MAYO CLINIC

ADVANCED POINT-OF-CARE ULTRASOUND

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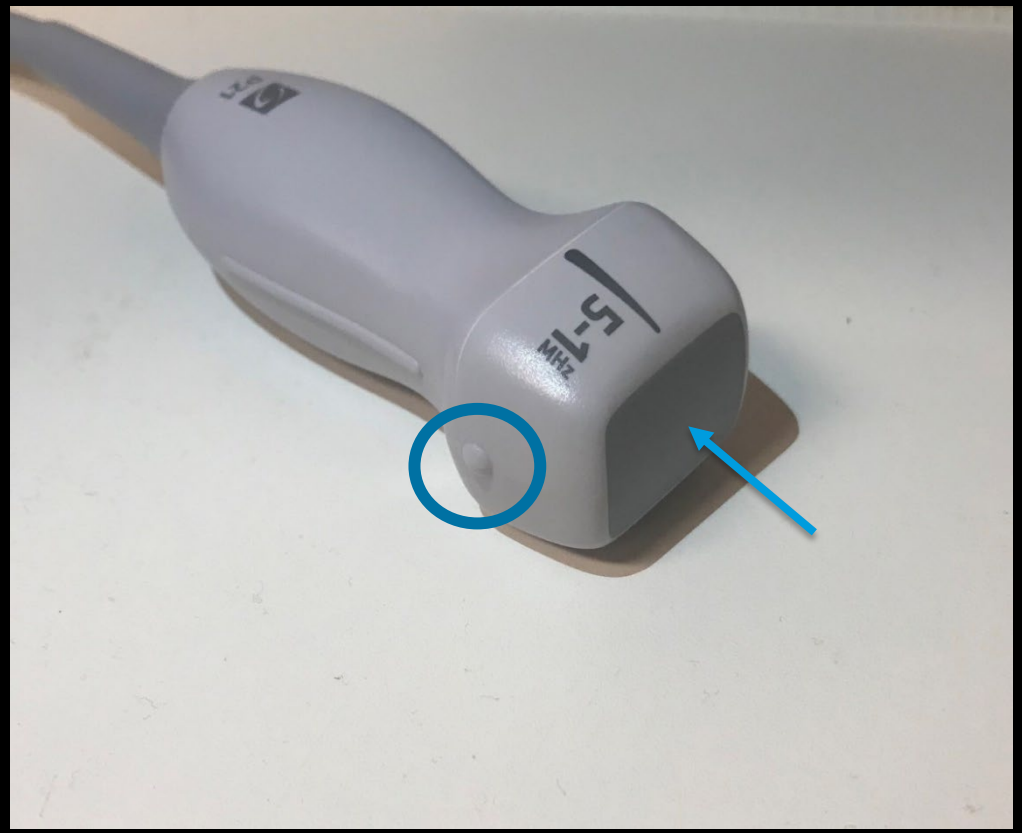
DISCLOSURES

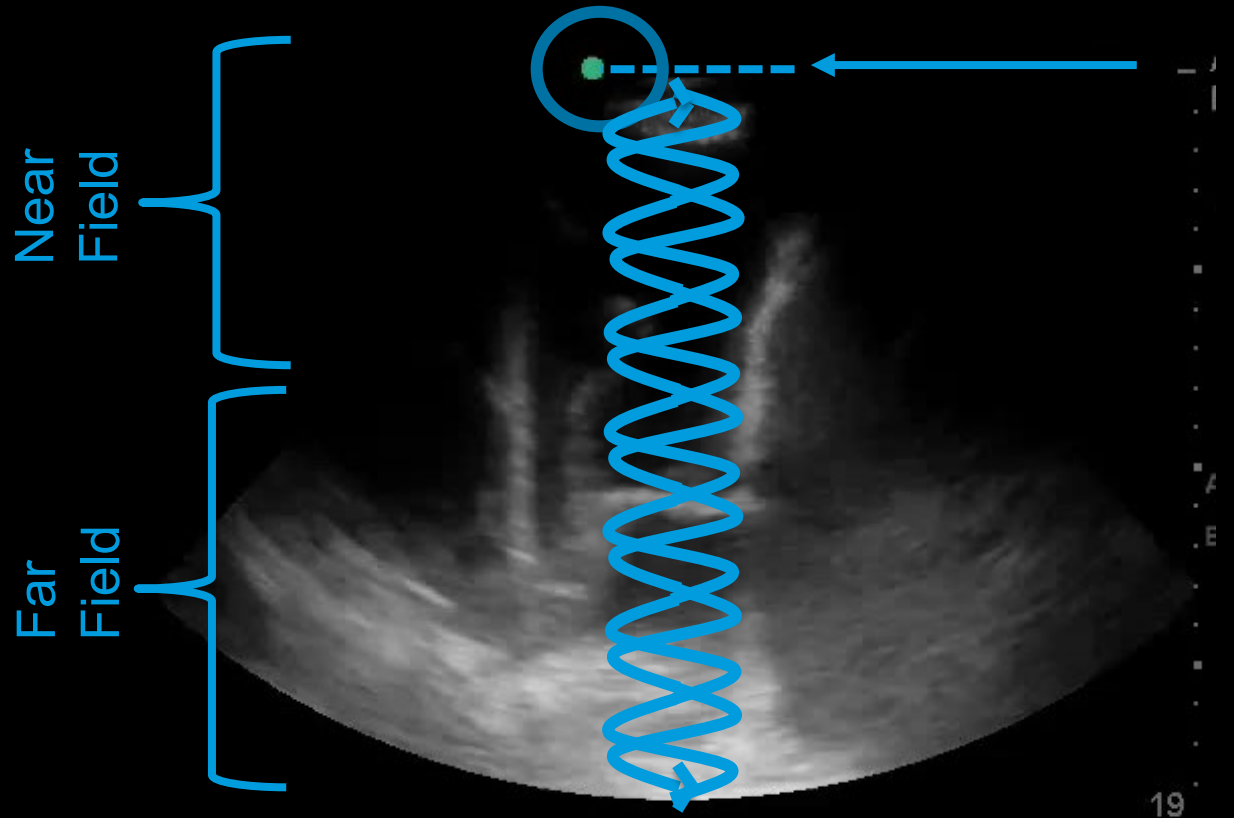
- No relevant commercial relationships to disclose

LEARNING OBJECTIVE

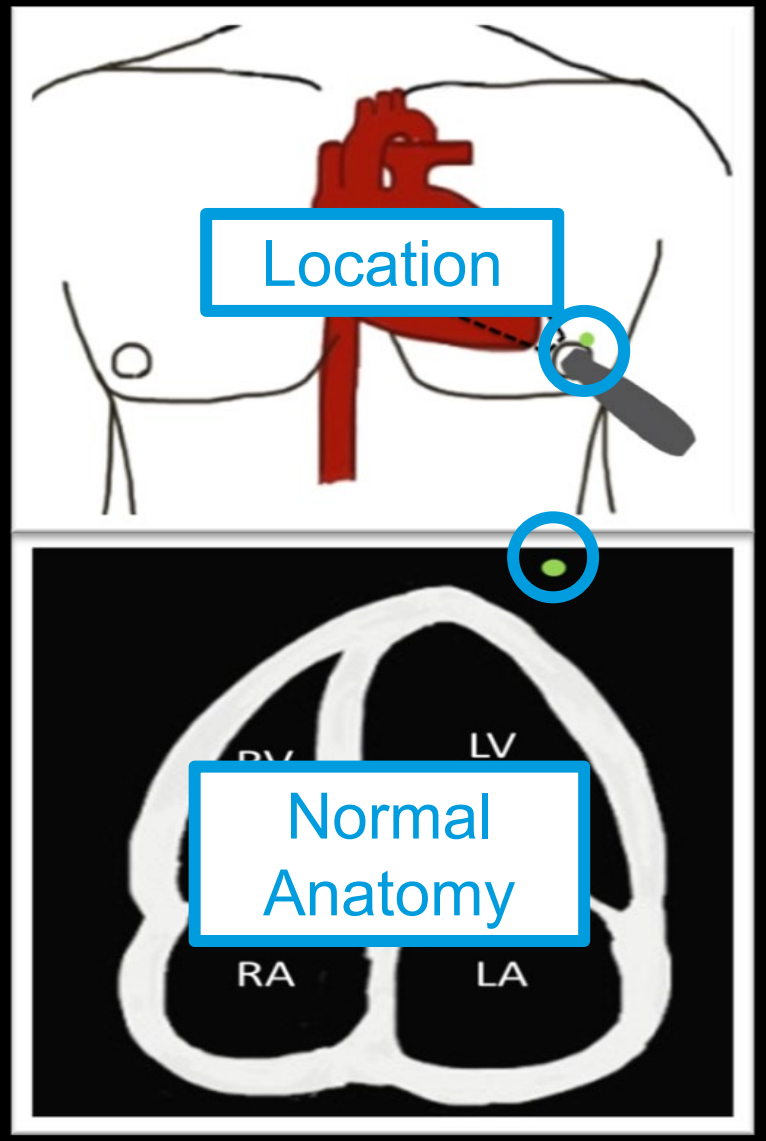
- Summarize scope and indications for Point-of-Care Ultrasound (POCUS) in the setting of acute, critical illness.
- Interpret POCUS images in the context of acute, critical illness.
- Contrast evidence for standard of care with POCUS.
- Discuss the effect POCUS has on diagnostic evaluation and treatment of acute, critical illness.

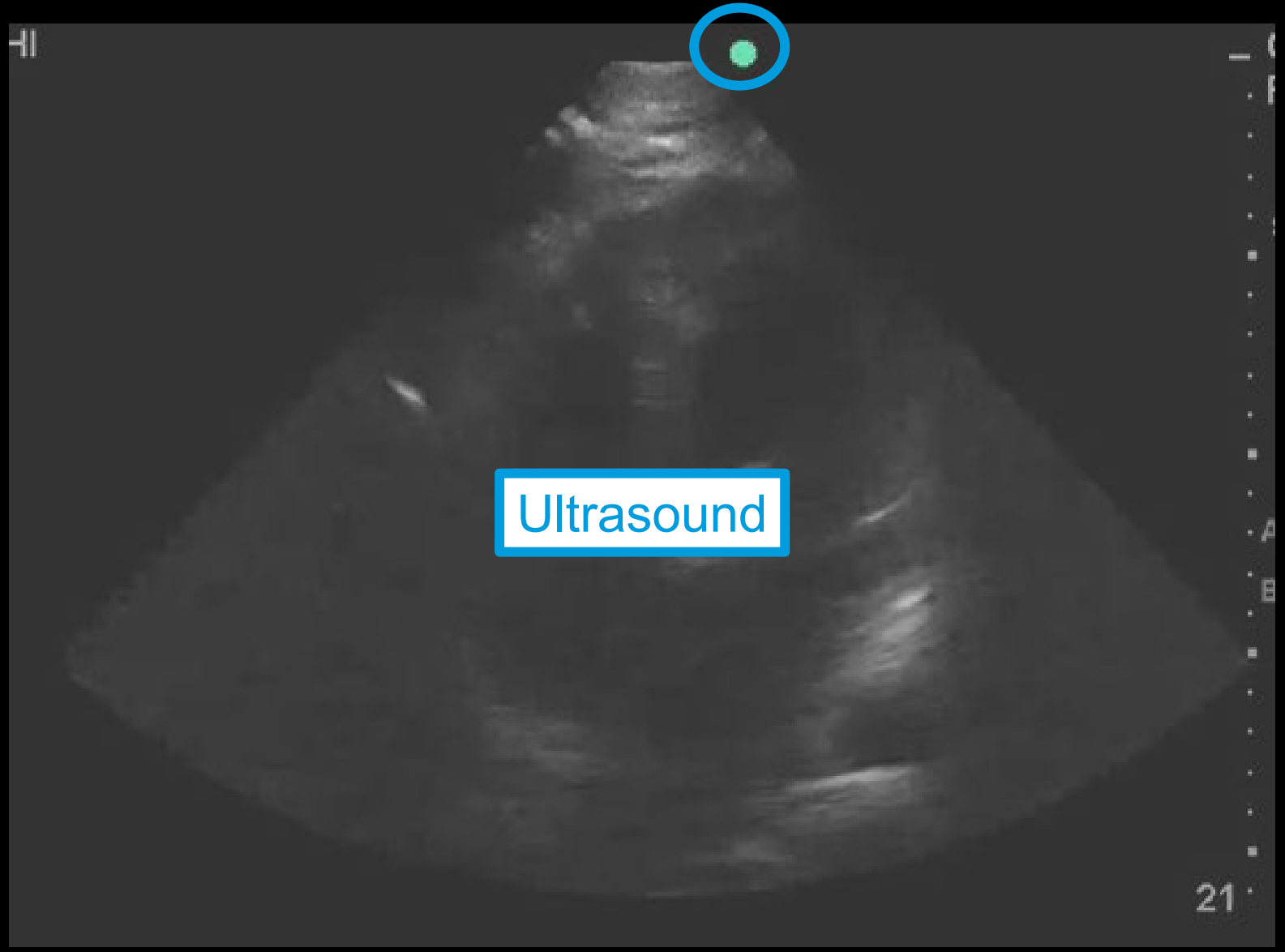
ORIENTATION





SLIDE CONVENTION





CASE 1

HPI

- Asked to urgently evaluate a 74 year-old gentleman for confusion and hypotension.
  - Unable to provide history.
- Hospital Course:
  - Admitted for osteomyelitis of the left lower extremity, status post BKA
  - Diagnosed with critical limb ischemia of the right upper extremity and started on a heparin infusion.
  - Dialyzed earlier that day.

HISTORY

- Past Medical History:
  - ESRD on HD
  - Diastolic left ventricular heart failure.
  - Diabetes mellitus type II.
- Past Social History:
  - Smoker (50 pack years).
  - Daily alcohol use.

OBJECTIVE DATA

- Vital Signs:
  - HR 98, BP **84/55** (from 148/90), SpO2 98% on room air, RR 18, Tmax 36.8 Celcius.
- Physical Exam:
  - Mental – Alert to person, not place or time. Lethargic. **CAM positive**.
  - Heart – Regular rhythm and rate.
  - Lungs – **Faint crackles at the left base**.
  - Abdomen – Mildly tender to palpation.

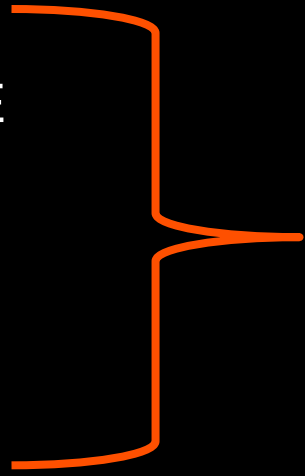
REFLECTION QUESTIONS

- What is this patient's differential diagnosis? What is his leading differential?

Hypovolemia
Sepsis
Hemorrhage
Cardiogenic

POCUS IN SHOCK

- Systematic POCUS protocol
  - RUSH: HI-MAP, RUSH: Pumps/Pipes/Tank, EGLS, FREE
- Central to every protocol:
  - LV size and function
  - RV size and function
  - IVC size and respiratory variation
- Additional:
  - Lungs
  - Aorta
  - Peripheral veins
  - Intra-abdominal cavity



Integrate findings

- Weingart SD, Duque D, Nelson B. The RUSH Exam: Rapid Ultrasound for Shock and Hypotension. https://emcrit.org/rush-exam/original-rush-article/
- Perera P, Mailhot, T, Riley D, Mandavia D. The RUSH Exam: Rapid Ultrasound in Shock in the Evaluation of the Critically Ill. Emerg Med Clin N Am 2010;28:29–56.
- Lanctot JF, Valois M, Beaulieu Y. EGLS: Echo-Guided Life Support – An algorithmic approach to undifferentiated shock. Crit Ultrasound J 2001;3:123-129.
- Ferrada P, Murthi S, Anand RJ, Bochicchio GV, Scalea T. Transthoracic Focused Rapid Echocardiographic Examination: Real-Time Evaluation of Fluid Status in Critically Ill Trauma Patients. J Trauma. 2011;70:56-64.

POCUS IN SHOCK

- Goals
  1. Quickly rule in / rule out specific pathology.
  2. Narrow differential diagnosis.
  3. Characterize type of shock / hypotension.

POCUS IN SHOCK

	Hypovolemic	Vasodilatory	Cardiogenic	Obstructive
Heart	Hyperdynamic LV function		Reduced / Severely Reduced LV fxn RV Dilation (MI)	+/- Dilated RV (PE) +/- Pericardial Effusion (Cardiac Tamponade)
IVC	Small IVC		Dilated IVC	Dilated IVC
Morrison's Pouch	+/- Abdominal free fluid (hemorrhage)	Normal	+/- Abdominal free fluid (ascites)	Normal
Aorta	+/- Aortic aneurysm / dissection	Normal	Normal	Normal
Pulmonary	Normal	+/- Consolidation (pneumonia)	B-Lines	+/- Absent lung sliding (pneumothorax)
Peripheral Veins	Normal	Normal	Normal	+/- DVT

Weingart SD, Duque D, Nelson B. The RUSH Exam: Rapid Ultrasound for Shock and Hypotension. https://emcrit.org/rush-exam/original-rush-article/

FOCUSED CARDIAC ULTRASOUND (FOCUS)

- Cardinal Views
  - Parasternal Long Axis (PLAX)
  - Parasternal Short Axis (PSAX)
  - Apical 4 Chamber (A4C)
  - Subcostal 4 Chamber (S4C)
  - Inferior Vena Cava (IVC)

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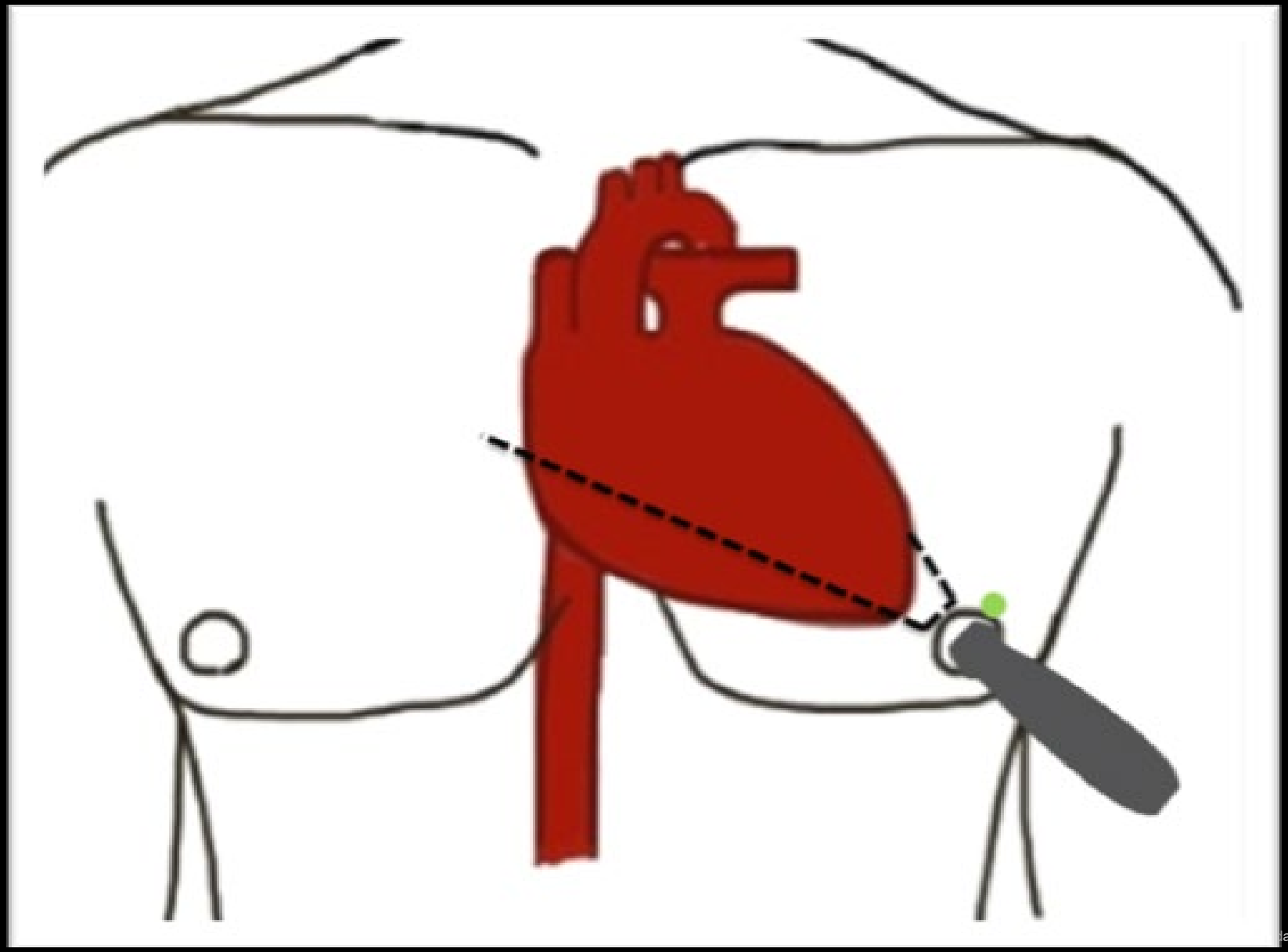
APICAL 4 CHAMBER (A4C)



