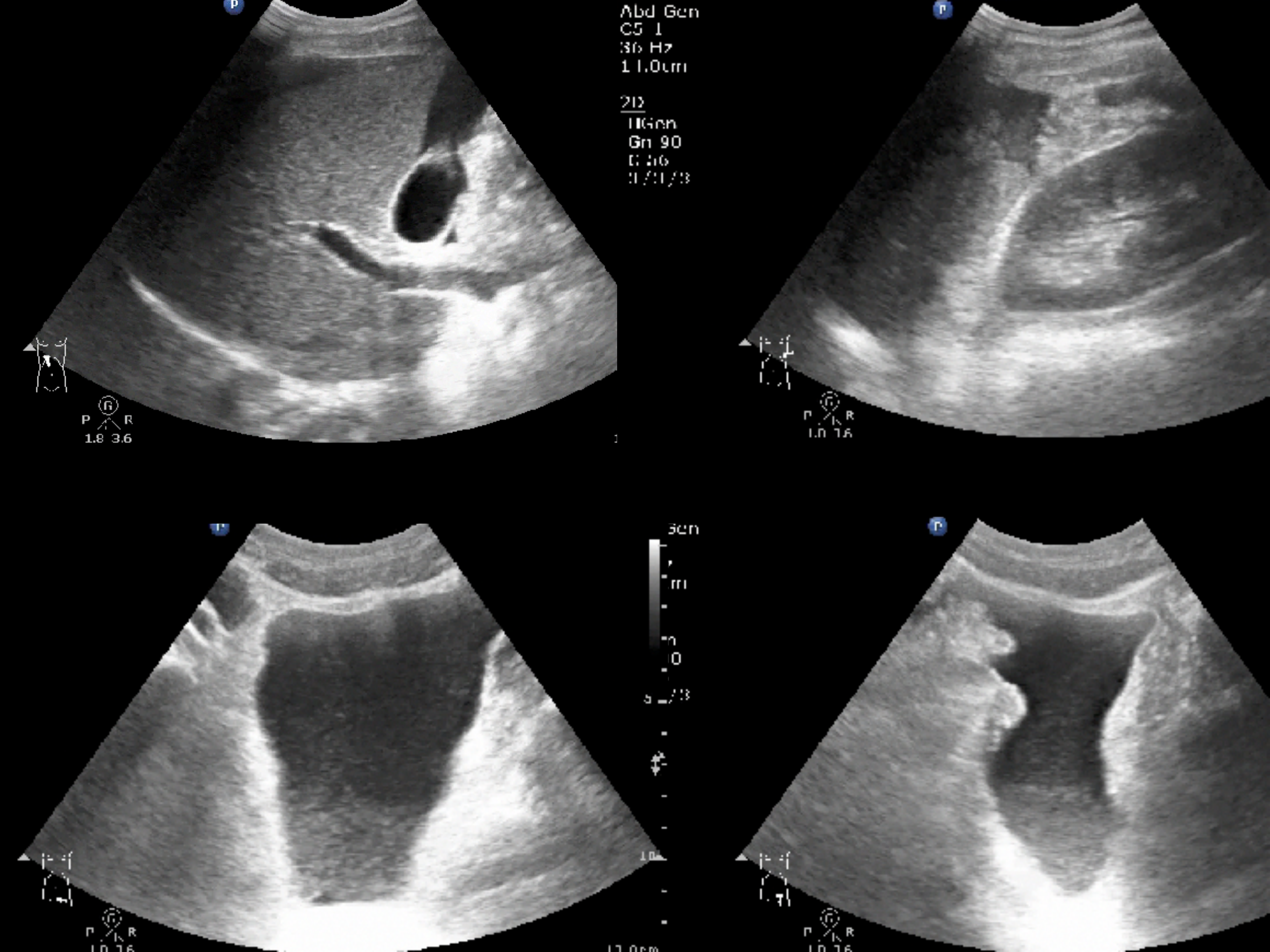


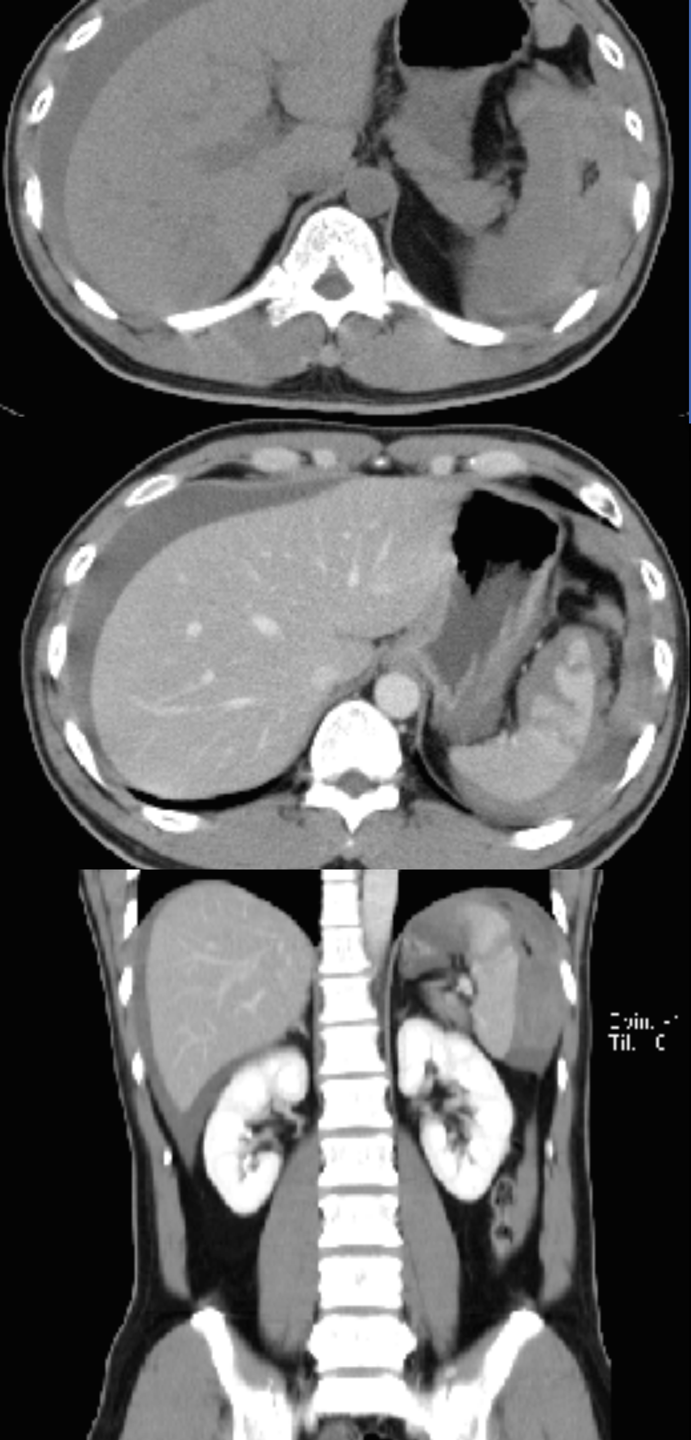
Penetrating injury

36M, Traffic accident victim

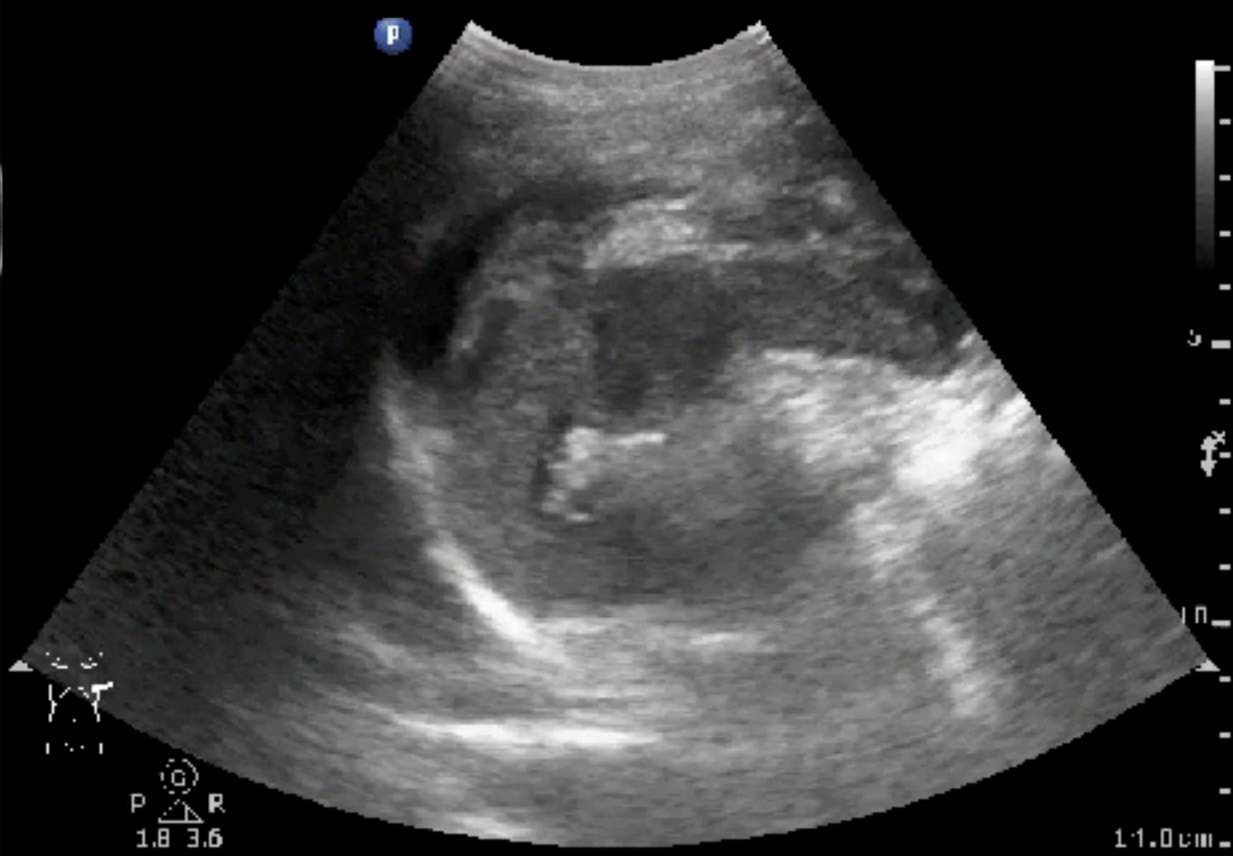
Blunt abdominal injury

Tachycardia & Low BP


Abd Gen
