Dialysis Access in children

Dr Sidharth Kumar Sethi
Pediatric Nephrology
Kidney and Urology Institute
Medanta-The Medicity

- 1 month old
- Excessive crying & Seizures
- Hyperammonemia 1232mmol/L

- 10 months old
- Sepsis; MODS; Shock; AKI
- Anuric

Access?

The System is Down due to poor Access!

bunchman

AJKD
Core Curriculum in Nephrology
Am J Kidney Dis. 2014;63(2):329-345

Pediatric Vascular Access: Performance = Blood Flow

- Minimum 30 to 50 ml/min to minimize access and filter clotting
- Maximum rate in CRRT 400 ml/min/1.73m^2 or
  - 10-12 ml/kg/min in neonates and infants
  - 4-6 ml/kg/min in children
  - 2-4 ml/kg/min in adolescents

Unique Considerations in Renal Replacement Therapy in Children: Core Curriculum 2014

Sidharth Kumar Sethi, MD,[1] Timothy Bunchman, MD,[2] Rupesh Raina, MD,[3] and Vijay Kher, MD[1]

Vascular Access Wisdom

"Size matters!"

Vascular Access- **Poiseuille's** Law

$$\underset{\text{Flowrate}}{\text{Volume}} = \mathcal{F} = \frac{P_1 - P_2}{\mathcal{R}} = \frac{\pi(\text{Pressure difference})(\text{radius})^4}{8(\text{viscosity})(\text{length})}$$

$$\underset{\text{to Flow}}{\text{Resistance}} \quad \mathcal{R} = \frac{8\eta L}{\pi r^4}$$

- Smaller diameters offer greater resistance to flow
- Longer lengths offer greater resistance to flow
- Decreasing the diameter by 1/5th is the same as doubling the length (roughly a 2 French size difference)

Vascular Access for Pediatric CRRT: Pros and Cons of **Femoral Site**

PROS

- Relatively larger vessel may allow for
  - larger catheter
  - higher flows
- Ease of placement
- No risk of pneumothorax
- Preserve potential future vessels for chronic HD

CONS

- Shorter femoral catheters with increased % recirculation
- Poor performance in patients with ascites/increased abdominal pressure
- Trauma to venous anastamosis site for future transplant

Vascular Access for Pediatric CRRT: Pros and Cons of **IJ/SCV** Site

PROS

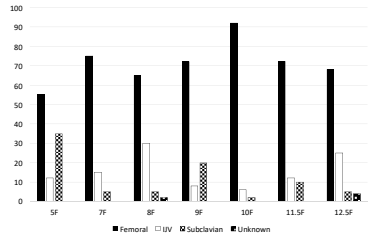
- Tip placement in right atrium decreases recirculation
- Not affected by ascites
- Preserve potential vein needed for transplant

CONS

- SCV stenosis (SCV)
- Superior vena cava syndrome
- Risk of pneumothorax in patients with high PEEP
- Trauma to veins needed potentially for future HD access

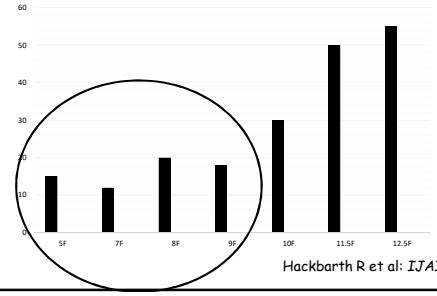
The effect of vascular access location and size on circuit survival in pediatric continuous renal replacement therapy: A report from the PPCRRT registry

- 13 Pediatric Institutions
- 376 patients
- 1574 circuits
- Circuit survival by Catheter size, site, and modality



Hackbarth R et al: *IJAIO* 30:1116-21, 2007

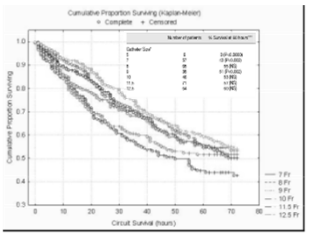
Catheter selection: Acute HD/CRRT



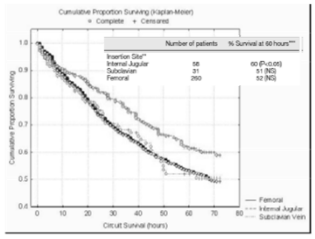
Hackbarth R et al: *IJAIO* 30:1116-21, 2007

Circuit Survival

Size



Site



Hackbarth R et al: *IJAIO* 30:1116-21, 2007

CRRT Circuit Survival & Access Size

n=122; 1996-2006
Pediatric CRRT
Spain

Univariate Analysis

Circuit Life Span (hours)		
	Mean	p
Two 4 French catheters	12.5	
Double-lumen 5 French	25.7	0.07
Double-lumen 6.5 French	34.2	
Double lumen 8-9 F	22.8	
Double lumen 10-11 F	36.1	
4-5 F	25	0.04
6.5-11 F	33	

Multivariate Analysis

Catheter Size 6.5-11F p 0.093

Filter Size; HDF & Heparin Dose

Critical Care 2008, 12:R93

Access Wisdom for Children

- Don't use a 5 French catheter.
- Choose the largest diameter that is safe for the child.
- Choose the smallest catheter that will achieve the necessary flow easily.
- Choose the minimum length to position the tip for optimal flow.
- In the femoral position, longer catheters will minimize recirculation

PATIENT SIZE	CATHETER SIZE & SOURCE	SITE OF INSERTION
NEONATE	~~Single-lumen 5 Fr (COOK)~~	~~Femoral artery or vein~~
	Dual-Lumen 7.0 French (COOK/MEDCOMP)	Femoral vein
3-6 KG	Dual-Lumen 7.0 French (COOK/MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
	Triple-Lumen 7.0 Fr (MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
6-30 KG	Dual-Lumen 8.0 French (KENDALL/ARROW)	Internal/External-Jugular, Subclavian or Femoral vein
>15-KG	Dual-Lumen 9.0 French (MEDCOMP)	Internal/External-Jugular, Subclavian or Femoral vein
>30 KG	Dual-Lumen 10.0 French (KENDALL, ARROW)	Internal/External-Jugular, Subclavian or Femoral vein
>30 KG	Triple-Lumen 12 French (KENDALL/ ARROW)	Internal/External-Jugular, Subclavian or Femoral vein

AJKD
Core Curriculum in Nephrology
Am J Kidney Dis. 2014;63(2):329-345

Unique Considerations in Renal Replacement Therapy in Children: Core Curriculum 2014

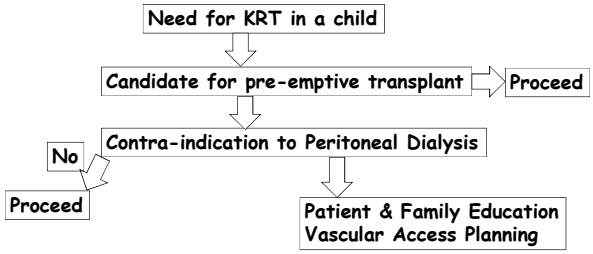
Sidharth Kumar Sethi, MD,[1] Timothy Bunchman, MD,[2] Rupesh Raina, MD,[3] and Vijay Kher, MD[4]

Long term dialysis

5 yrs, female
Bilateral Wilm's
Unfavourable
Post bilateral nephrectomy

6 yrs, female
FSGS
ESRD within 2 years
Tracheostomy
Permacath Right IJV
Genetic assessment -

KRT Discussion



Indian Society of Pediatric Nephrology CKD Registry

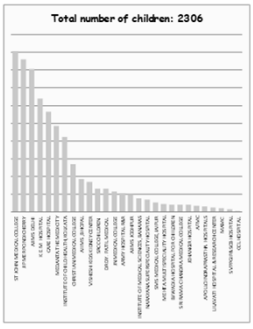
Convener: Arvind Bagga
Co-Convener: Sidharth Sethi; Rajiv Sinha

Initiated Jan 2017

June 2018
28 centres; 2306 patients

2008 to 2010
&
2017 to 2020

TOTAL NUMBER OF CENTRES: 28



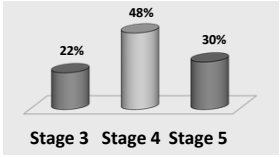
State	%
AP	2.65
UP	8.41
Assam	0.84
Bihar	3.11
CHATTISHGARH	0.71
Delhi	6.65
HARAYANA	4.42
J and K	2.48
Jharkhand	1.01
Karnataka	10.60
kerala	2.14
MP	8.92
Maharashtra	12.70
Rajasthan	2.82
Tamil Nadu	11.14
West Bengal	7.78
Others	13.62

Indian Society of Pediatric Nephrology CKD Registry

Convener: Arvind Bagga
Co-Convener: Sidharth Sethi; Rajiv Sinha

Initiated Jan 2017

June 2018
28 centres; 2306 patients



2008 to 2010 & 2017 to 2020

Indian Society of Pediatric Nephrology CKD Registry

Convener: Arvind Bagga
Co-Convener: Sidharth Sethi; Rajiv Sinha

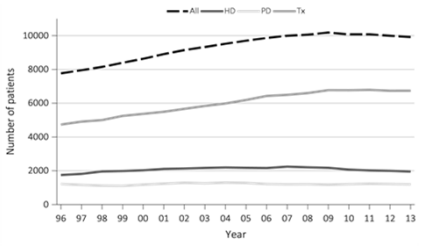
Initiated Jan 2017

June 2018
28 centres; 2306 patients

2008 to 2010 & 2017 to 2020

Treatment of ESRD	n	%
PALLATIVE	51	18.15
MHD	127	45.20
CAPD	103	36.65

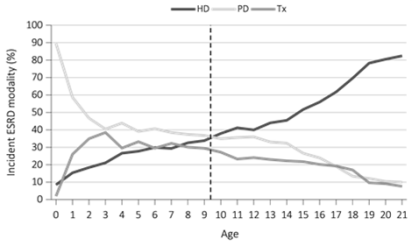
Prevalent ESRD
Pediatric patients (aged 0–21 years), by modality, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis and continuous cycling peritoneal dialysis. All consists of hemodialysis, peritoneal dialysis, uncertain dialysis, and transplant. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Vol 2, ESRD, Ch 8

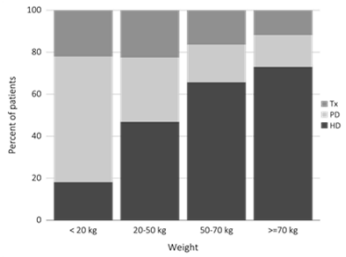
Trends in ESRD modality at initiation, by patient age 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Includes incident ESRD patients in the years 1996-2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Vol 2, ESRD, Ch 8

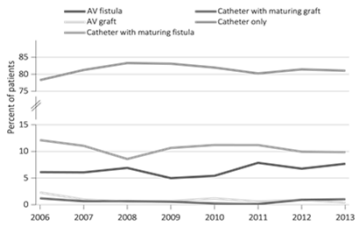
ESRD modality at initiation, by patient weight, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Includes incident ESRD patients in the years 1996-2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Vol 2, ESRD, Ch 8

Vascular Access Type: Choice

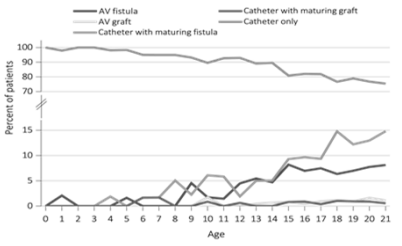


Similar trends in NAPRCTS data
CVC 78.9%
AVF 12.3%
AVG 8.5%

Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2006-2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Vol 2, ESRD, Ch 8

Vascular access type at initiation by age



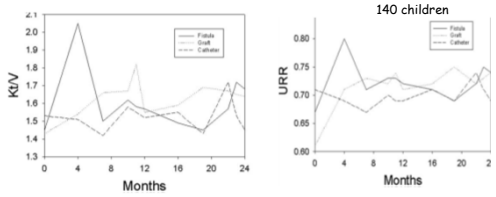
Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2006-2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Vol 2, ESRD, Ch 8

AVF an Ideal Access, even in children!

Better Clearances

Renal Network
2000-2002
601 observations
140 children

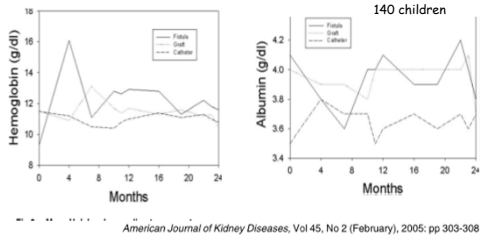


American Journal of Kidney Diseases, Vol 45, No 2 (February), 2005: pp 303-308

AVF an Ideal Access, even in children!

Better Hb & Albumin

Renal Network
2000-2002
601 observations
140 children

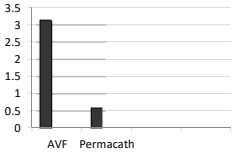


American Journal of Kidney Diseases, Vol 45, No 2 (February), 2005: pp 303-308

AVF an Ideal Access, even in children!

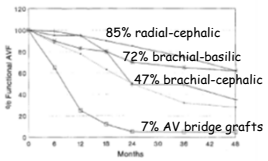
Longer Life

20 yrs retrospective study
314 procedures
114 children



Am J Kidney Dis 45:708-714, 2005

France
384 children, 434 angioaccess

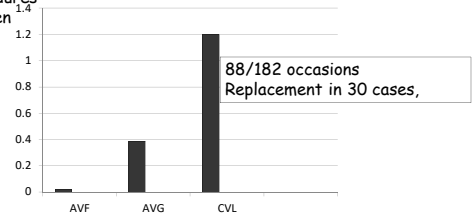


Pediatr Nephrol 4:156- 159, 1990

AVF an Ideal Access, even in children!

20 yrs
314 procedures
114 children

Lower Infection Rates
[per 12 months access usage]



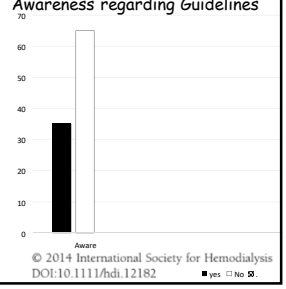
Am J Kidney Dis 45:708-714, 2005

Barriers; Biases & Beliefs regarding AVF

MWPNC
MIDWEST PEDIATRIC NEPHROLOGY CONSORTIUM

- 52 surveys
- Dialysis staff & proceduralists
- ***International Pediatric Fistula First Initiative***

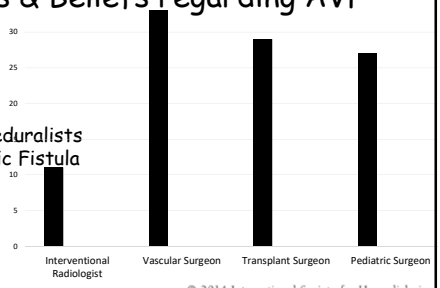
Awareness regarding Guidelines



Barriers; Biases & Beliefs regarding AVF

MWPNC
MIDWEST PEDIATRIC NEPHROLOGY CONSORTIUM

- 52 surveys
- Dialysis staff & proceduralists
- International Pediatric Fistula First Initiative

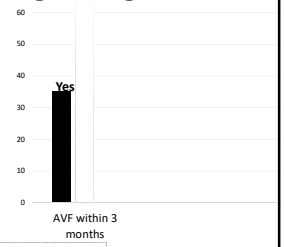


DOI:10.1111/hdi.12182

Barriers; Biases & Beliefs regarding AVF

MWPNC
MIDWEST PEDIATRIC NEPHROLOGY CONSORTIUM

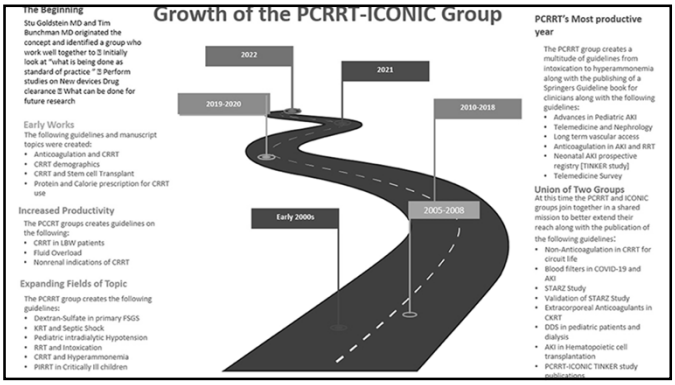
- 52 surveys
- Dialysis staff & proceduralists
- International Pediatric Fistula First Initiative



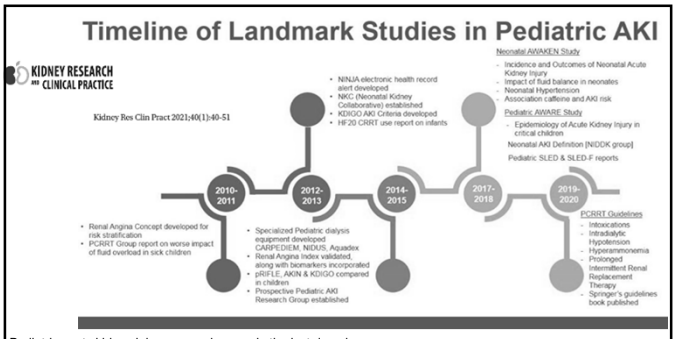
Major Barrier- Interdisciplinary Communication Problems

DOI:10.1111/hdi.12182

Growth of the PCRRT-ICONIC Group

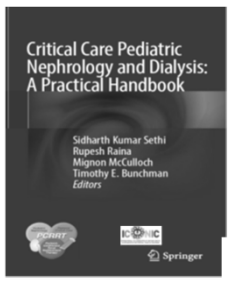


Timeline of Landmark Studies in Pediatric AKI



Pediatric acute kidney injury: new advances in the last decade.
Sethi SK, Bunchman T, Chakraborty R, Raina R.
Kidney Res Clin Pract. 2021 Mar;40(1):40-51.

Suggested Reading



Unique Considerations in Renal Replacement Therapy in Children: Core Curriculum 2014

Sidharth Kumar Sethi, MD,[1] Timothy Bunchman, MD,[2] Rupesh Raina, MD,[3] and Vijay Kher, MD[1]

POCUS in Critical Care Nephrology

Abhilash Koratala MD FASN
Division of Nephrology
Medical College of Wisconsin

@NephroP

Disclosures

None

What is POCUS?

Ultrasonography performed at the patient's bedside (= point of care) by the clinician to answer focused questions.

Provide the diagnosis

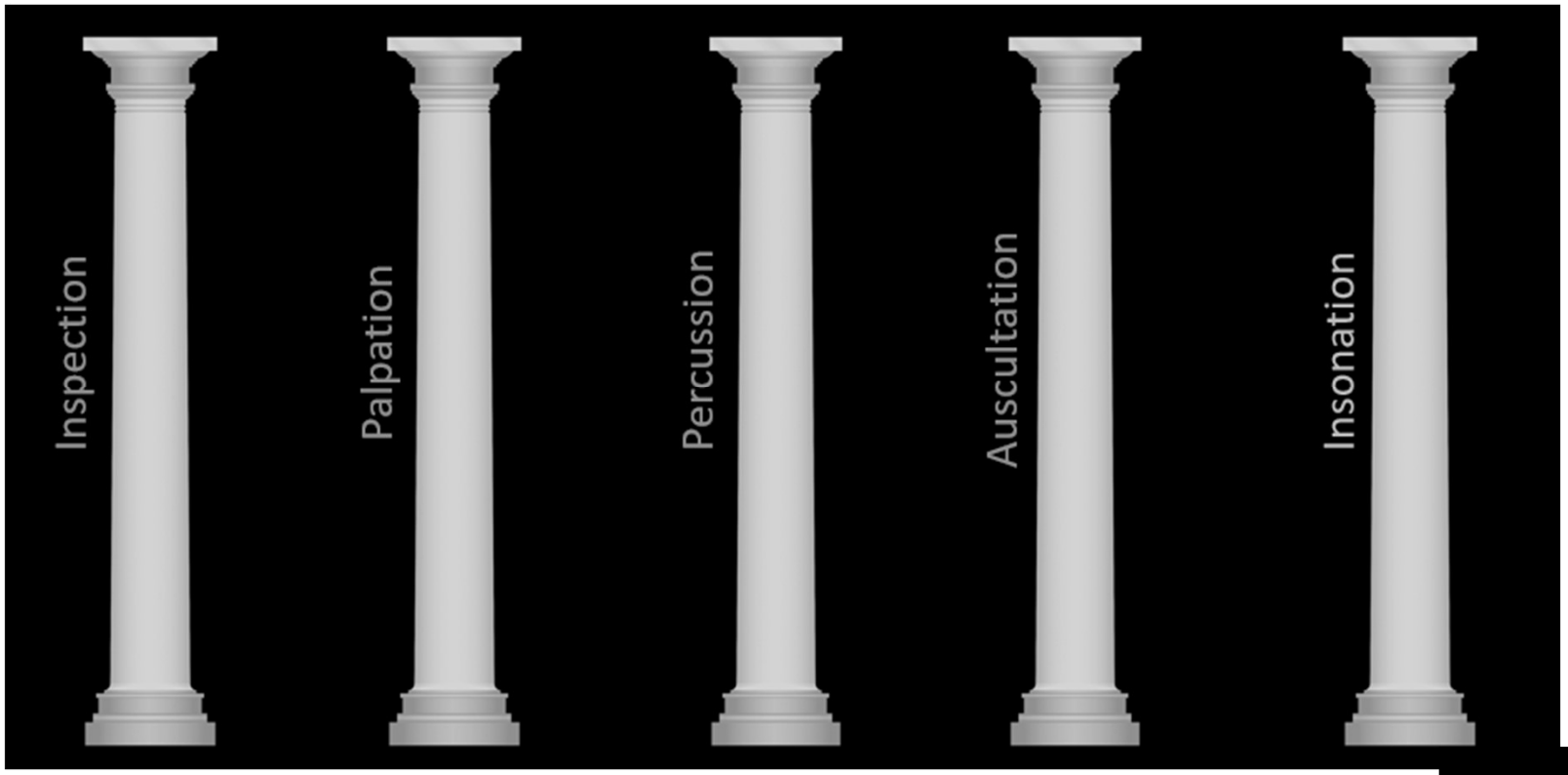
Narrow the differential

Guide a bedside procedure

NephroPOCUS

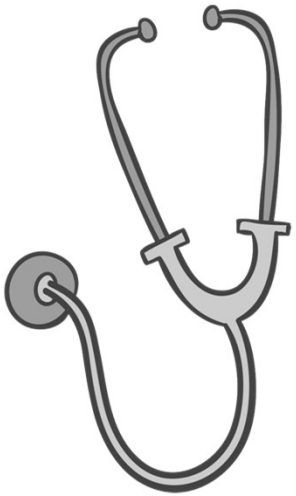
Examples of focused questions

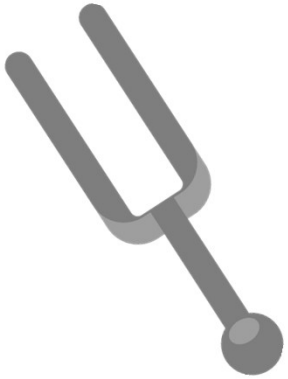
POCUS is a component of physical examination

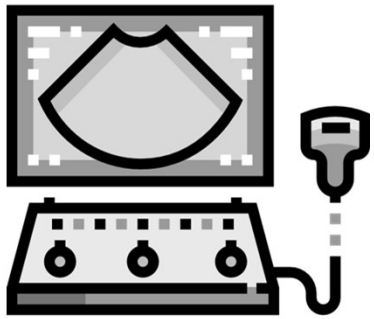


NephroPOCUS

Point-of-care devices

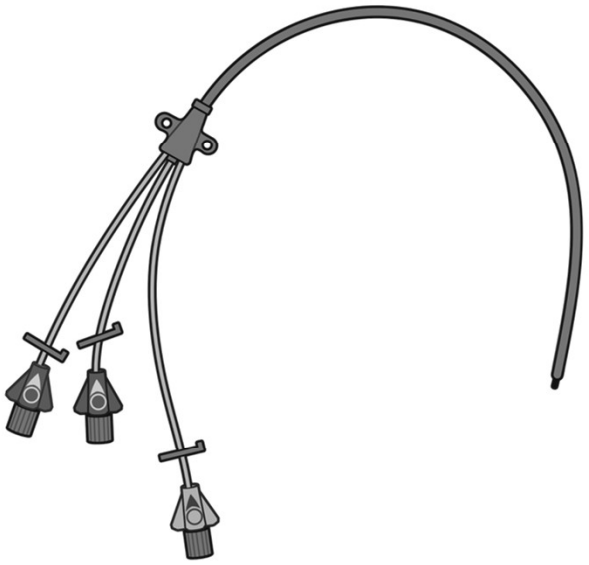


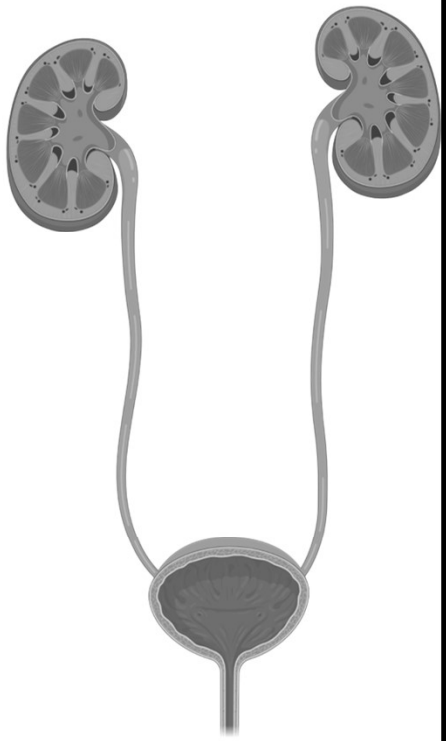




NephroPOCUS

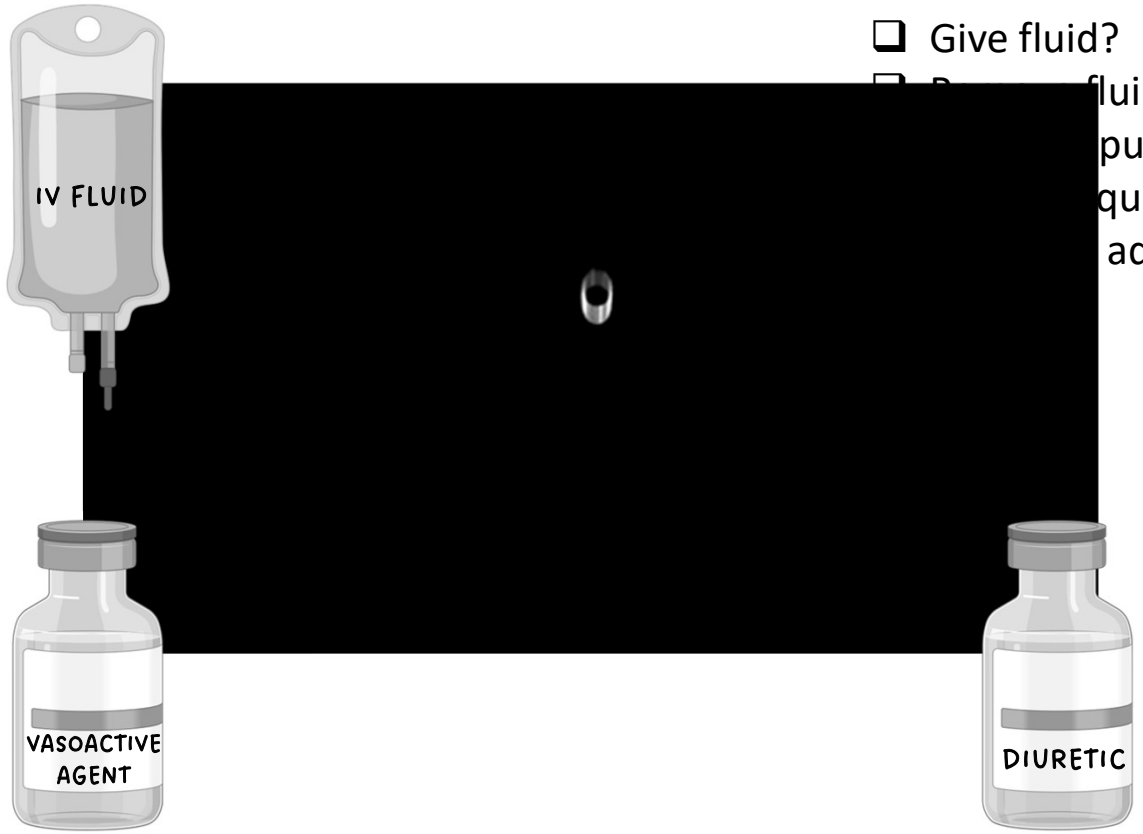
Nephrologist-performed POCUS





NephroPOCUS

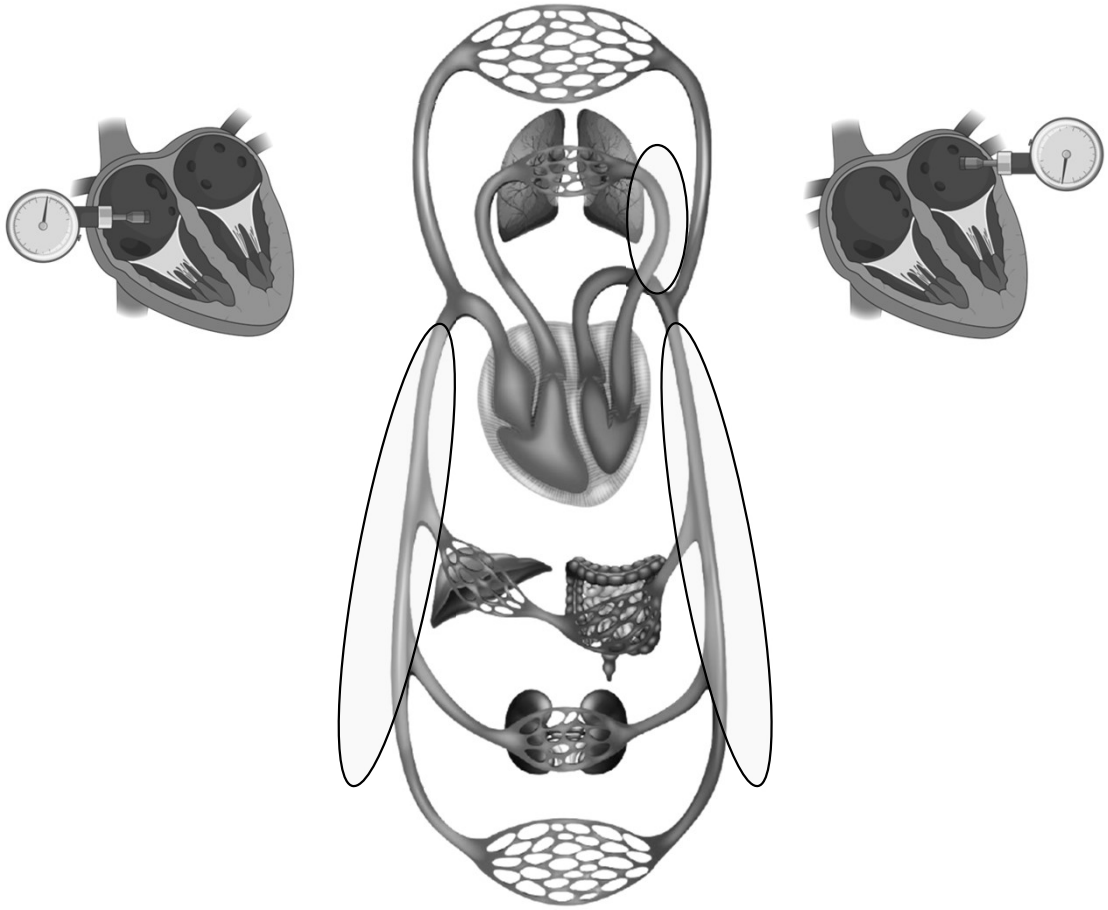
Focused questions in the ICU



- ❑ Give fluid?
- ❑ luid?
- pump need help?
- quate amount?
- adequate amount?