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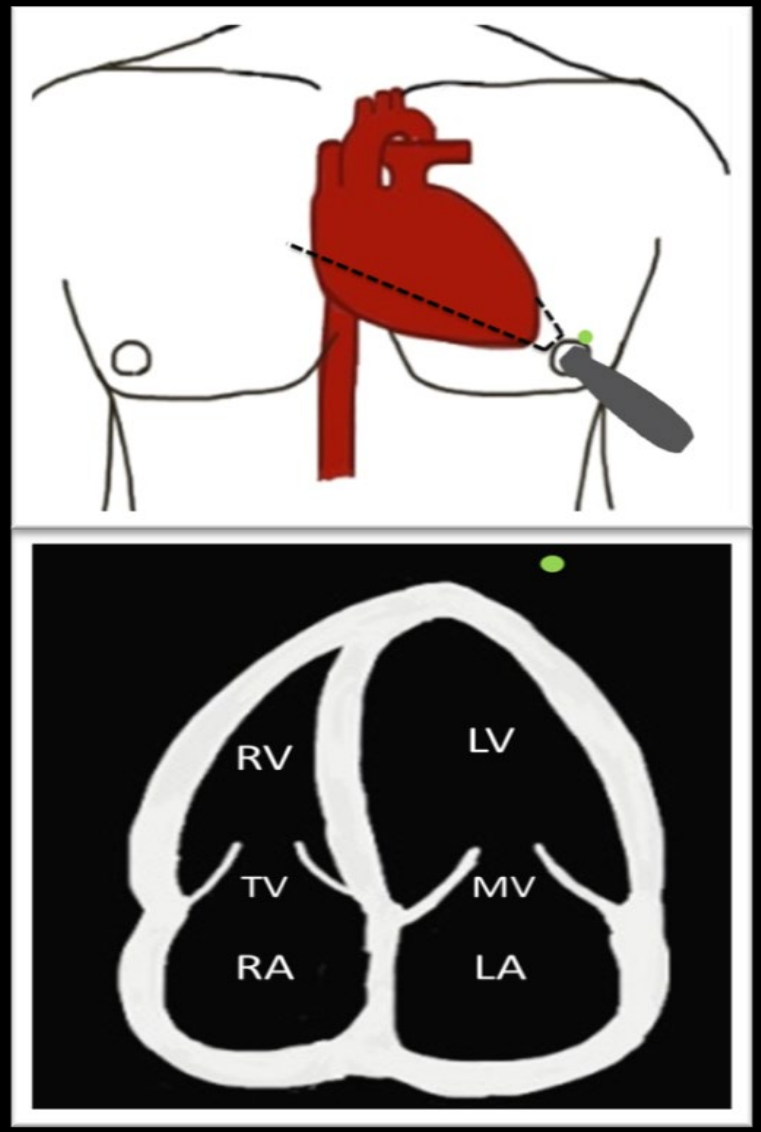
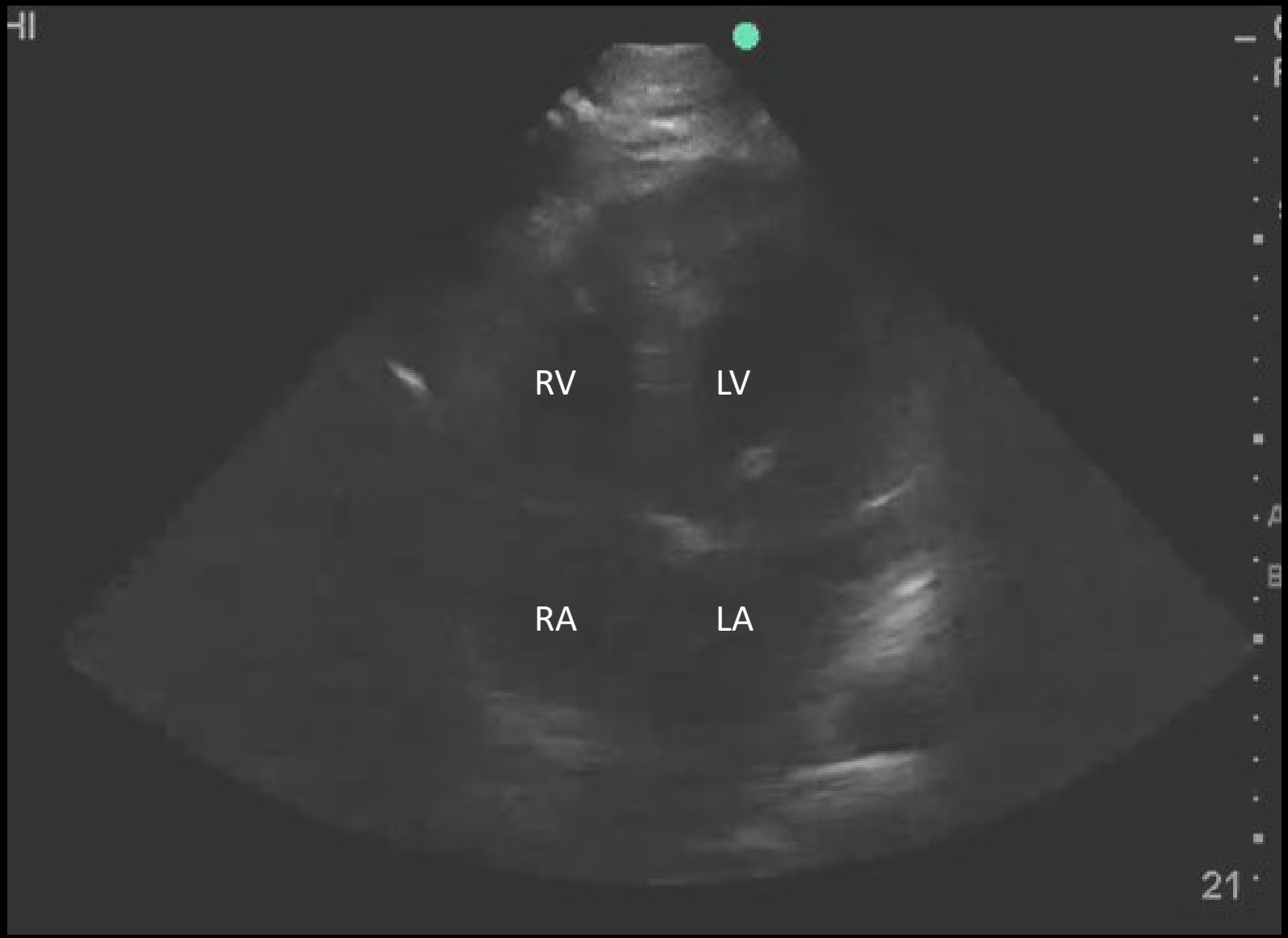
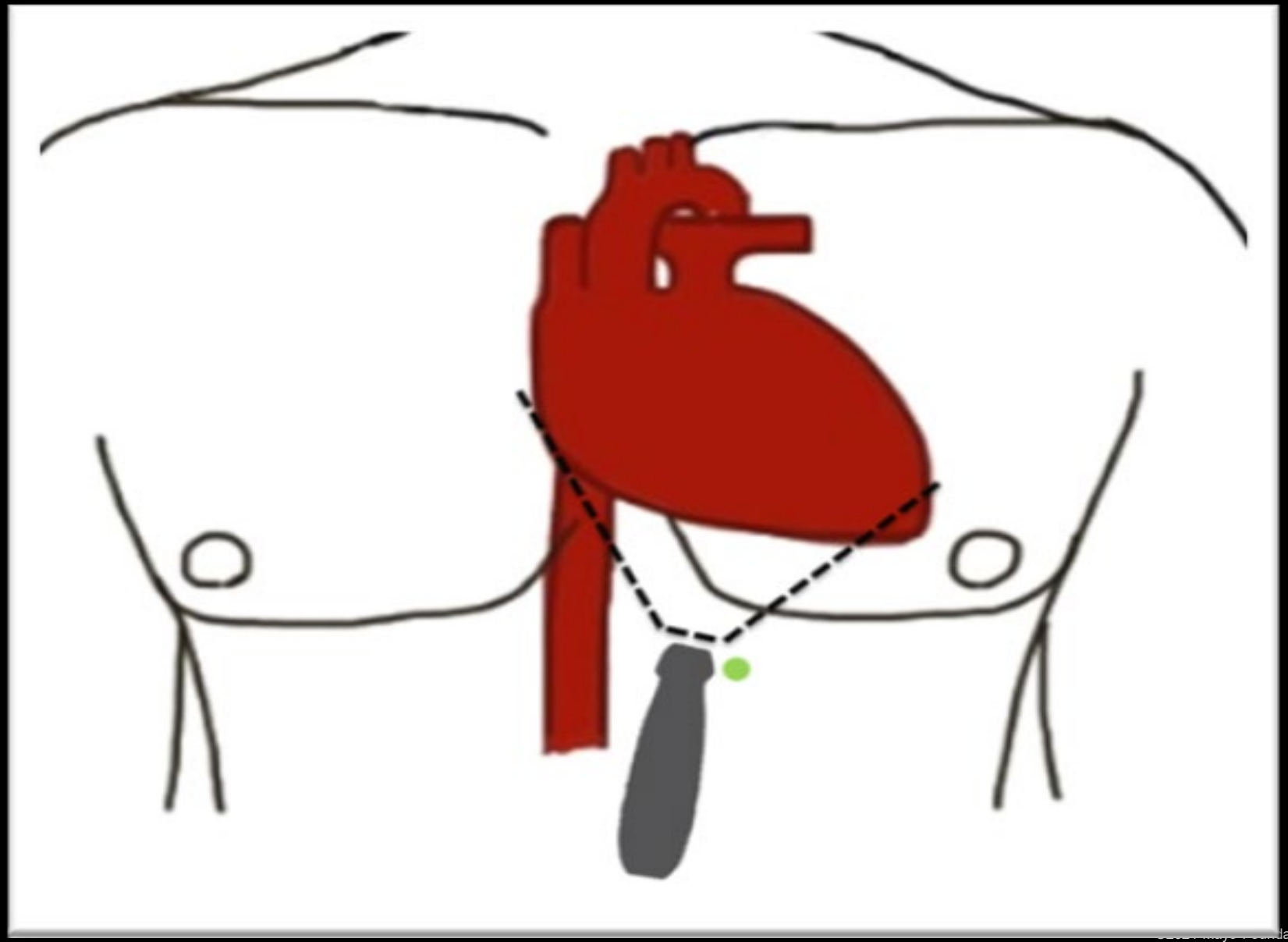




SUBCOSTAL 4 CHAMBER (S4C)



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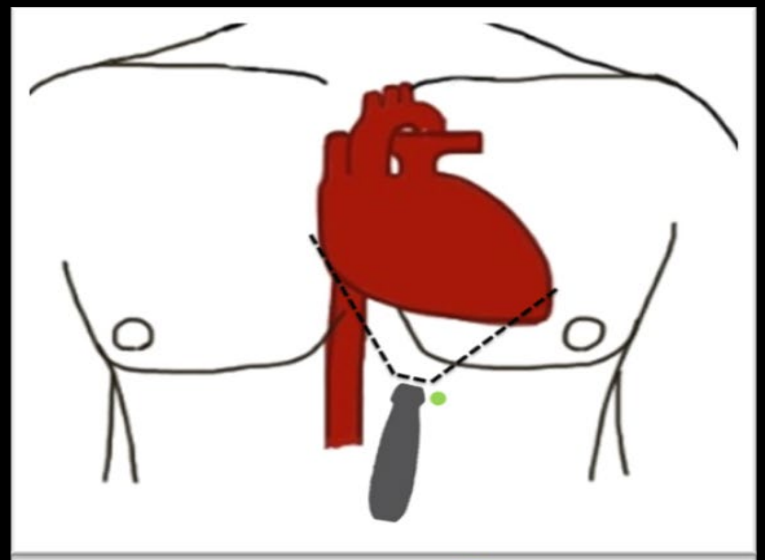
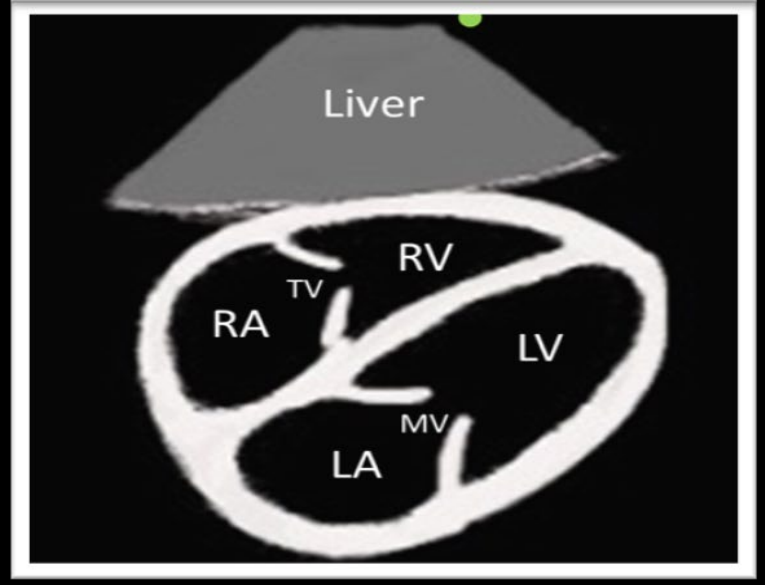
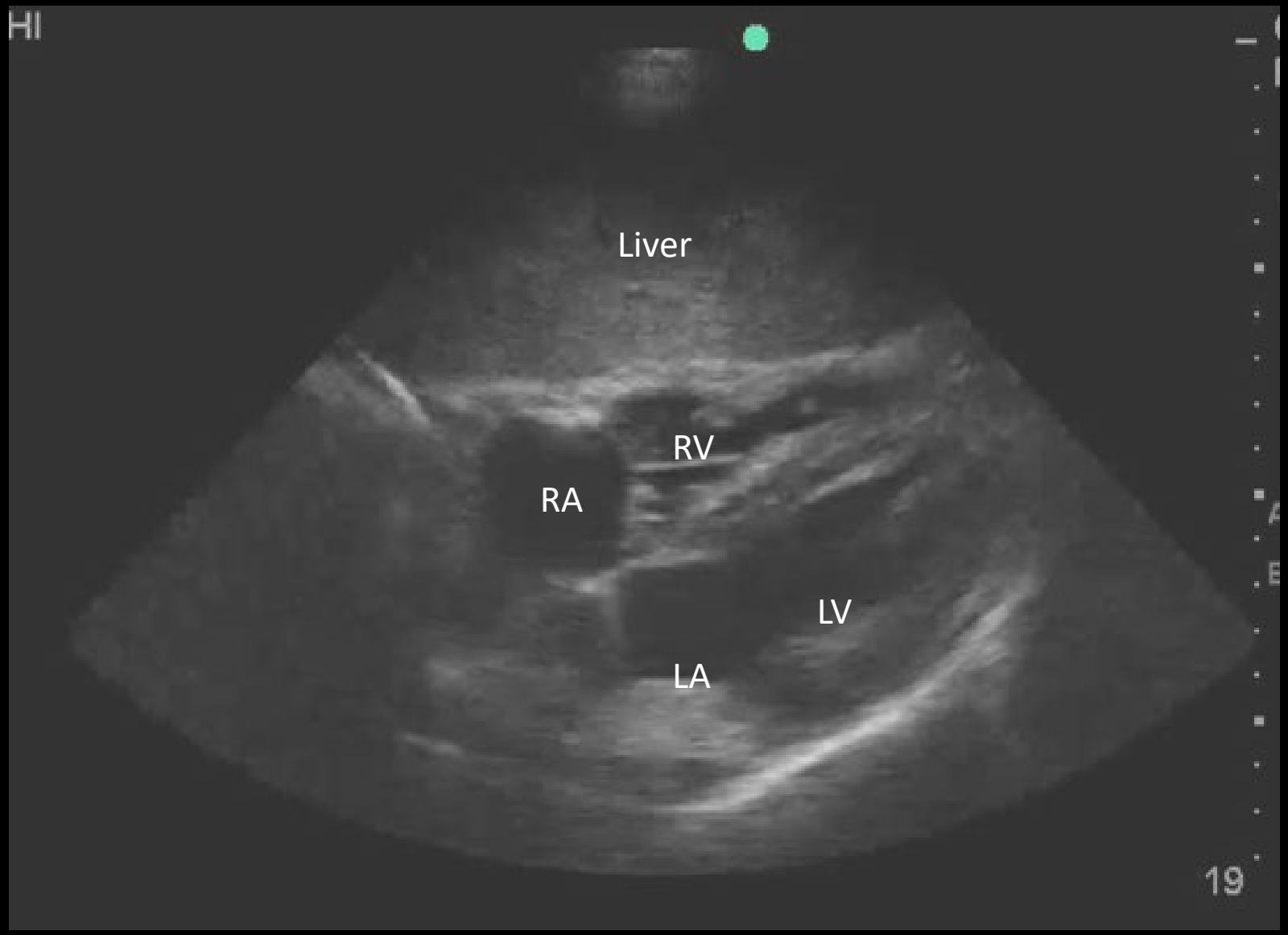
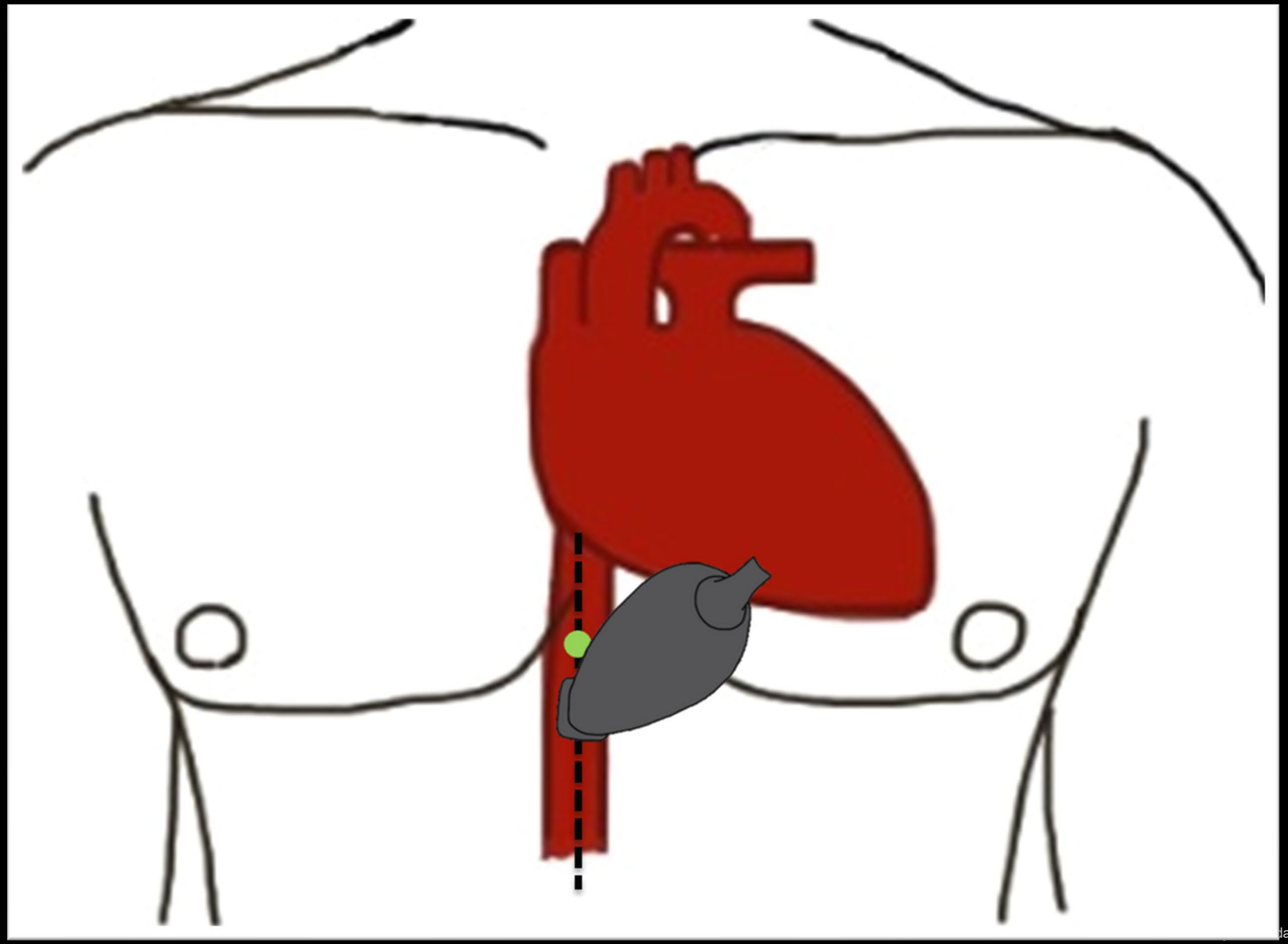