2D
Gn 90
P R
1.8 3.6



Splenic laceration



ICU POCUS

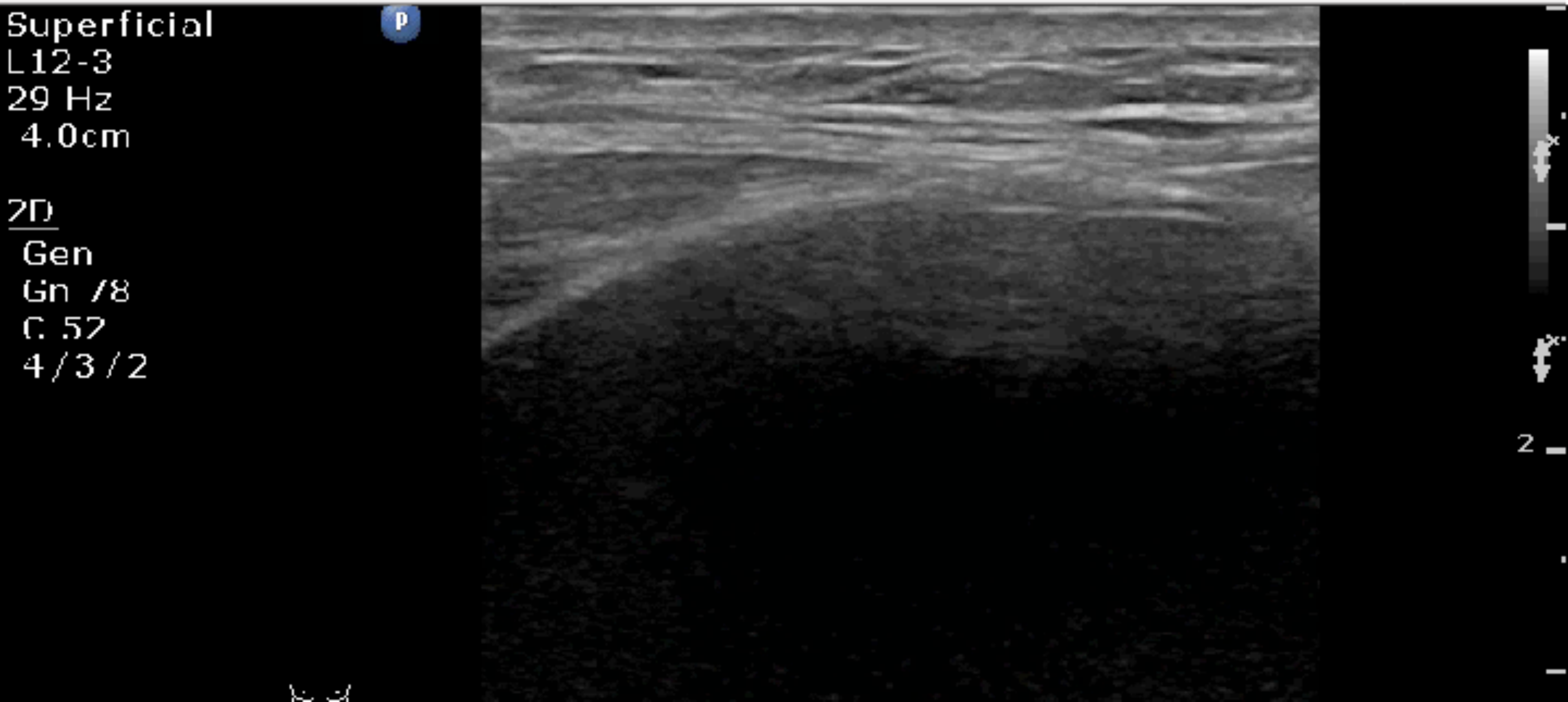
- CVC
- ECHO
- Resus
- Lung
- DVT
- Trauma
- IVC
- Shock
- Abdomen

We Recommend That Ultrasound Guidance (vs Landmark Technique), Whether Real-Time or Preprocedure, Be Used to Determine the Optimal Location for Performance of Paracentesis. Grade 1B (47–49)

Quality Assessment							Summary of Findings	
							Study Result	
Three Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Ultrasound	Without Ultrasound
Success rate								
1 randomized controlled trial + 2 observational	No risk of bias	No serious inconsistency	No indirectness	Imprecision	Undetected	⊖⊖⊖⊖ Moderate	95%	61%