NephroPOCUS

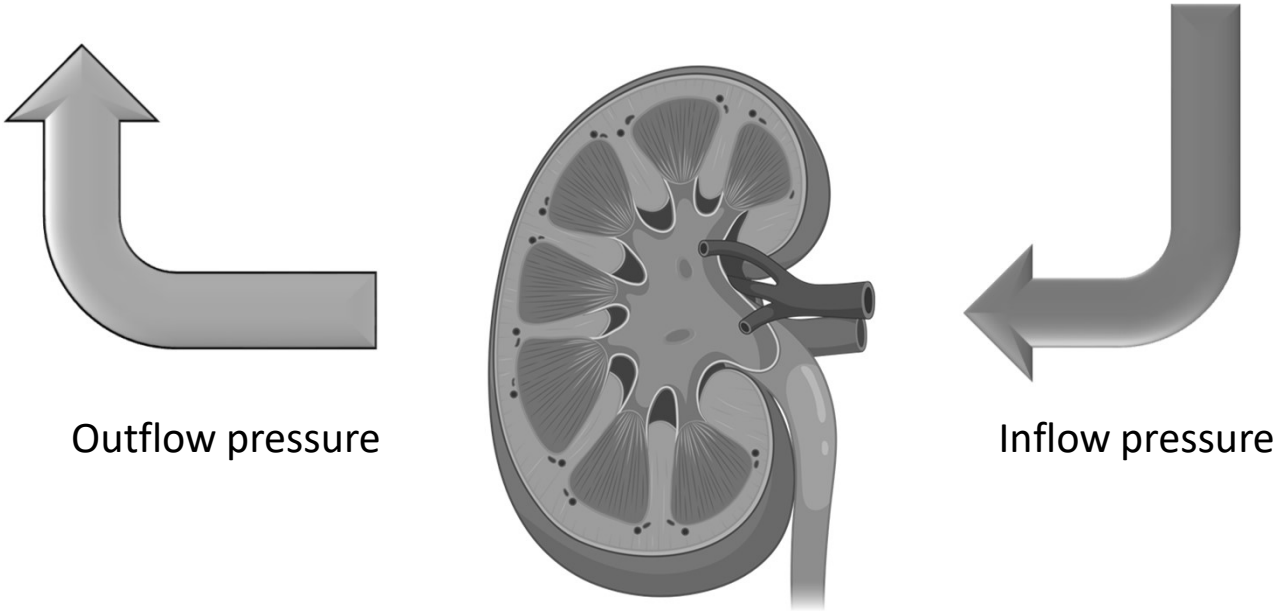
Hemodynamic circuit



NephroPOCUS

Organ perfusion pressure

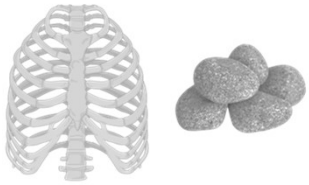
Perfusion pressure = inflow-outflow
= MAP – CVP (or IAP when elevated)



Outflow pressure

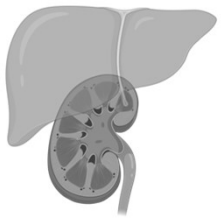
Inflow pressure

Sonographic appearance of various structures



HYPERECHOIC

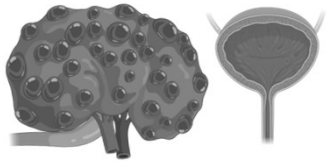
Stones
Bones
Fibrous structures
Air



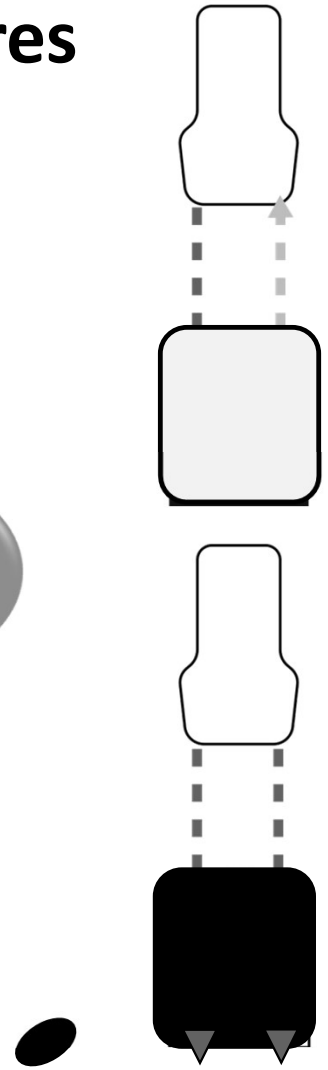
SHADES OF GREY

Soft tissues

More echoes
= More bright



Blood
Urine
Serous fluid

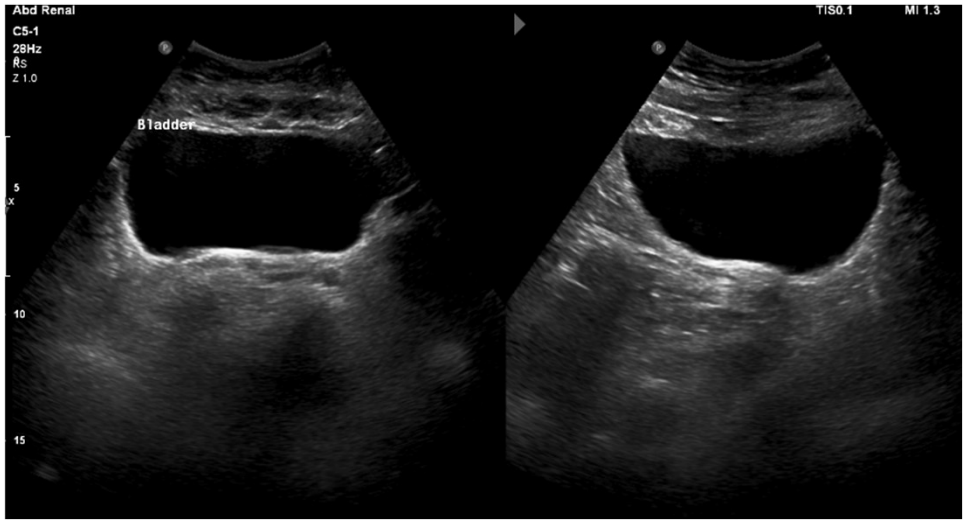


Case: A patient with AKI stage III is in the ICU. Was making urine till this morning but stopped now. Medicine PG asks if you want to place a catheter for dialysis?

NephroPOCUS

Normal urinary bladder

Filled with urine



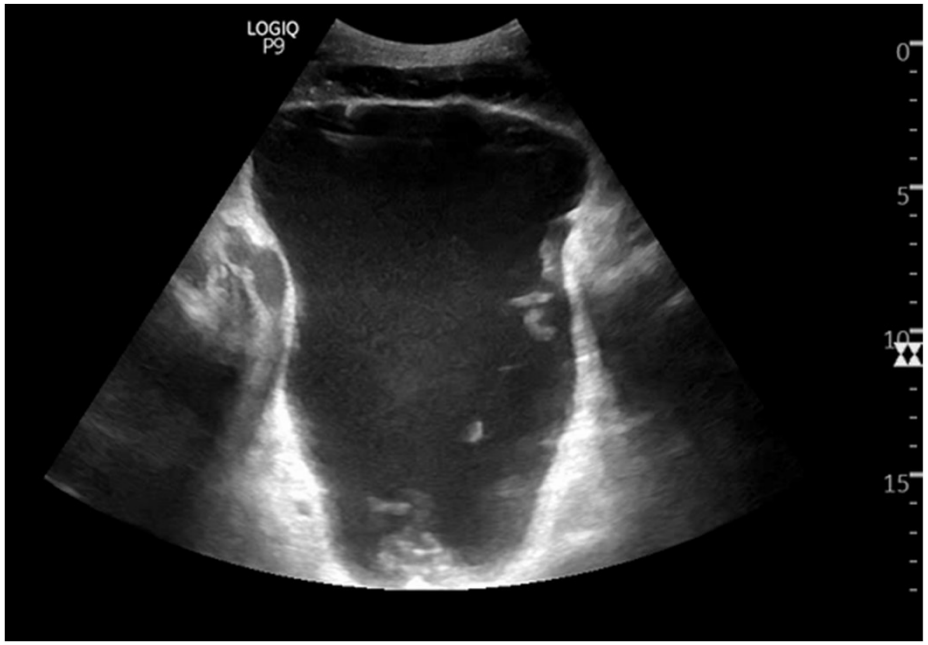
Decompressed by Foley

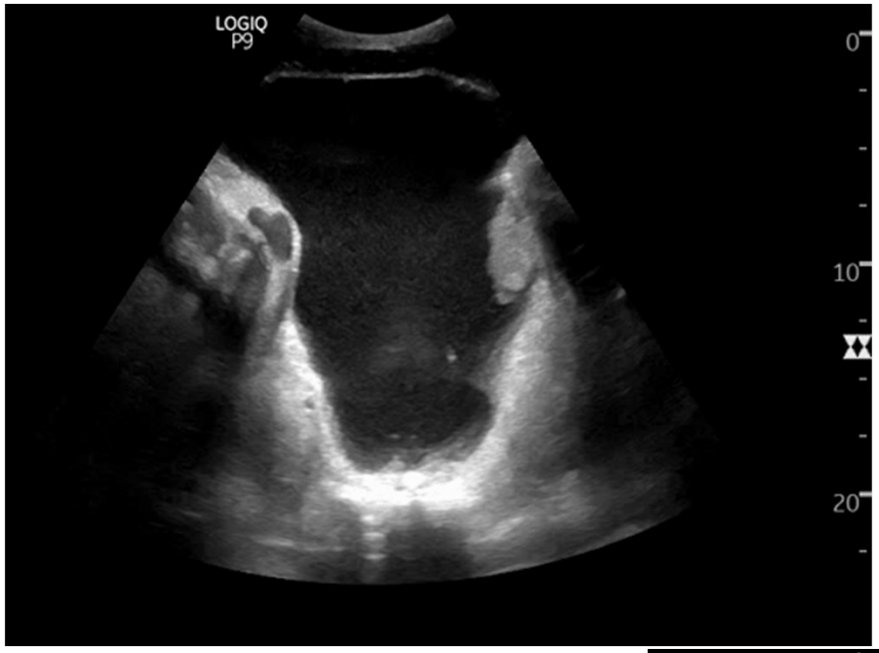
NephroPOCUS

Going back to our case

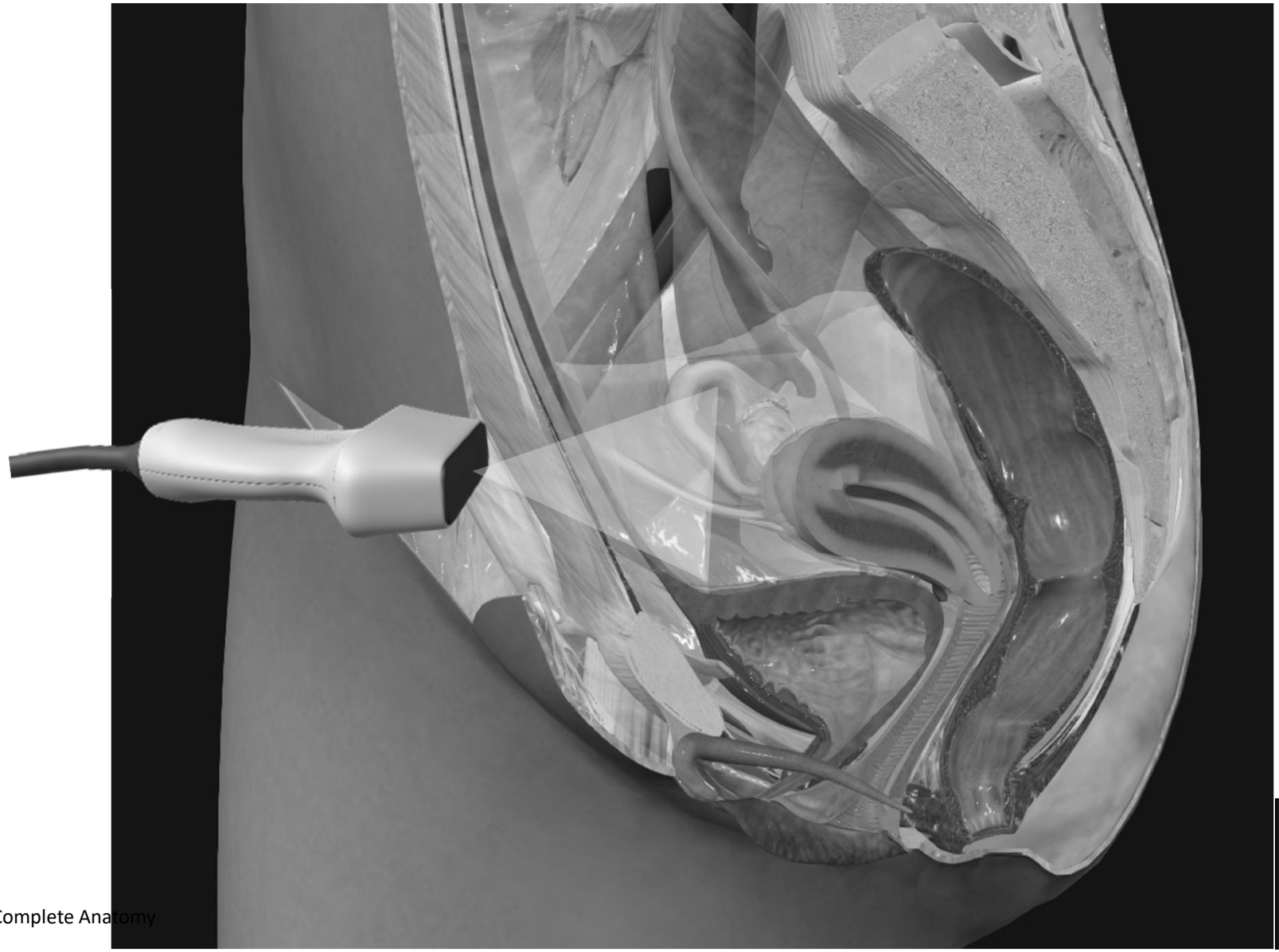
NephroPOCUS

Case: A patient with cirrhosis and AKI is not making urine. Bedside automated bladder scanner reads 450 cc, but nothing comes out on straight cath. Call urology?





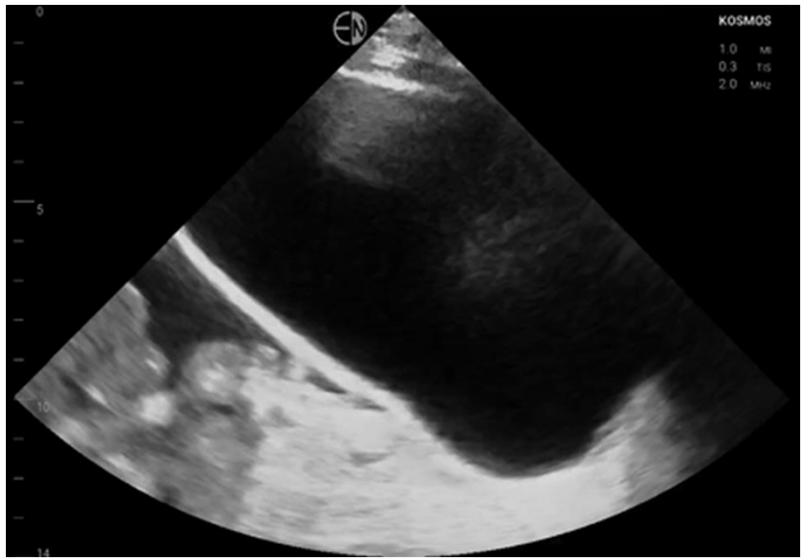
NephroPOCUS

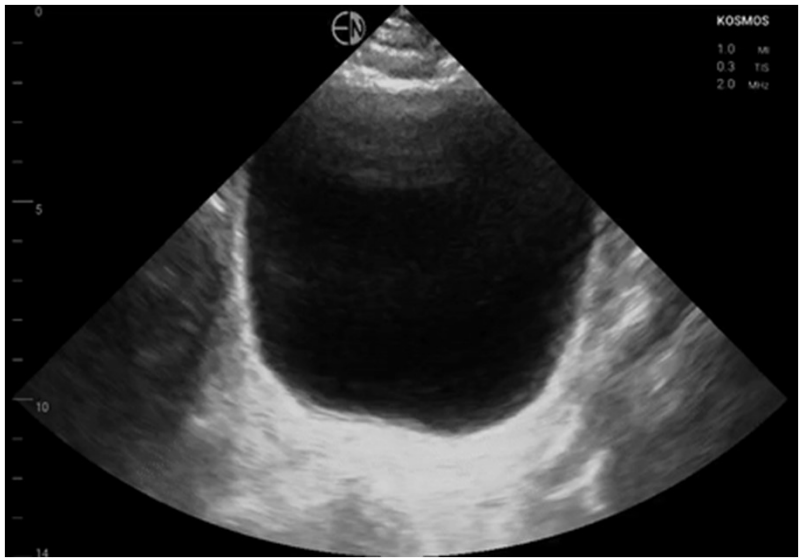


Courtesy: Complete Anatomy

NephroPOCUS

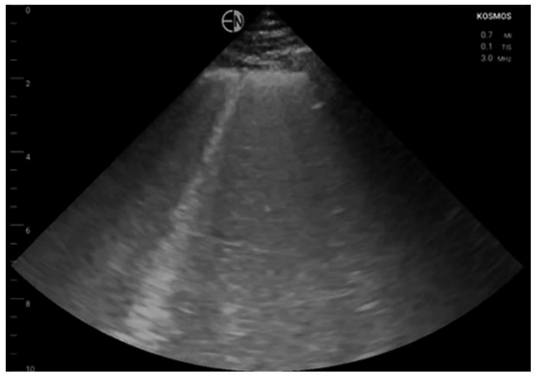
Another example

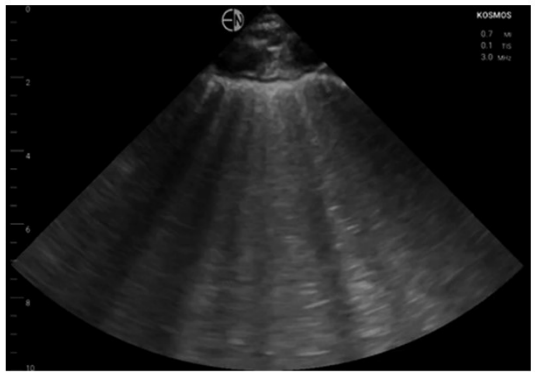


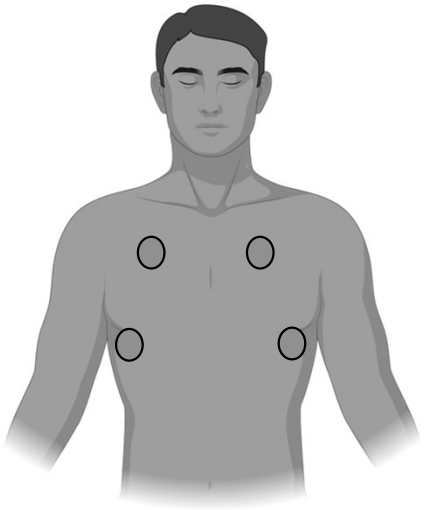


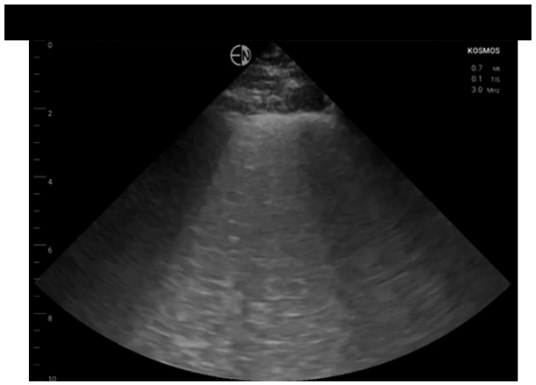
NephroPOCUS

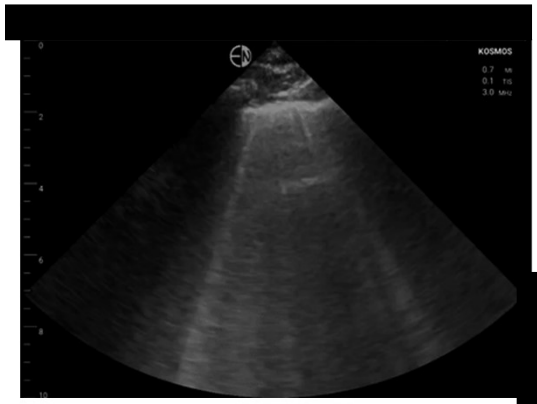
Case: A patient with AKI is being evaluated during hemodialysis.
He is oliguric but as there is no pedal edema and the lungs were ‘clear’, nephrology fellow wrote for minimal ultrafiltration (UF). BP 134/76 mmHg.
Lung ultrasound findings shown below. Would you change the amount of UF?





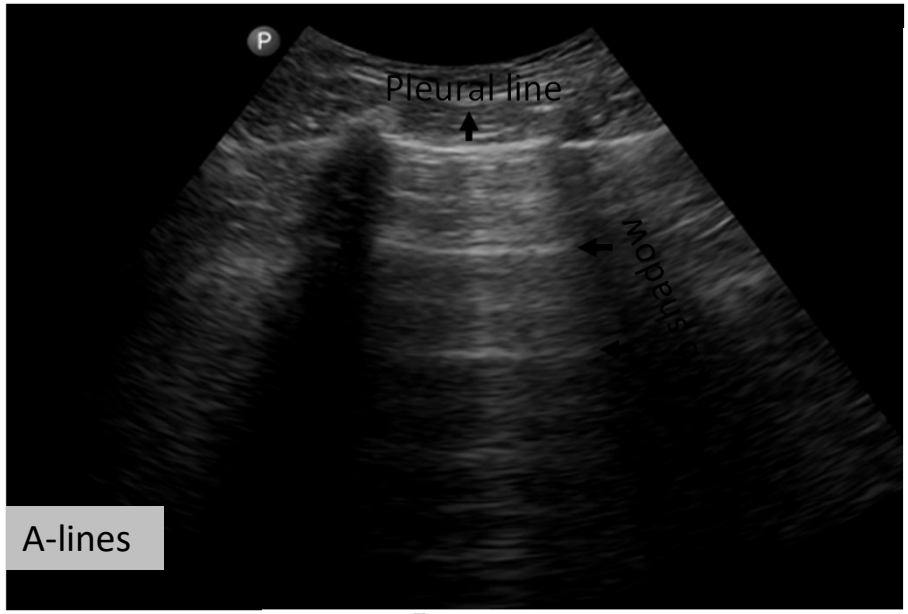


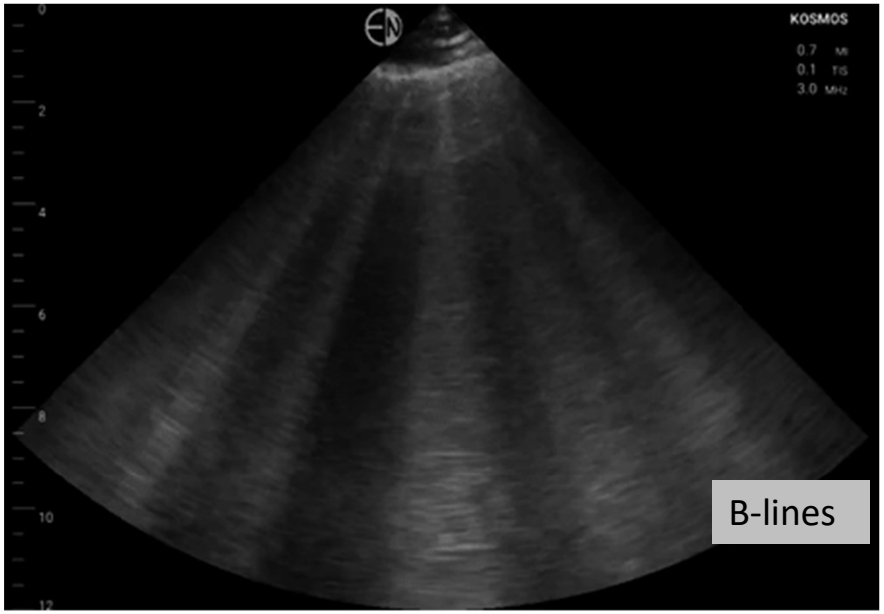


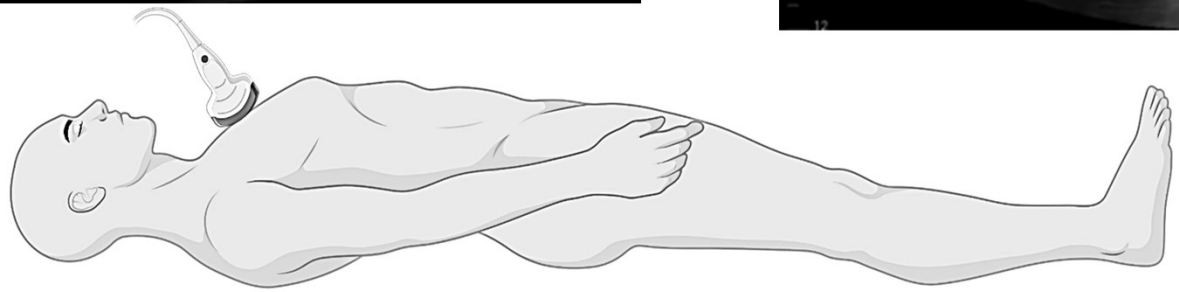


NephroPOCUS

Lung ultrasound





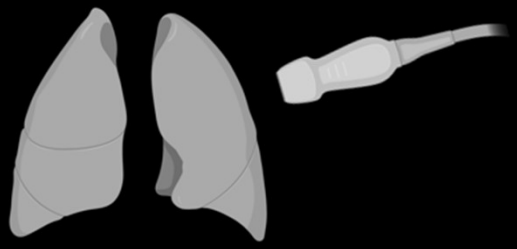


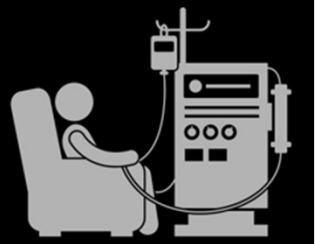
NephroPOCUS

Sensitivity of physical exam is low

Diagnostic value	Lung crackles	Peripheral edema	Crackles + edema
Sensitivity (%)	9	3	13
Specificity (%)	98	100	97

Vs.





Torino C, et al. Clin J Am Soc Nephrol. 2016;11(11):2005-2011.

NephroPOCUS

Sensitivity of physical exam is low

Prospective observational study

926 ICU patients
57% Mechanically Ventilated

Vs.

6-point lung ultrasound

Auscultation

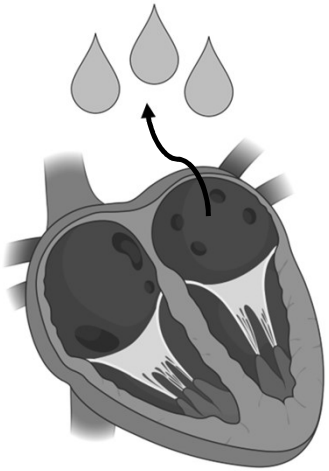
For pulmonary edema:

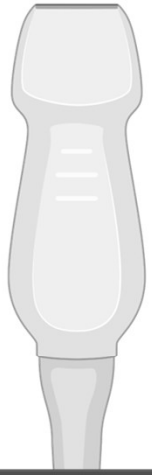
	Sensitivity (%)	Specificity (%)
Crepitations	**66**	**71**
Rhonchi	**47**	**69**
Abnormal auscultation (and/or above)	**52**	**74**

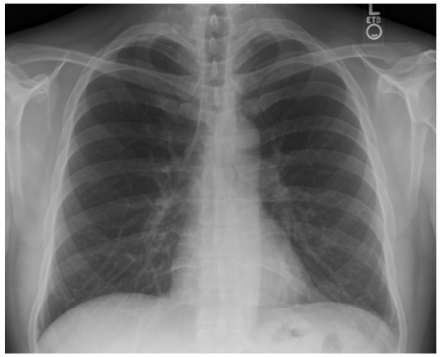
Cox EGM, et al. Crit Care. 2020;24(1):14.

NephroPOCUS

POCUS vs Chest X-ray



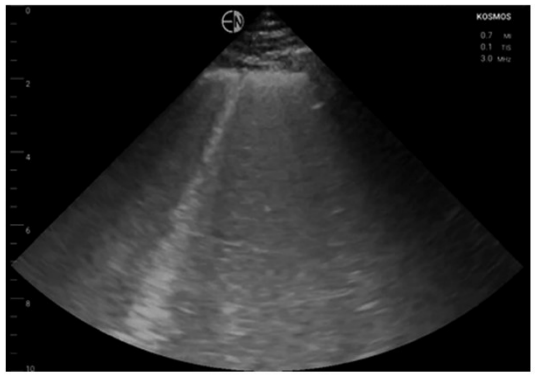


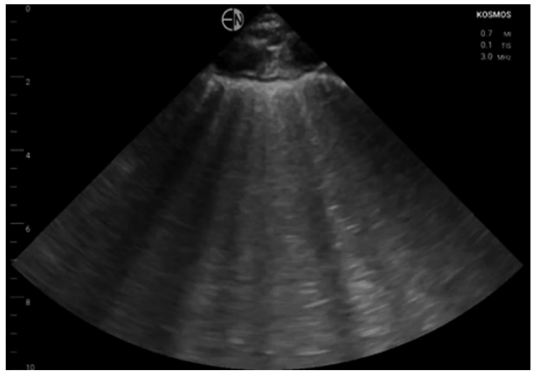


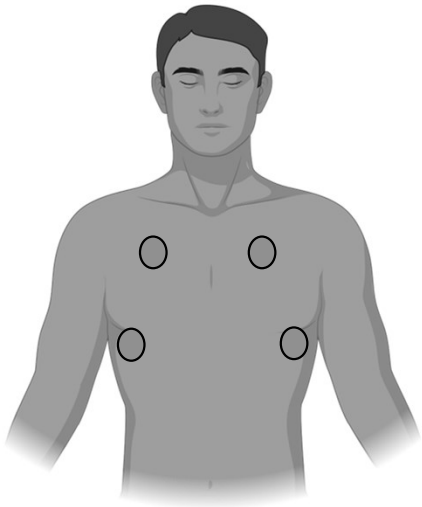
Sensitivity	91.8%	76.5%
Specificity	92.3%	87%

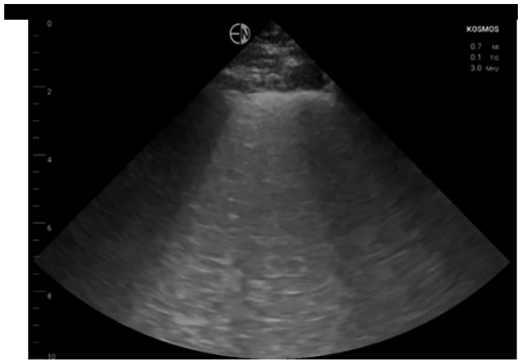
Chiu L, et al. Am J Cardiol. 2022:S0002-9149(22)00334-4.

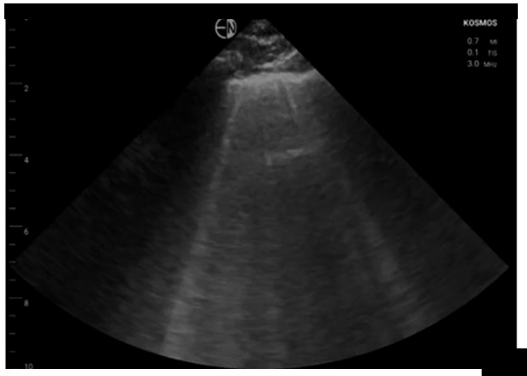
Going back to our case





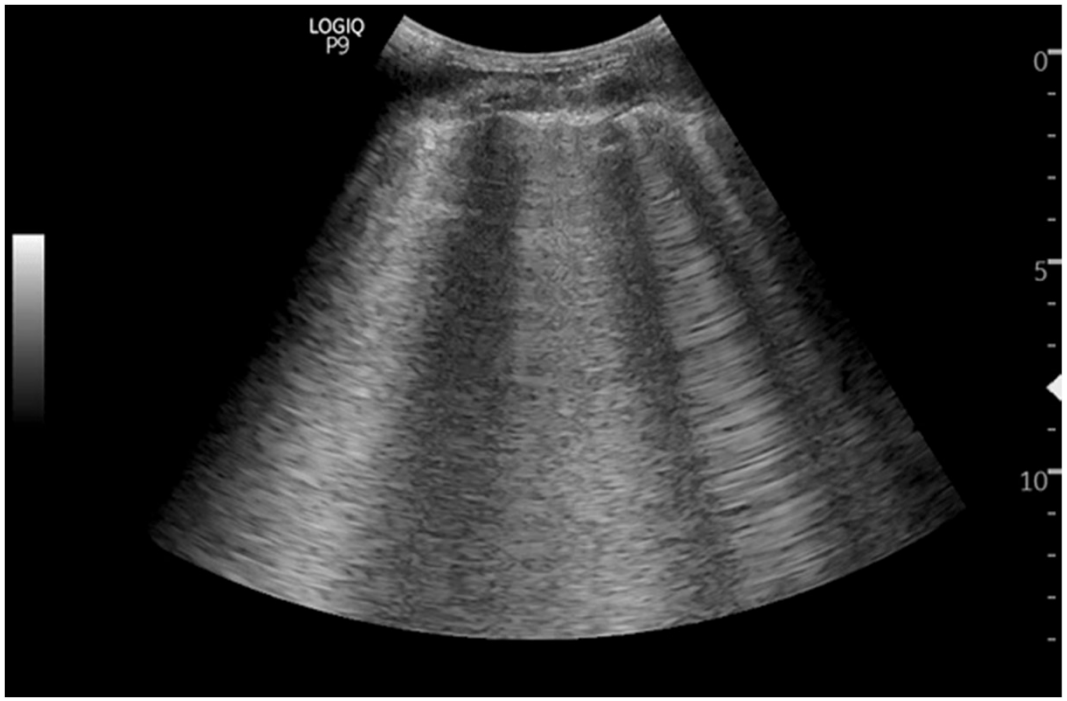






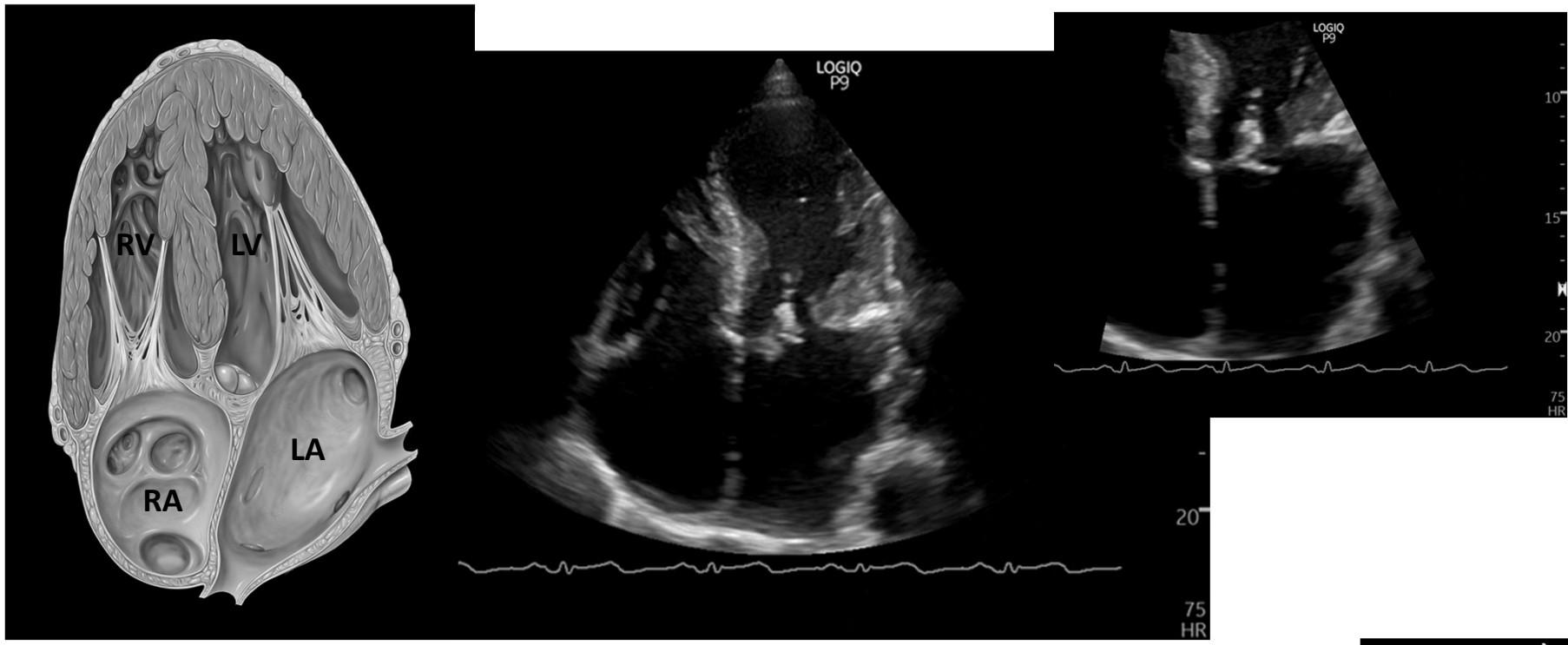
NephroPOCUS

Case: A patient with ESKD on hemodialysis is admitted for sepsis presumed to be secondary to catheter infection. ICU team asks for additional ultrafiltration as the lung ultrasound shows B-lines. Is there more to physical exam?