INFERIOR VENA CAVA (IVC)



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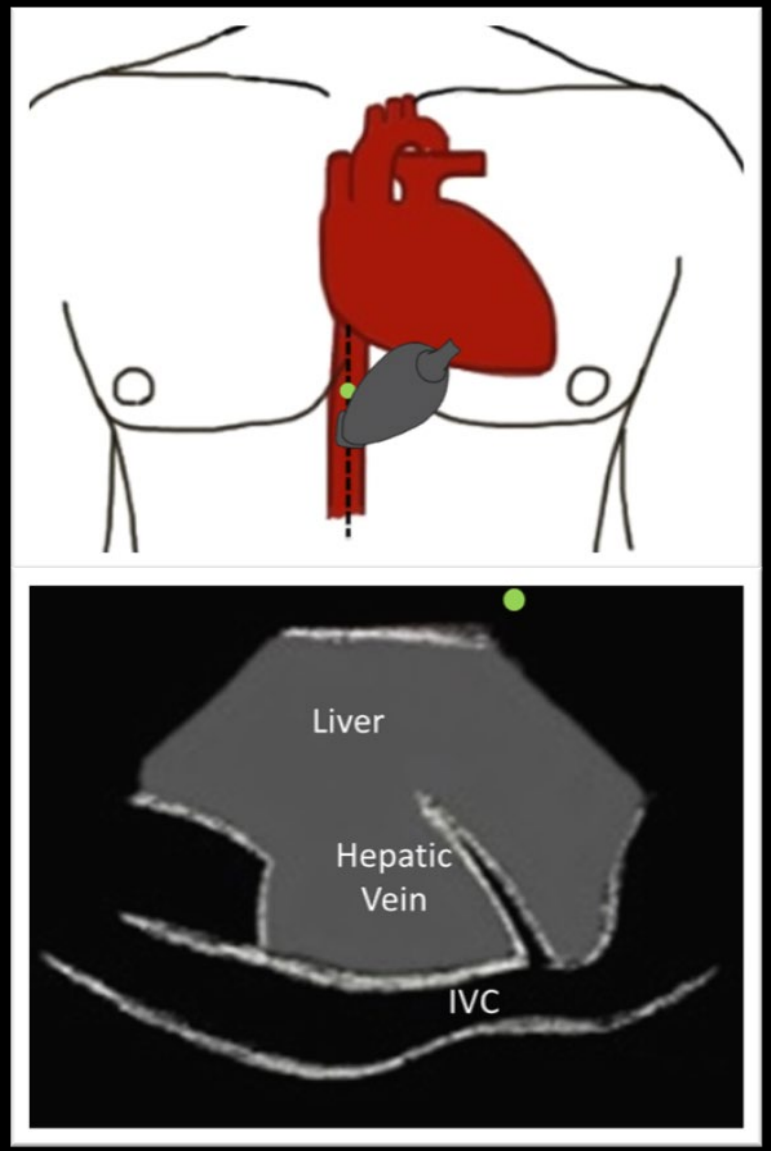
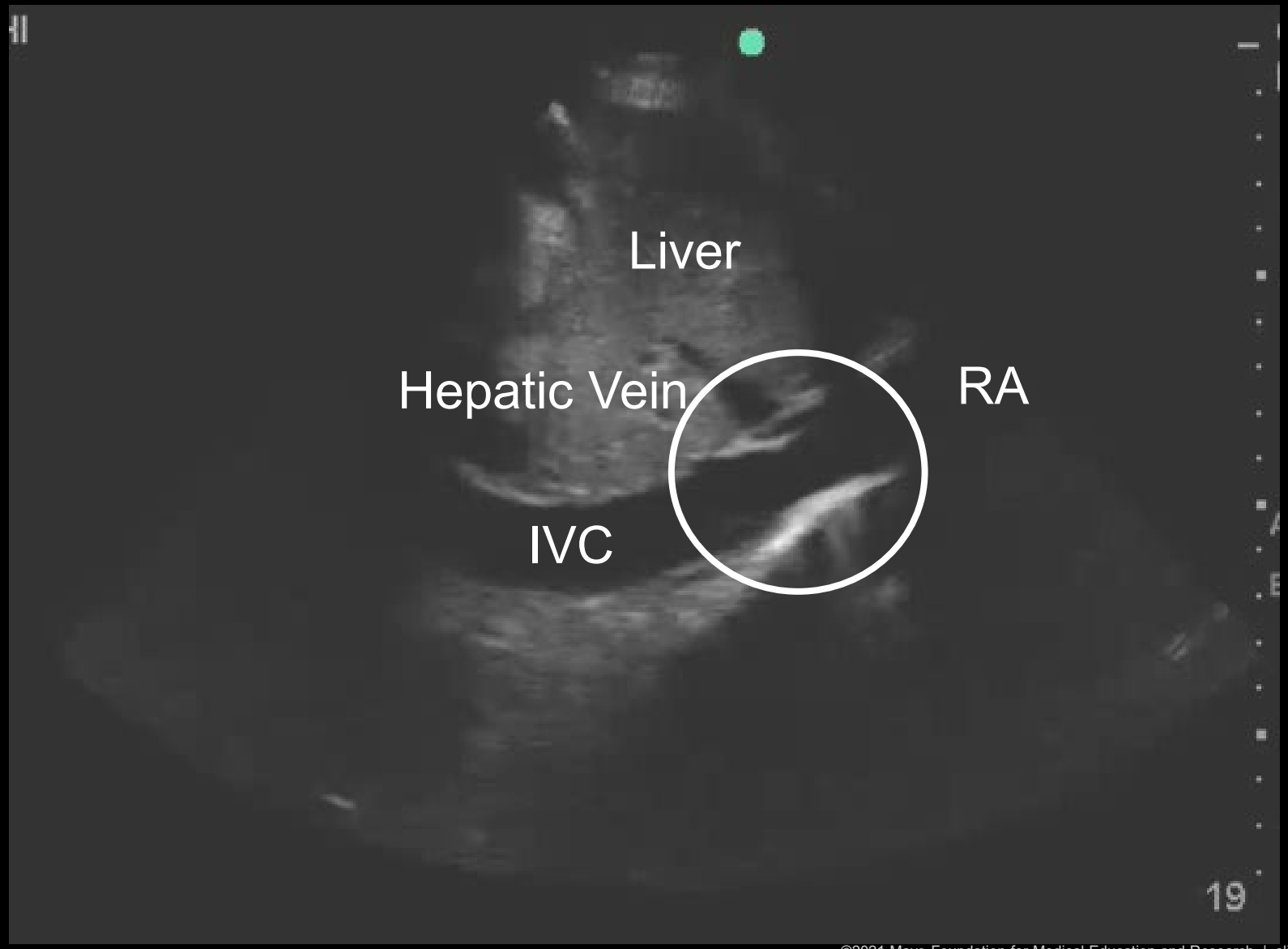
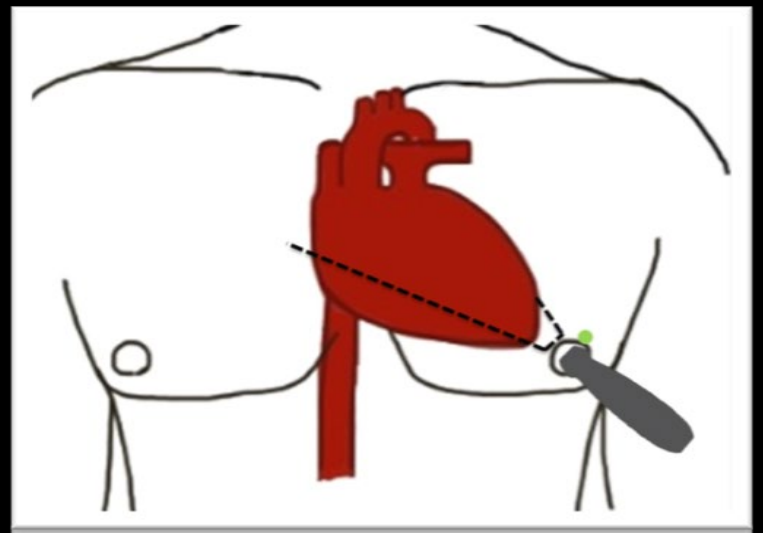
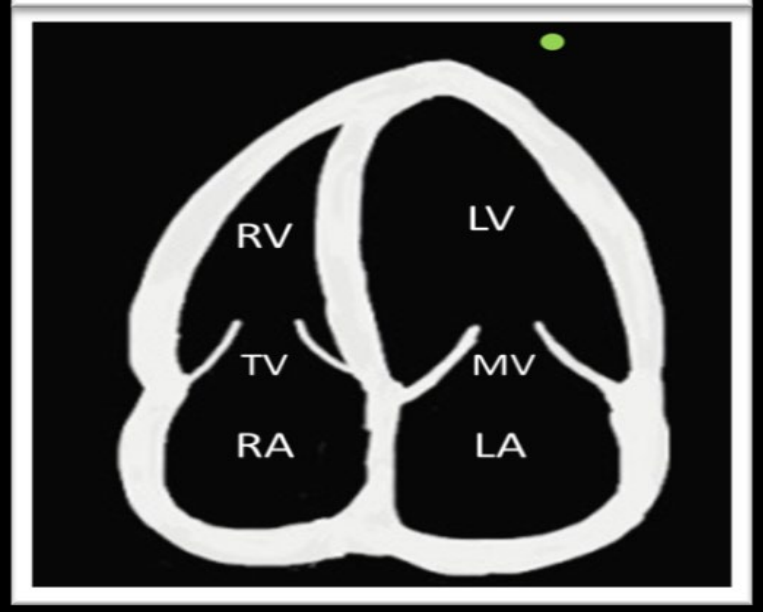
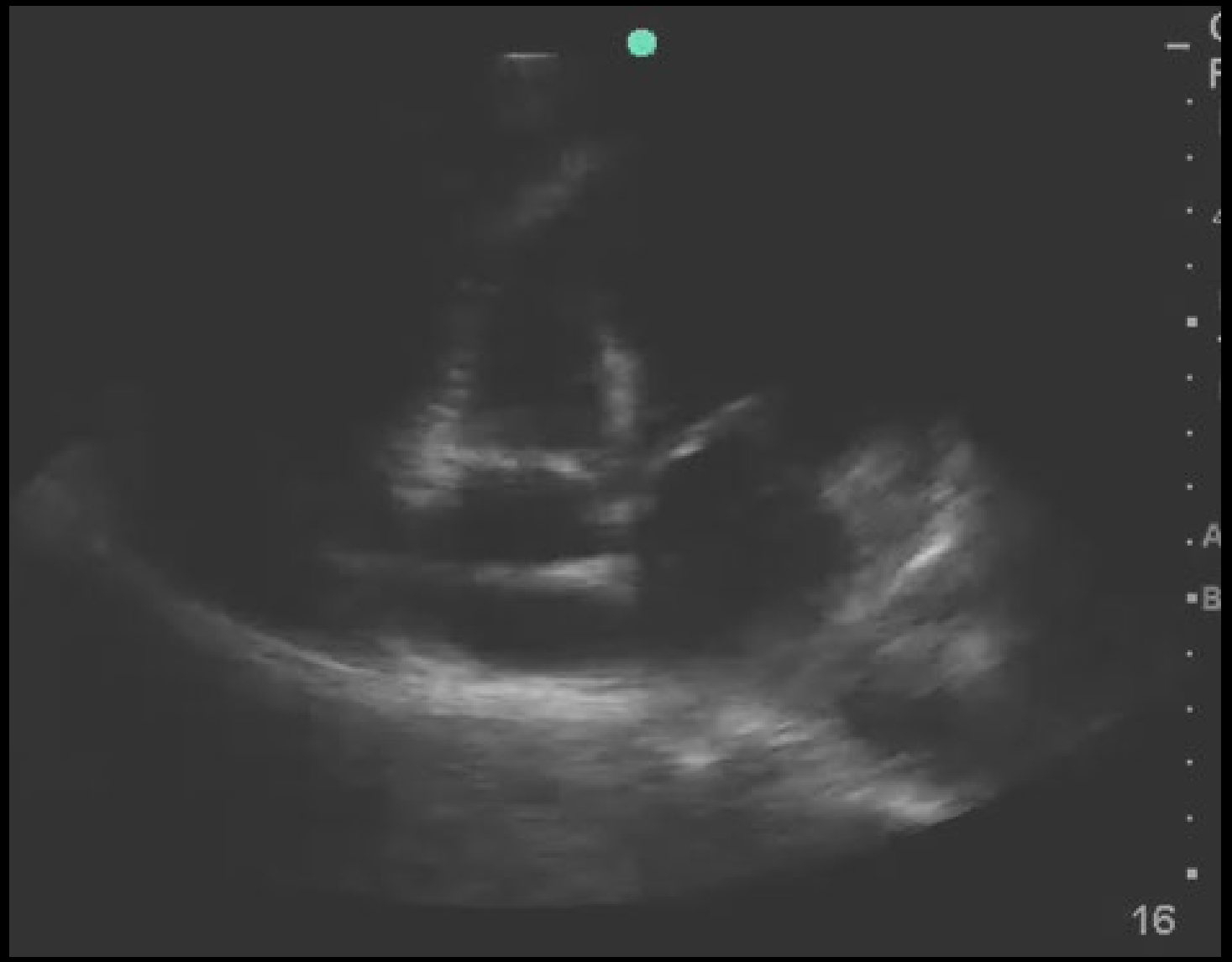