Determine the safest pathway

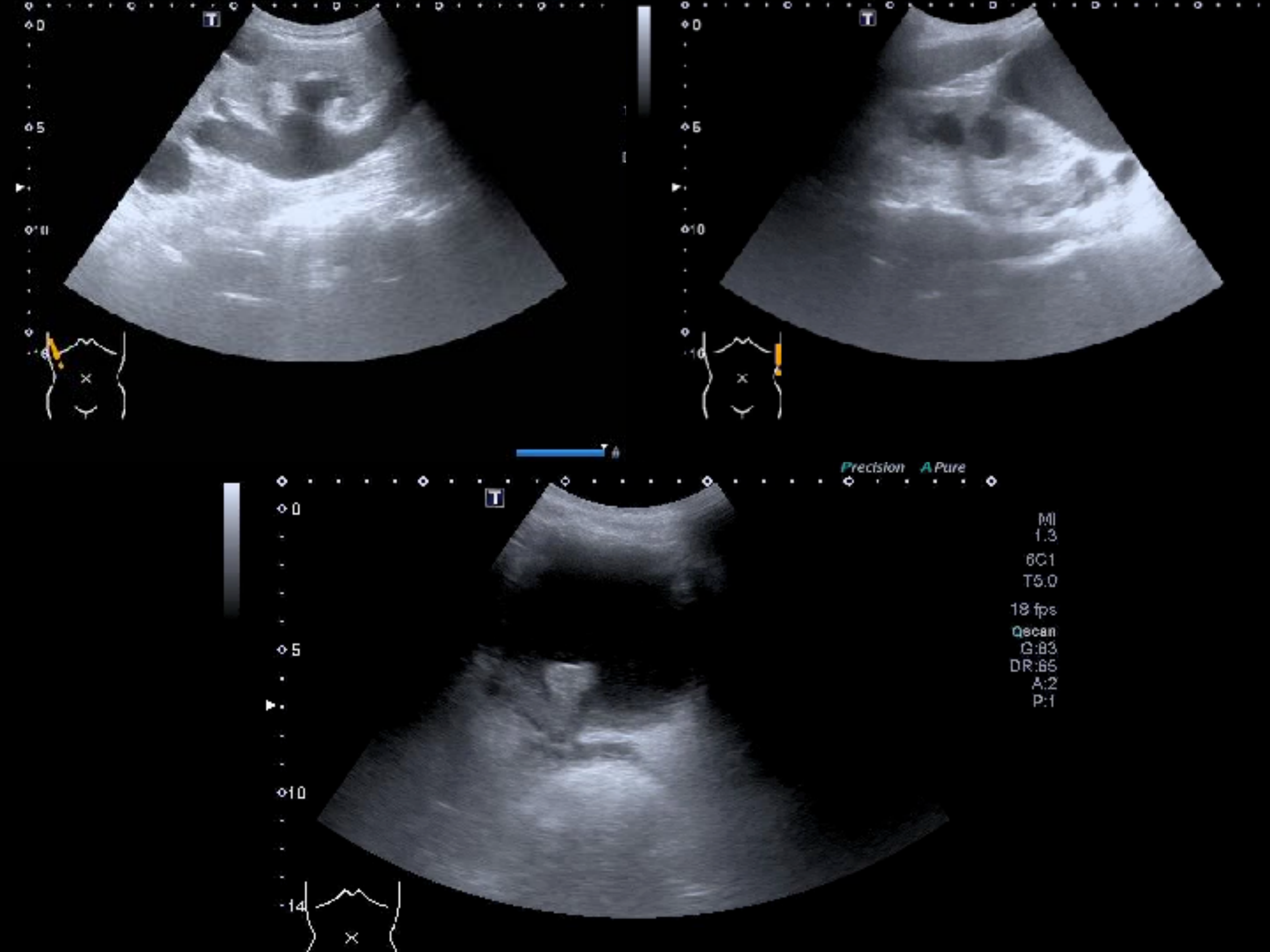
We Recommend That Ultrasound Guidance (vs Landmark Technique), Whether Real-Time or Preprocedure, Be Used to Determine the Optimal Location for Performance of Paracentesis. Grade 1B (47–49)								
Quality Assessment							Summary of Findings	
							Study Result	
Three Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Ultrasound	Without Ultrasound
Success rate								
1 randomized controlled trial + 2 observational	No risk of bias	No serious inconsistency	No indirectness	Imprecision	Undetected	⊖⊖⊖⊖ Moderate	95%	61%



Mechanical Causes of Anuria/Oliguria

Hydronephrosis

Suitability v.s. Ability


Precision
A Pure
MI
1.3
6C1
T5.0
18 fps
Qscan
G:83
DR:65
A:2
P:1

We Suggest That Intensivists Not Personally Perform Ultrasound Primarily for the Diagnosis of Acute Cholecystitis. Grade 2B (50–53)

Quality Assessment							Summary of Findings		
							Study Result		
Nine Studies	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	Sensitivity	specificity	Accuracy
Diagnostic accuracy									
Meta-analysis (eight studies) cross sectional	No risk of bias	No serious inconsistency	Indirectness	No imprecision	Undetected	⊕⊕⊕⊖ Moderate	89.8–96%	88–90%	90.5%

Acalculous cholecystitis

GB wall thickening (> 3mm)