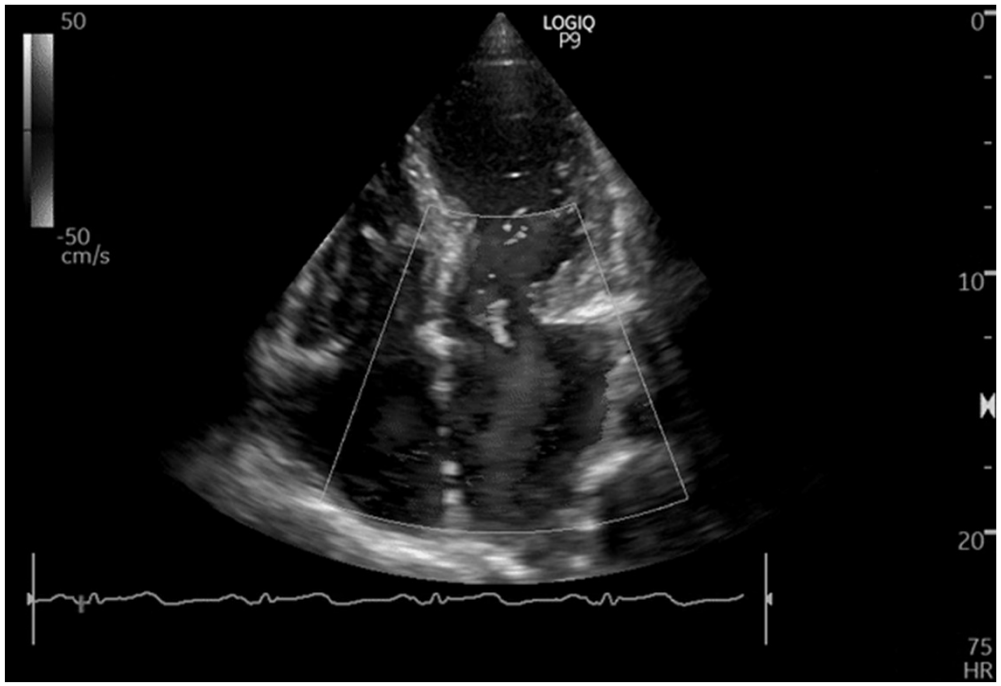
NephroPOCUS

Focused cardiac ultrasound



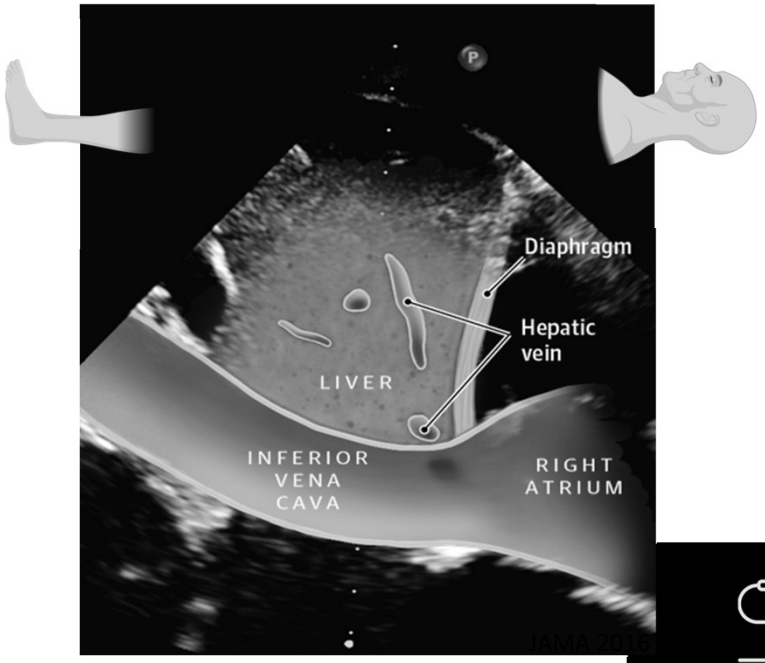
NephroPOCUS

Color Doppler



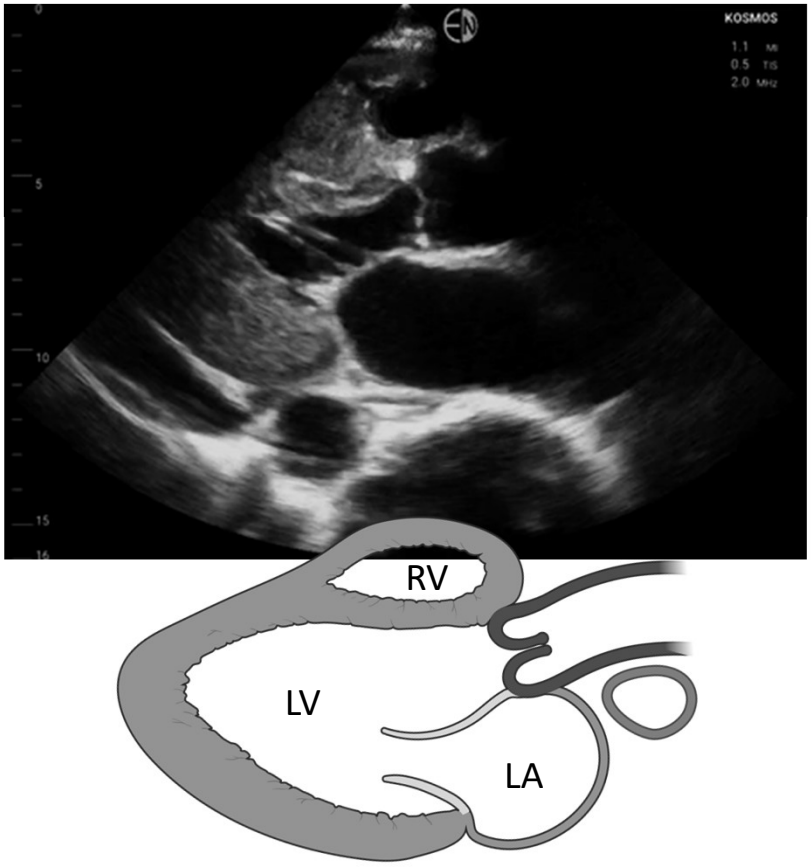
NephroPOCUS

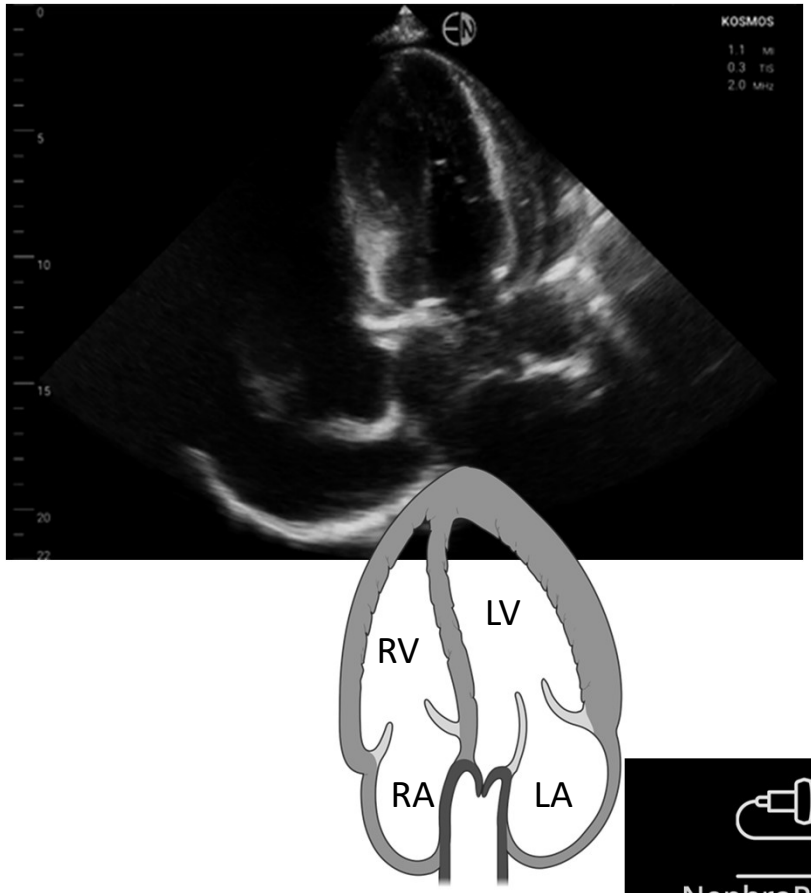
Case: A patient with ESKD on hemodialysis is admitted to the ICU for post-operative care following vascular access revision. During dialysis, the blood pressure drops to 90/58 mmHg. Nephrology fellow finds A-lines on lung ultrasound and asks the nurse to stop UF. Of note, patient has pedal edema, feels slightly short of breath and has not been getting full 4-hour dialysis for the past few weeks due to access issues. No history suggestive of volume loss. Would you do something else?



NephroPOCUS

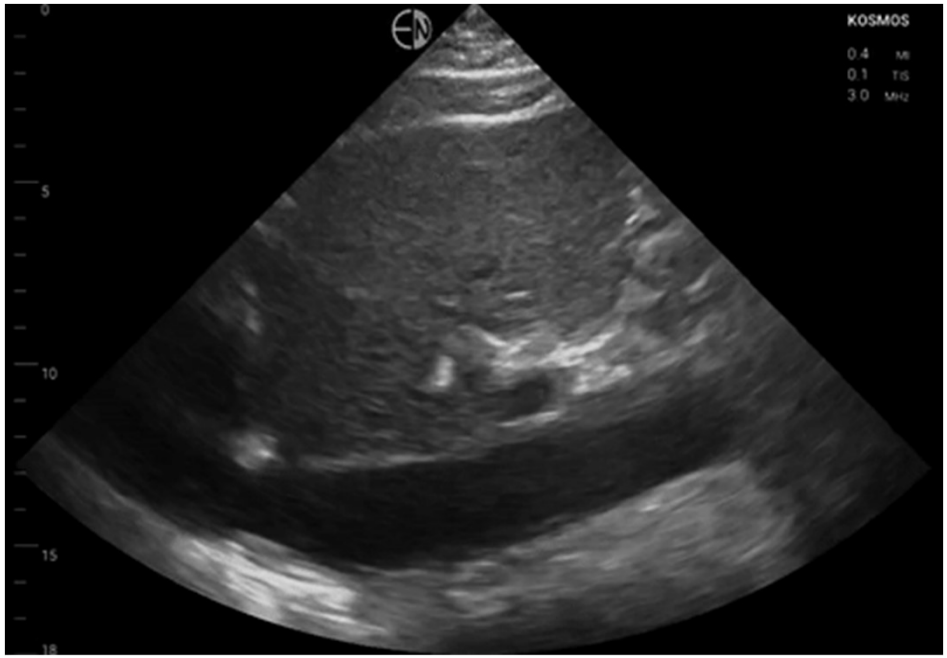
Focused cardiac ultrasound





NephroPOCUS

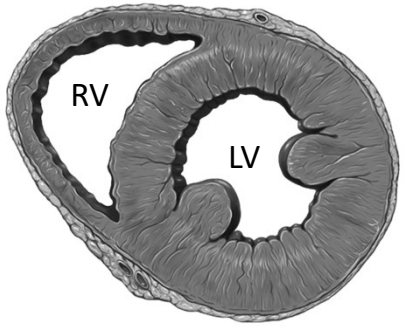
Case: A patient on chronic mechanical ventilation is admitted for sepsis secondary to pneumonia. He developed AKI during the course of critical illness and has been started on hemodialysis. Documented fluid balance is +14 L since admission. Dialysis nurse pages nephrology fellow as the patient is hypotensive prior to starting the procedure. Fellow says, “don’t pull fluid today, I’ll also place PRN albumin order”. Is it appropriate response?

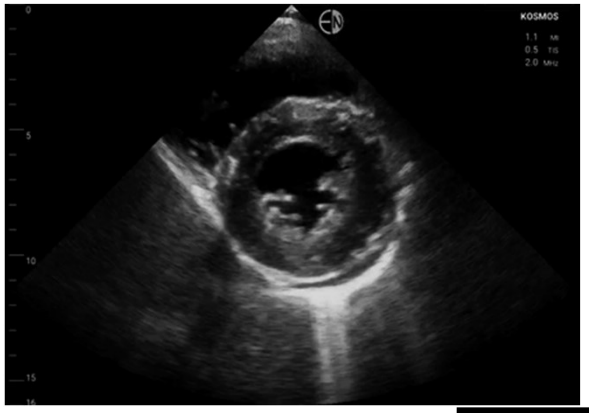


NephroPOCUS

Focused cardiac ultrasound

Patient's PSAX

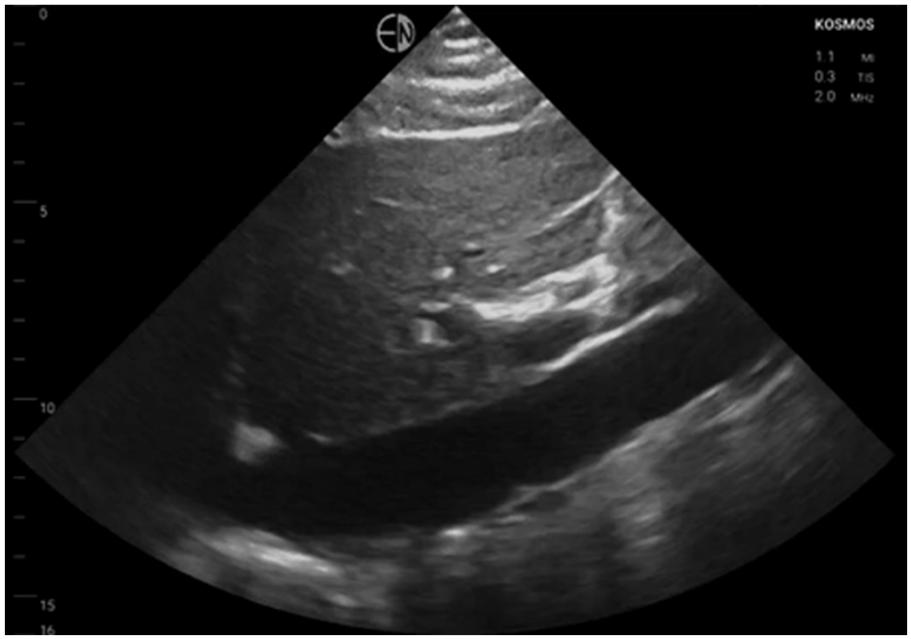


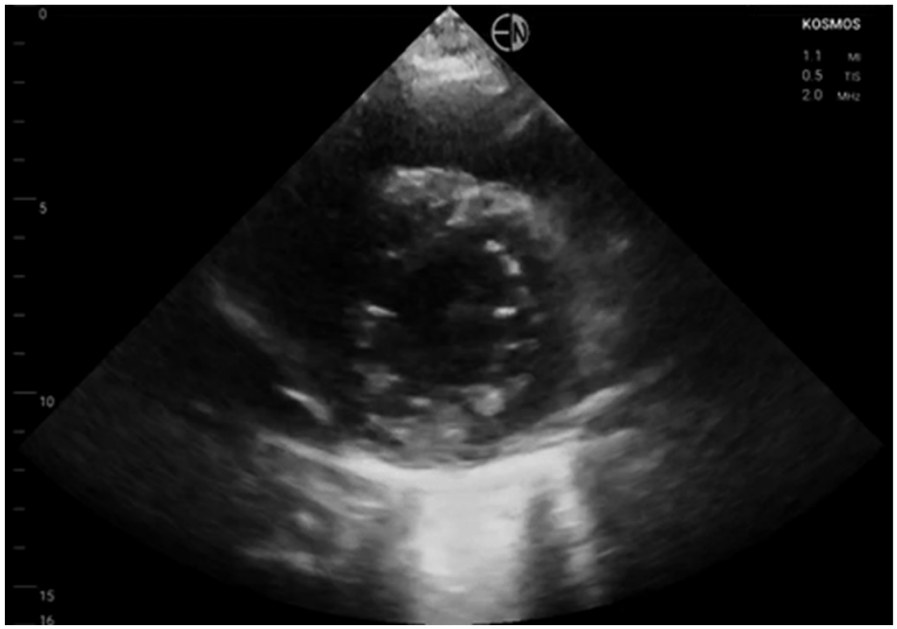


Normal

NephroPOCUS

After 12 L negative on CRRT

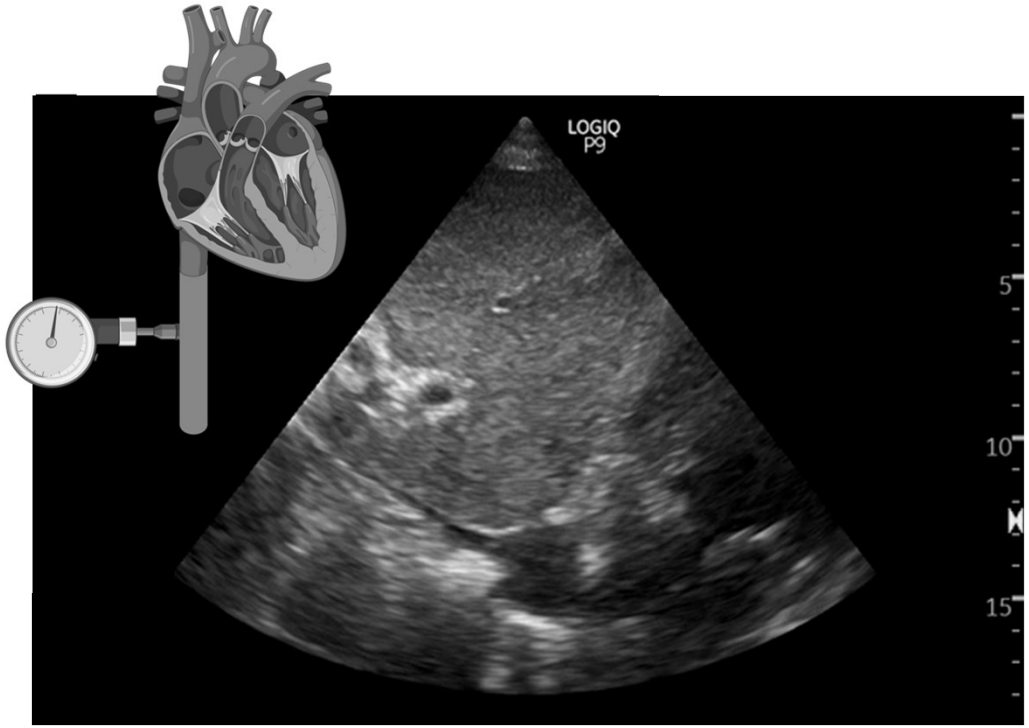


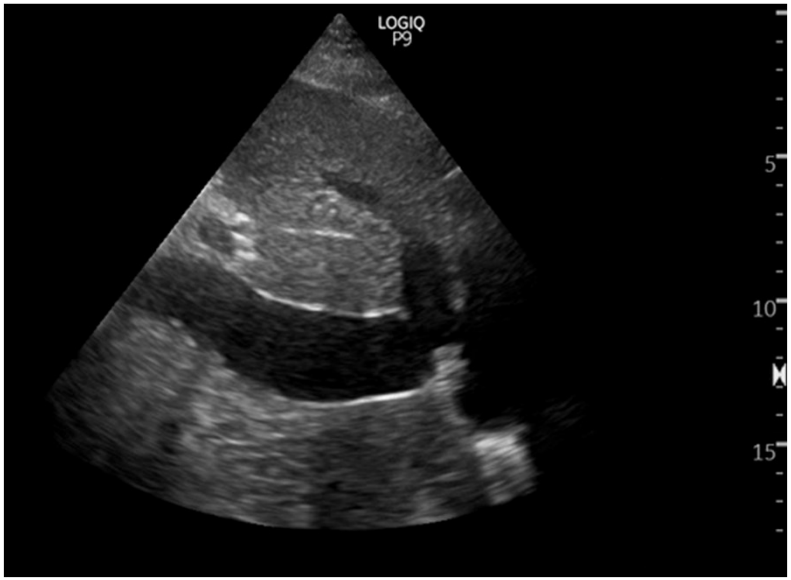


NephroPOCUS

IVC indicates right atrial pressure. That's it!

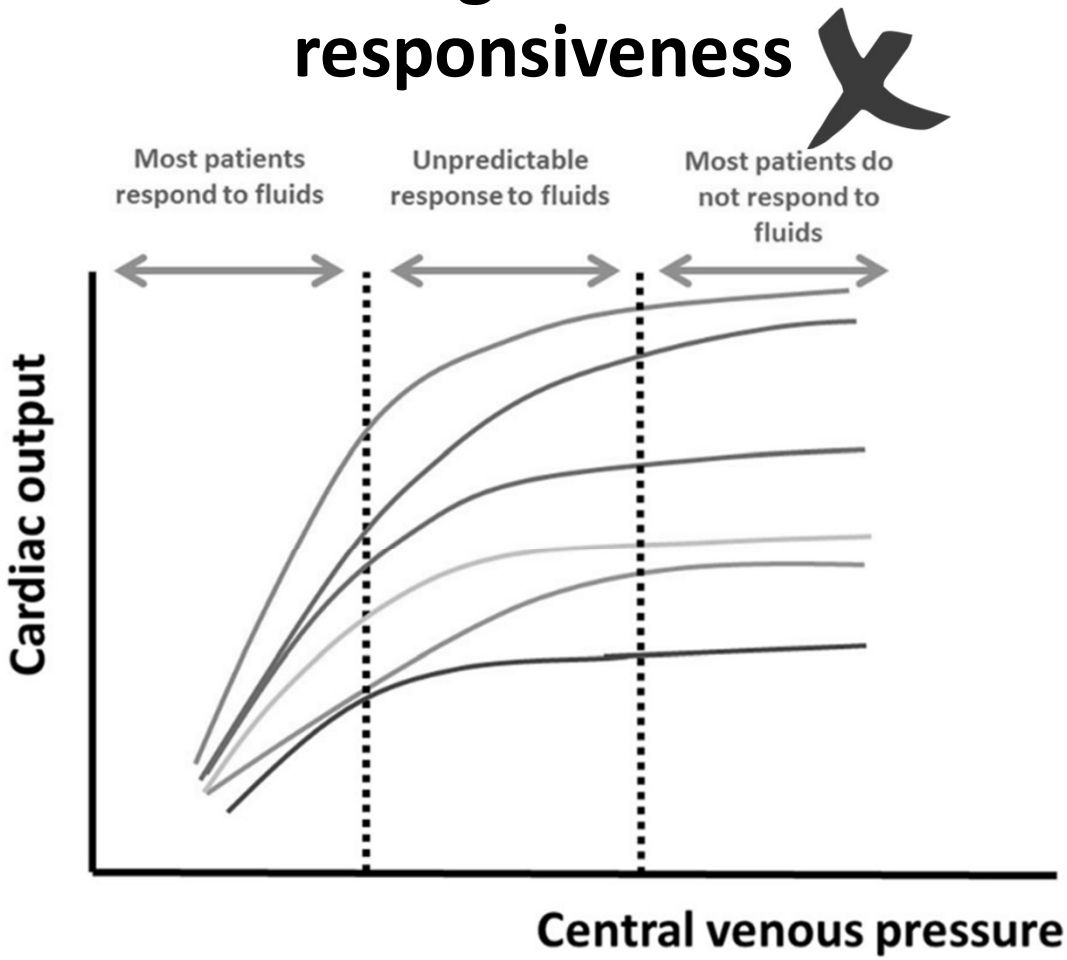
Does not determine the need for fluid vs diuretic therapy by itself





NephroPOCUS

IVC ultrasound is a great tool to assess fluid responsiveness



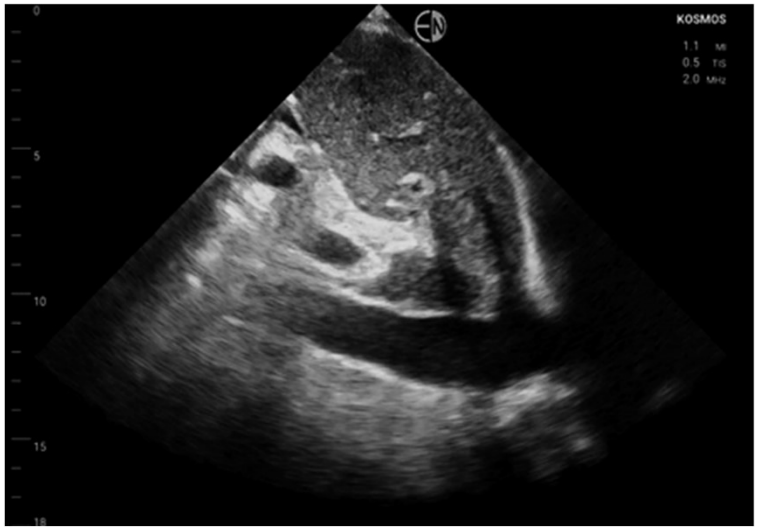
De Backer D, Vincent JL. Crit Care. 2018;22(1):43.

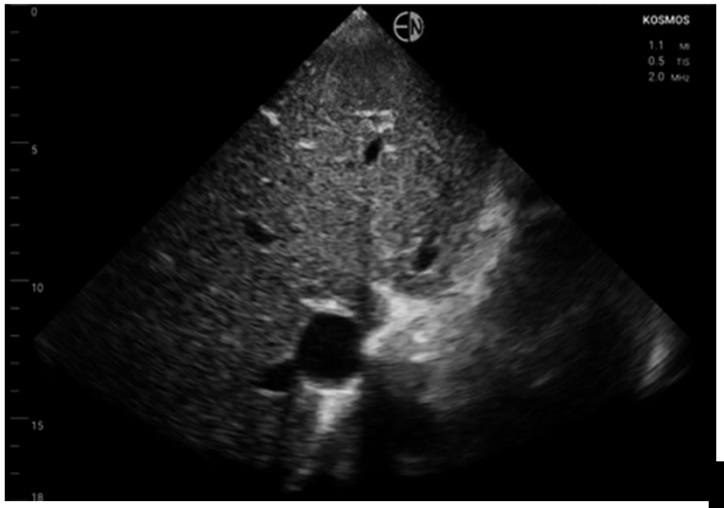
NephroPOCUS

What will you do by assessing fluid responsiveness?

NephroPOCUS

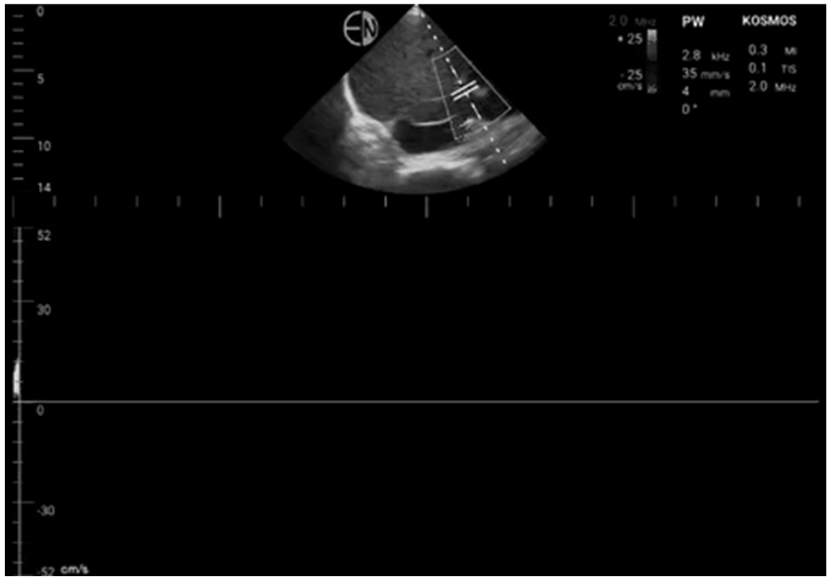
Case: Elderly patient with complicated vascular surgery developed AKI requiring hemodialysis. Has not been tolerating ultrafiltration more than 1 L for the past few sessions due to hypotension. Surgery team thinks the patient is ‘dry’. He appears thin, there is trace pedal edema, lungs sound clear; does have sacral ulcers. Has been having paroxysmal atrial fibrillation. Documented fluid balance: +10 L. Does POCUS change anything in this case?