APICAL 4 CHAMBER (A4C) – CASE 1







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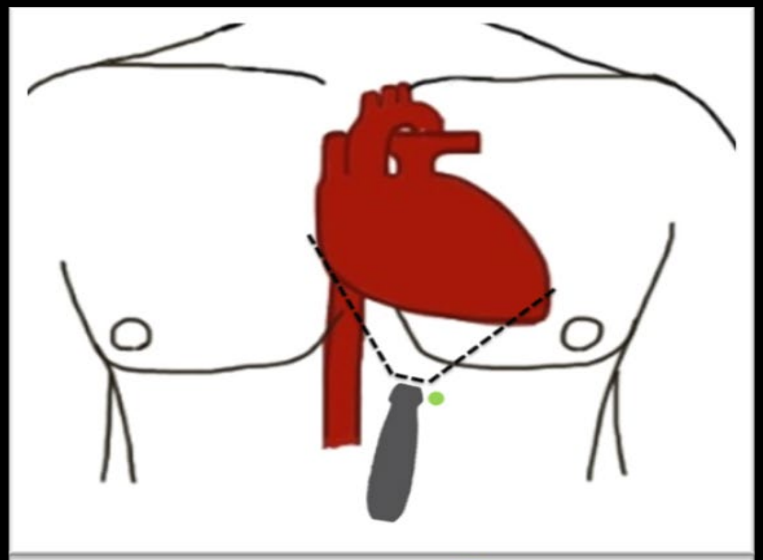
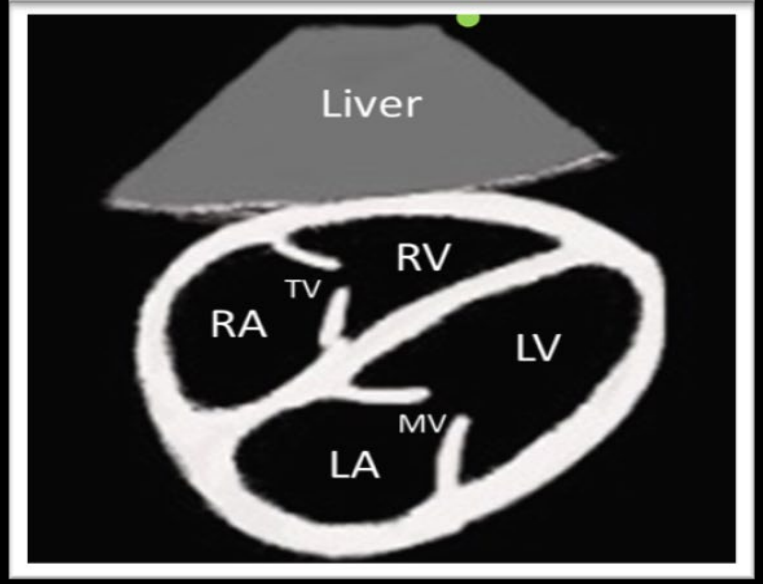
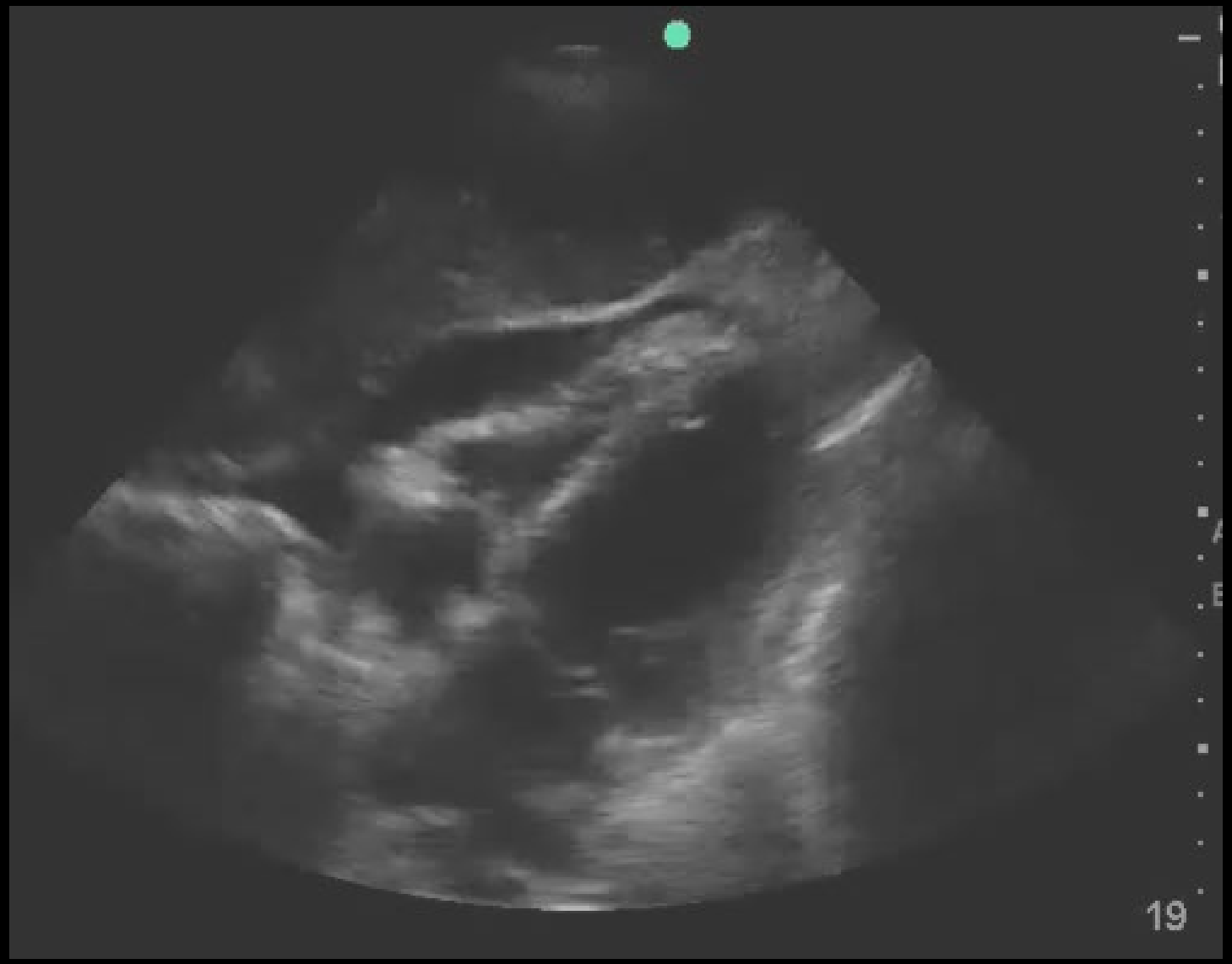
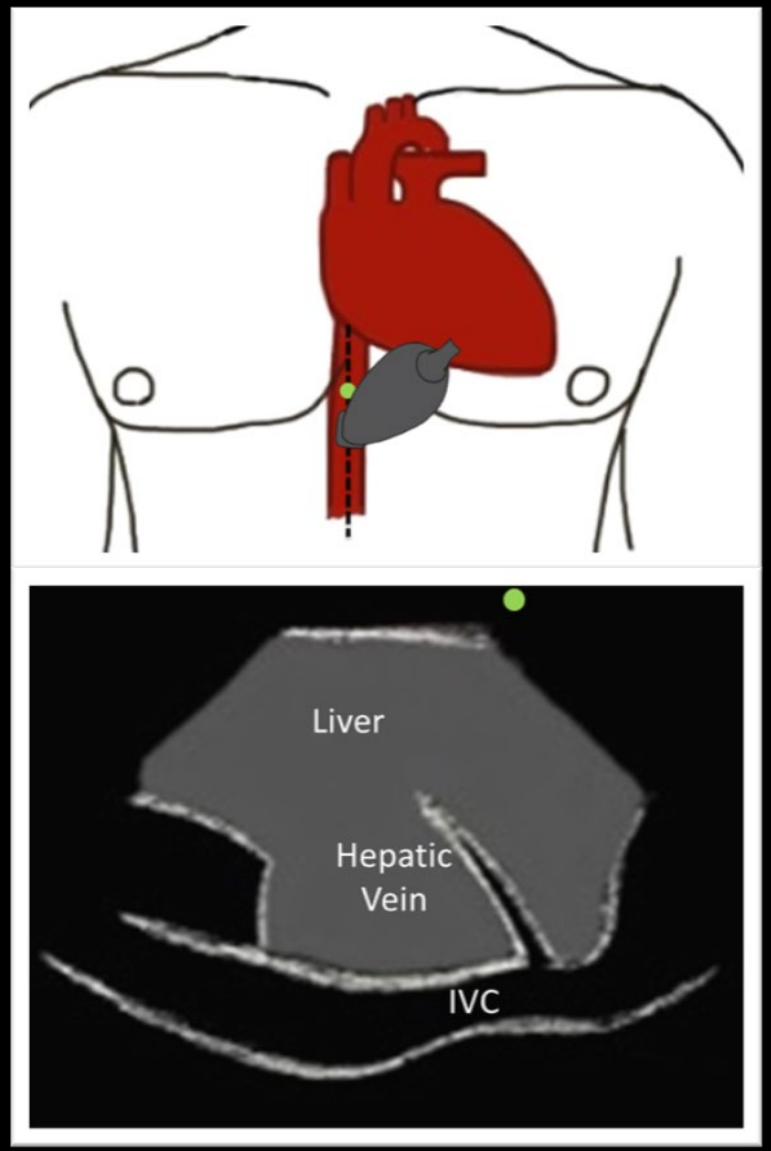
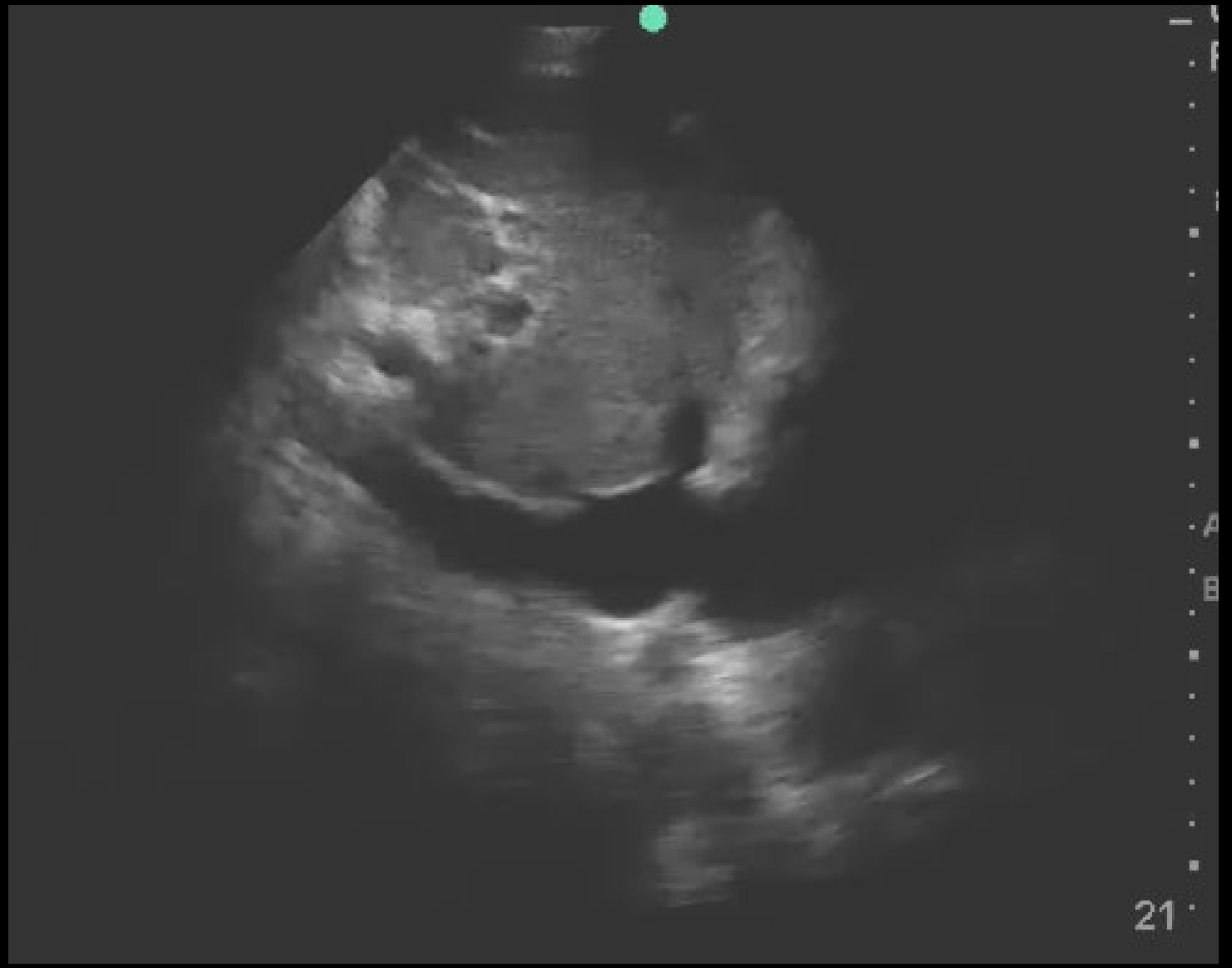






INFERIOR VENA CAVA (IVC) – CASE 1

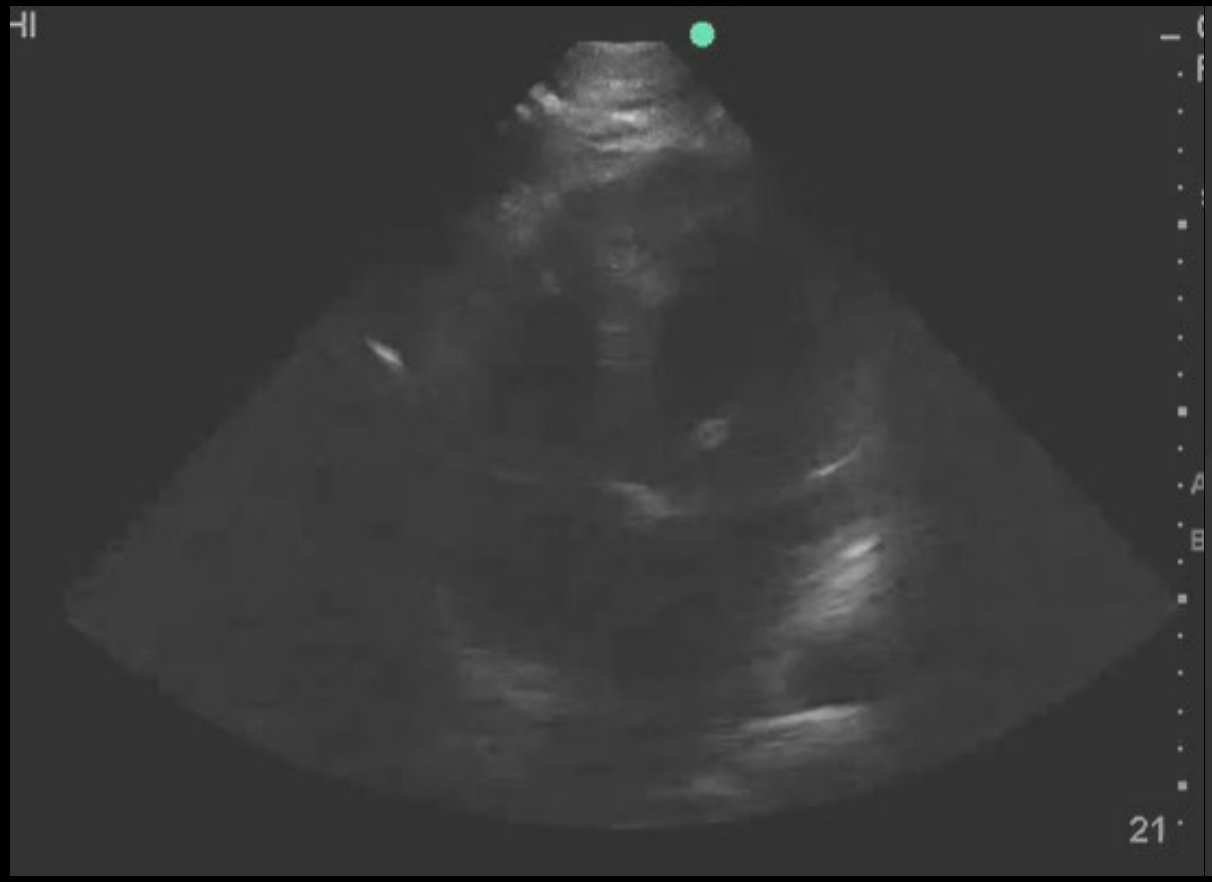




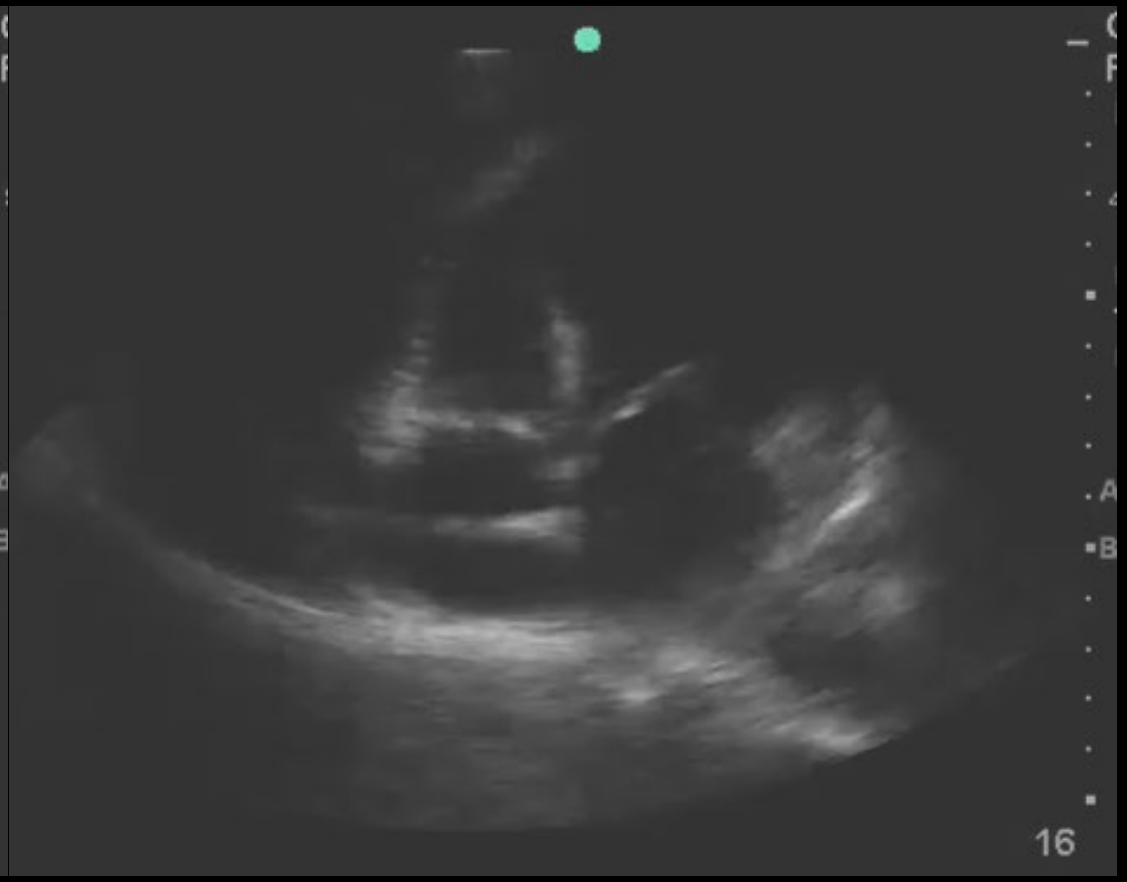
REFLECTION QUESTIONS

- What is your interpretation of the patient's FoCUS?

APICAL 4 CHAMBER (A4C)



Normal



Patient’s

SUBCOSTAL 4 CHAMBER (S4C)

Normal

Patient's

SUBCOSTAL 4 CHAMBER (S4C)

Normal

Patient’s

CASE 1

- Findings **VERY** concerning for cardiac tamponade.
- Transferred to the Cardiac ICU for emergent pericardial drain placed.
- Diagnosed with hemorrhagic pericarditis causing cardiac tamponade.

LITERATURE REVIEW – CASE 1

Does Point-of-Care Ultrasonography Improve Clinical Outcomes in Emergency Department Patients With Undifferentiated Hypotension? An International Randomized Controlled Trial From the SHoC-ED Investigators

Conclusion: To our knowledge, this is the first randomized controlled trial to compare point-of-care ultrasonography to standard care without point-of-care ultrasonography in undifferentiated hypotensive ED patients. We did not find any benefits for survival, length of stay, rates of CT scanning, inotrope use, or fluid administration. The addition of a point-of-care ultrasonography protocol to standard care may not translate into a survival benefit in this group. [Ann Emerg Med. 2018;72:478-489.]

Atkinson PR, Milne J, Diegelman L, Lamprecht H, StanderM, Lussier D, et al. Does Point-of-Care Ultrasonography Improve Clinical Outcomes in Emergency Department Patients With Undifferentiated Hypotension? An International Randomized Controlled Trial From the SHoC-ED. Annals of Emergency Medicine 2018.

LITERATURE REVIEW – CASE 1

- Diagnostic Evaluation

Measurement	Standard of Care	Standard of Care + POCUS
Number of viable Diagnoses on initial eval	9	4
Provider confidence in diagnosis	50%	80%
Patient's with definitive diagnosis on initial eval	0.8%	12.7%

- Diagnosis by POCUS has excellent concordance with final consensus diagnosis (*k*=0.80).
- Evidence mixed on CT, IVF, Inotropes/Vasopressor usage

- Shokoohi H, Boniface KS, Pouramand A, Liu YT, et al. Bedside Ultrasound Reduces Diagnostic Uncertainty and Guides Resuscitation in Patients With Undifferentiated Hypotension. Critical Care Medicine Journal 2015;43(12):2562-2569.
- Jones AE, Tayal VS, Sullivan DM, et al: Randomized, controlled trialof immediate versus delayed goal-directed ultrasound to identifythe cause of nontraumatic hypotension in emergency departmentpatients. Crit Care Med 2004; 32:1703–1708
- Atkinson PR, Milne J, Diegelman L, Lamprecht H, StanderM, Lussier D, et al. Does Point-of-Care Ultrasonography Improve Clinical Outcomes in Emergency Department Patients With Undifferentiated Hypotension? An International Randomized Controlled Trial From the SHoC-ED. Annals of Emergency Medicine 2018.

LITERATURE REVIEW – CASE 1

- The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: A systematic review and meta-analysis (2019)
  - Hypovolemic shock: LR+ 8.25, LR- 0.19
  - Cardiogenic shock: LR+ 24.14, LR- 0.24
  - Obstructive shock: LR+ 40.54, LR-0.13
  - Distributive shock: LR+ 17.56, LR- 0.30
  - Mixed shock: LR+ 12.91, LR- 0.32

"RUSH exam performs better when used to rule in causes of shock, rather than to definitely exclude specific etiologies."

- Stickles SP, Carpenter CR, Gekle R, Kraus CK, Scoville C, Theodoro D, Tran VH, Ubiñas G, Raio C. The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: A systematic review and meta-analysis. CJEM. 2019 May;21(3):406-417. doi: 10.1017/cem.2018.498. Epub 2019 Jan 30. PMID: 30696496.

LITERATURE REVIEW – CASE 1

- Pericardial Effusion
  - Sensitivity 96%, Specificity 98%
- Cardiac Tamponade

FoCUS Findings	Sensitivity	Specificity
RA Systolic Collapse	64-100%	82%
RV Diastolic Collapse	60-92%	85-100%
Normal IVC*	97%	N/A

	Sensitivity	Specificity
Hypotension	26% (16-36%)	N/A
Elevated JVP	76% (62-90%)	N/A
Muffled heart sounds	28% (21-35%)	N/A
Pulsus Paradoxus	82-98%	83%

- Mandavia DP, Hoffner RJ, Mahaney K, Henderson SO. Bedside echocardiography by emergency physicians. Ann Emerg Med. 2001;38:377-382.
- Gillam LD, Guyer DE, Gibson TC, et al. Hydrodynamic compression of the right atrium: a new echocardiographic sign of cardiac tamponade. Circulation. 1983:68(2);294-301.
- Singh S, Wann LS, Schuchard GH, et al. Right ventricular and right atrial collapse in patients with cardiac tamponade – a combined echocardiographic and hemodynamic study. Circulation. 1984:70(6);966-971.
- Jacob S, Sebastian JC, Cherian PK, Abraham Aril, John SK. Pericardial effusion impending tamponade: a look beyond beck's triad. Am J of Emerg Med. 2009;27:216-219.
- Roy CL, Minor MA, Brookhart MA, Choudhry NK. Does this patient with a pericardial effusion have cardiac tamponade? JAMA. 2007;297(16): 1810 – 1818.
- Guberman BA, Folwer NO, Engel PJ, Gueron M, Allen JM. Cardiac tamopnade in medical patients. Circulation. 1981;64(3): 633-640.