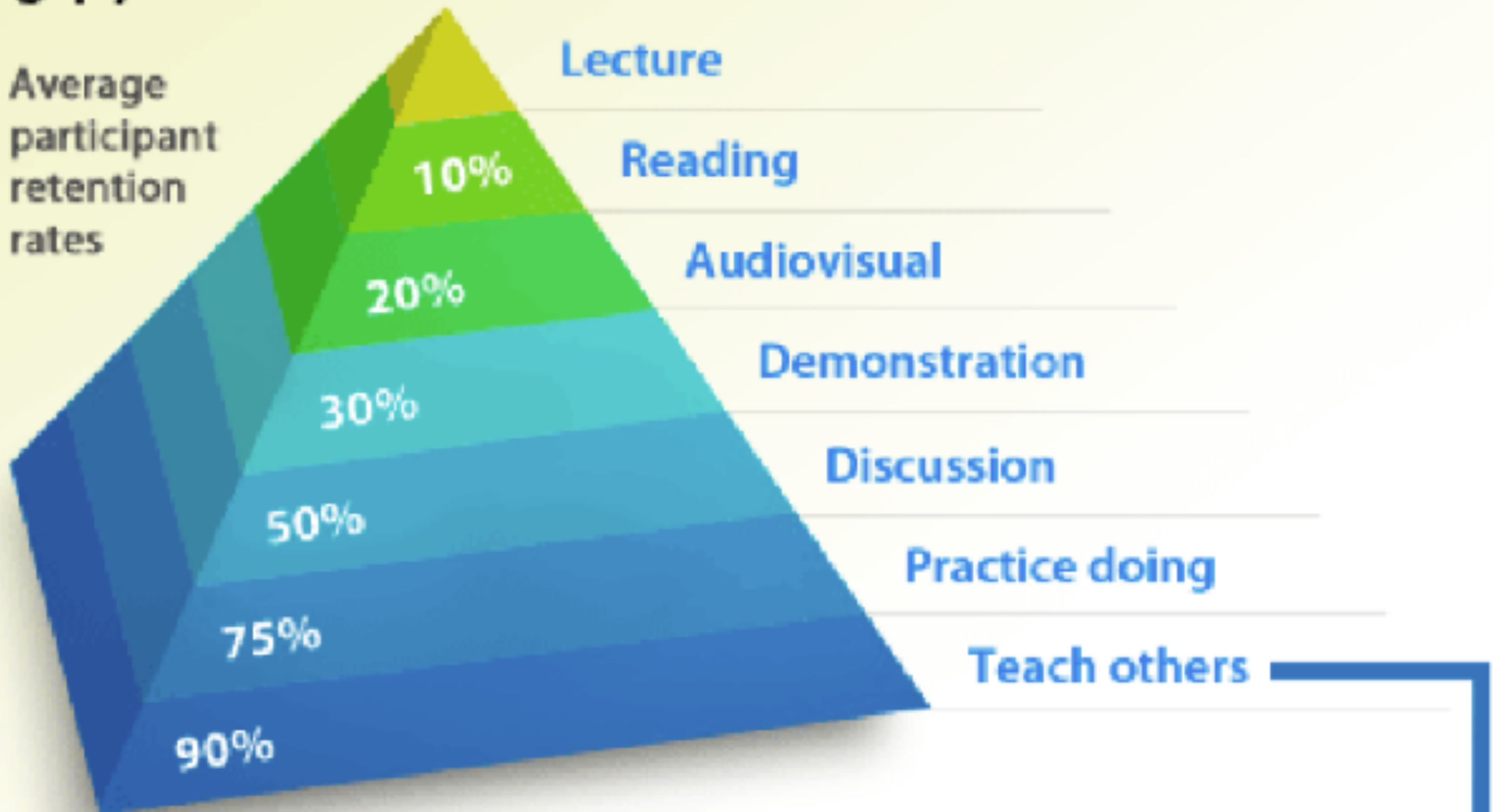
GB distension (short axis > 4cm)