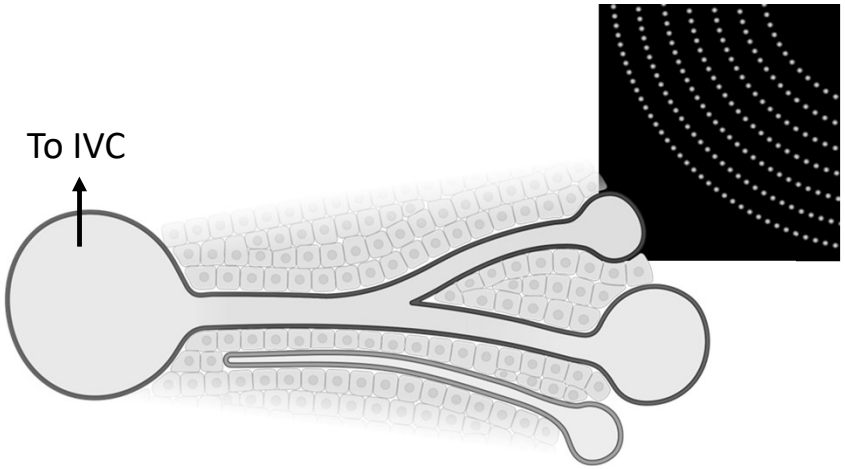


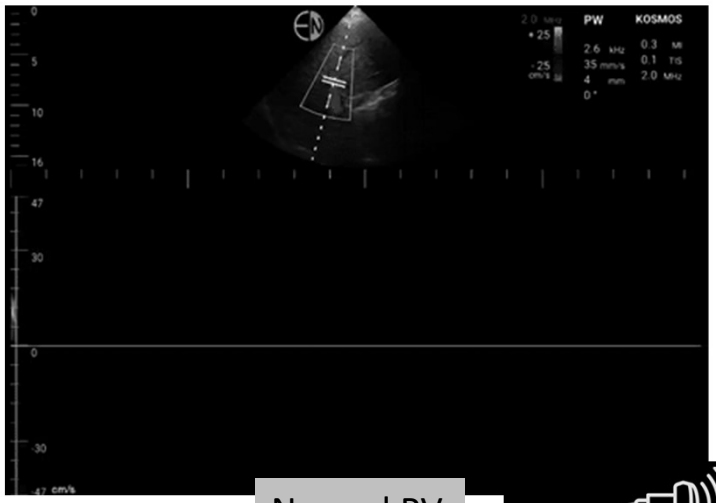
NephroPOCUS

Portal vein Doppler



Patient's PV

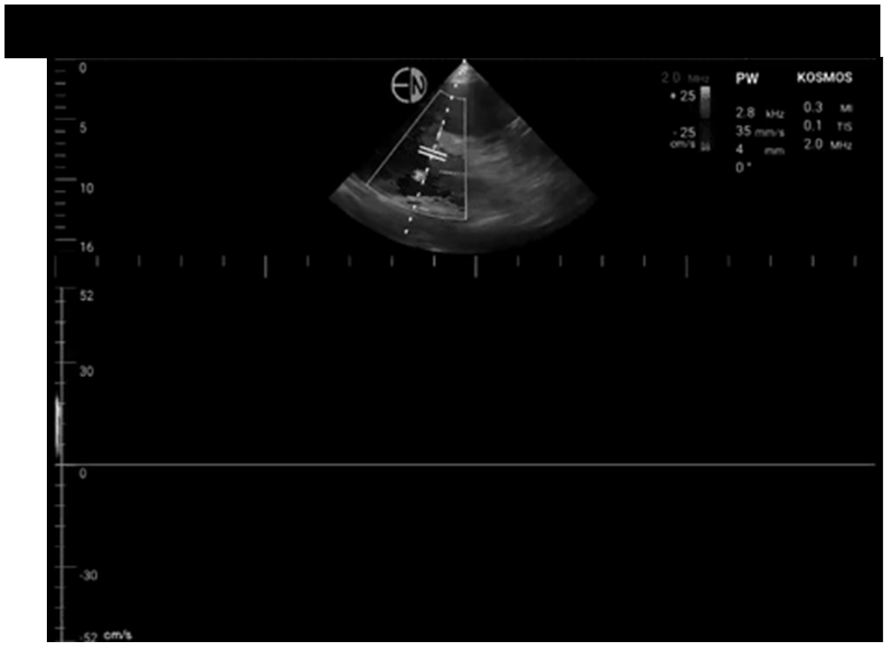


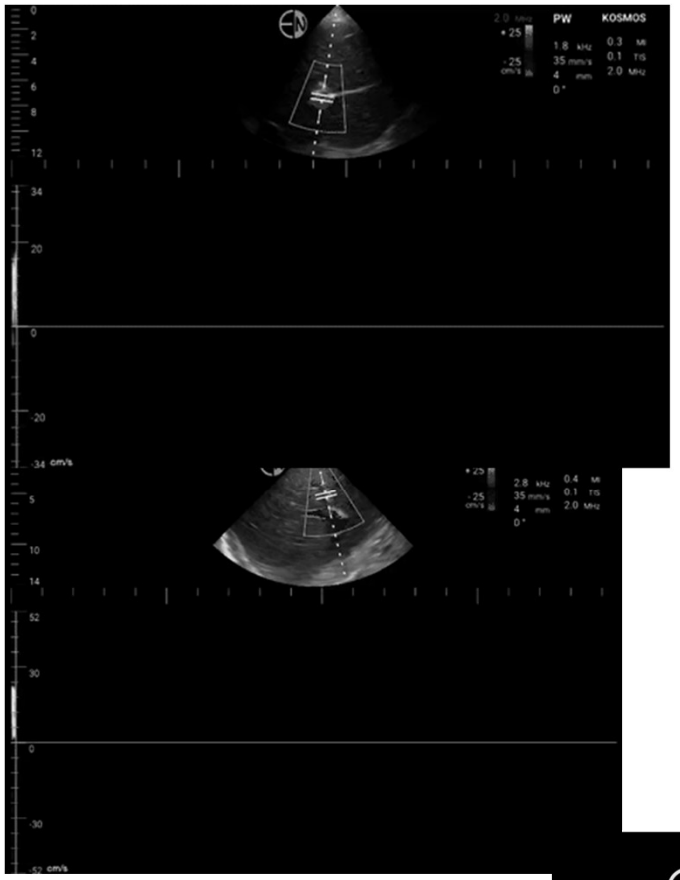


Normal PV

NephroPOCUS

Portal vein Doppler

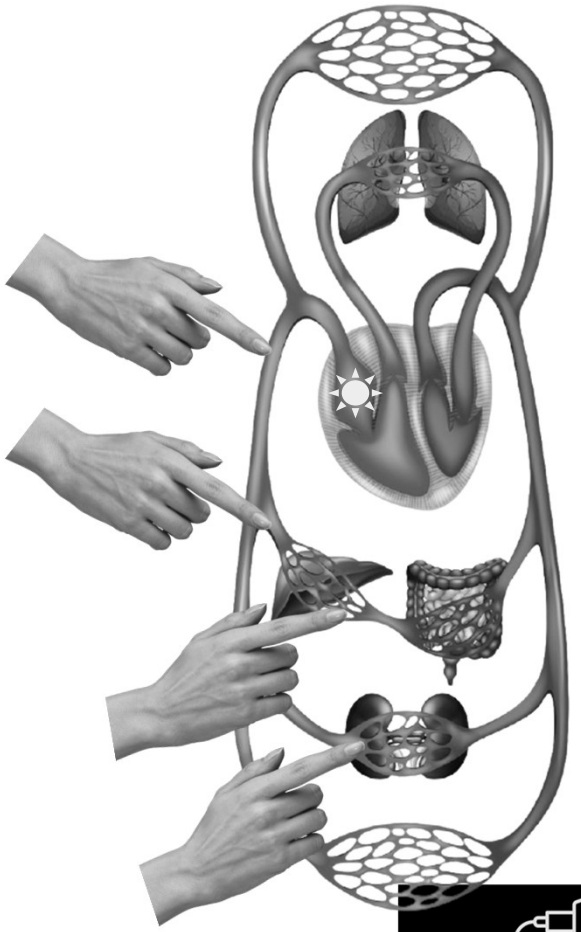




NephroPOCUS

VExUS

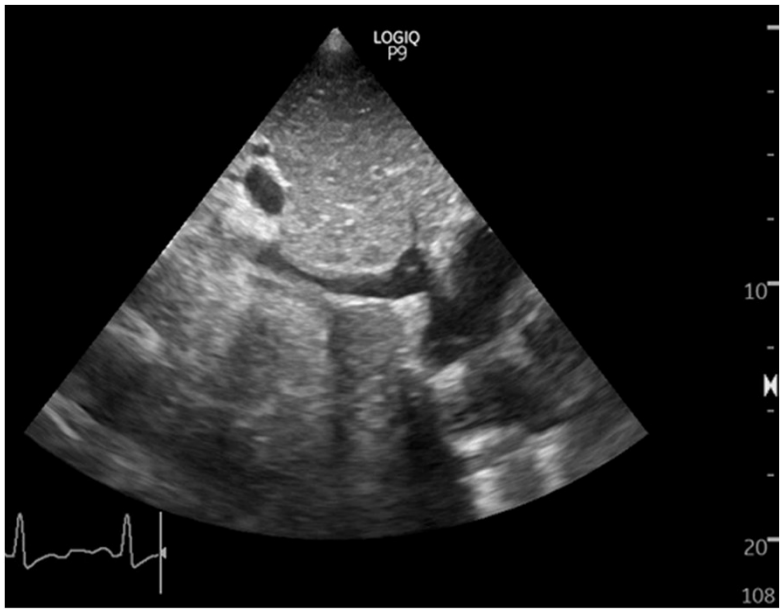
Severe venous congestion defined as the presence of severe flow abnormalities in multiple Doppler patterns with a dilated IVC (≥ 2 cm) showed the strongest association with the development of subsequent AKI compared with other combinations (HR: 3.69 CI 1.65-8.24 p = 0.001).

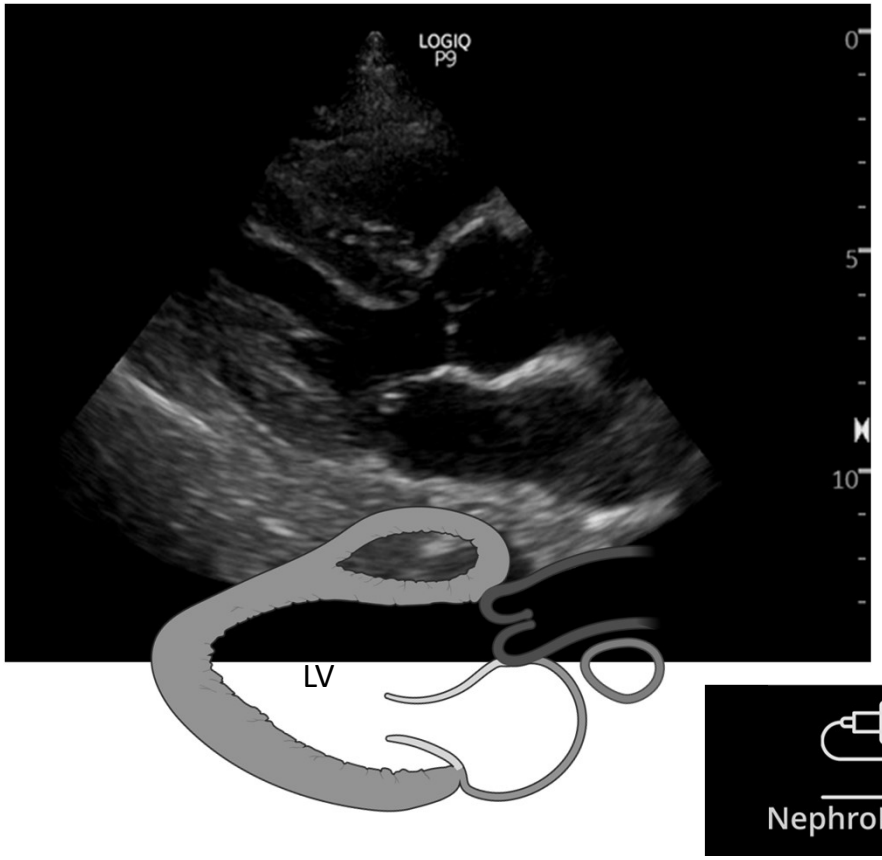


Beaubien-Souligny W, et al. Ultrasound J. 2020;12(1):16.

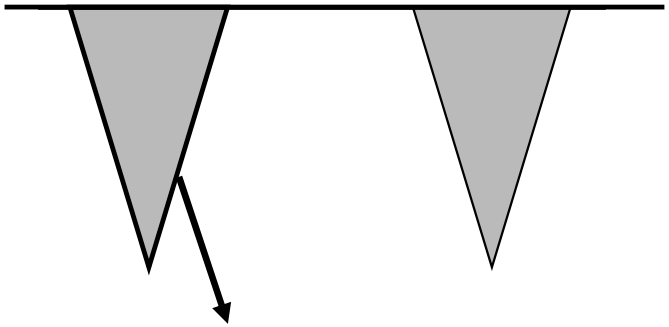
NephroPOCUS

Case: A patient with cirrhosis is seen for AKI. Urine sodium is less than 20 mEq/L. Should we start albumin for presumed volume depletion?





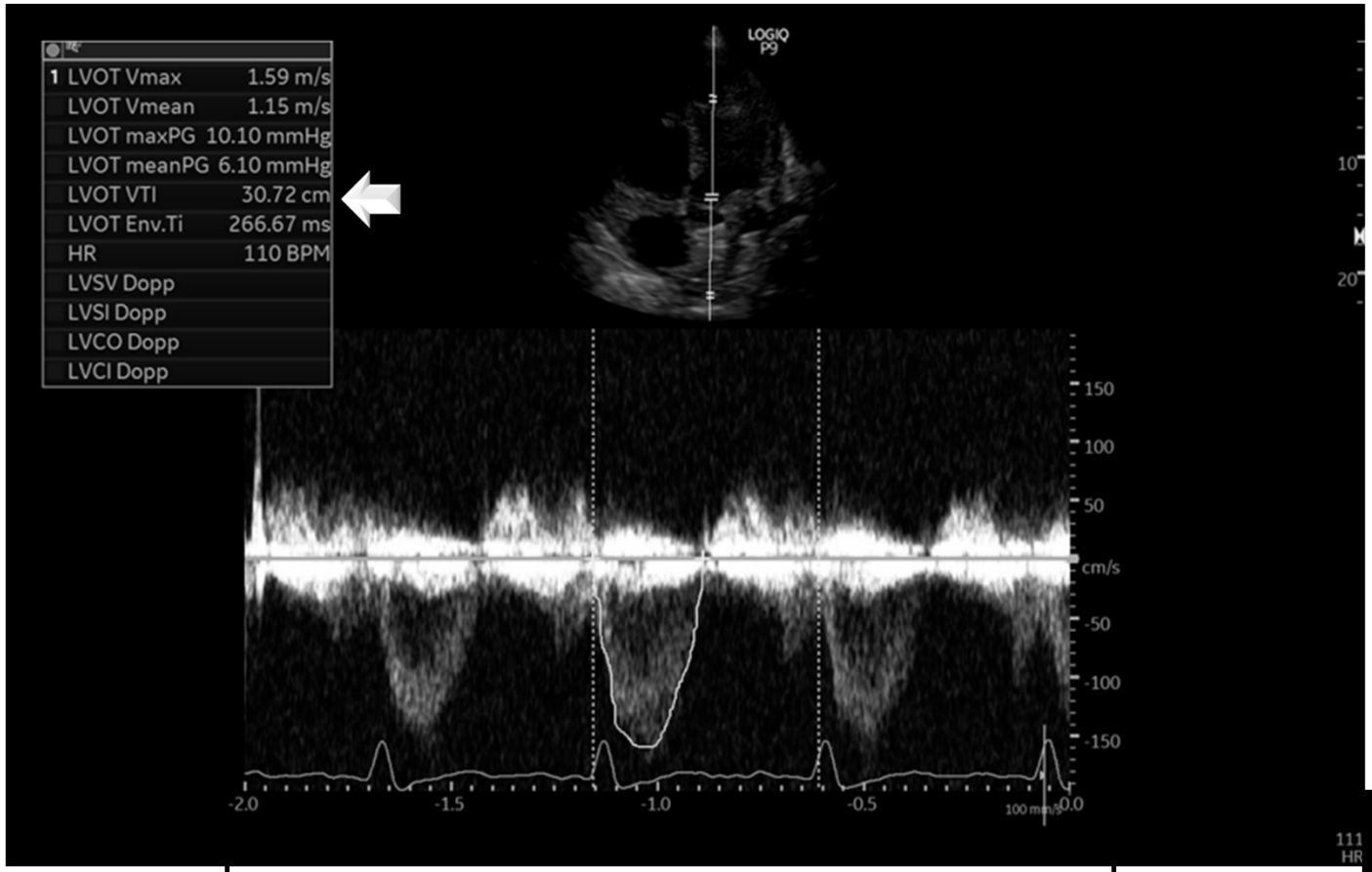
Stroke volume



Stroke distance in cm (18-22)

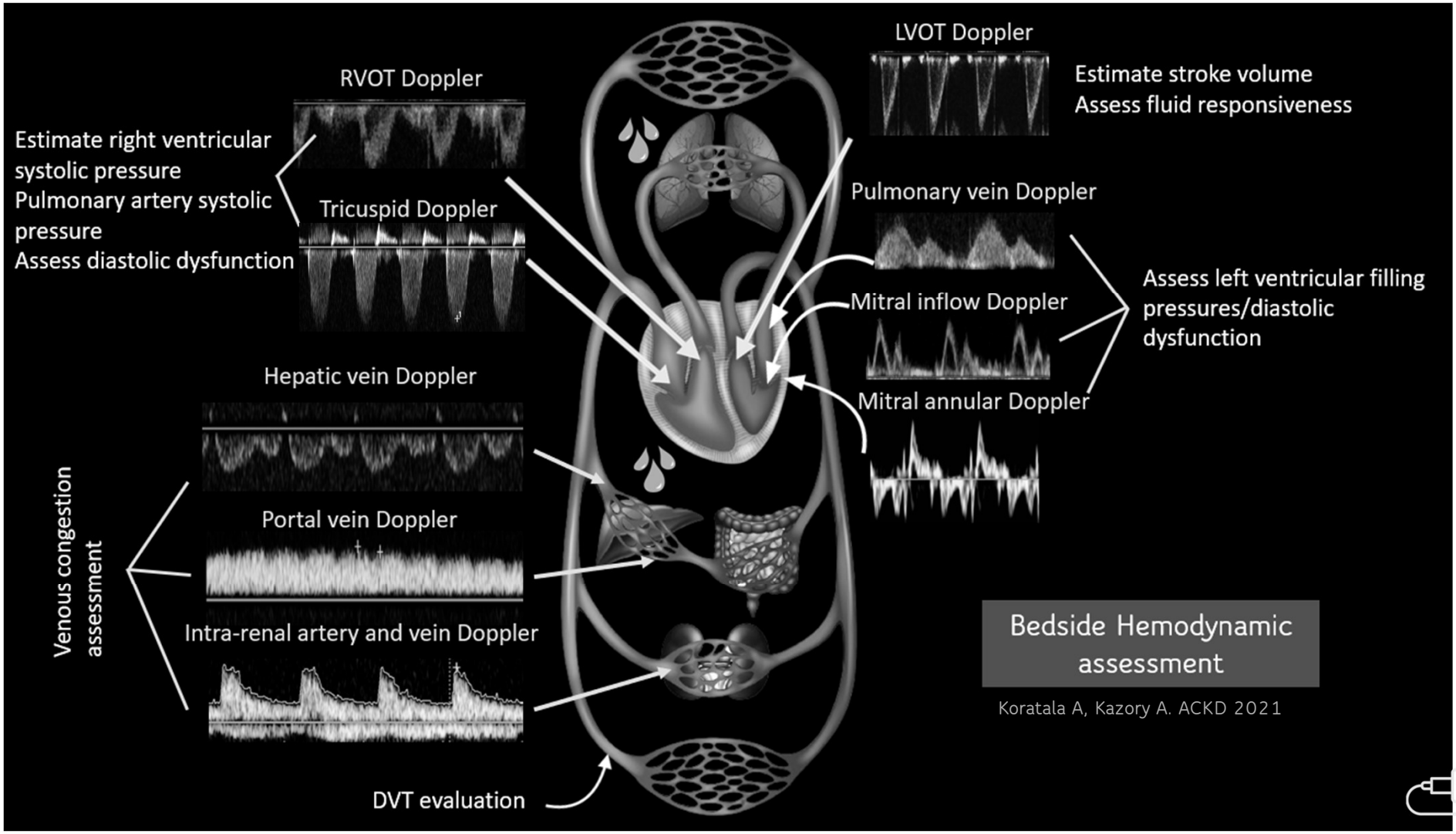
NephroPOCUS

Going back to our patient



Hyperdynamic heart is NOT equal to volume depletion

NephroPOCUS


LVOT Doppler
Estimate stroke volume
Assess fluid responsiveness
RVOT Doppler
Estimate right ventricular systolic pressure
Pulmonary artery systolic pressure
Assess diastolic dysfunction
Tricuspid Doppler
Pulmonary vein Doppler
Mitral inflow Doppler
Assess left ventricular filling pressures/diastolic dysfunction
Mitral annular Doppler
Hepatic vein Doppler
Venous congestion assessment
Portal vein Doppler
Intra-renal artery and vein Doppler
DVT evaluation
Bedside Hemodynamic assessment
Koratala A, Kazory A. ACKD 2021
NephroPOCUS

Thank you

Abhilash Koratala

@NephroP

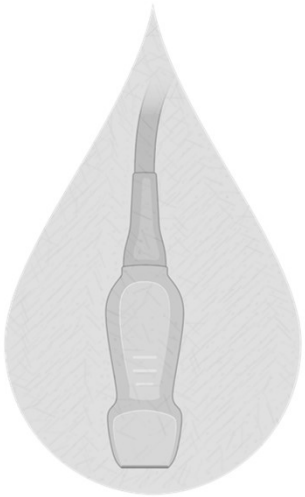
POCUS-assisted Fluid Status Assessment in the Intensive Care Unit