CASE 2

HPI

- A 72 year-old male presents who was directly admitted to the hospital service for evaluation of fevers, rigors, fatigue, and shortness of breath and presumed COVID-19.
- PMH:
  - HLH
  - Pancytopenia
  - Disseminated Mycobacterium chimaera infection
  - CHF

HPI

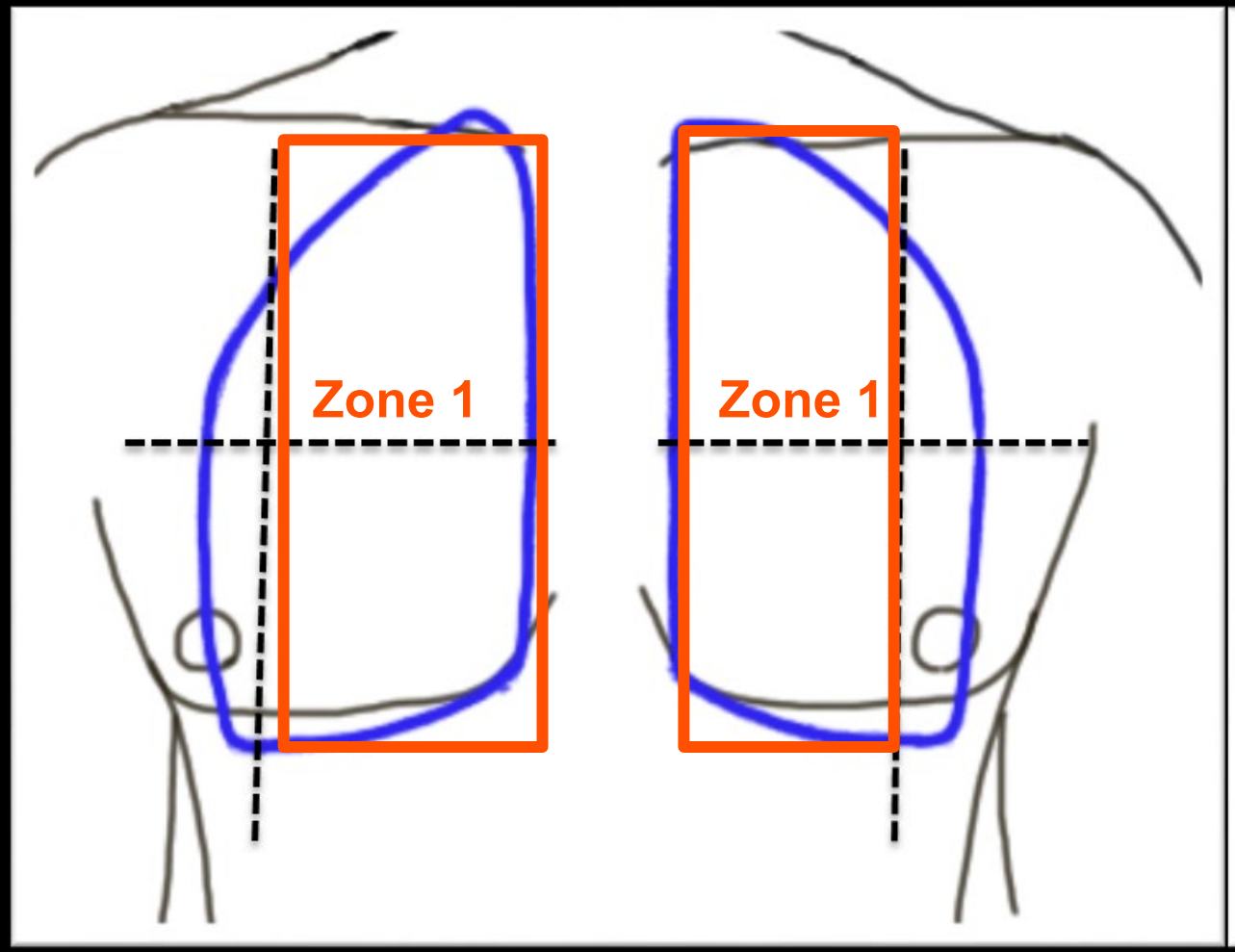
- Vital Signs
  - HR 115, BP **134/67,** SpO2 90% on room air, RR 26, Tmax 37.8 Celcius
- Labs
  - CBC + BMP
  - Inflammatory markers
  - Sars-COV-2 PCR
  - Chest x-ray

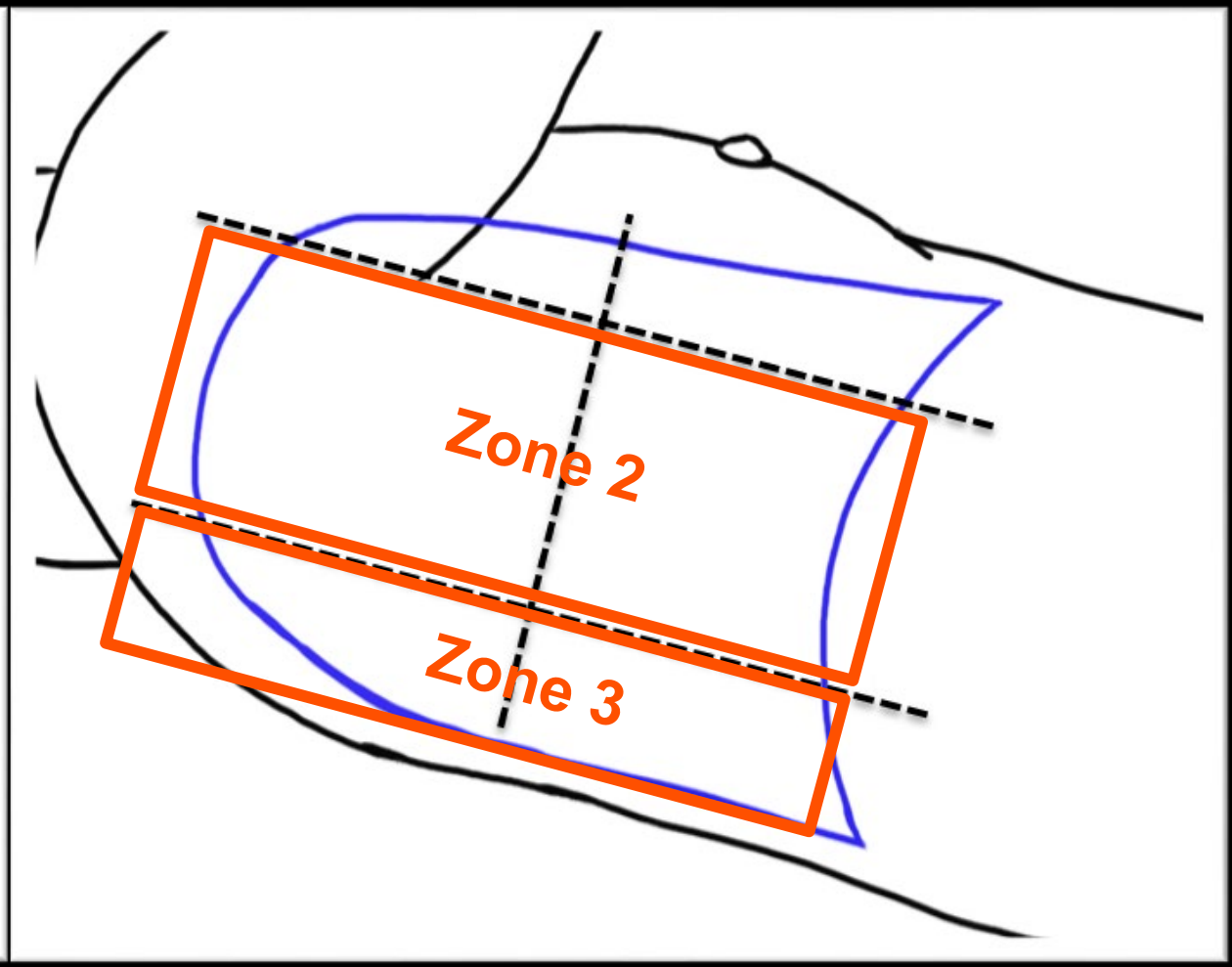
LUNG ULTRASOUND

- Scope:
  - Pulmonary edema
  - Consolidation/Pneumonia
  - Pleural effusions
  - Pneumothorax
  - PE, Asthma, COPD (in the absence of other findings)
- Indications:
  - Hypoxia / Dyspnea.
  - Cough
  - Assessing volume status / Fluid resuscitation.