Peri-GB fluid

Sonographic Murphy's sign

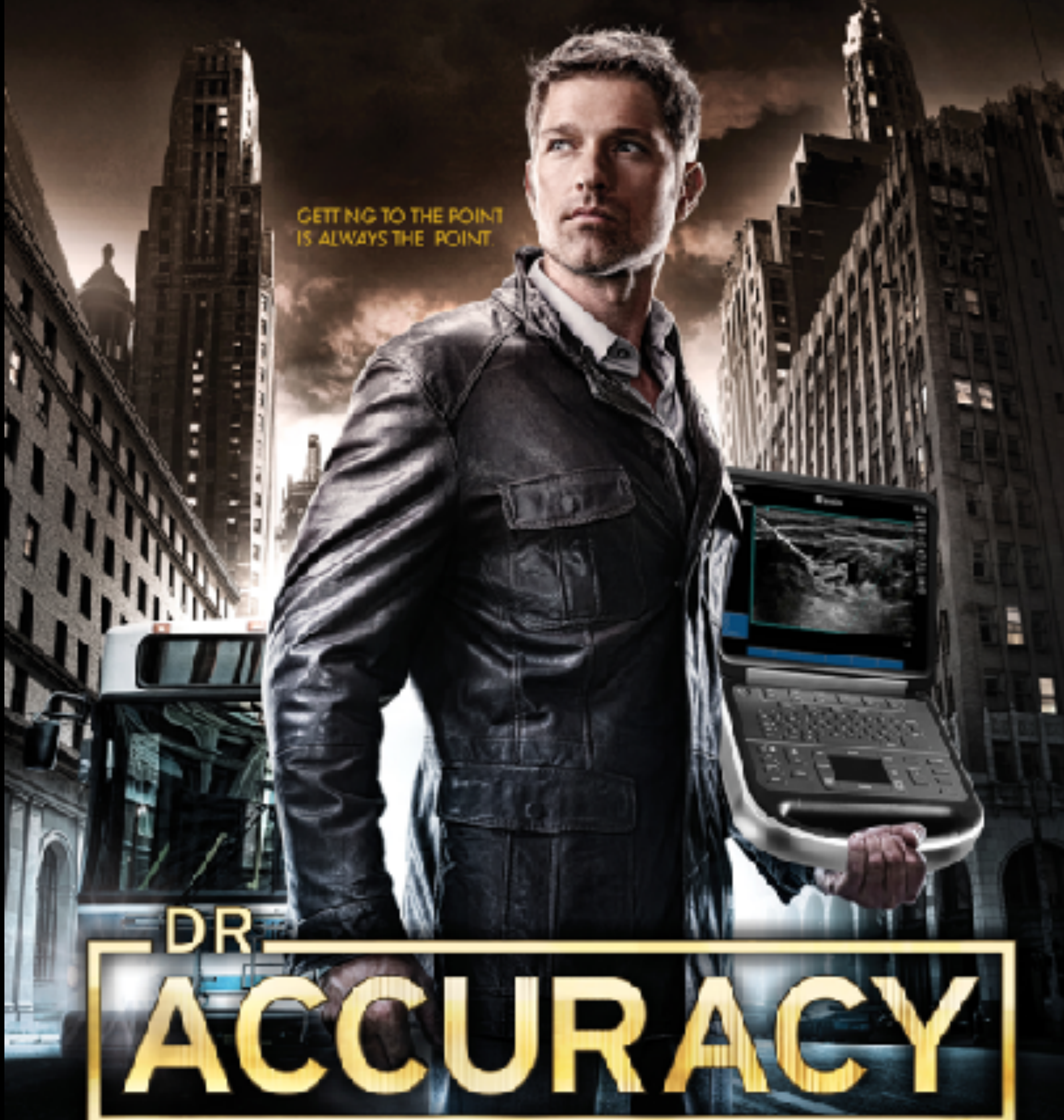

C5 1
31 Hz
17.0cm
2D
HGen
Gn 94
C 55
3/3/3

Learning pyramid



We combine consultation with onsite, customized training and coaching. The results are optimal.

Source : National Training Laboratories, Arlington, Virginia



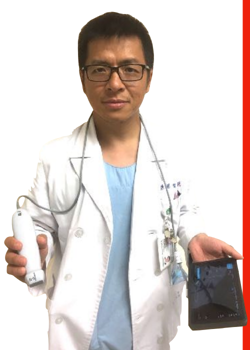
視覺化

即時性

改變你看病人的觀點

ULTRASOUND PROGRAM

HOLA in Your ICU



優先問題

掃描品質

流程改造

設備

訓練

團隊