Abhilash Koratala MD FASN

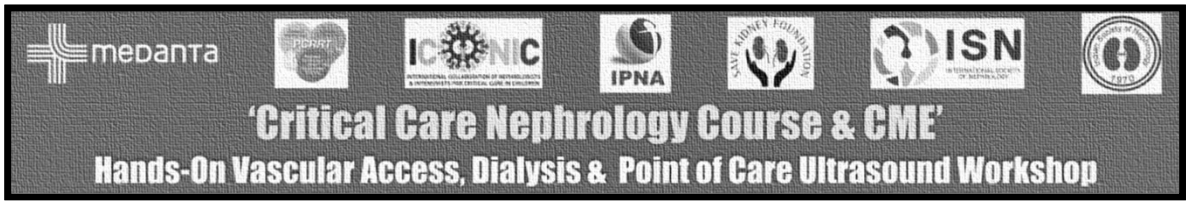
Associate Professor of Medicine

Division of Nephrology

Medical College of Wisconsin



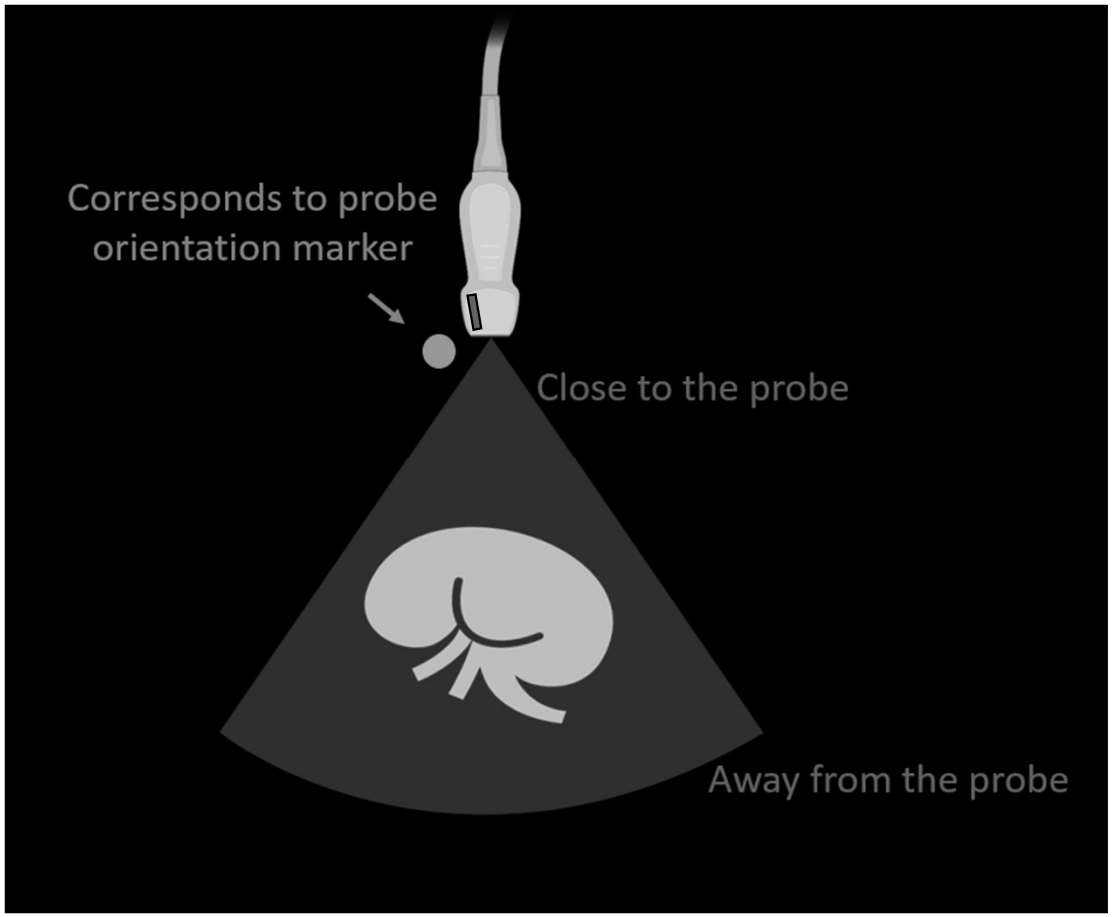
@NephroP



Disclosures

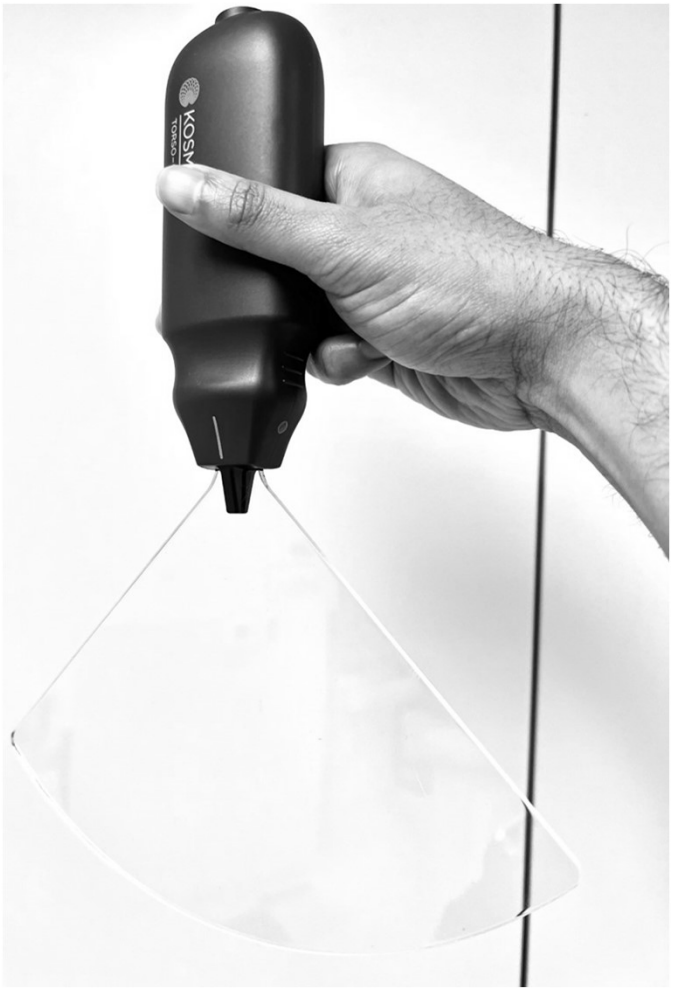
None

Orientation

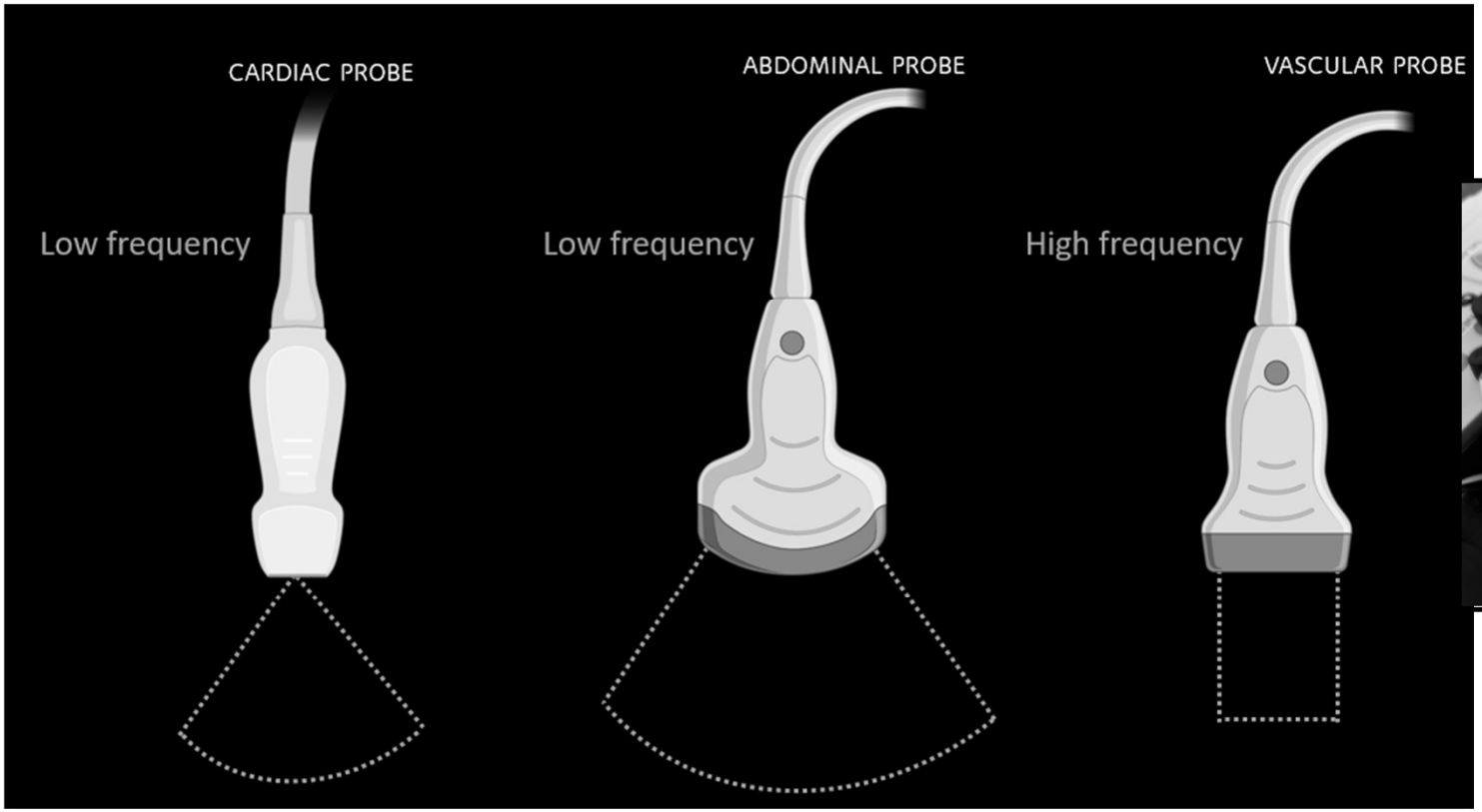


Probe marker

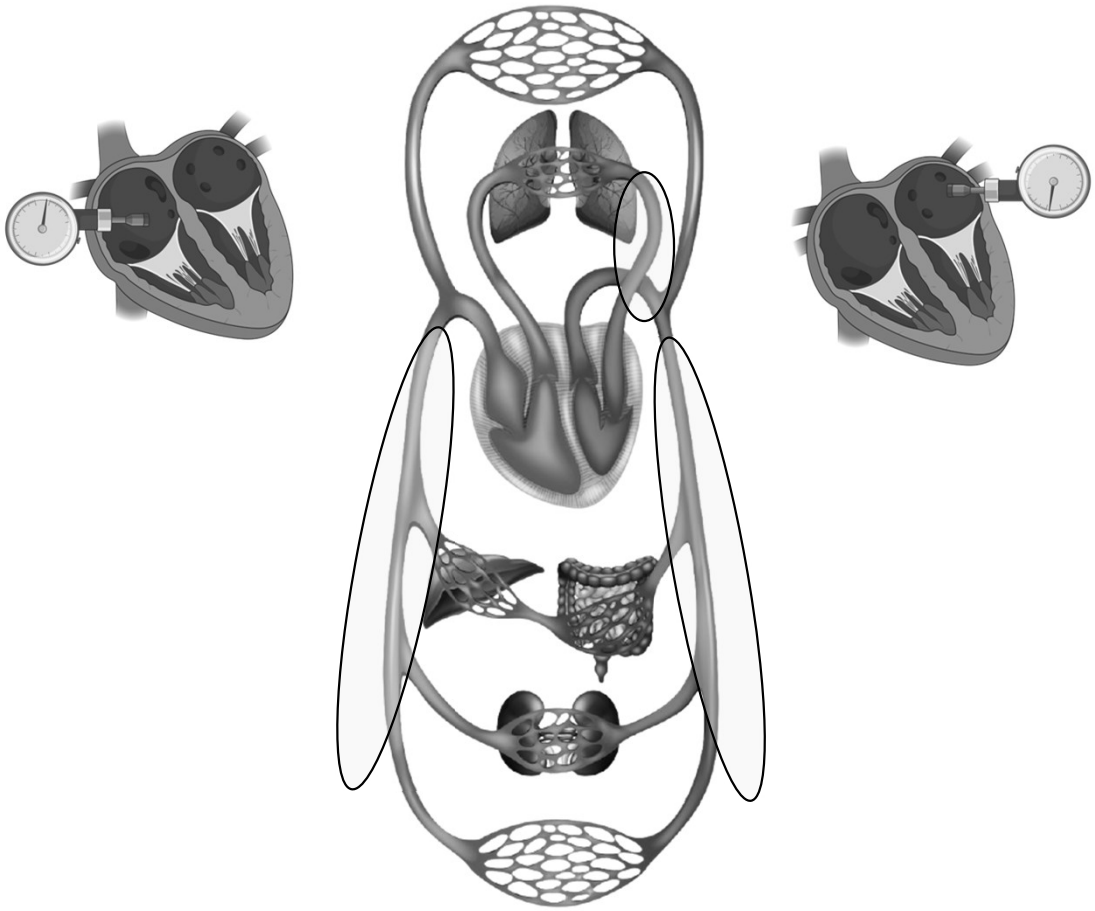
Orientation



Picking the right transducer

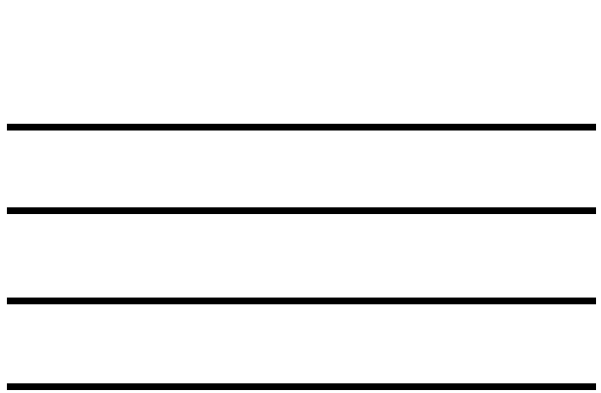


Hemodynamic circuit

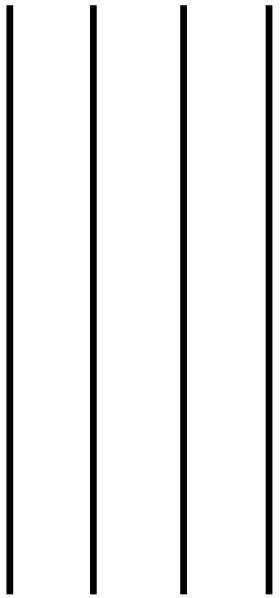


Lung tissue is not seen on ultrasound

Unless consolidated/atelectatic

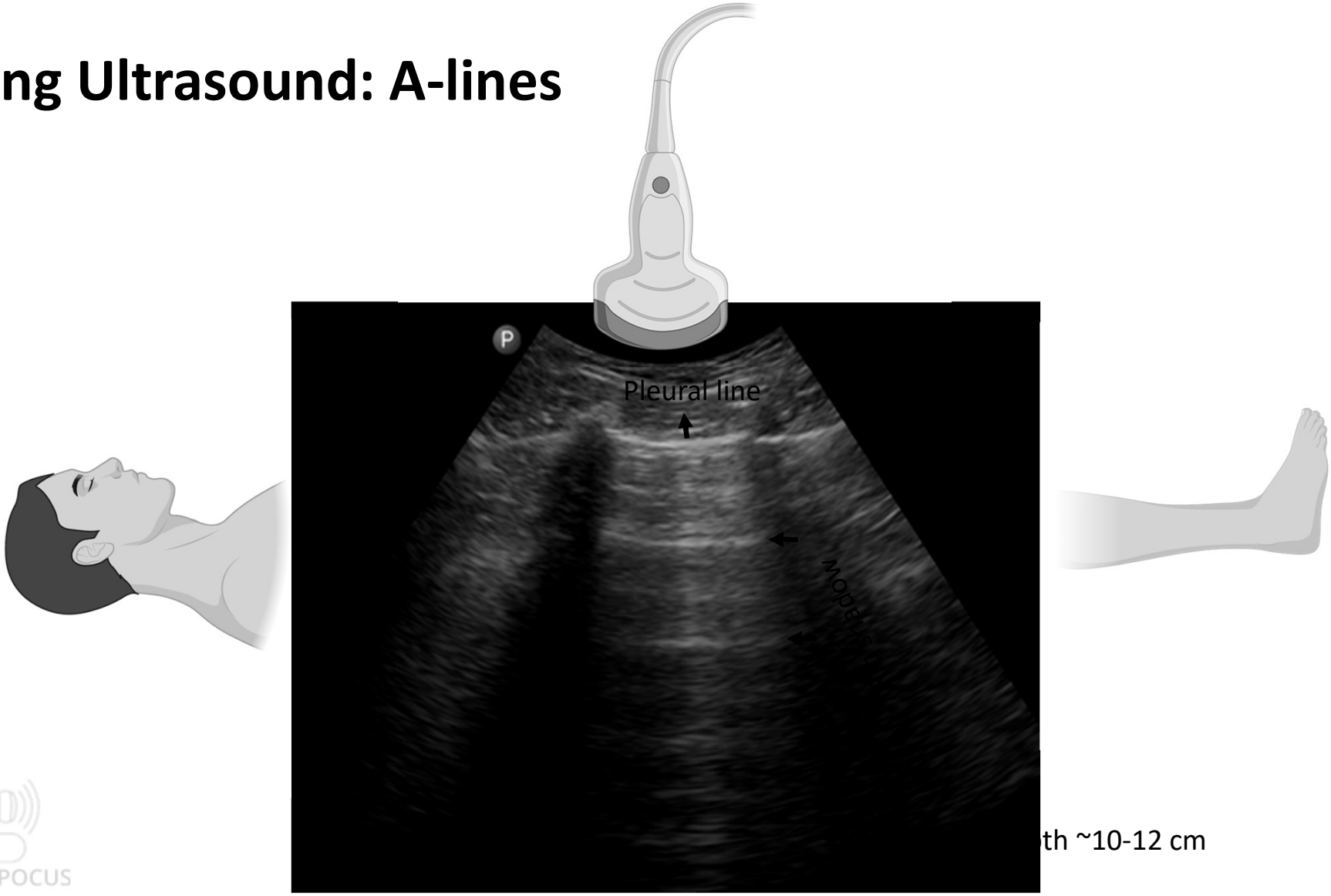


A-lines



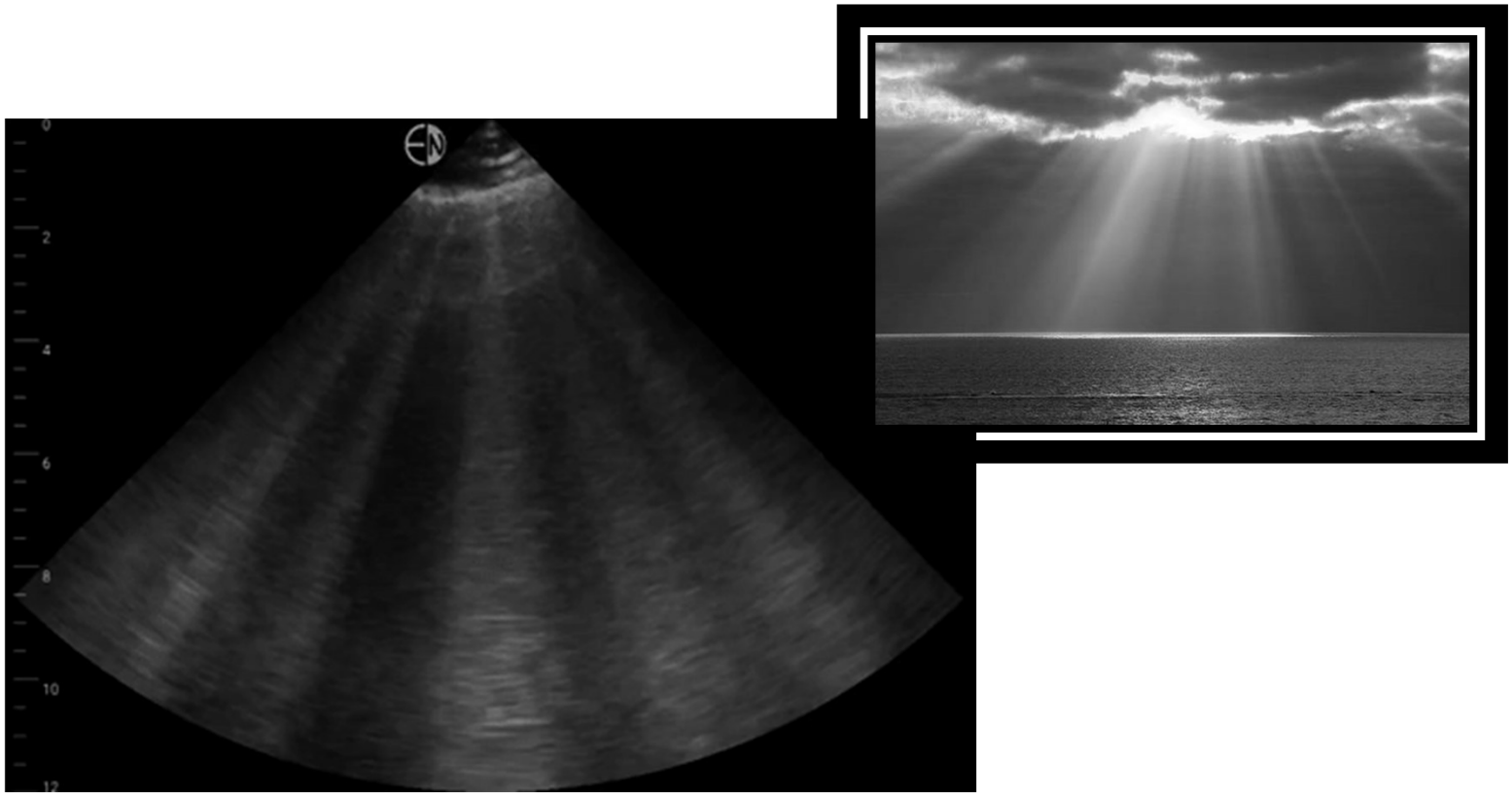
B-lines

Lung Ultrasound: A-lines



th ~10-12 cm

Lung Ultrasound: B-lines



NephroPOCUS

Lung Ultrasound: B-lines

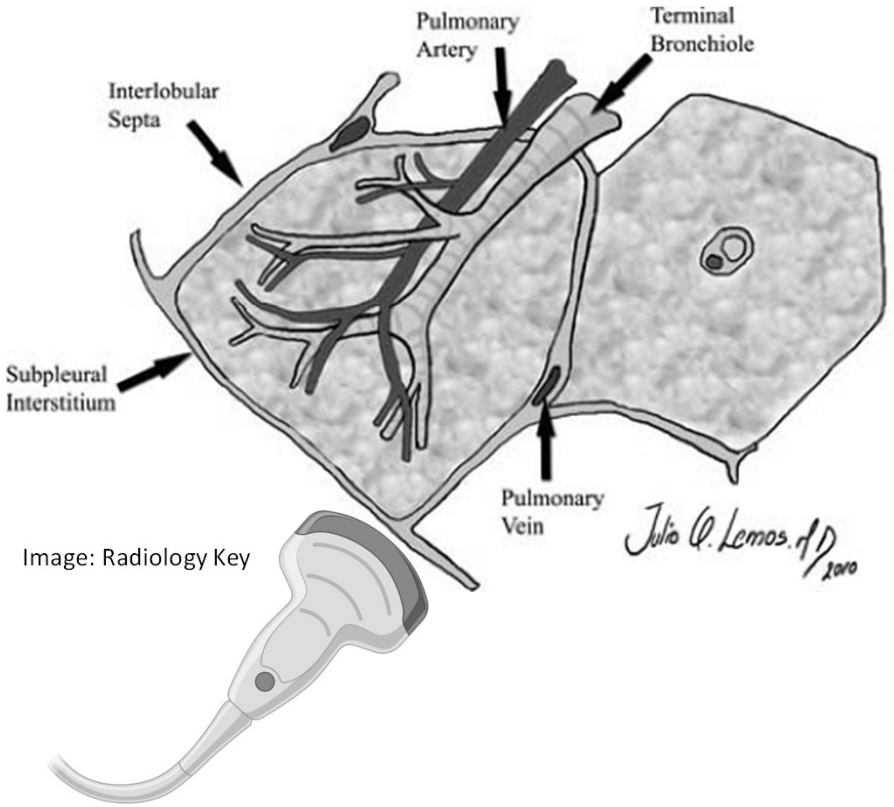
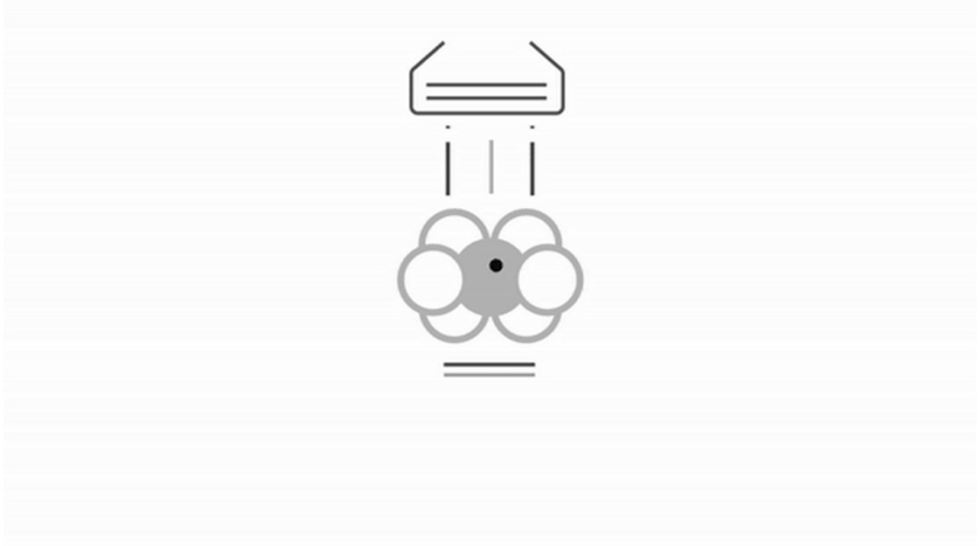


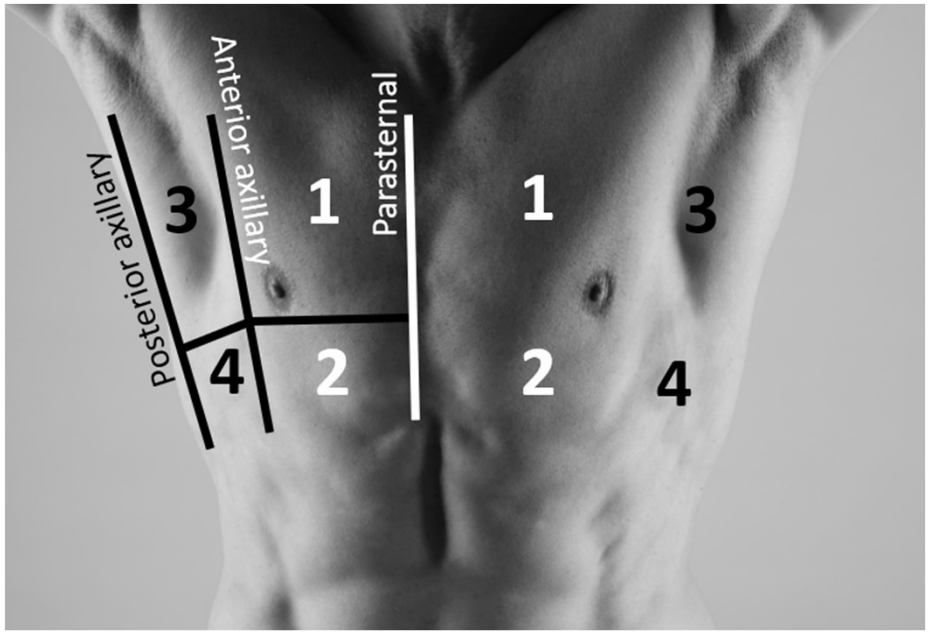
Image: Radiology Key



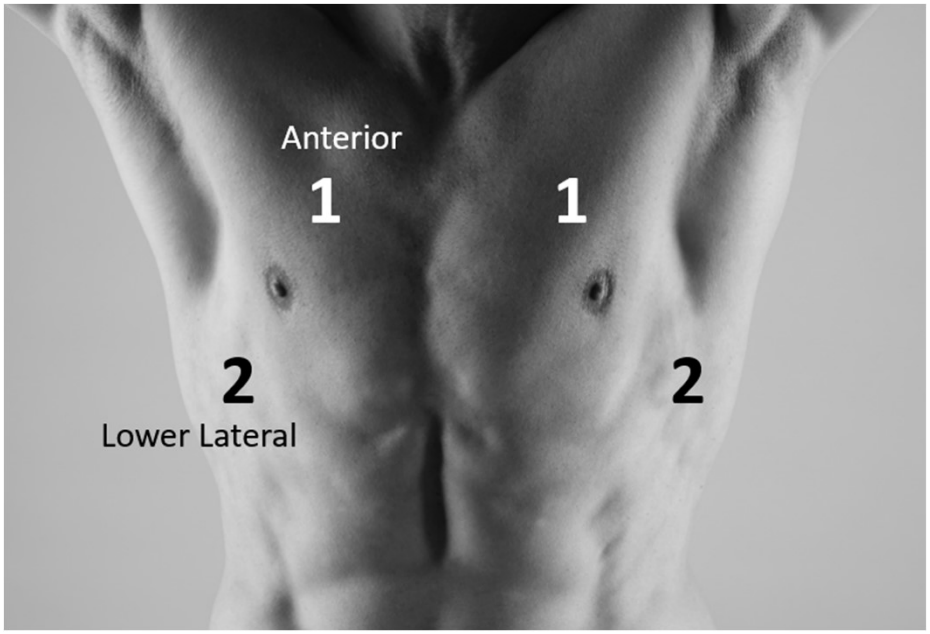
NephroPOCUS

Technique

Zones of sono-auscultation

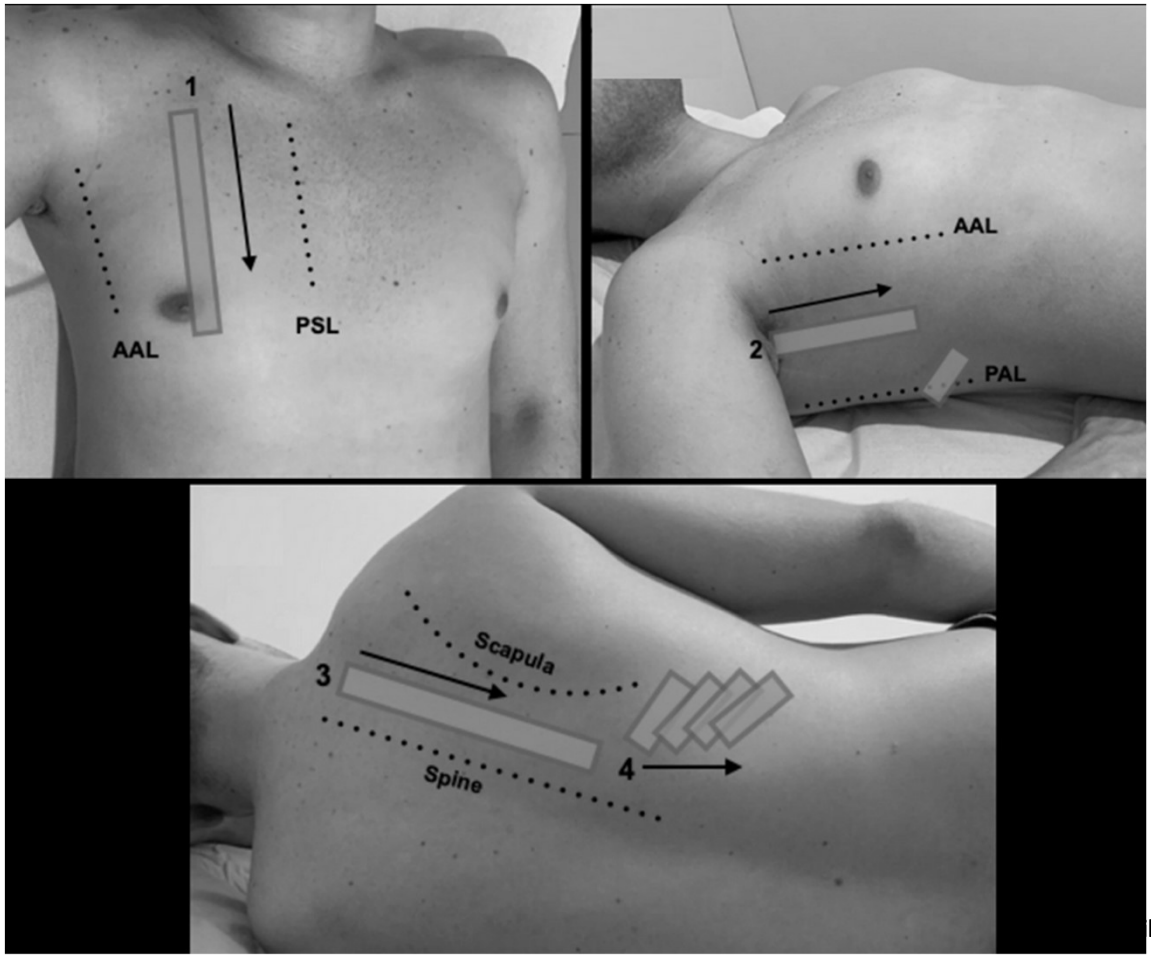


8



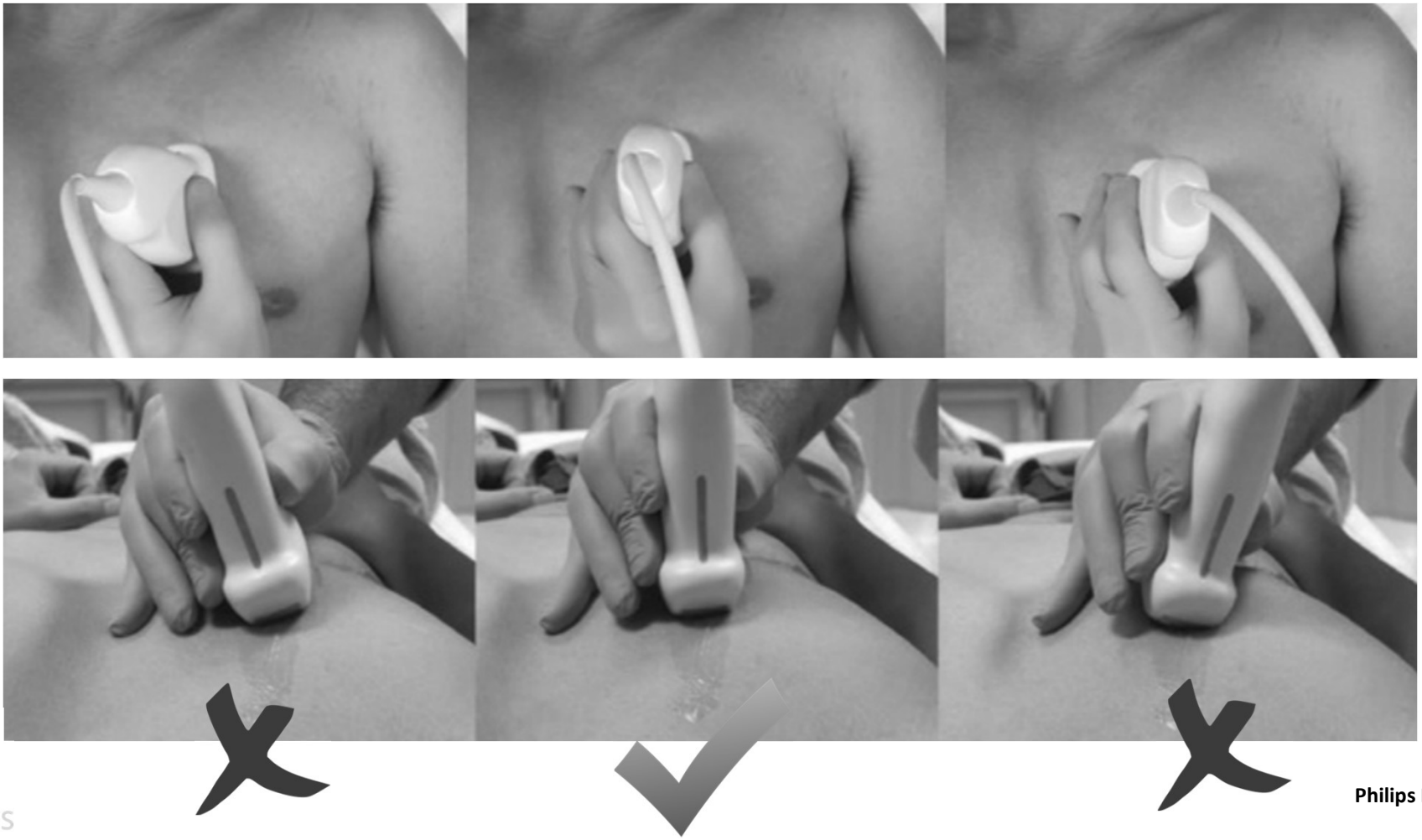
4

Technique



llington SJ, et al. CHEST 2020

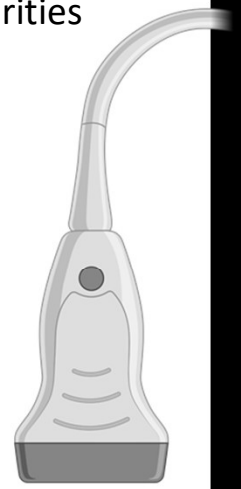
Pay attention to the chest wall curvature

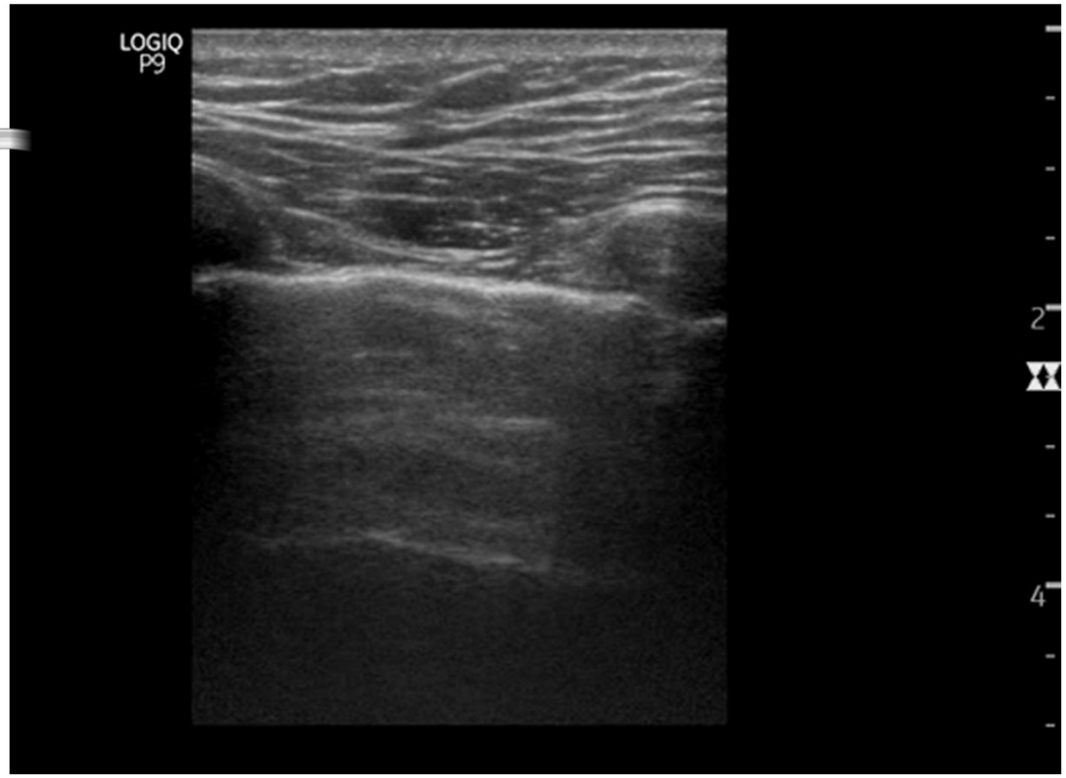


Philips Healthcare

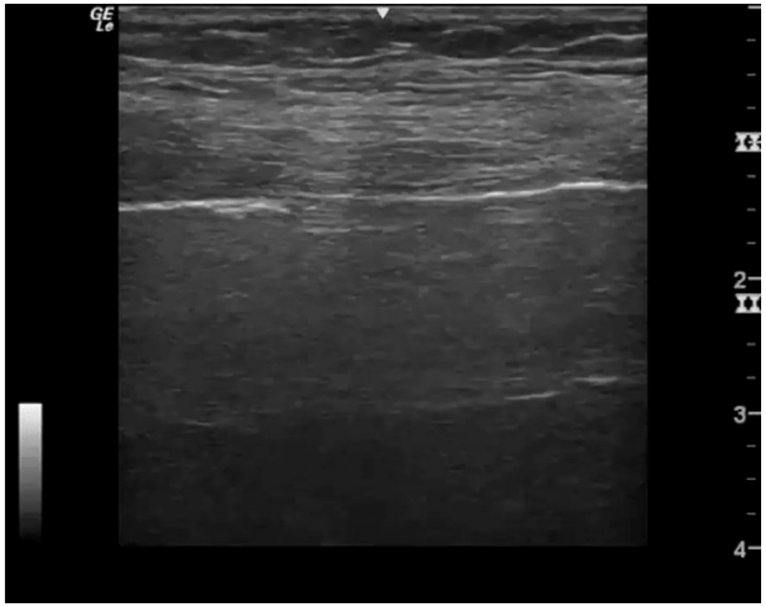
Pleural line

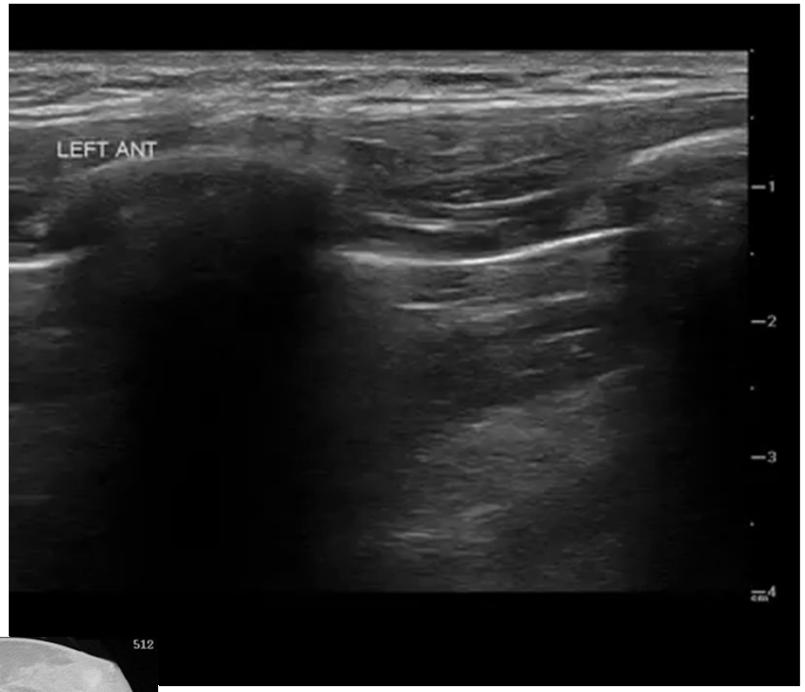
- Sliding
- Irregularities





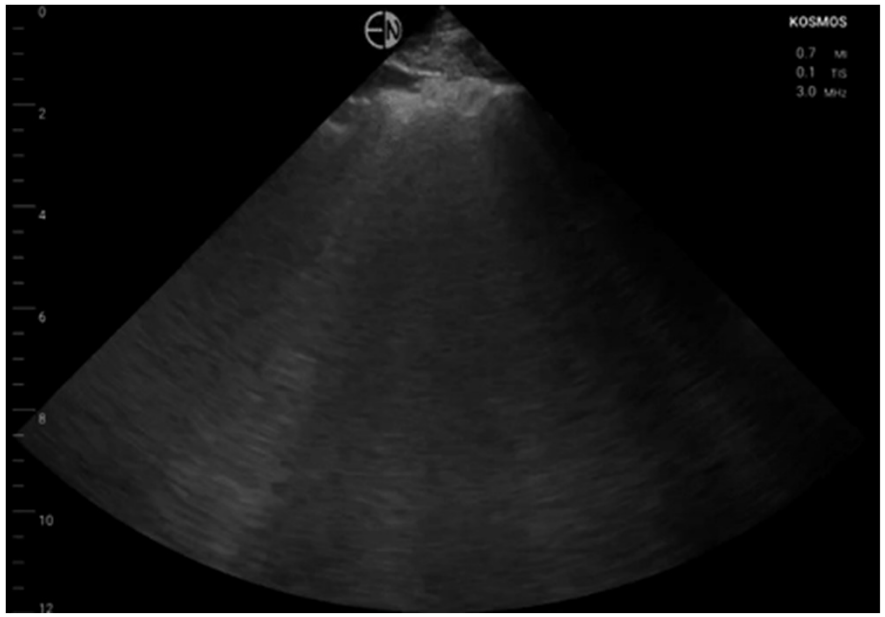
Pneumothorax - Lung point

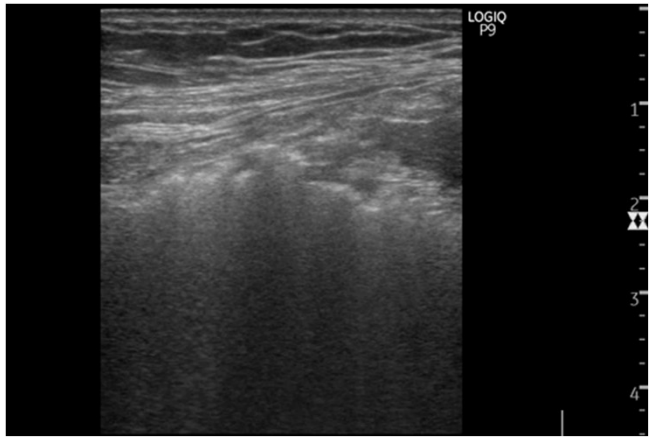


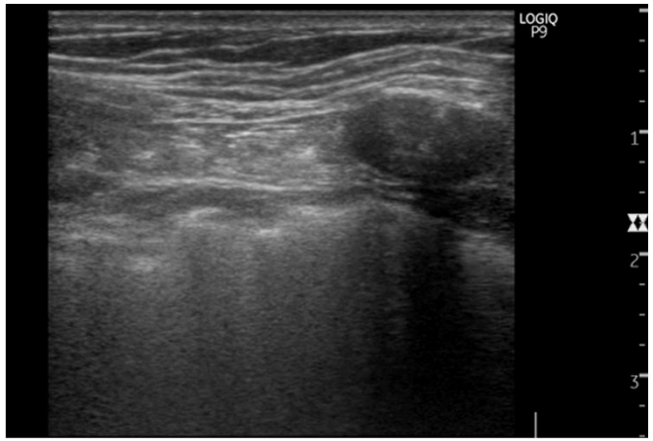


Philips Healthcare

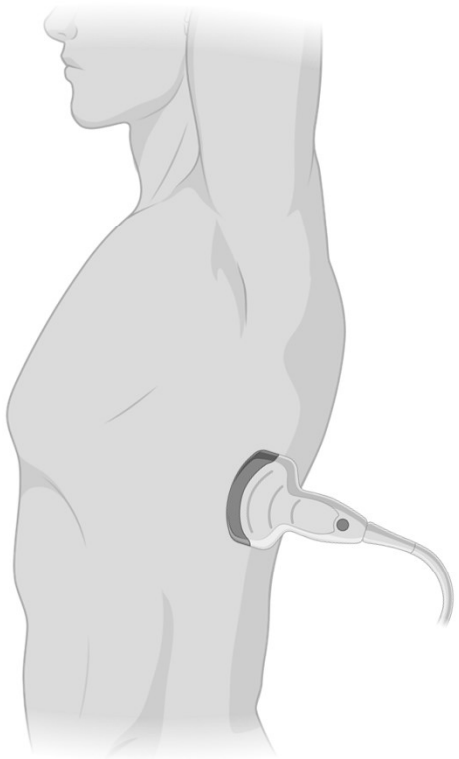
B-lines are not specific for pulmonary edema