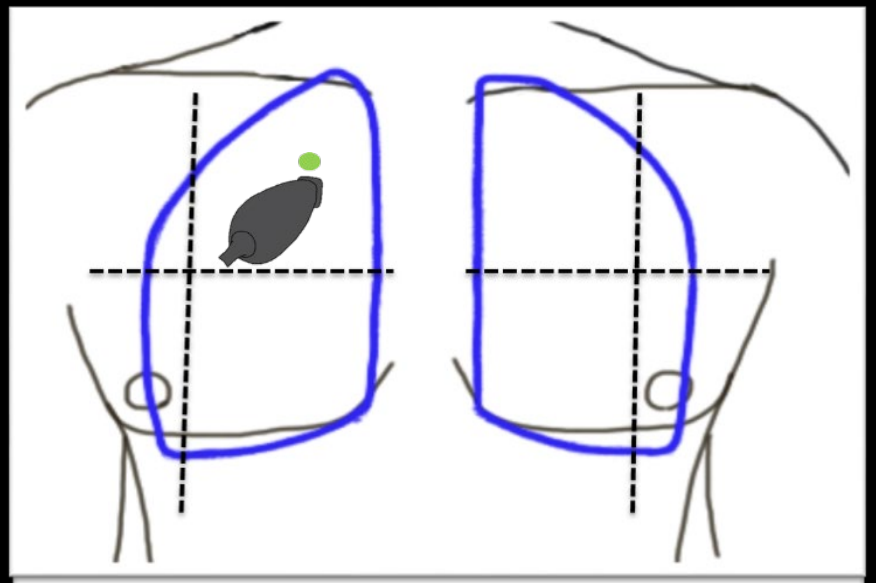
COVID-19

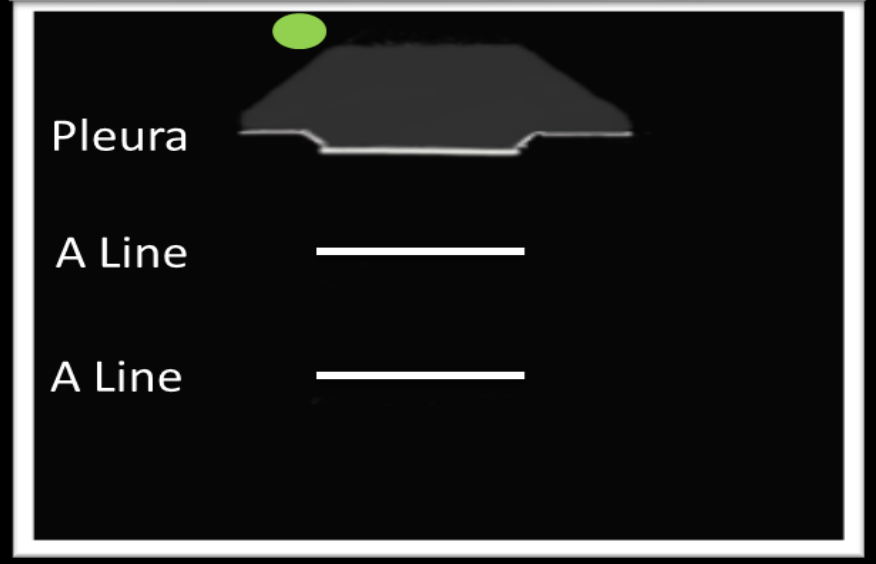
LUNG ULTRASOUND

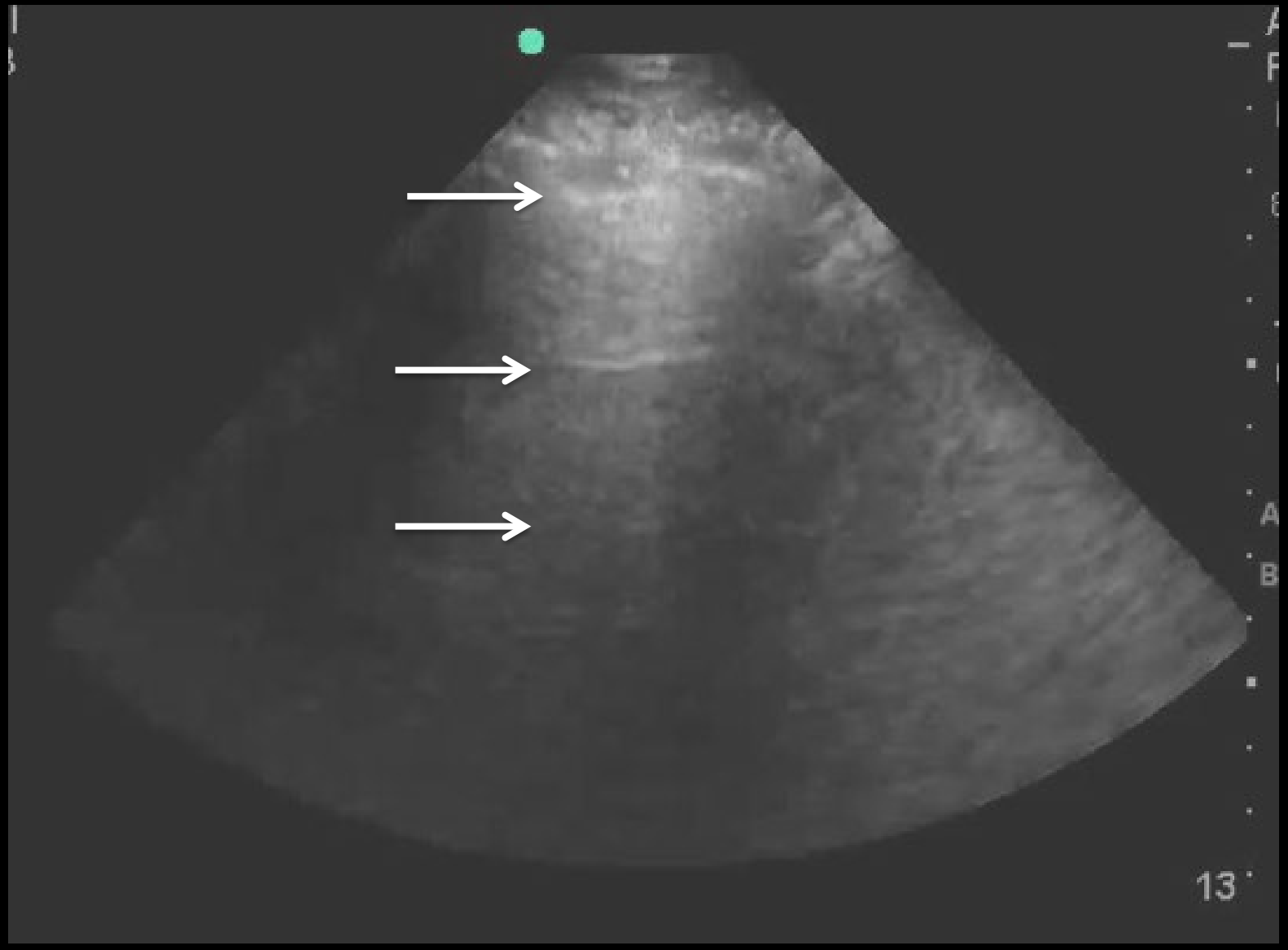




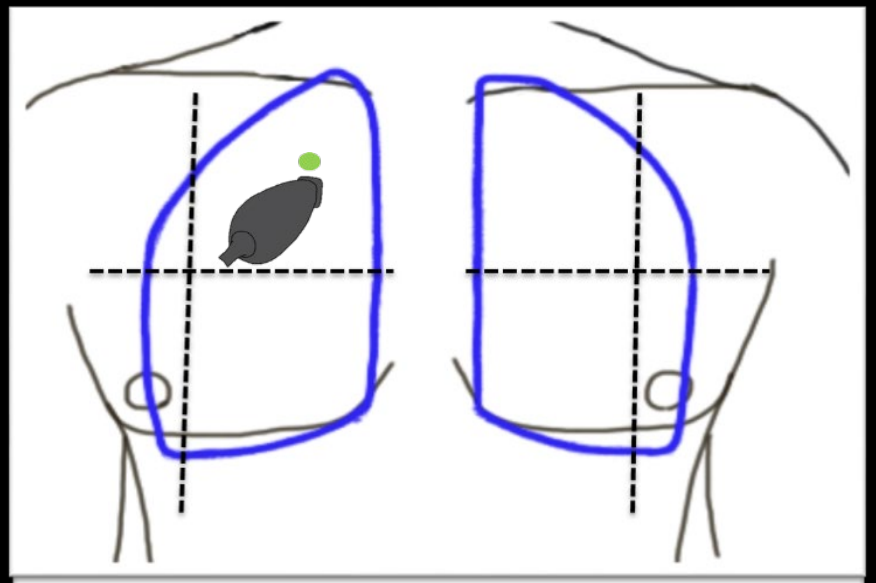
LUNG ULTRASOUND – A LINES

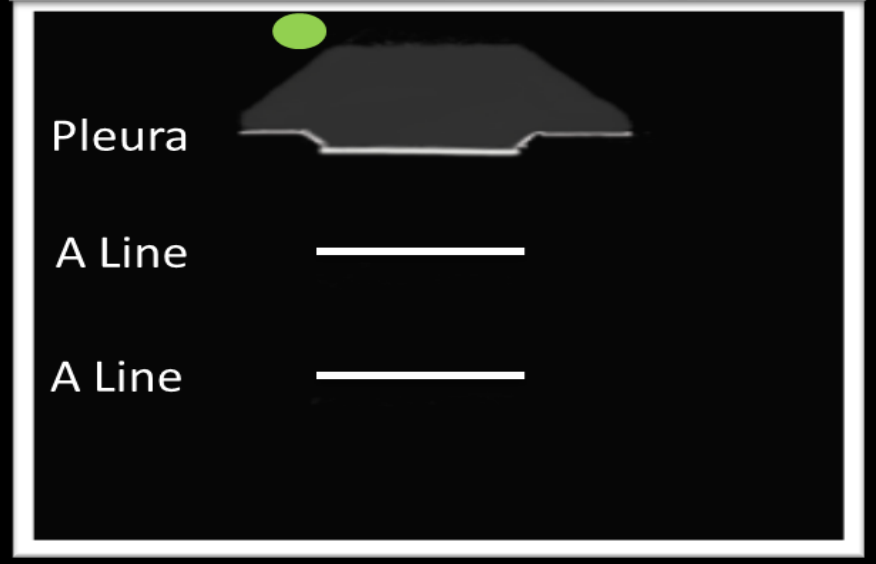


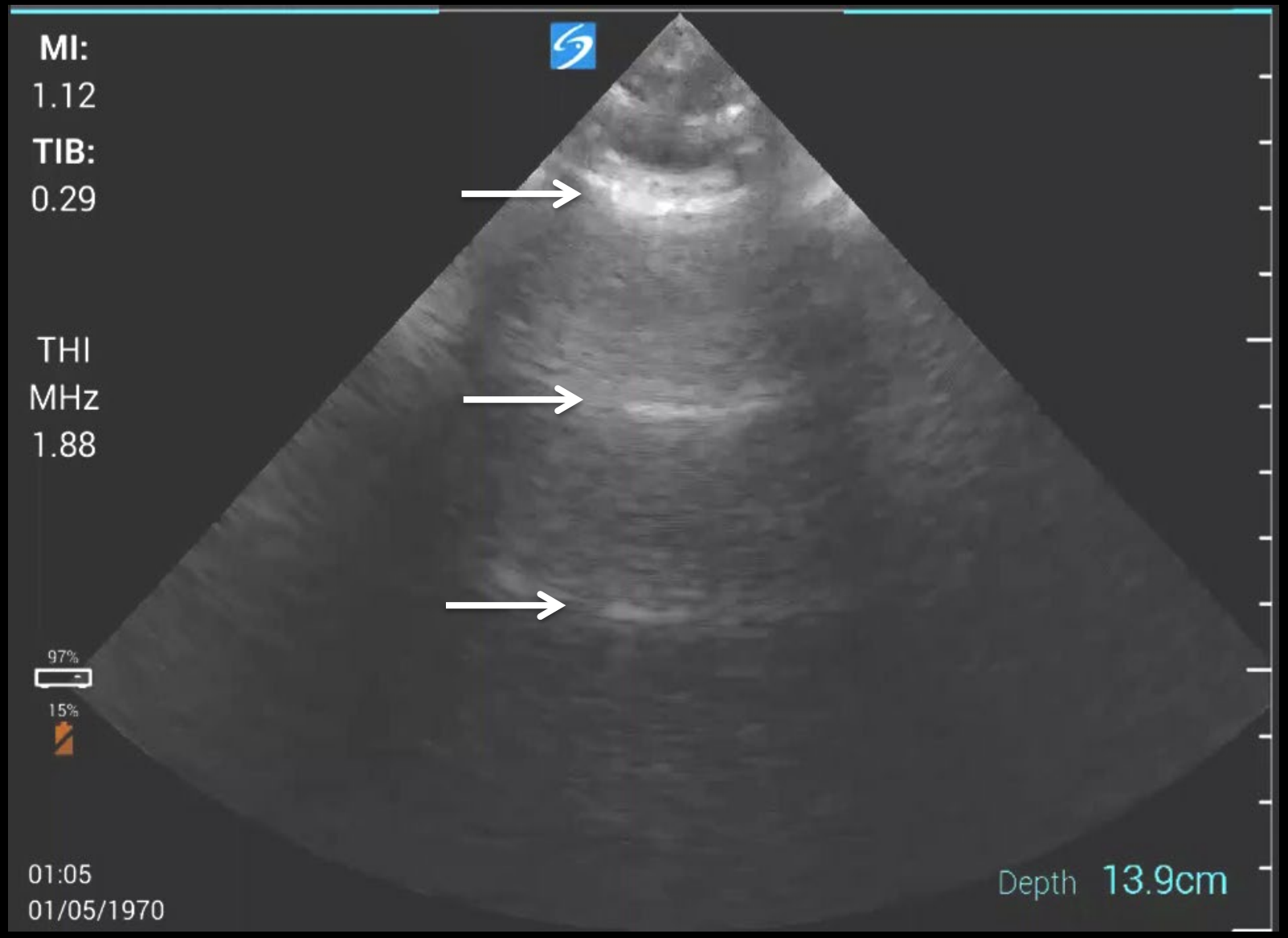




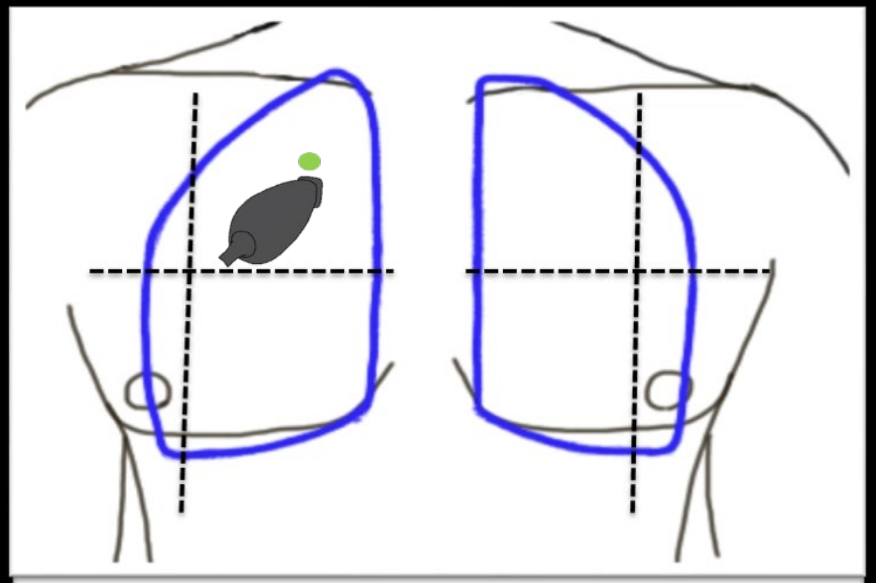
LUNG ULTRASOUND – ABSENT LUNG SLIDING

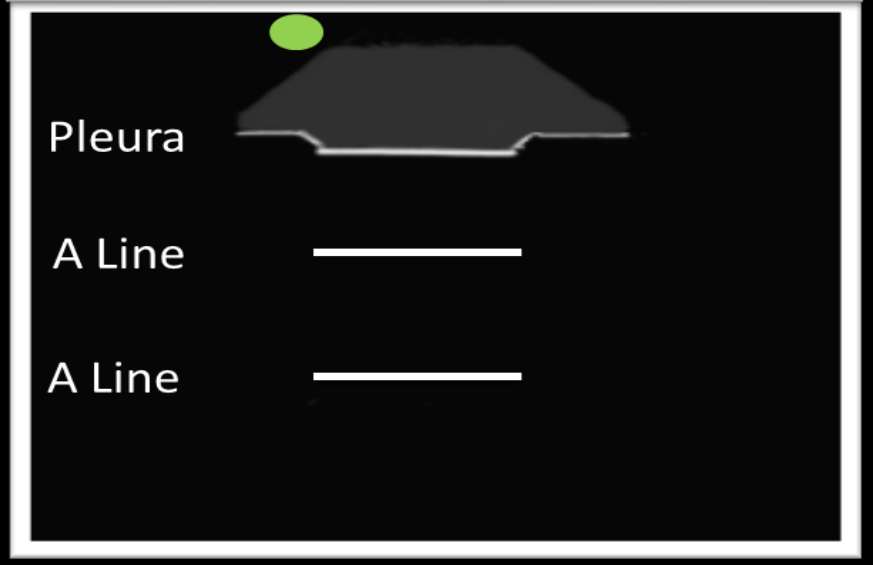


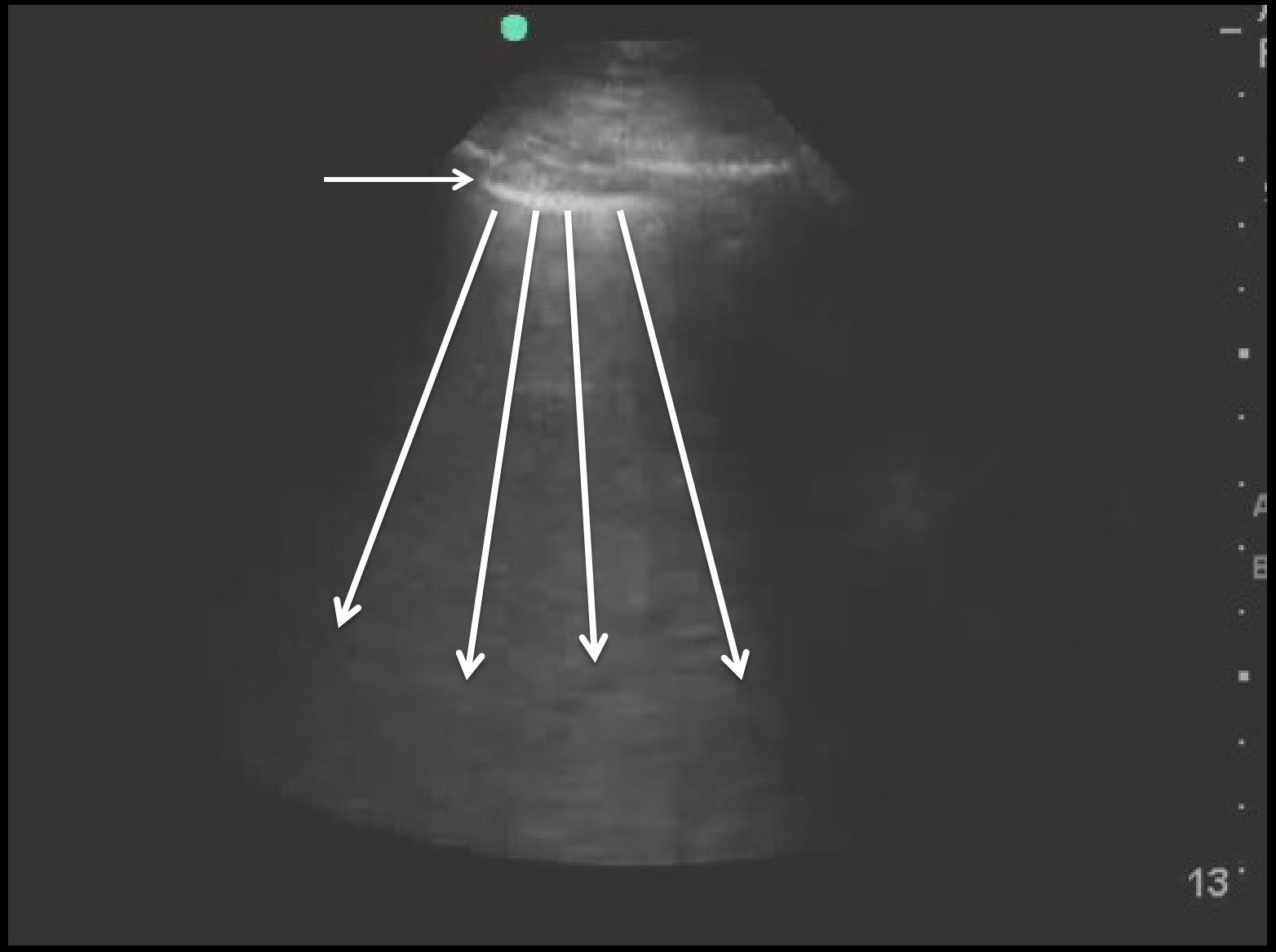




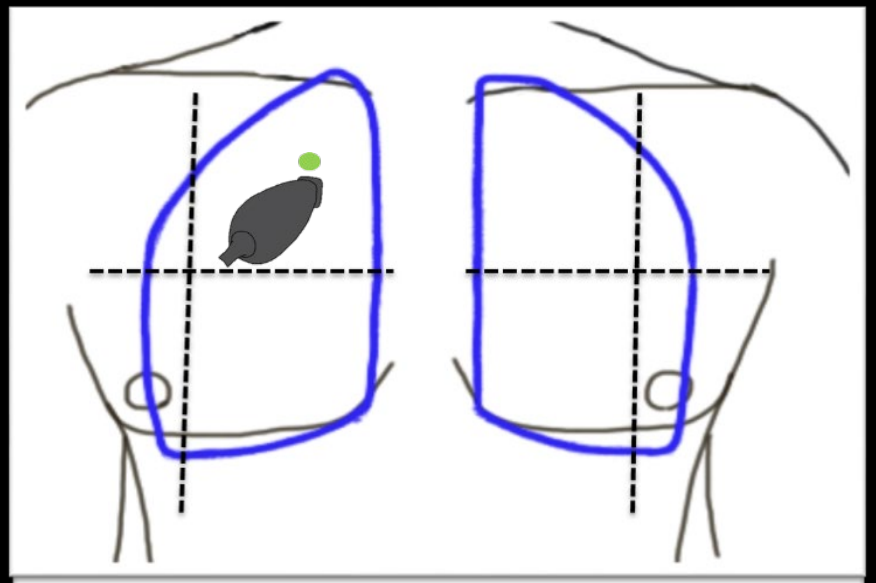
LUNG ULTRASOUND – B LINES

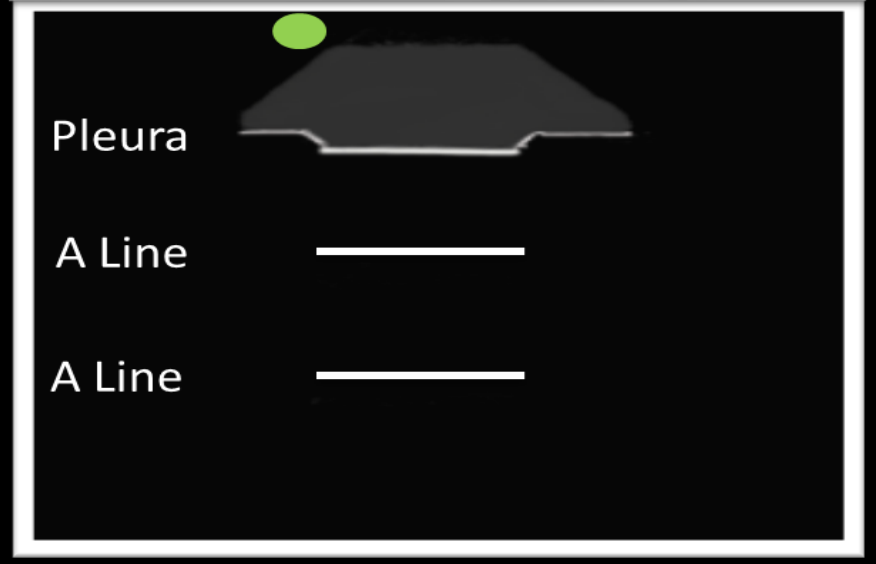


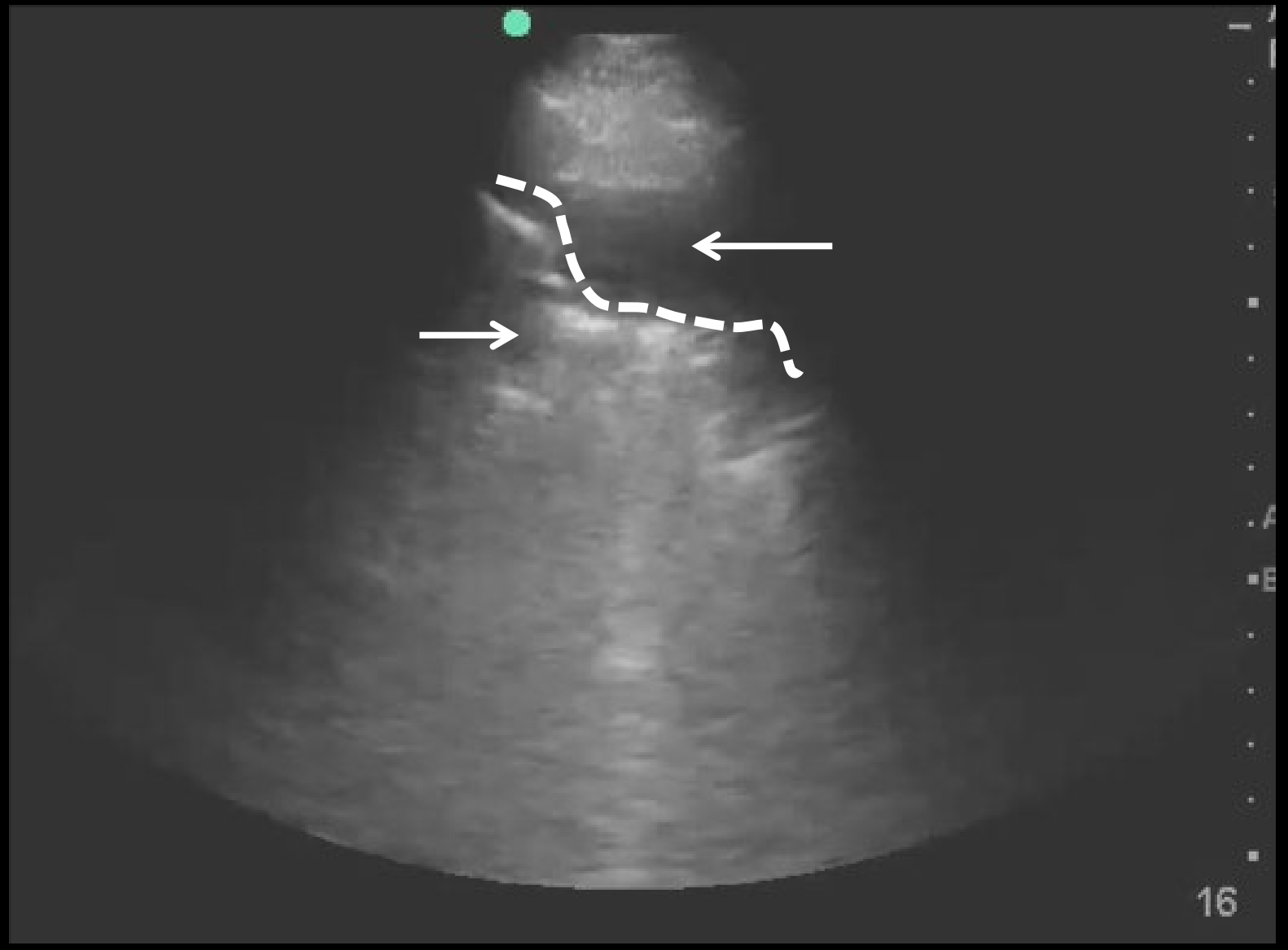




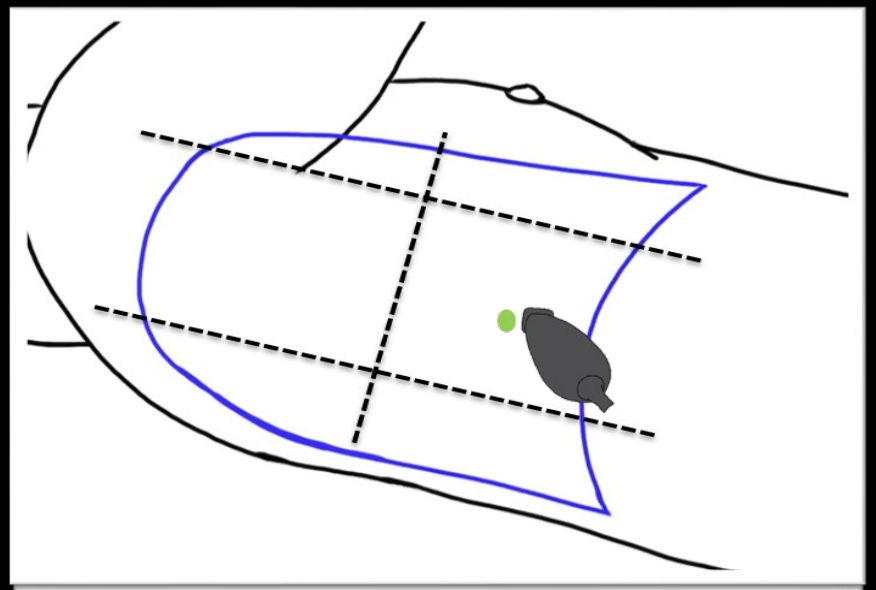
LUNG ULTRASOUND – CONSOLIDATION

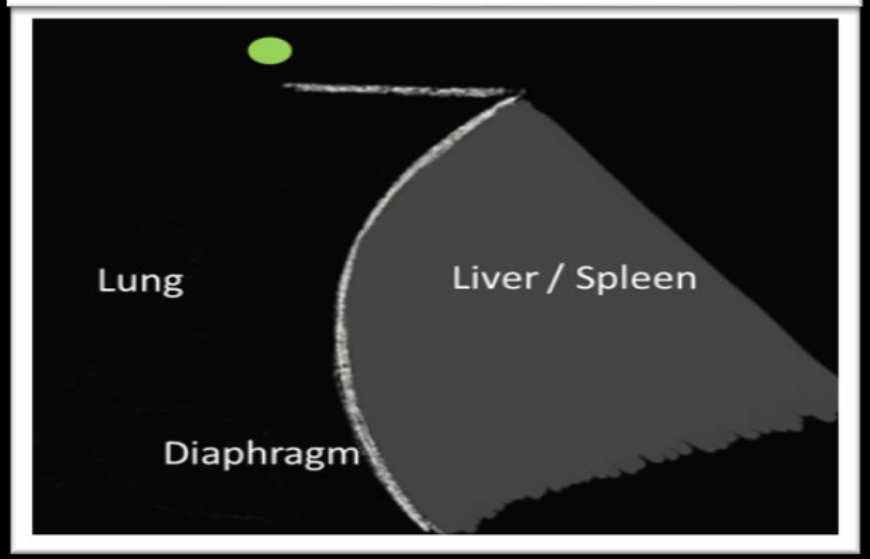