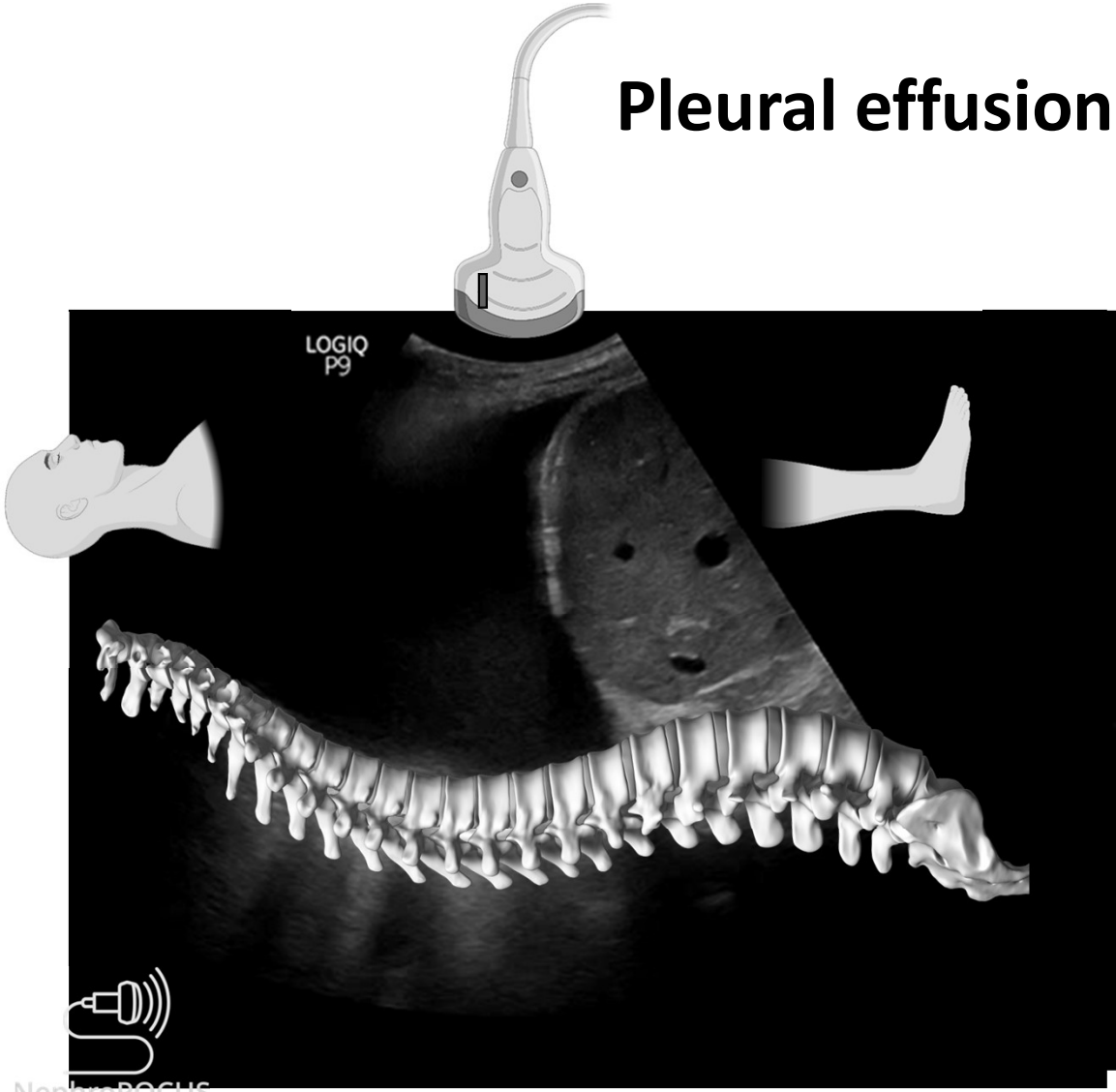


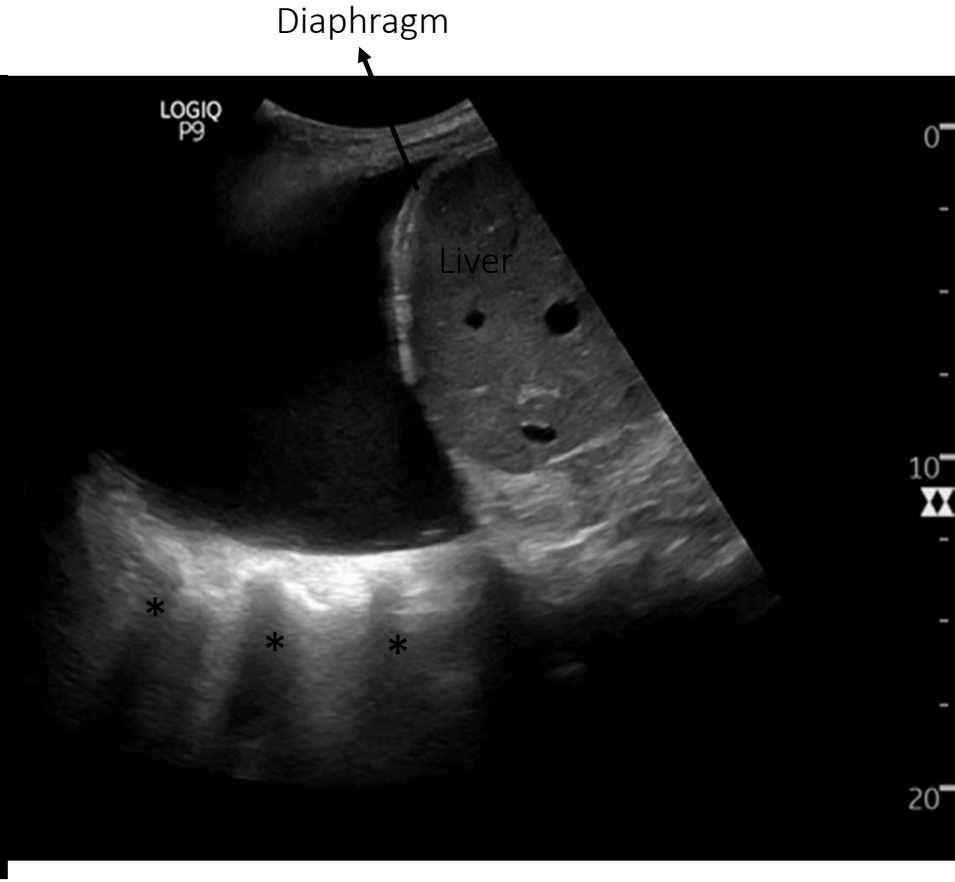


Pleural effusion

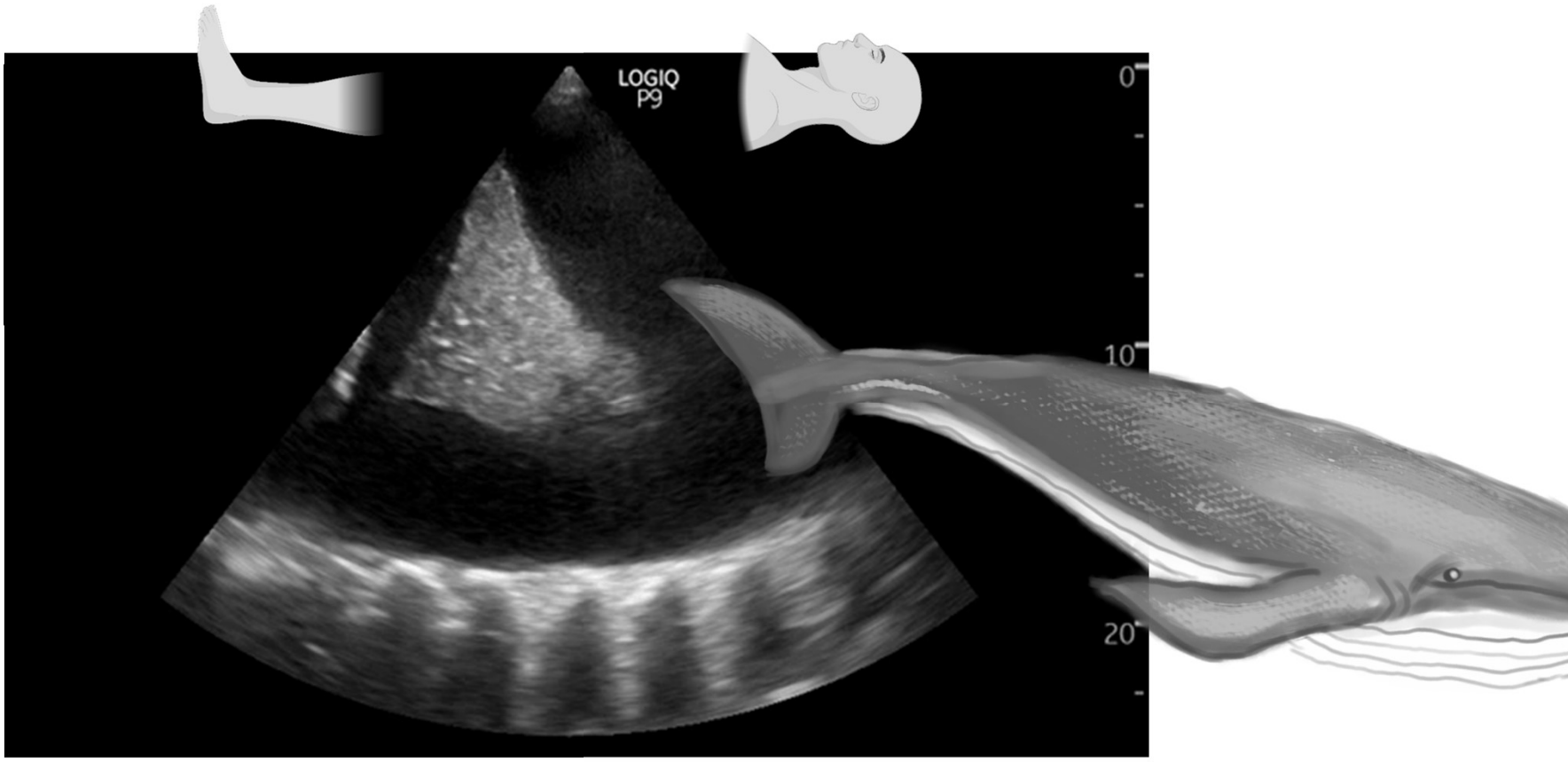


Pleural effusion - spine sign

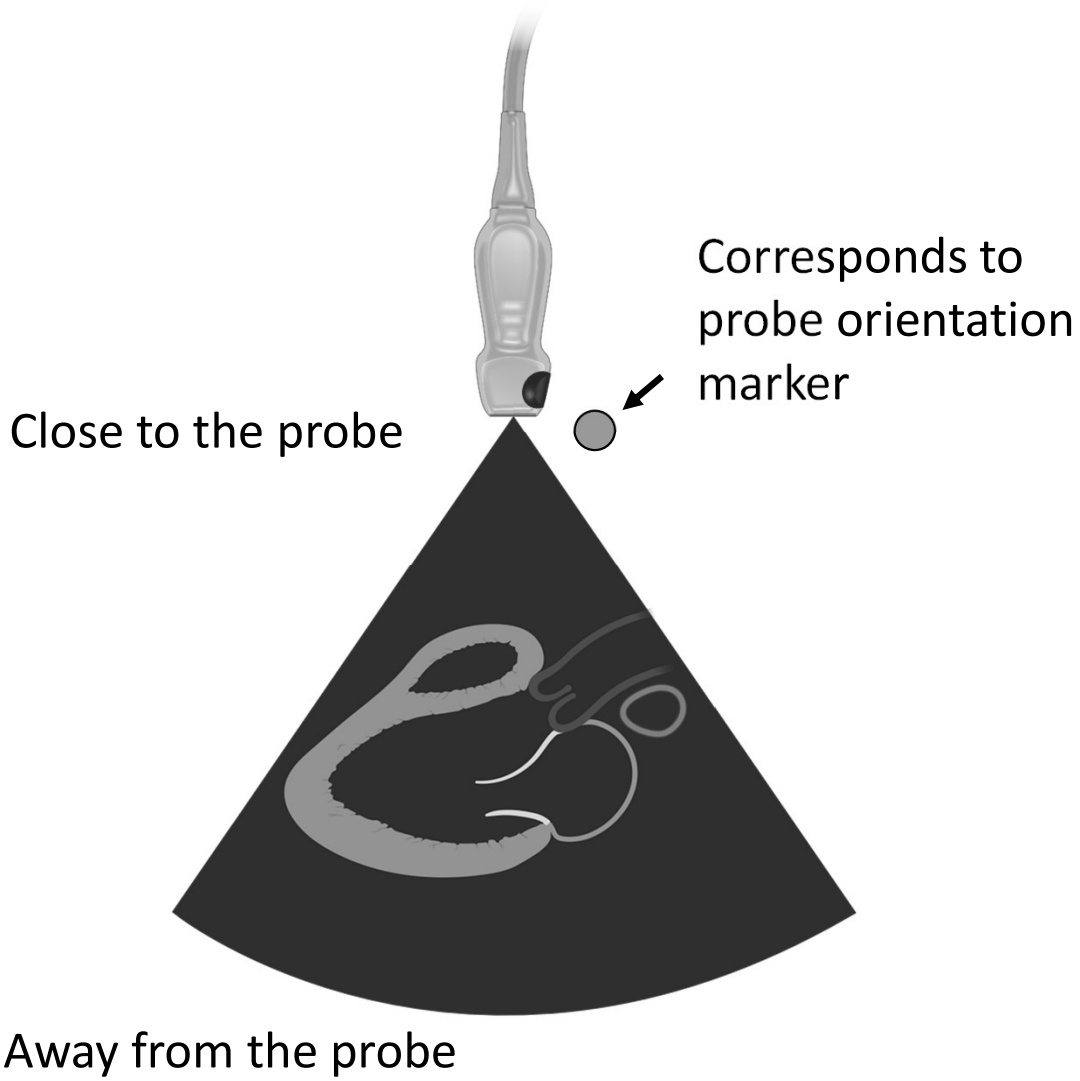




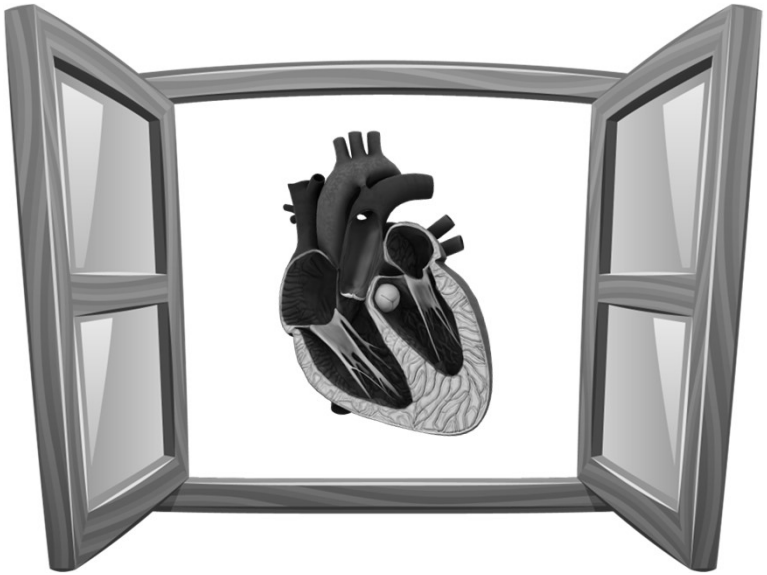
Pleural effusion - Whale tail

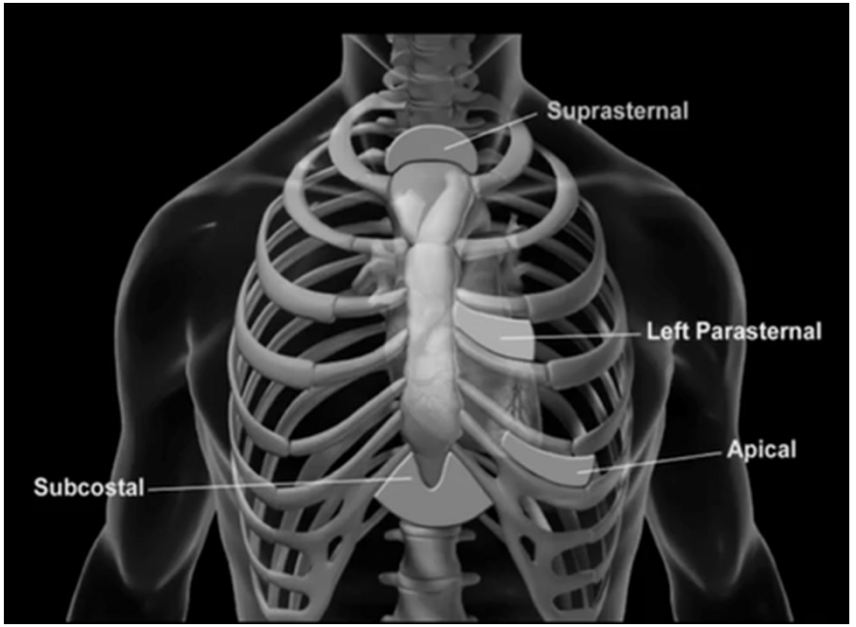


FoCUS



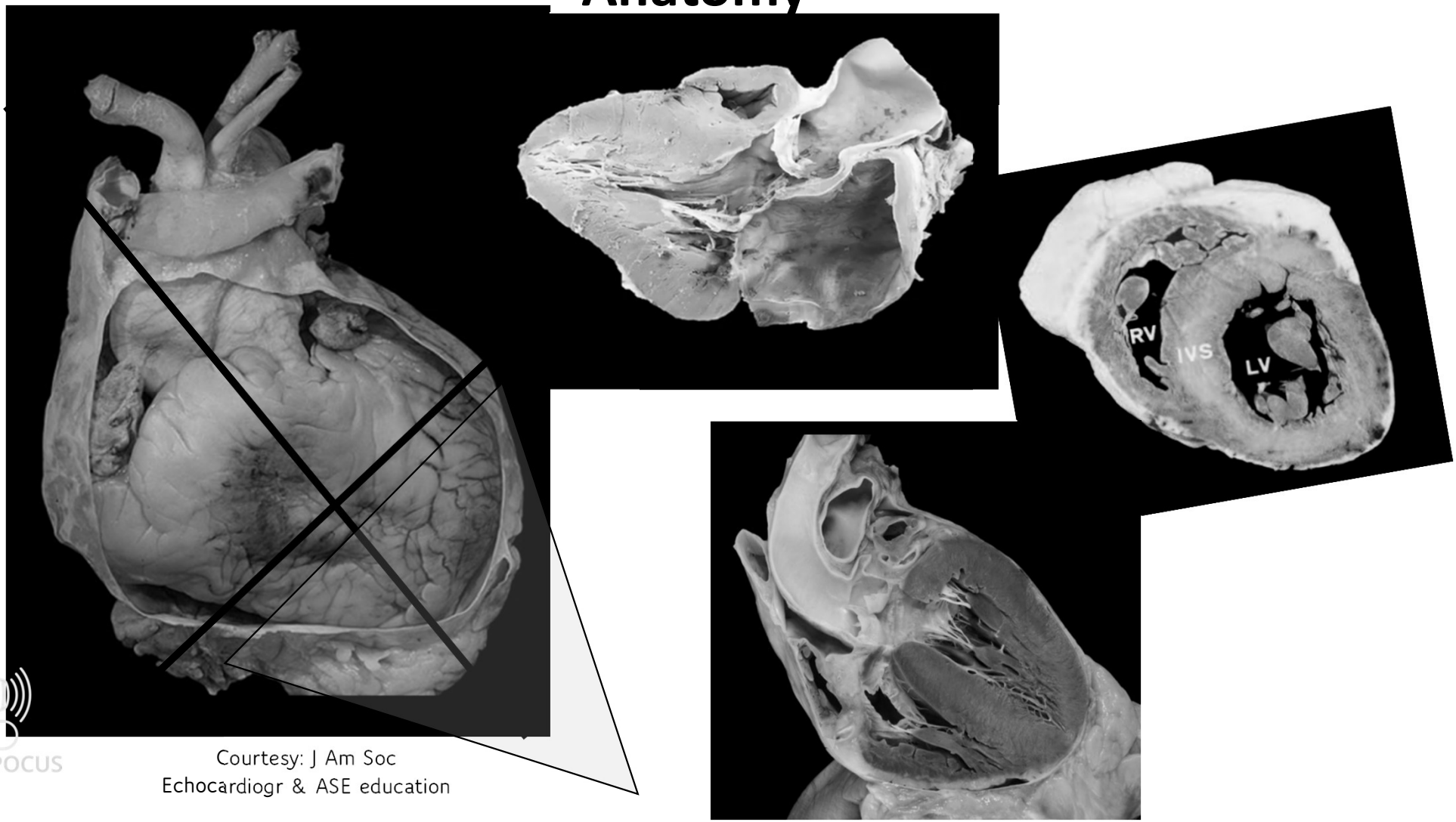
Windows





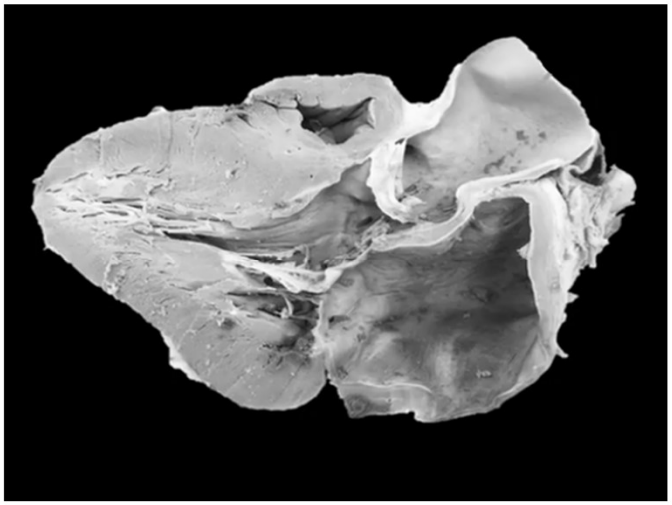
Courtesy: ASE learning hub

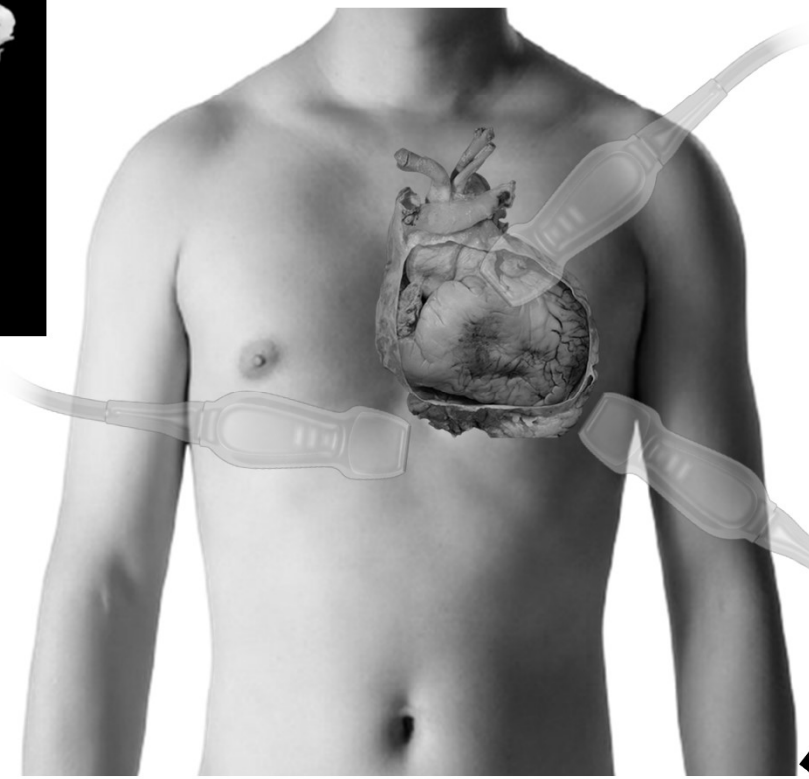
Anatomy

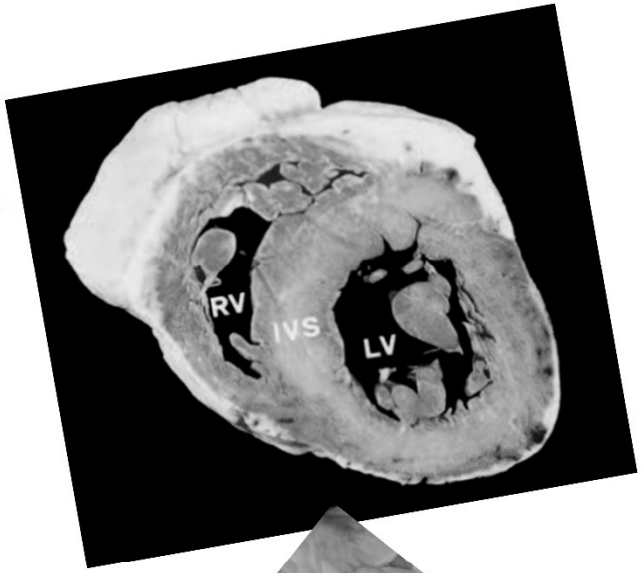


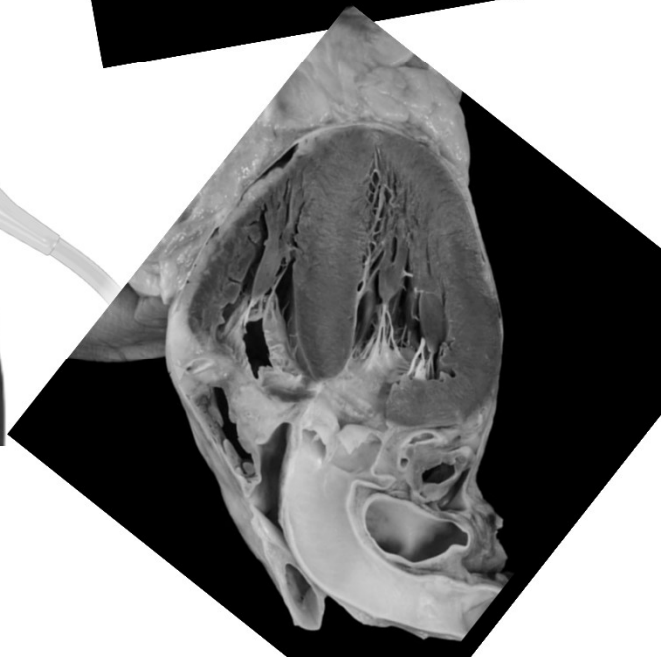
Courtesy: J Am Soc
Echocardiogr & ASE education

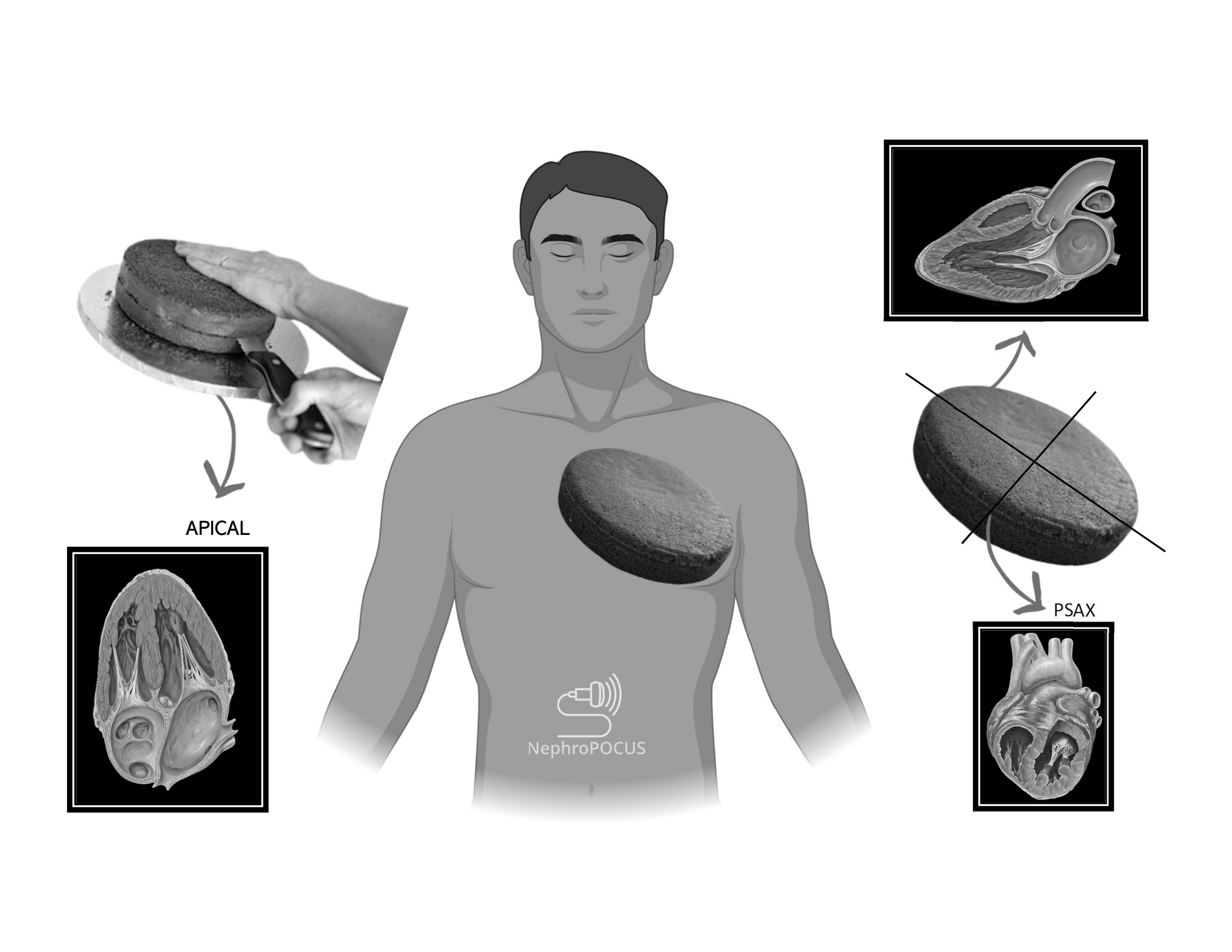
Orientation





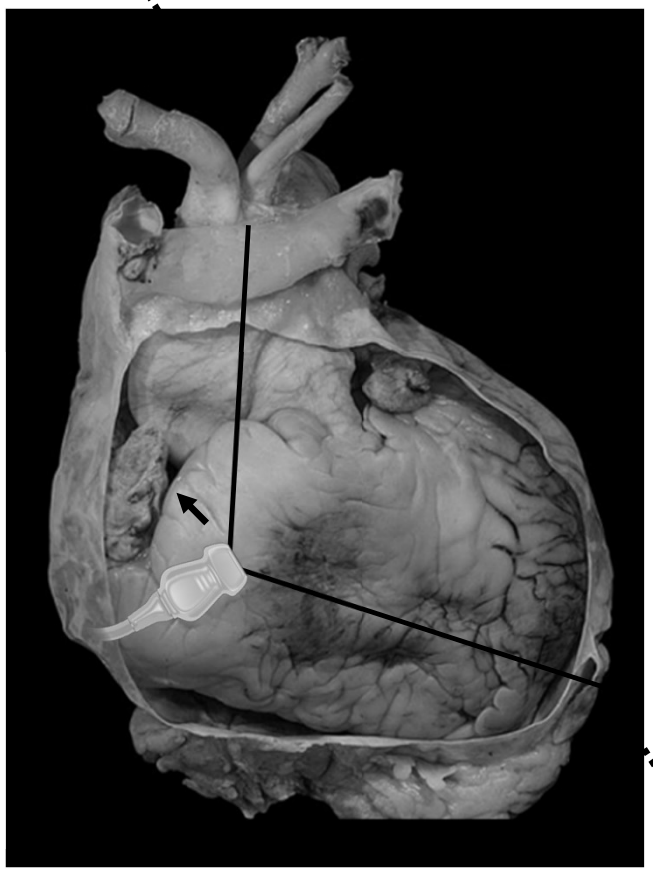





APICAL
PSAX
NephroPOCUS

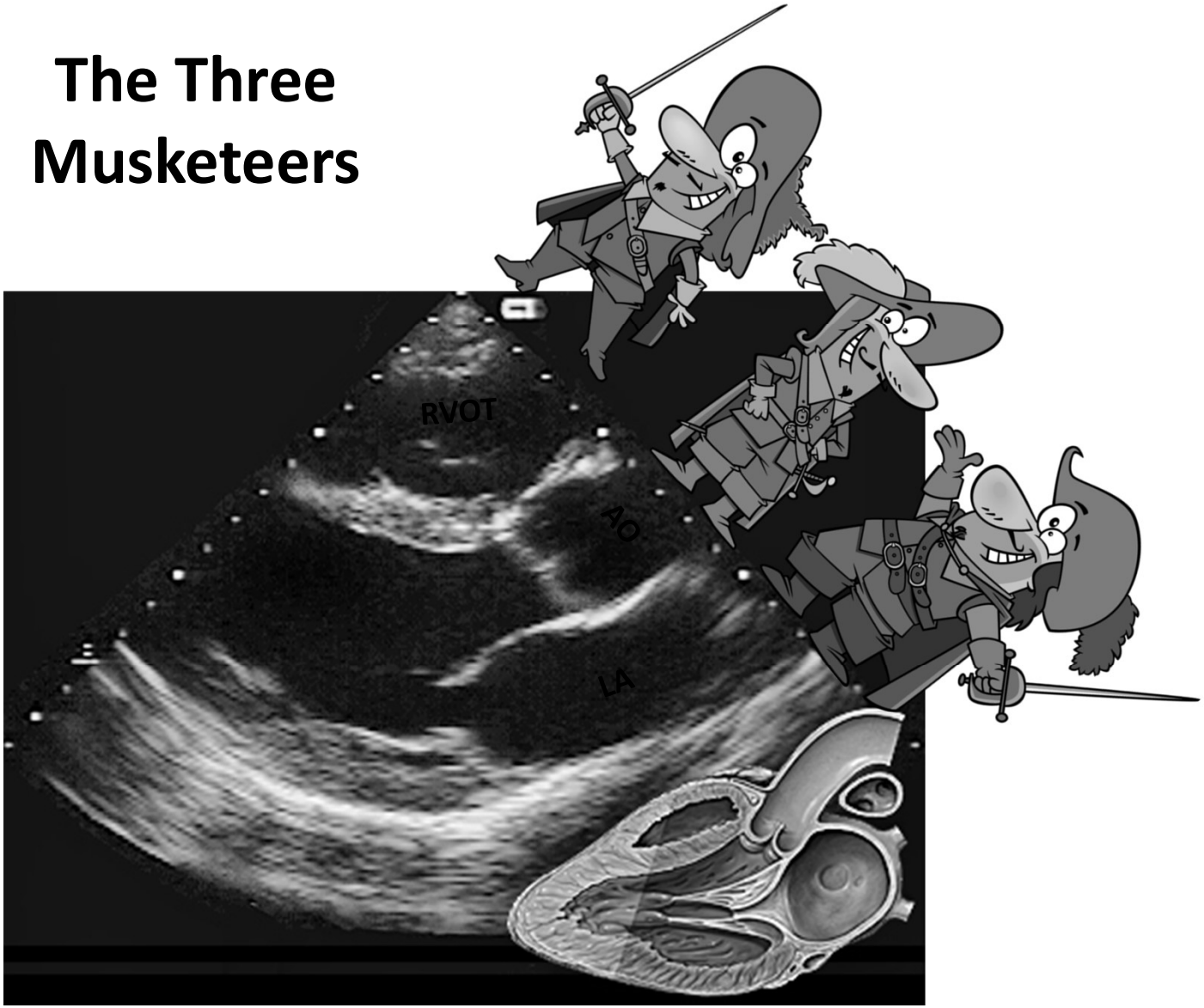
Parasternal long axis

Towards right shoulder

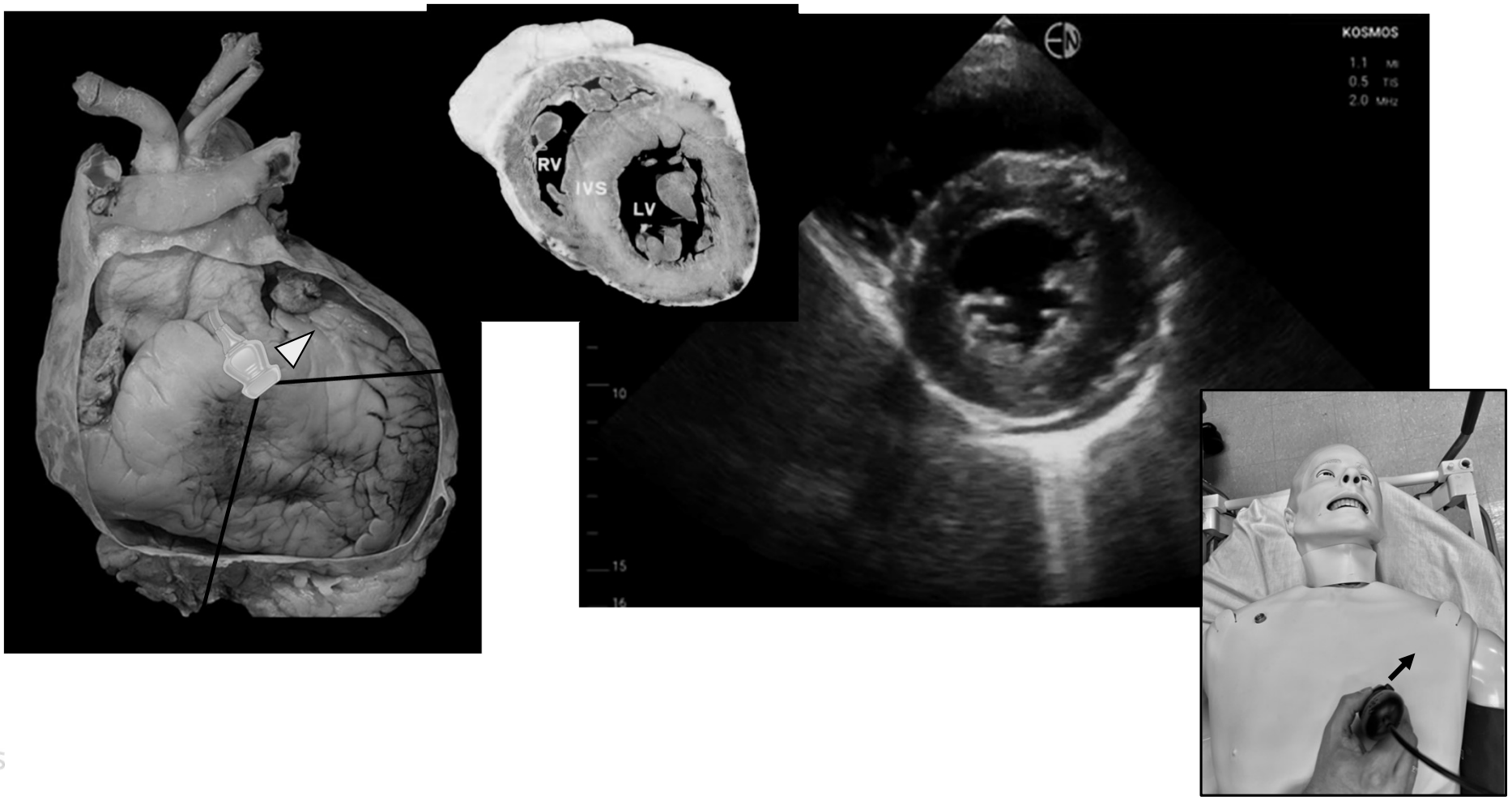


Away from the right shoulder

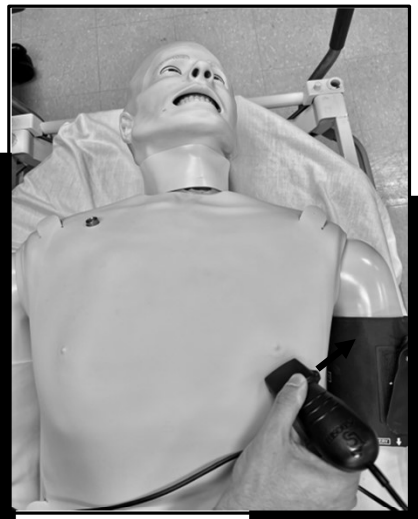
The Three Musketeers

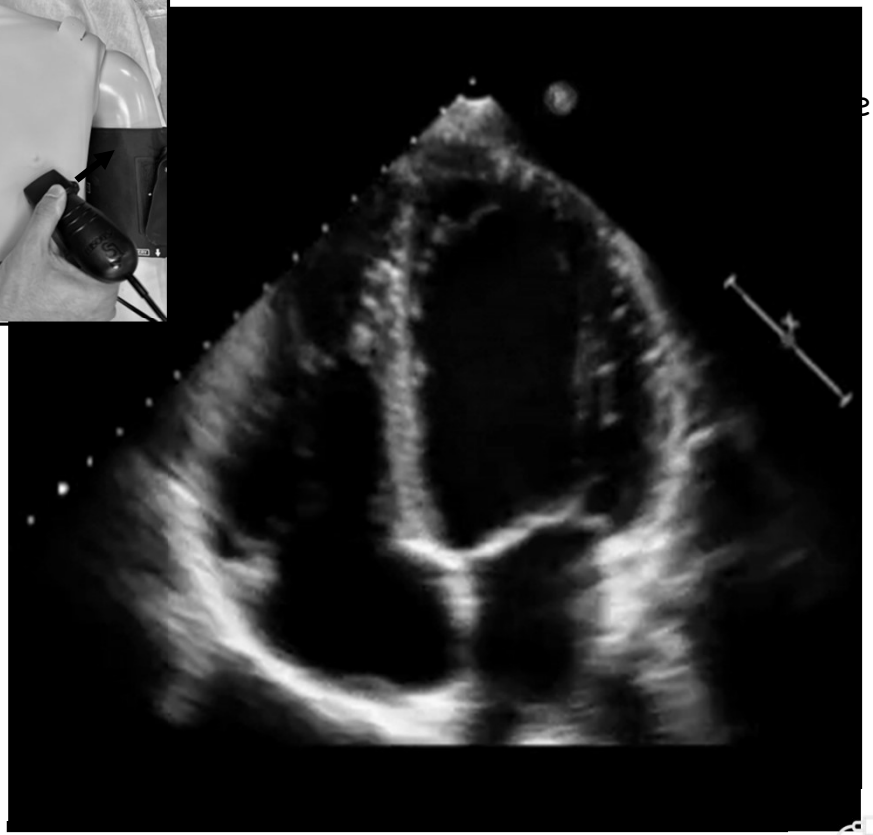


Parasternal short axis (PLAX)

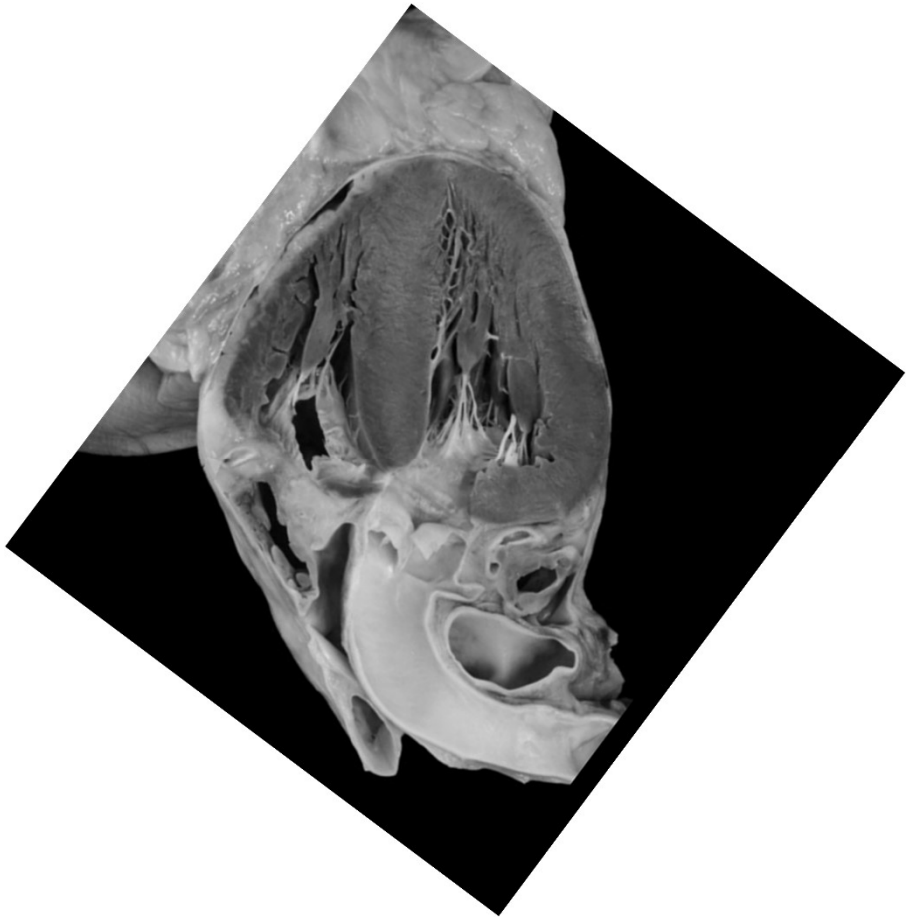


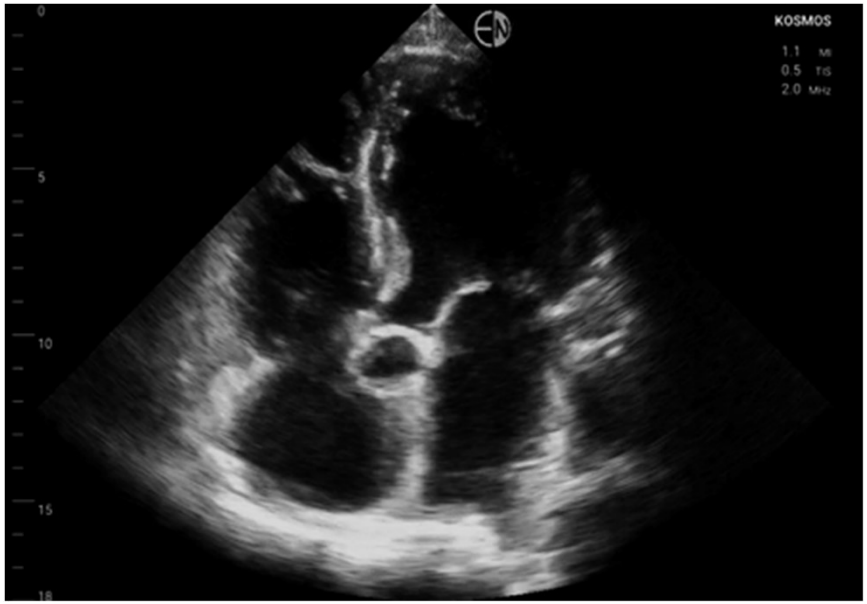
Apical 4-chamber



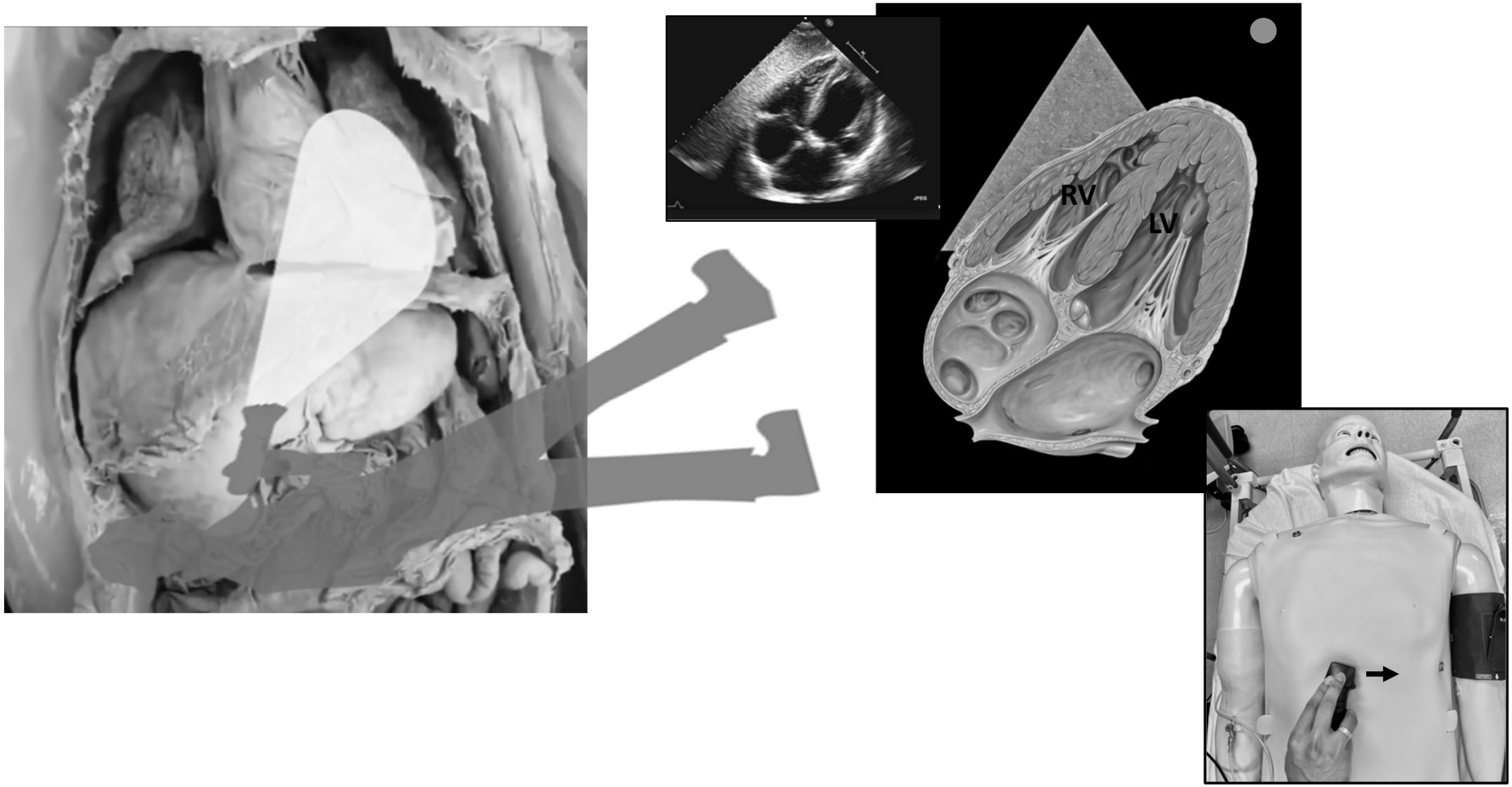


Apical 5-chamber view





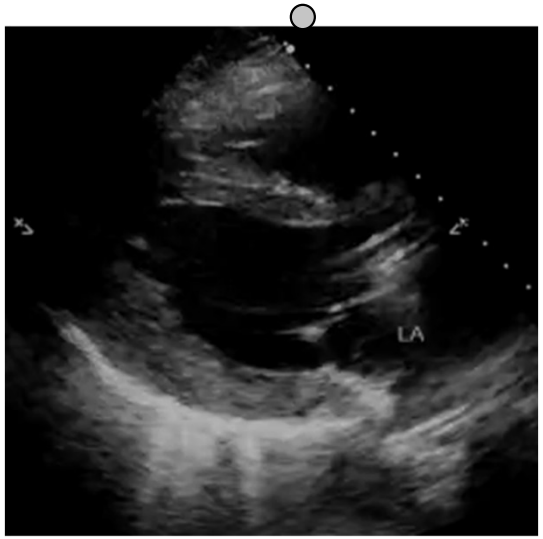
Subxiphoid 4-chamber view



The 5Es of FoCUS

Ejection
Effusion
Equality
Entrance
Exit

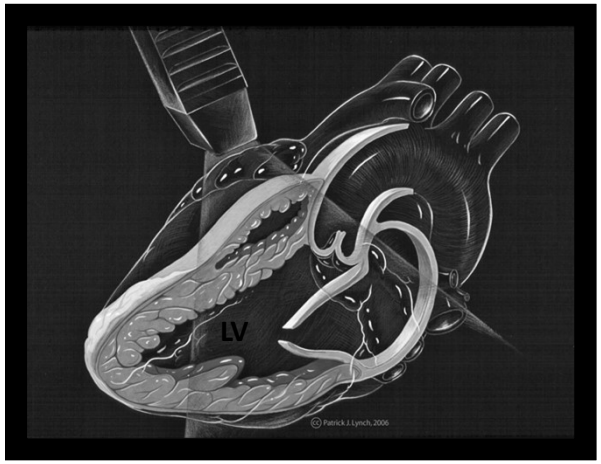
Ejection: ‘Eyeballing’ the LV systolic function



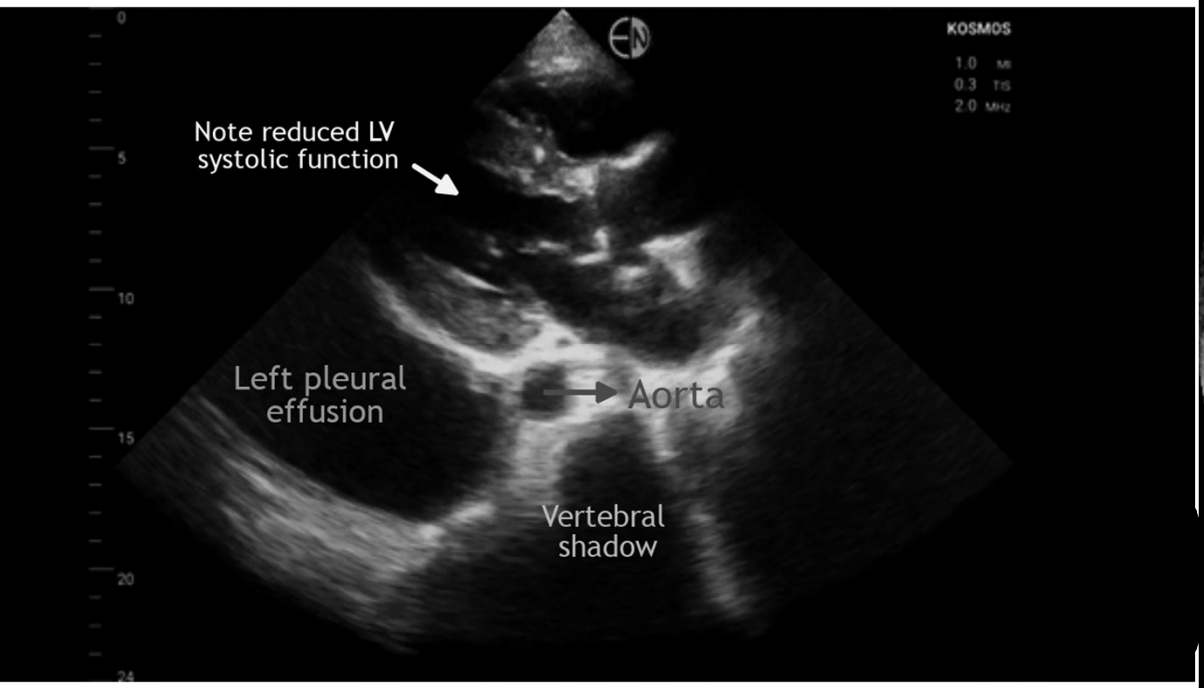
Moderately reduced LVEF

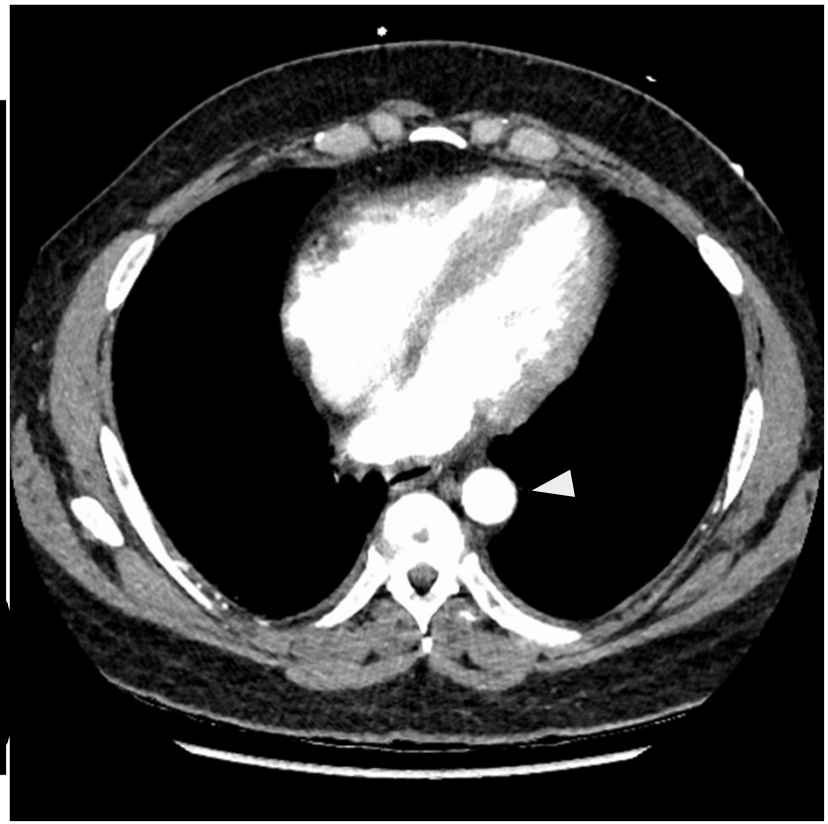
Severely reduced LVEF

Pericardial effusion

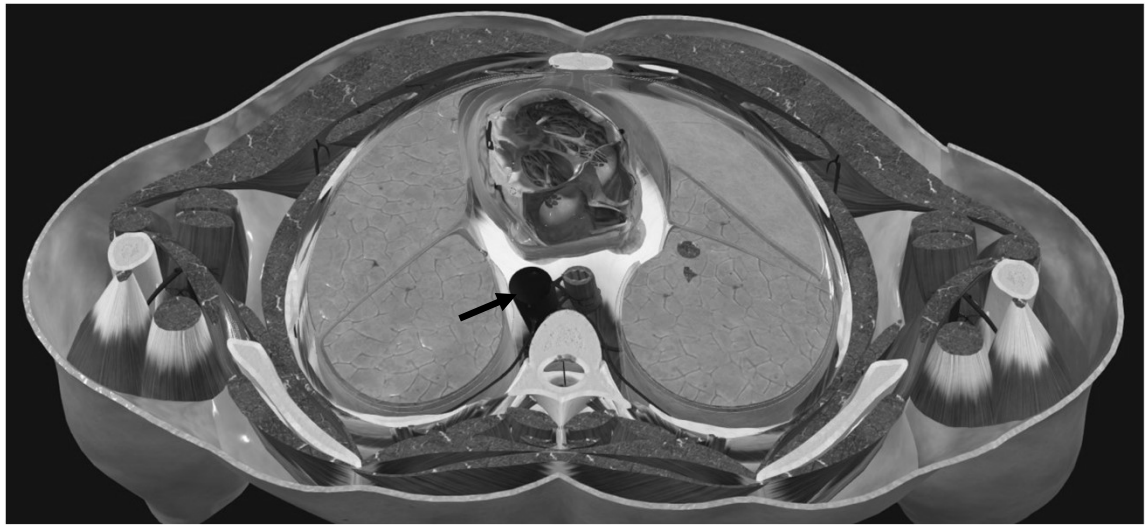


NOT pericardial effusion



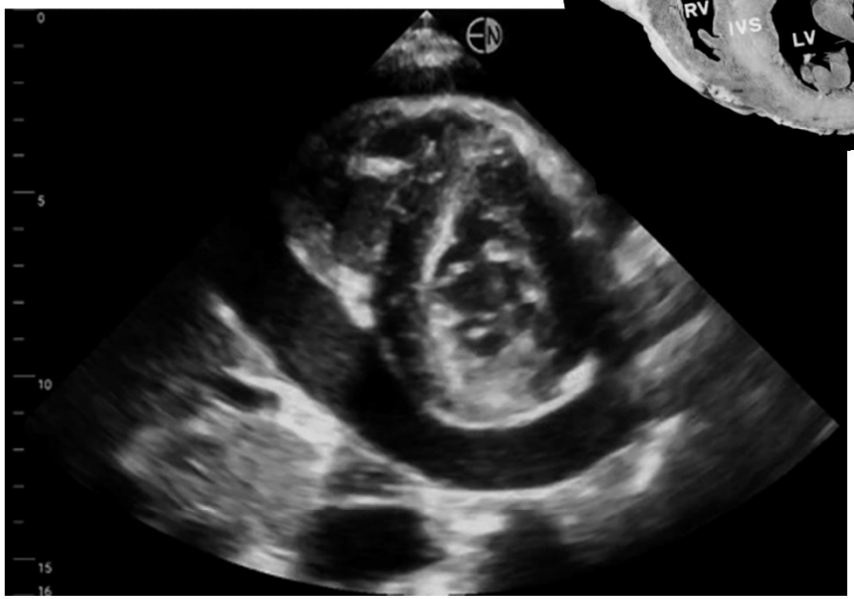


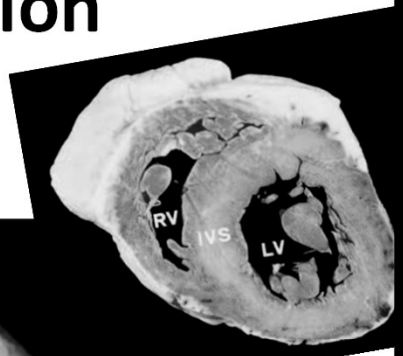
Pericardial and pleural Effusion

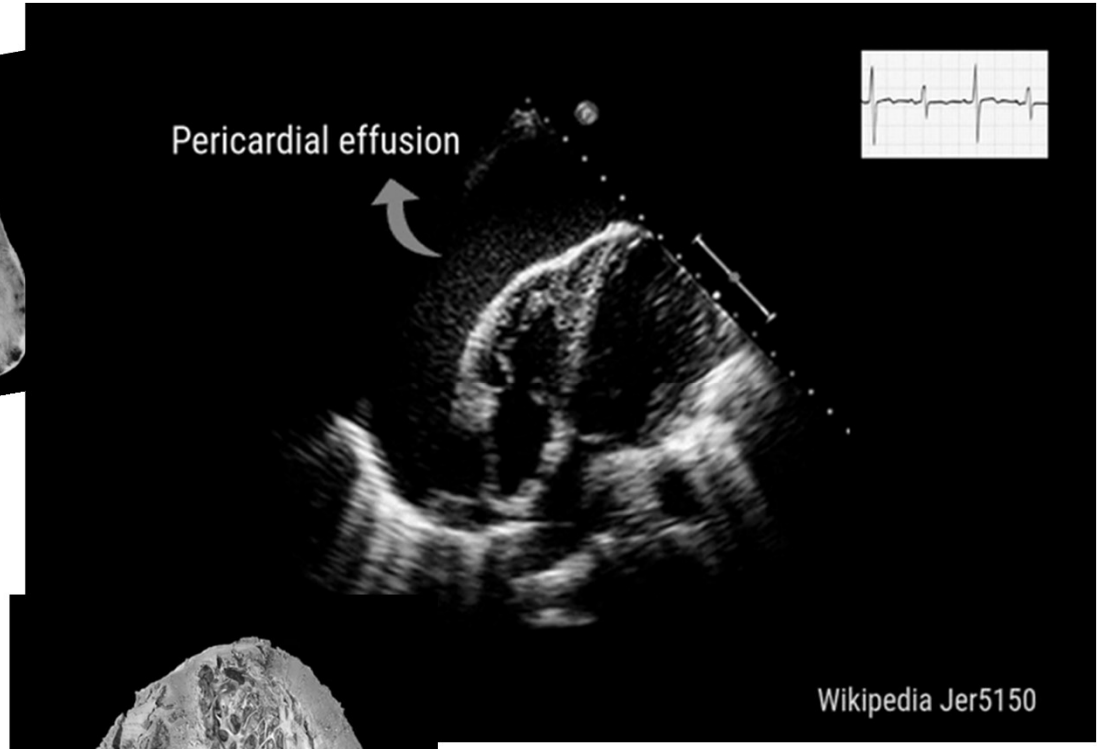


Courtesy: Complete anatomy

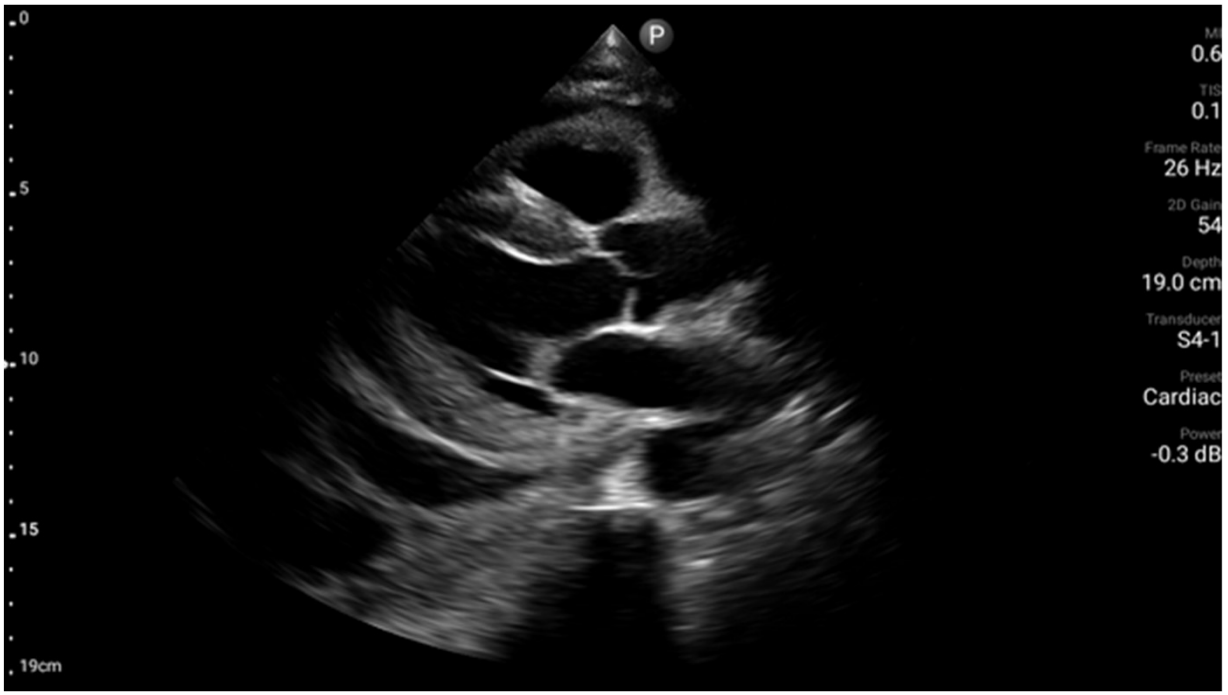
Pericardial effusion

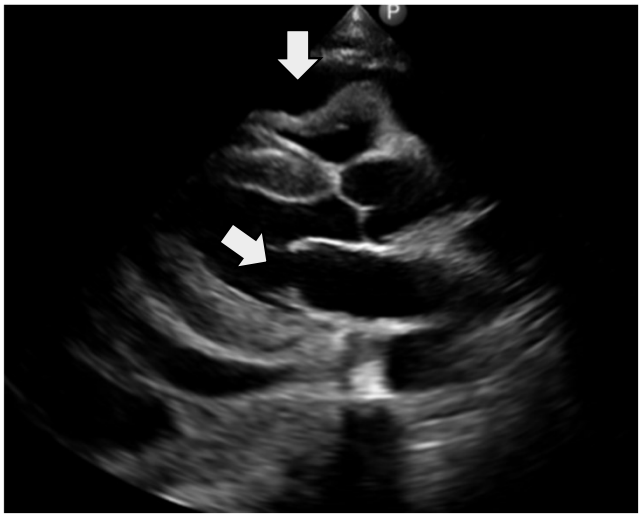




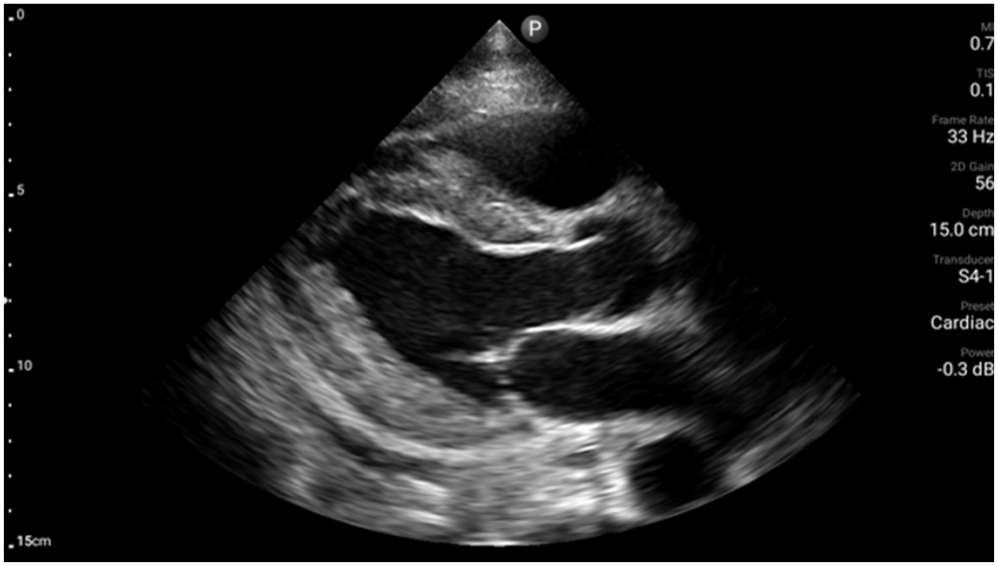


What do you see here?