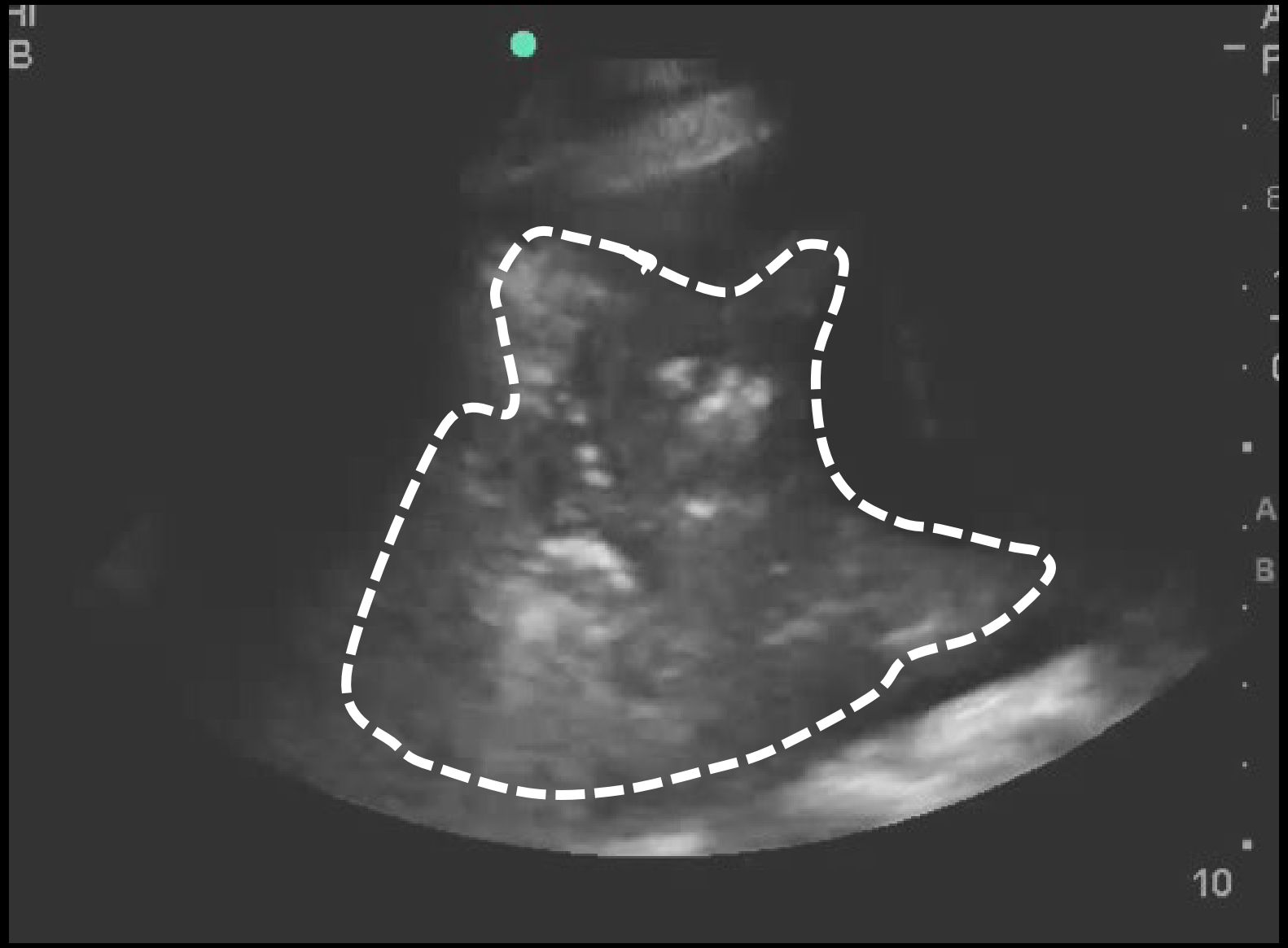




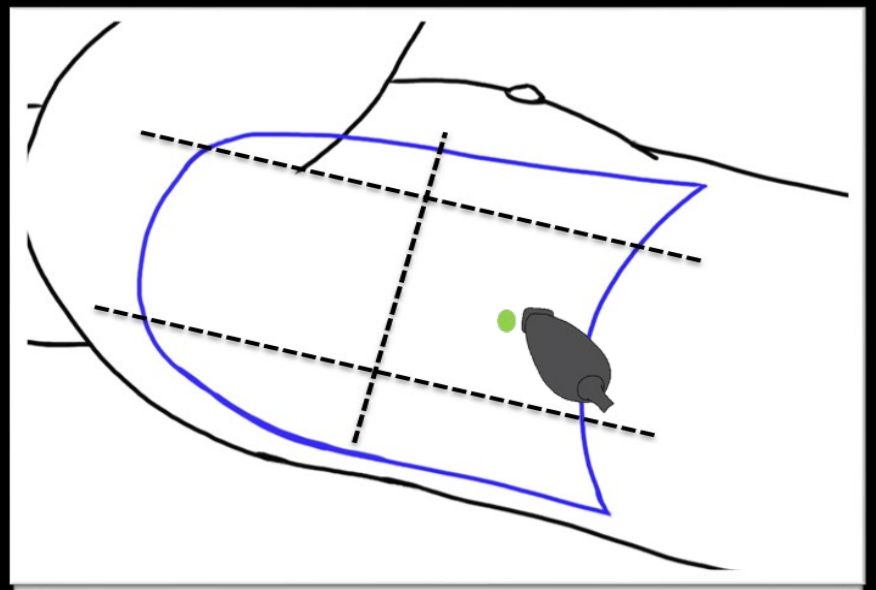
LUNG ULTRASOUND – CONSOLIDATION

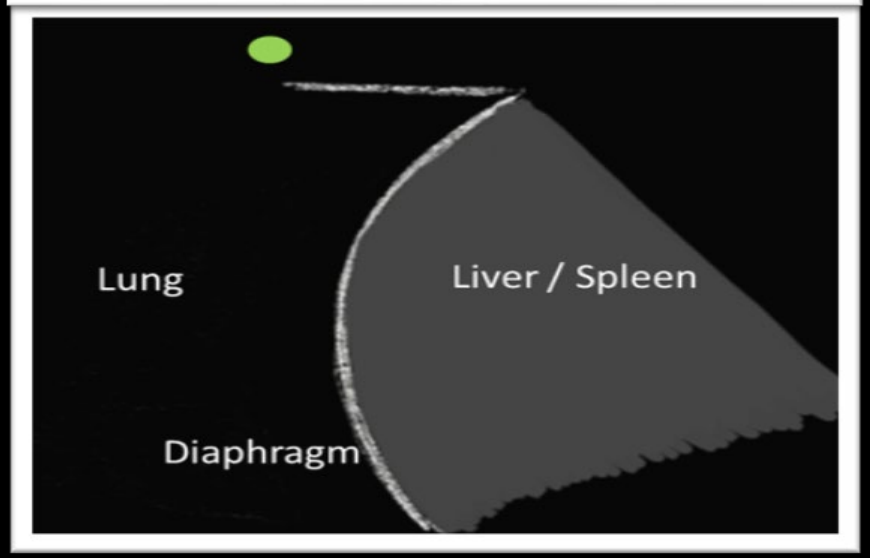


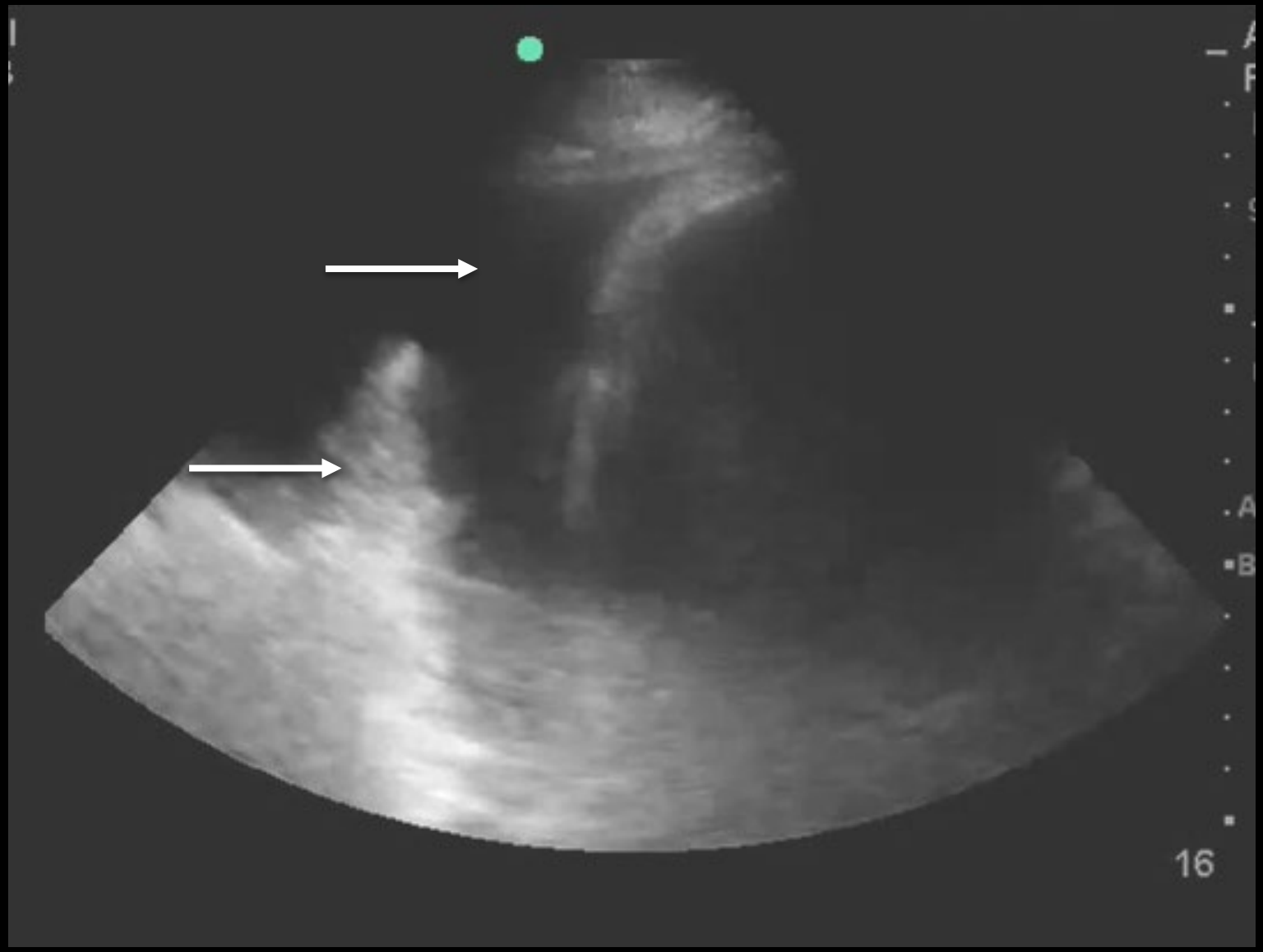


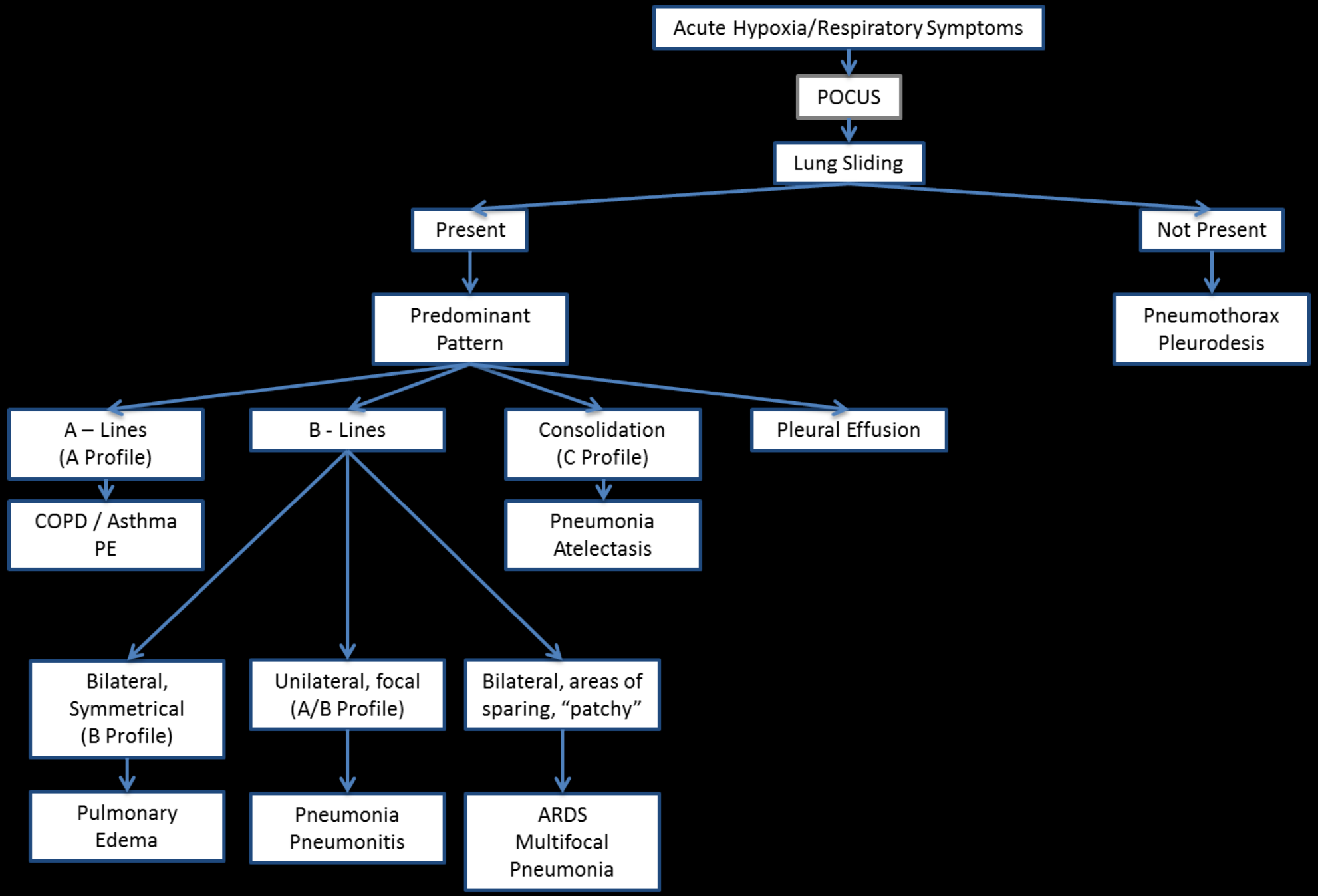


LUNG ULTRASOUND – PLEURAL EFFUSION

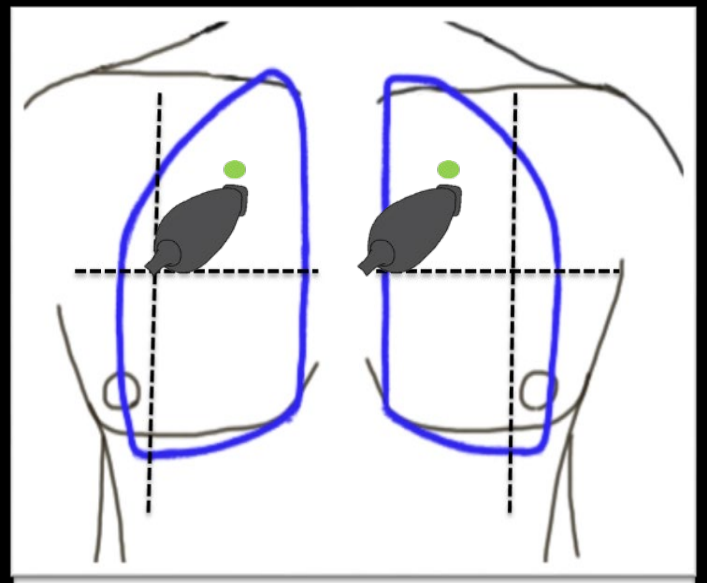


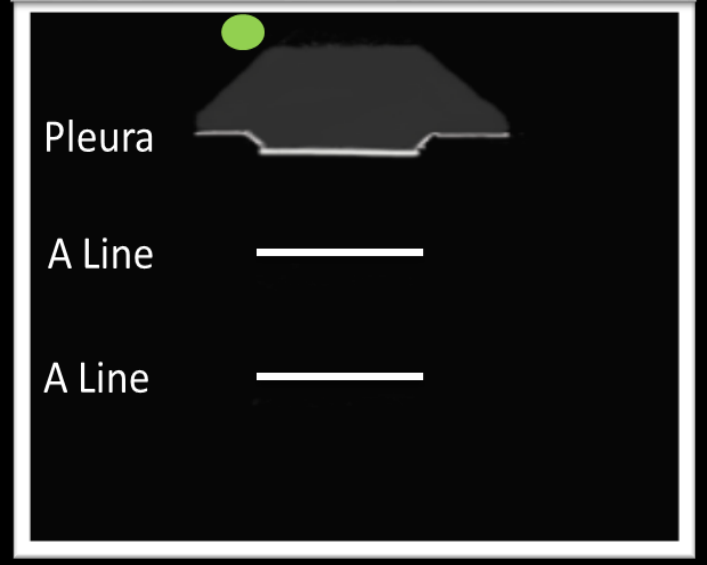






CASE 2





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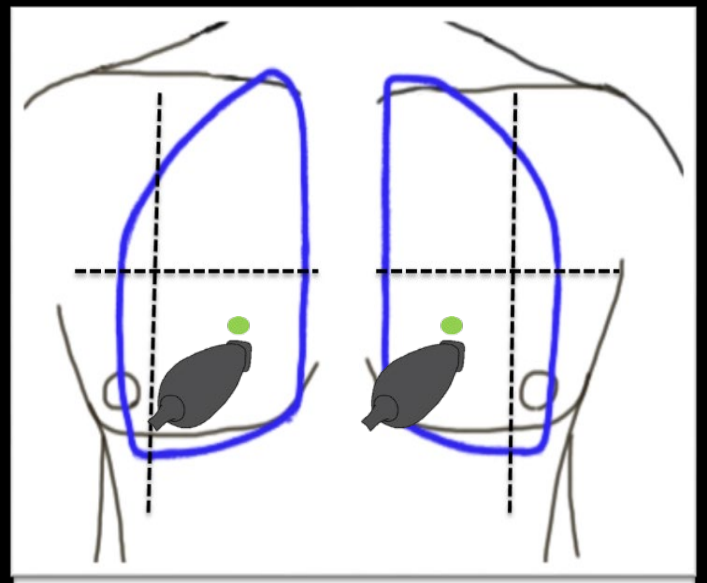

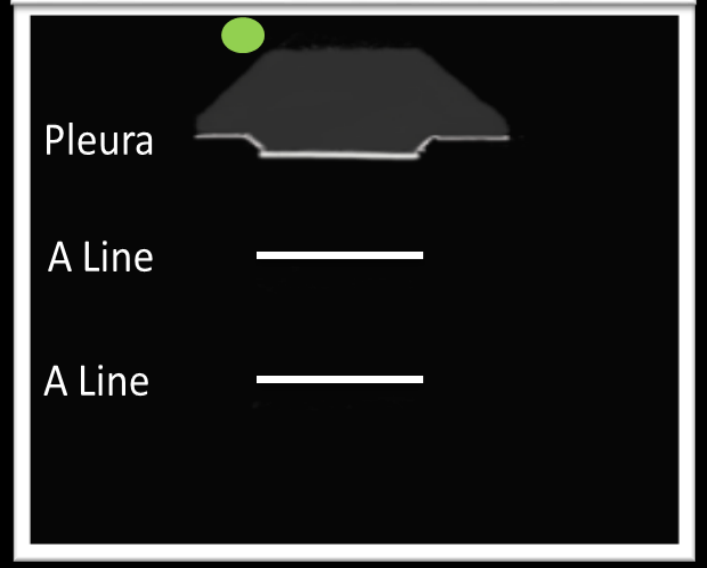

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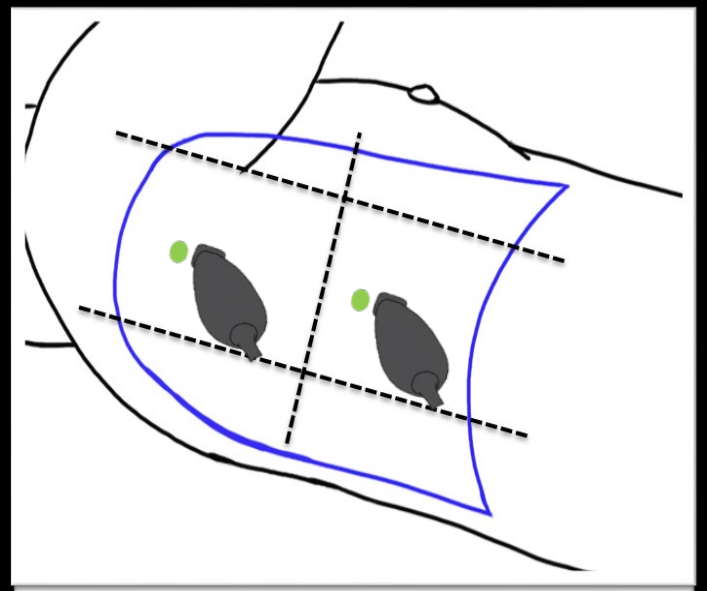

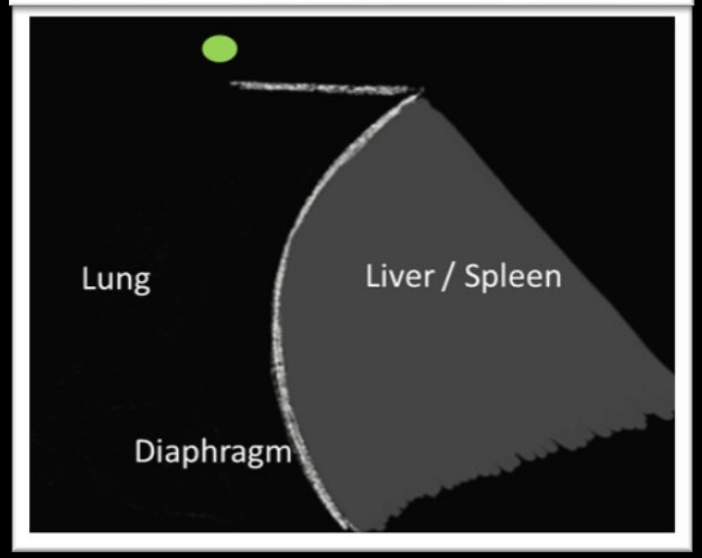

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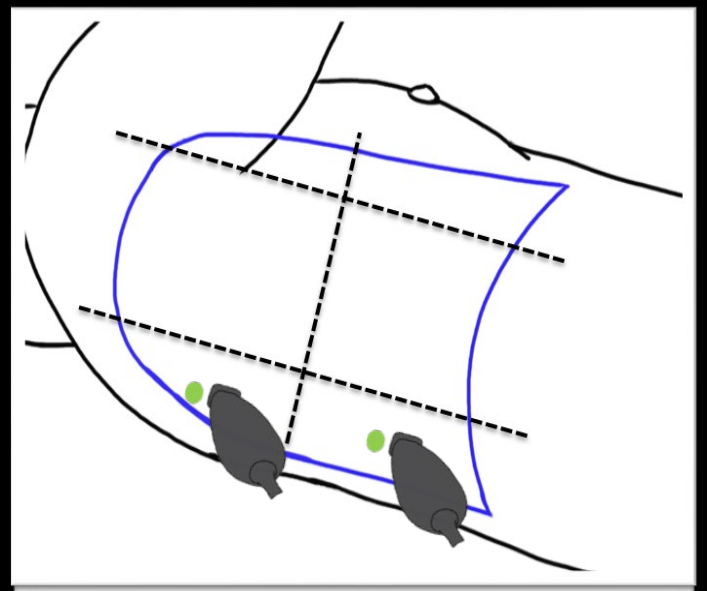