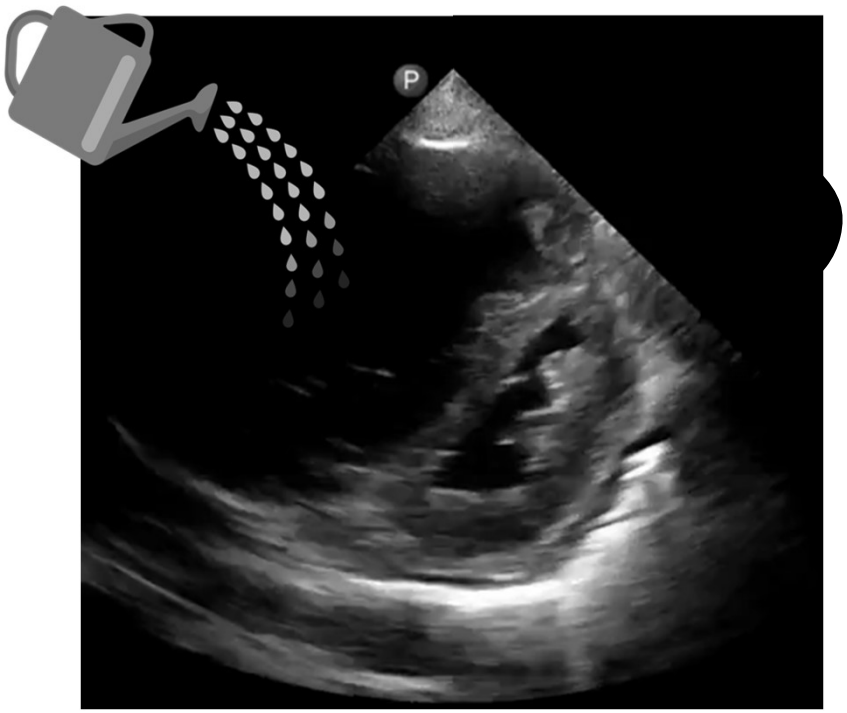


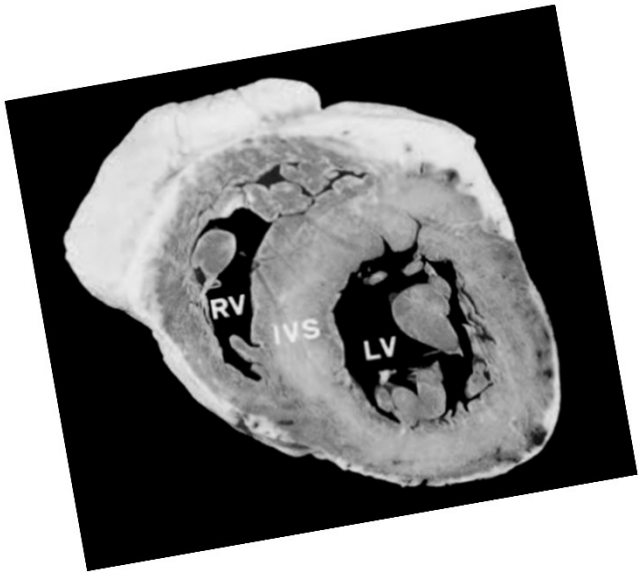


Post-pericardiocentesis

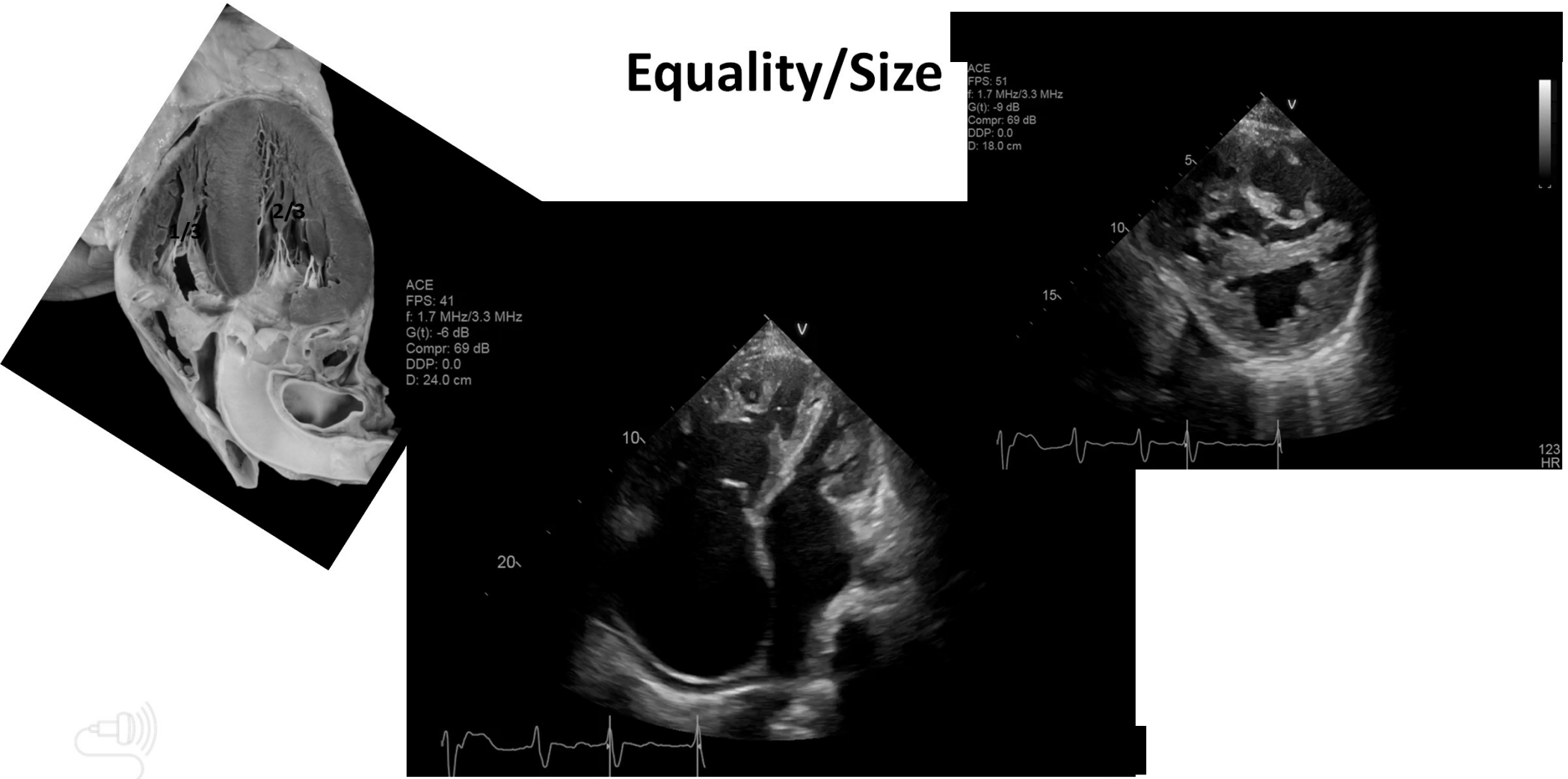


Equality/Size



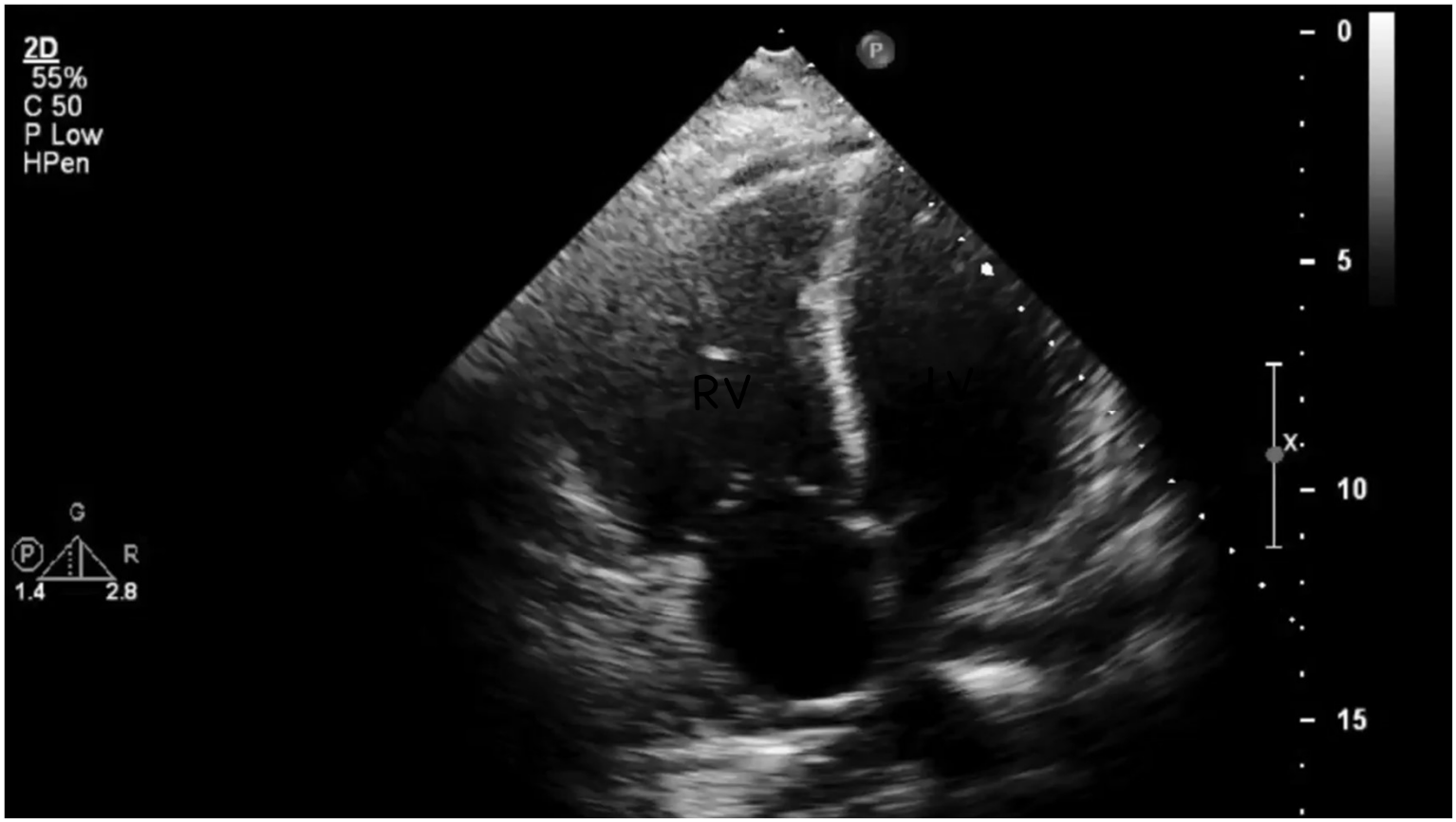


Equality/Size



Sadeghpour, A, et al. CASE 2022

McConnell's sign



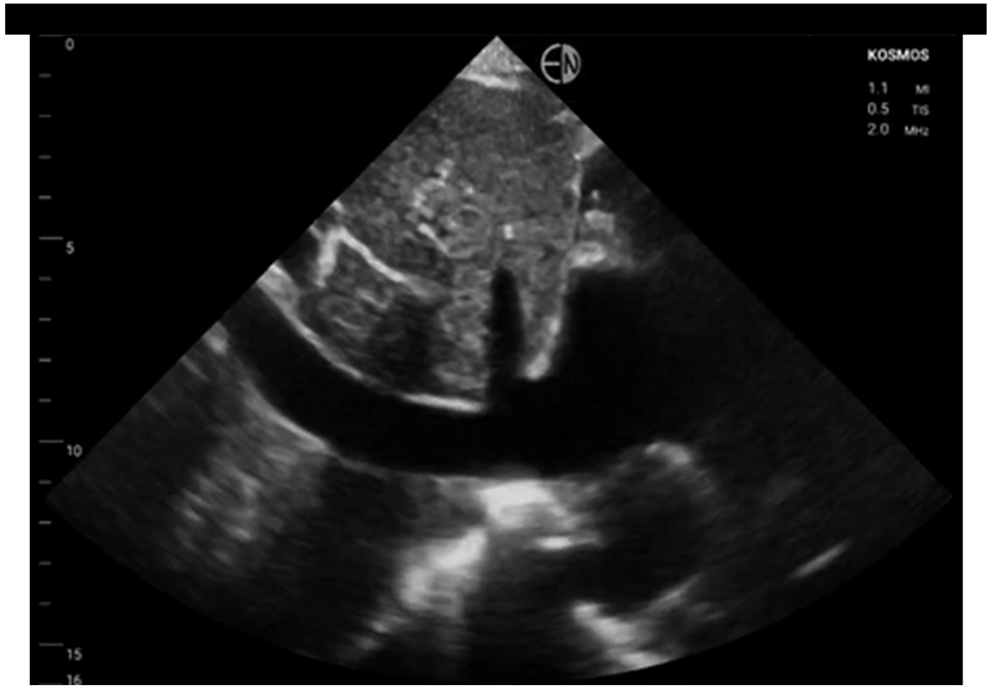
Hassan, et al. CASE 2021

McConnell's sign and more

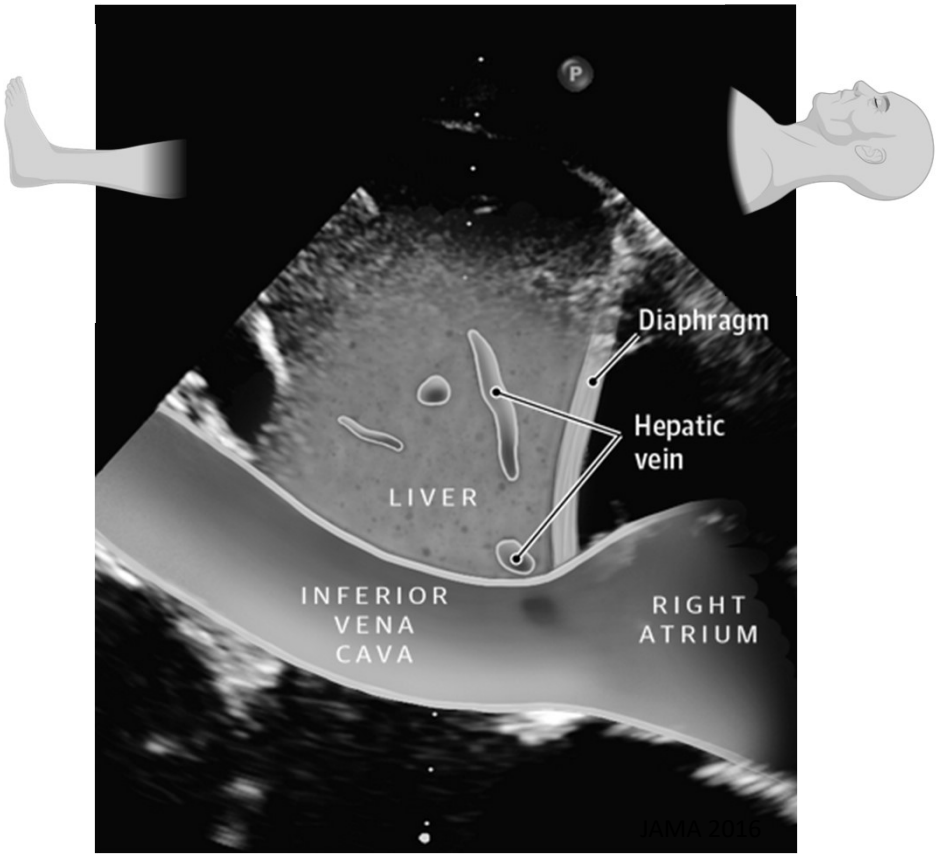
Montemerani, et al. BMJ Case Rep 2020

Entrance: IVC

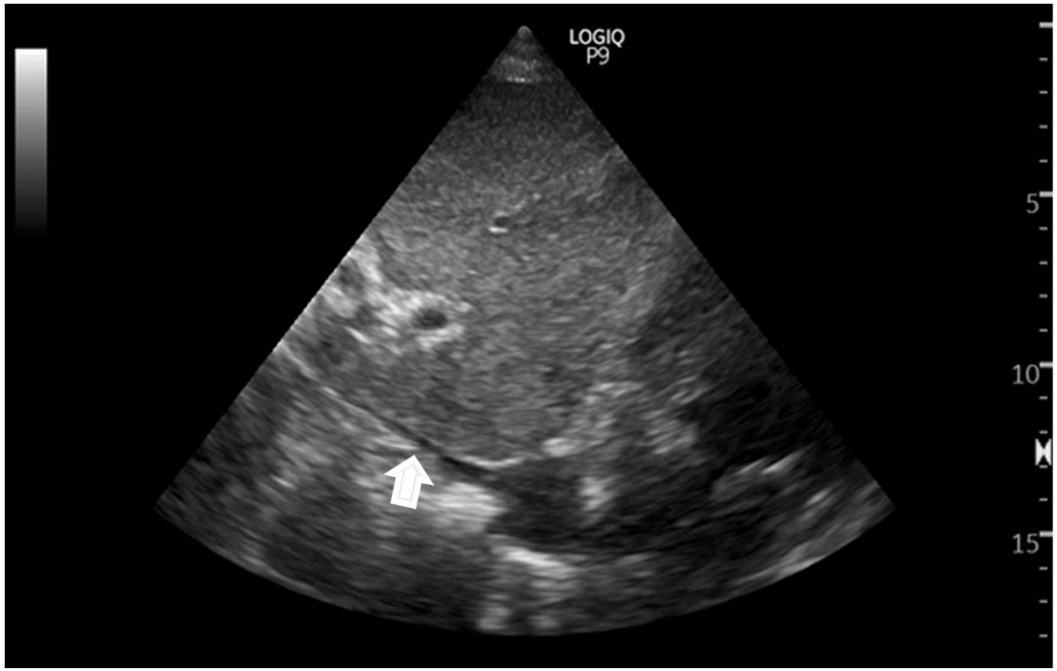
ANTERIOR

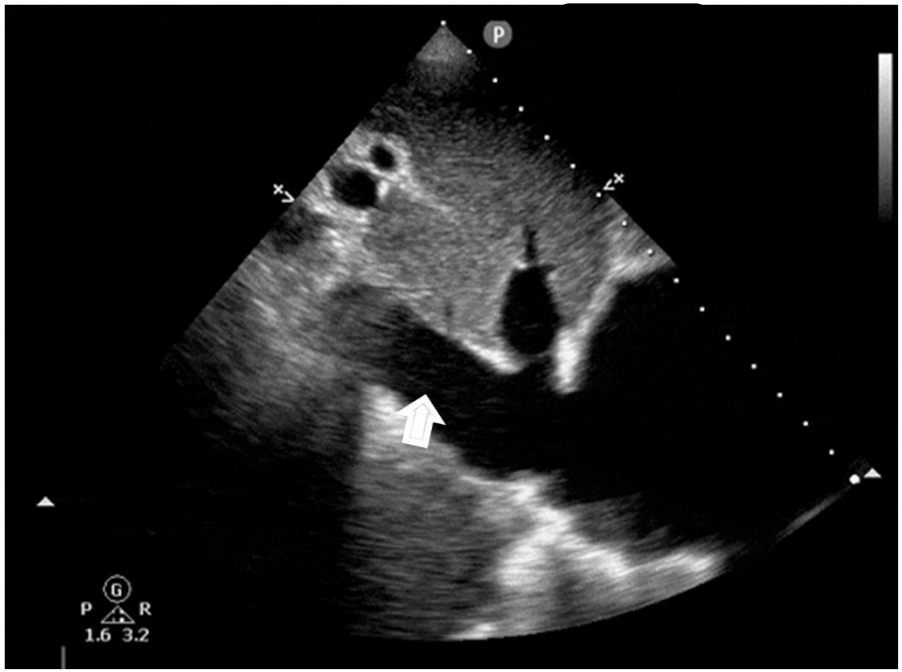


POSTERIOR

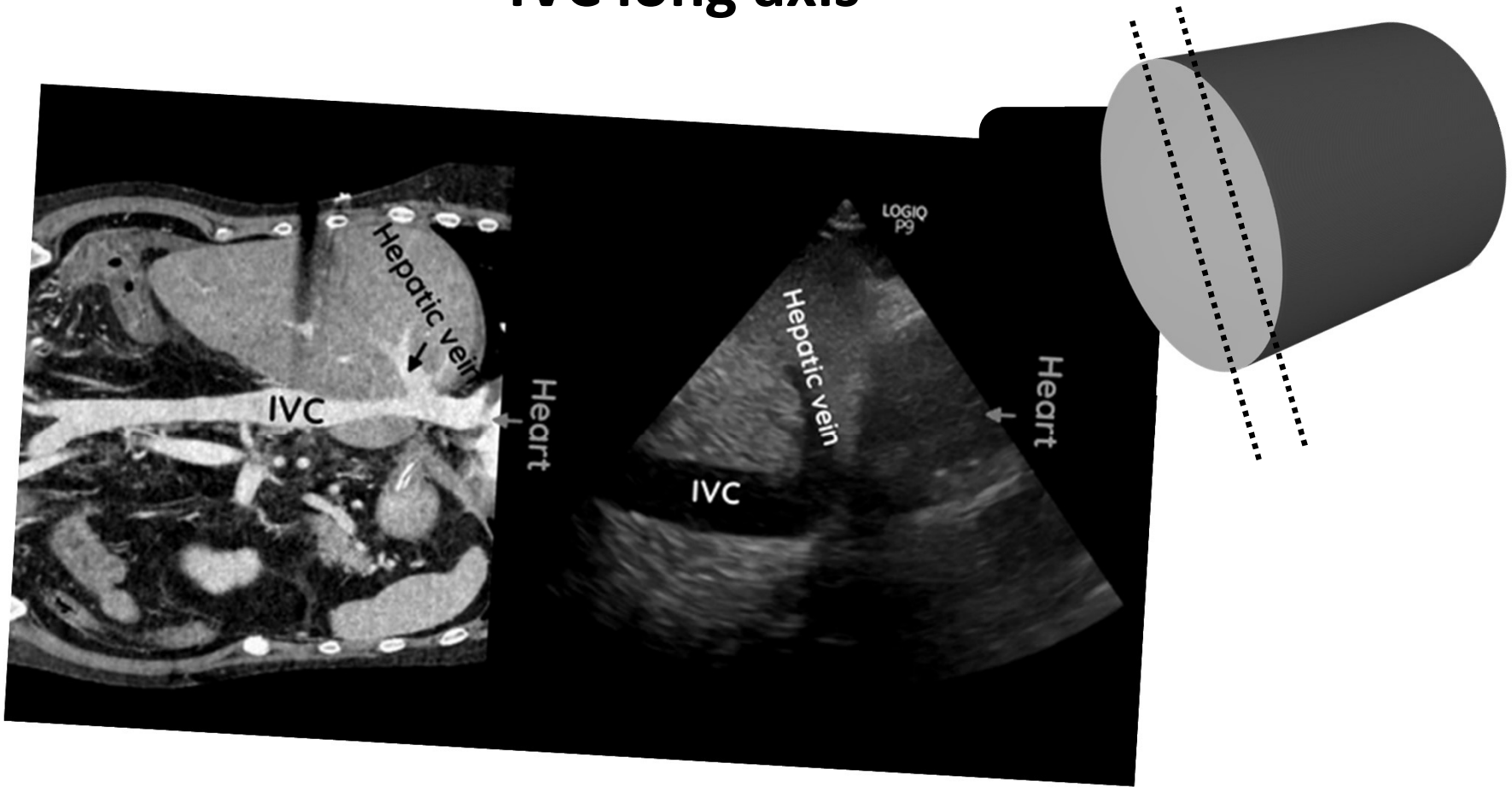


IVC

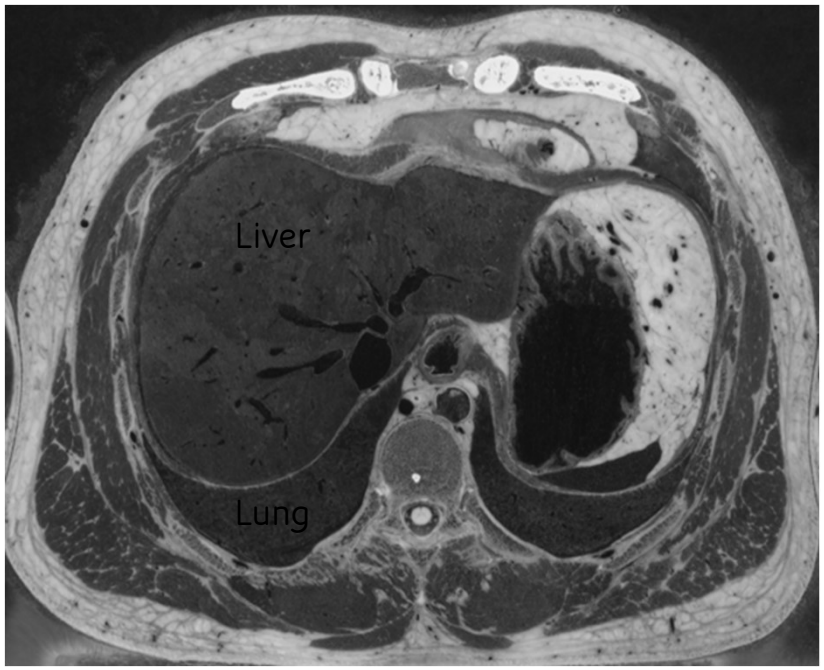


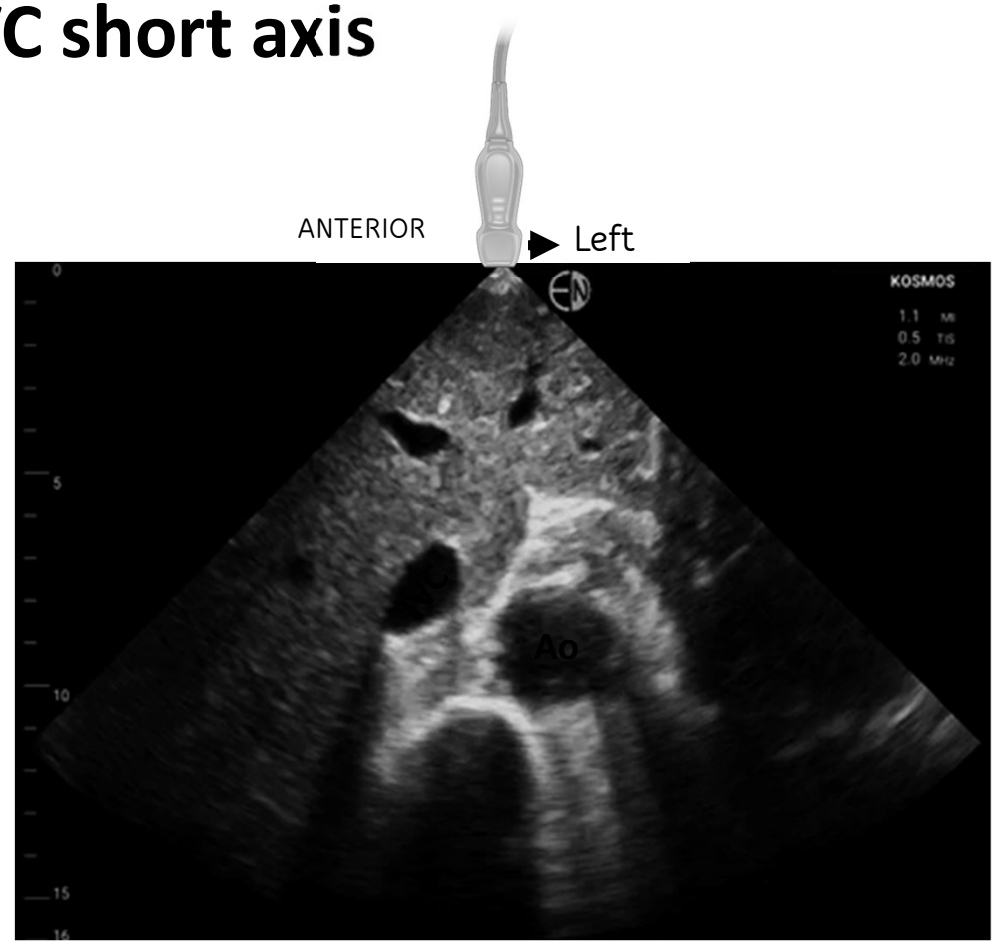


IVC long axis

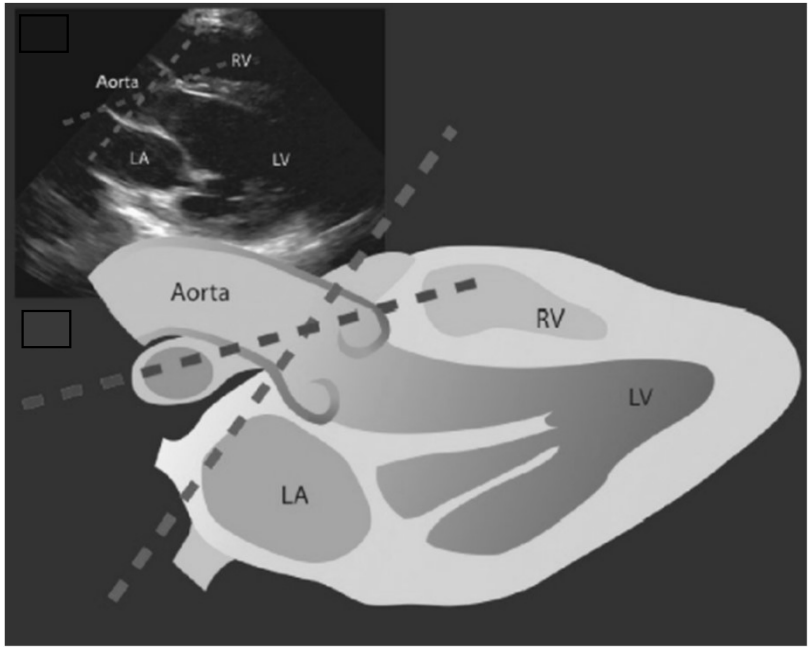


IVC short axis





Exit: aorta

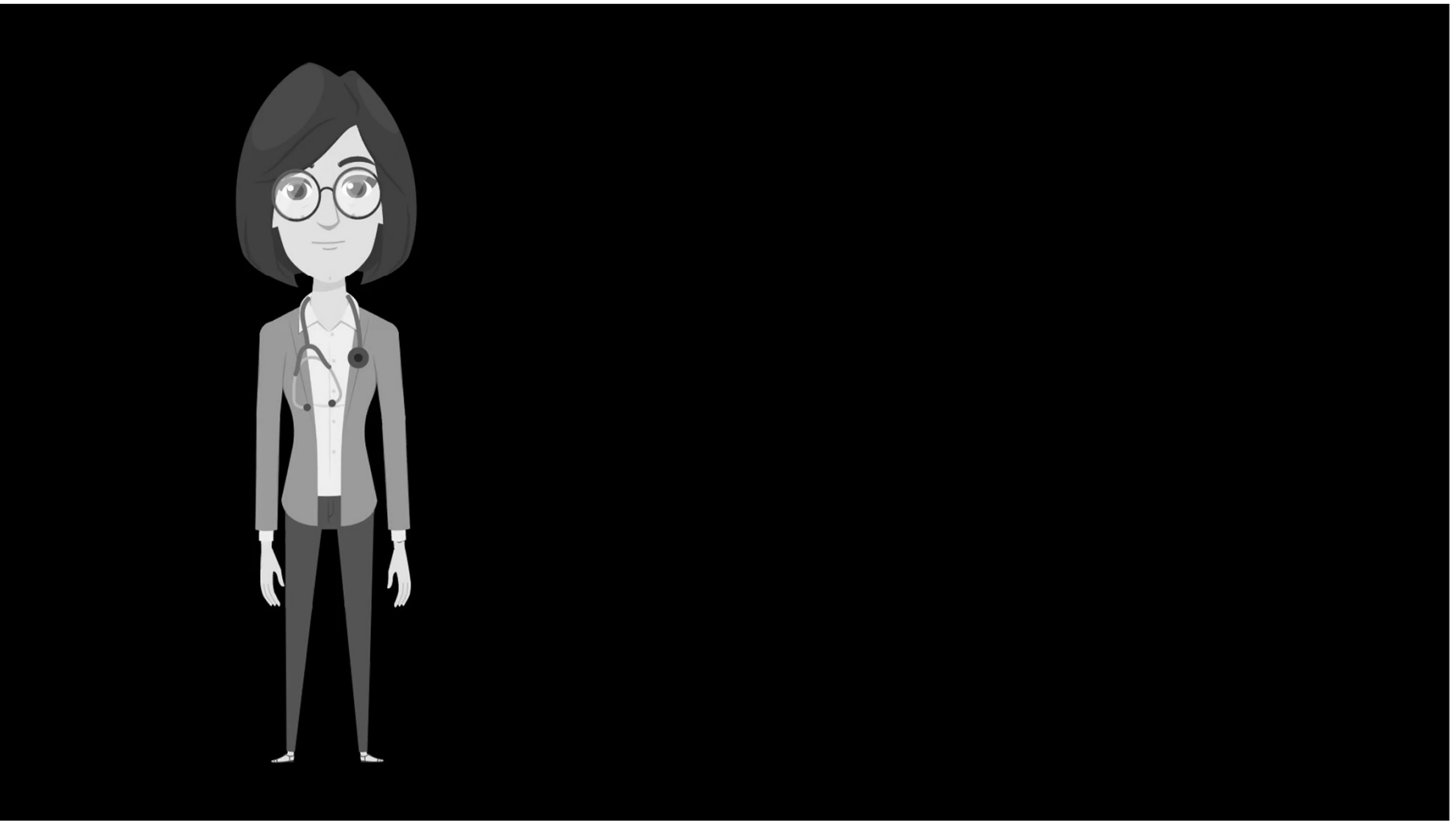


Hall KM, et al.

Courtesy: Dr. Ivan Stankovic, MD, PhD

>4.5 cm not good

SHOCK	HYPOVOLEMIC	CARDIOGENIC	OBSTRUCTIVE	DISTRIBUTIVE
Problem	Volume depletion	Pump (heart) failure	Obstruction of the pump – pericardial effusion or pulmonary embolism	Excessive vasodilatation – impaired distribution of cardiac output to vital organs
FoCUS	• Hyperdynamic LV • Decreased cardiac output • Small, collapsible IVC with IVC-aorta ratio <0.8	• Decreased LV function • Decreased cardiac output • Dilated IVC with IVC-aorta ratio >1	• Pericardial effusion • Dilated right ventricle in case of pulmonary embolism • Decreased cardiac output • Dilated IVC with IVC-aorta ratio >1	• Range from hyperdynamic to decreased LV function (septic cardiomyopathy) • Usually normal to increased cardiac output • IVC variable
LUS	A-lines	• B-lines (usually diffuse) • Pleural effusions likely	• A-lines • Focal B-lines may be seen with pulmonary infarction	• A-lines • Focal B-lines ± consolidation can be seen with pneumonia



Thank You

Happy Scanning