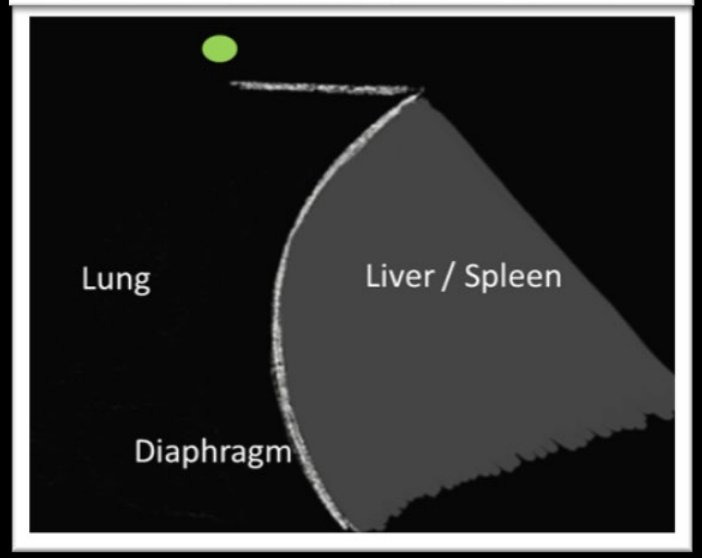

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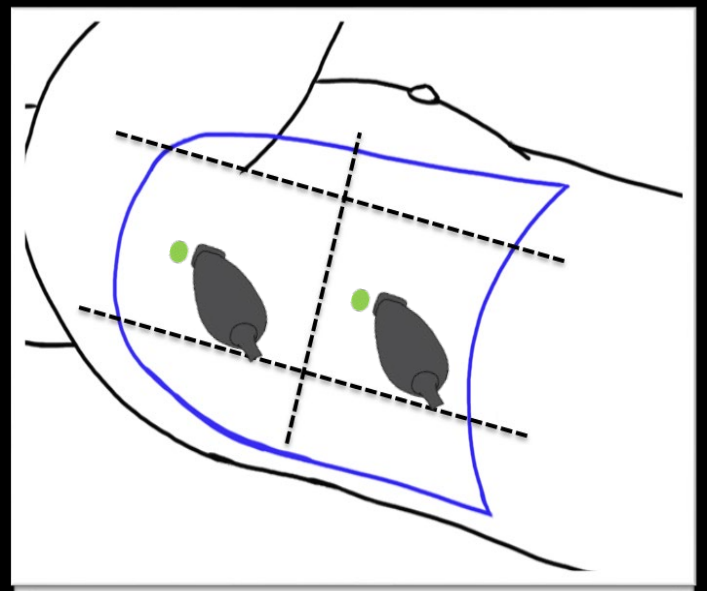

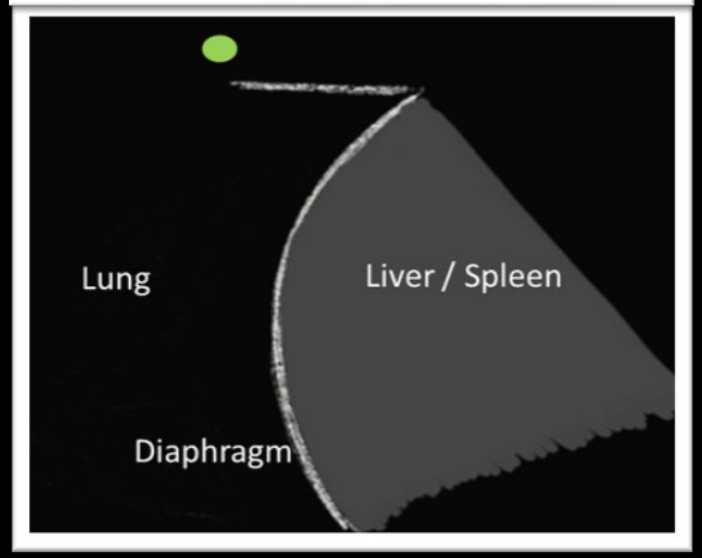

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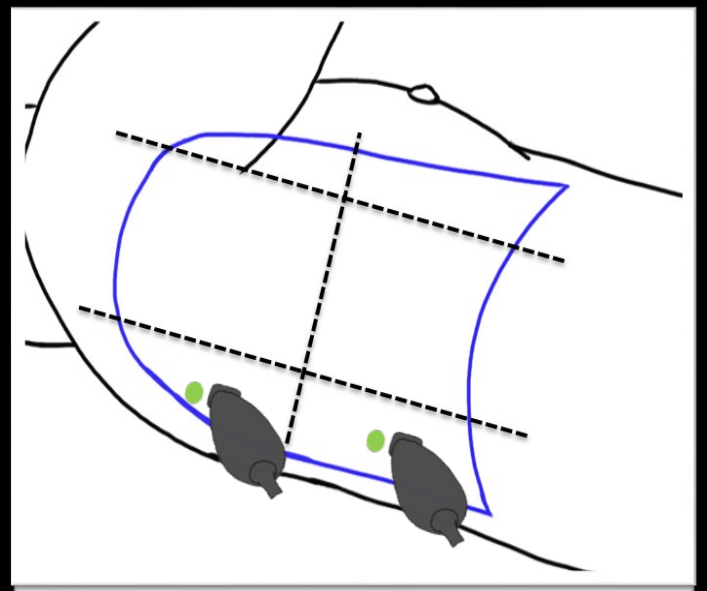
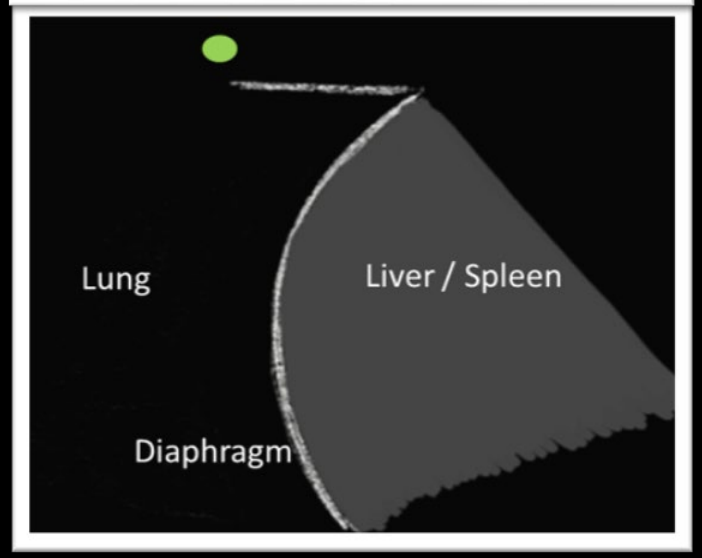
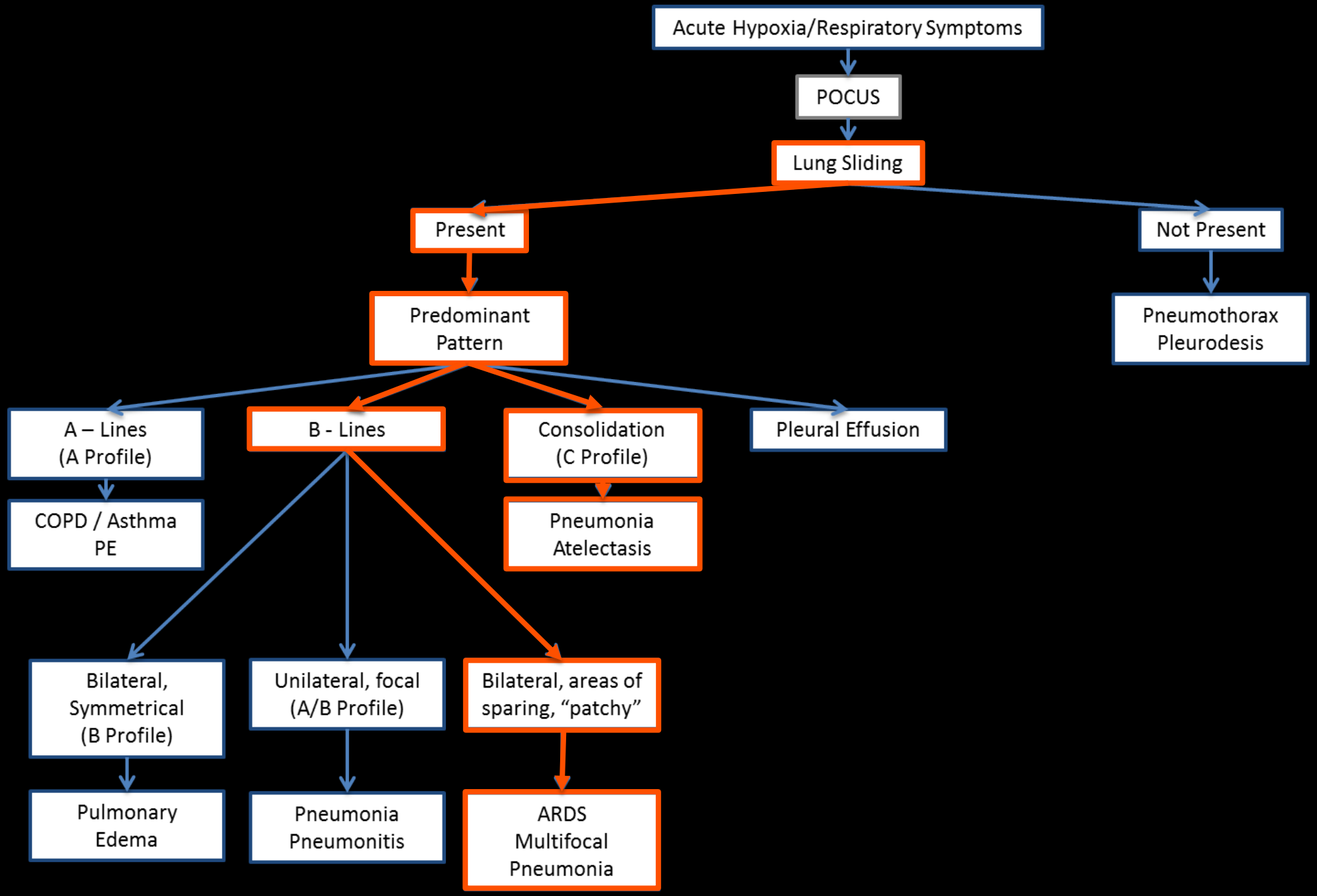






CASE 2 – LITERATURE REVIEW

- Findings
  - Change depending on the severity of the disease. Patchy, multifocal peripheral findings.
  - A Lines → B Lines → Confluent B Lines → Consolidation +/- Pleural Effusion
- Diagnosis
  - CXR sensitivity 51.9%; LUS sensitivity 88.9%.
- Multi-organ point-of-care ultrasound for COVID-19 (PoCUS4COVID): international expert consensus

Hussain, A., Via, G., Melniker, L. *et al.* Multi-organ point-of-care ultrasound for COVID-19 (PoCUS4COVID): international expert consensus. *Crit Care* **24,** 702 (2020). https://doi.org/10.1186/s13054-020-03369-5

Pare JR, Camelo I, Mayo KC, Leo MM, Dugas JN, Nelson KP, Baker WE, Shareef F, Mitchell PM, Schechter-Perkins EM. Point-of-care Lung Ultrasound Is More Sensitive than Chest Radiograph for Evaluation of COVID-19. West J Emerg Med. 2020 Jun 19;21(4):771-778. doi: 10.5811/westjem.2020.5.47743. PMID: 32726240; PMCID: PMC7390587.

CASE 2 – LITERATURE REVIEW

- Prognostication:
  - Li et al.
    - Adverse outcomes – Sensitivity 90.5%, Specificity 91.9%
  - De Alencar et al.
    - ICU Admission – OR 1.14 (95% CI 1.07 – 1.21, p <0.001)
    - Endotracheal Intubation – OR 1.17 (95% CI 1.09 – 1.26, p <0.001)
    - Mortality – OR 1.13 (95% CI 1.07 – 1.21, p <0.001)
  - Lichter et al.
    - Endotracheal Intubation or Mortality – 1.12 (95% CI 1.05 – 1.2, p = 0.008)

- Ji L, Cao C, Gao Y, Zhang W, Xie Y, Duan Y, Kong S, You M, Ma R, Jian L, Liu J, Sun Z, Zhang Z, Wang J, Yang Y, Lv Q, Zhang L, Li Y, Zhang J, Xie M. Prognostice value of beside lung ultrasound score in patients with COVID 19. Crit Care. 2020; 24:700
- de Alencar, J.C.G., Marchini, J.F.M., Marino, L.O. *et al.* Lung ultrasound score predicts outcomes in COVID-19 patients admitted to the emergency department. *Ann. Intensive Care* **11,** 6 (2021). https://doi.org/10.1186/s13613-020-00799-w
- Lichter Y, Topilsky Y, Taieb P, Banai A, Hochstad A, Merdler I, Gal Oz A, Vine J, Goren O, Cohen B, Sapir O, Granot Y, Mann T, Friedman S, Angle Y, Adi N, Laufer-Perl M, Ingbir M, Arbel Y, Matot I, Szekely Y. Lung Ultrasound predicts clinical course an doutcomes in COVID-19 patients. Intensive Care Med. 2020;46:1873-1883

REFLECTION QUESTIONS

- In the setting of severe COVID-19, would you fluid resuscitate this patient?

VOLUME STATUS

Exam Finding	Sensitivity	Specificity	-LR	+LR
Dry Axilla	50%	82%	0.6	2.8
Prolonged Capillary Refill	34%	95%	0.7	6.9
Dry Mucous Membranes	85%	58%	0.3	2.0
Postural Hypotension (non-bleeding)	29%	81%	0.9	1.5
Postural tachycardia (non-bleeding)	43%	75%	0.8	1.7
Postural tachycardia (bleeding)	22% (moderate loss) 97% (large loss)	98% -	0.8	11

- Simel DL, Goldberg K, Raja A. Make the Diagnosis: Hypovolemia, Adult. The Rational Clinical Exam.

FLUID RESPONSIVENESS

Exam Finding	Sensitivity	Specificity	-LR	+LR
CVP	62%	76%	0.5	2.6
Passive Leg Raise (Pulse Pressure)	79 – 86%	80 – 90%	0.45	3.6
Passive Leg Raise (Cardiac Output)	88%	92%	0.13	11

- Simel DL, Goldberg K, Raja A. Make the Diagnosis: Hypovolemia, Adult. The Rational Clinical Exam.

LITERATURE REVIEW – CASE 2

- POCUS-Guided Fluid Resuscitation
  - DO NOT IGNORE THE GUIDELINES.
  - POCUS may be beneficial to help guide IVF.
  - IVF Resuscitation is not a benign treatment.

LITERATURE REVIEW – CASE 2

DOES RESPIRATORY VARIATION IN INFERIOR VENA CAVA DIAMETER PREDICT FLUID RESPONSIVENESS: A SYSTEMATIC REVIEW AND META-ANALYSIS

- “A small IVC is moderately predictive of fluid responsiveness, however, a dilated IVC cannot rule out fluid responsiveness.”

Long E, Oakly E, Duke T, Babl FE. Does Respiratory Variation in Inferior Vena Cava Diameter Predict Fluid Responsiveness: A Systematic Review and Meta-Analysis. SHOCK 2017; 47(5):550–559.

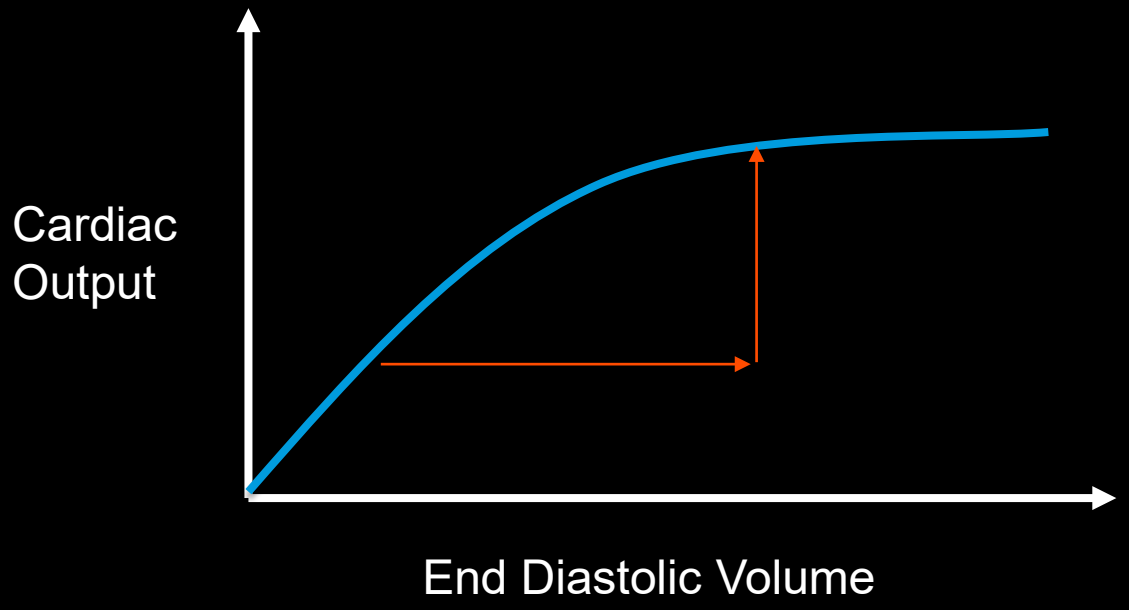
LITERATURE REVIEW – CASE 2

- Accuracy of Ultrasonographic Measurements of Inferior Vena Cava to Determine Fluid Responsiveness: A Systematic Review and Meta-Analysis (2020)
  - Pooled sensitivity 71%, specificity 75%.
  - “Ultrasound evaluation of the diameter of the IVC and its respiratory variations does not seem to be a reliable method to predict fluid responsiveness.”

Orso D, Paoli I, Piani T, Cilenti FL, Cristiani L, Guglielmo N. Accuracy of Ultrasonographic Measurements of Inferior Vena Cava to Determine Fluid Responsiveness: A Systematic Review and Meta-Analysis. Journal of Intensive Care Medicine. 2020; 35(4)354-363.

LITERATURE REVIEW – CASE 2

- Fluid Tolerance – The ability to receive IV fluids without developing adverse affects; such as, pulmonary edema/hypoxia.
- Clinical Question -> Can POCUS help determine who will likely tolerate additional fluid administration?
  - Integrated POCUS exam of heart, IVC and lungs.
  - Based upon expert opinion; not supported by current evidence.



- Theerawit P, Tomuan N, Sutherasan Y, Kiatboonsri S. Critical Care 2012,16(Suppl 1): P248. doi: 10.1186/cc10855.
- Lictenstein D, Karakitsos D. Integrating lung ultrasound in the hemodynamic evaluation of acute circulatory failure (the fluid administration limited by lung sonography protocol). Journal of Critical Care (2012)27, 533.e11–533.e19.

FOCUS

- Scope:
  - LV size / systolic function
  - RV size / systolic function
  - IVC size and respiratory variation
  - Pericardial effusions / Cardiac Tamponade

Hyperdynamic
Normal
Reduced / Severely Reduced
(not Quantitative)

- Indications:
  - Hypotension
  - Respiratory Failure
  - Intravascular volume assessment

IVC ≈ RAP / CVP

IVC Findings	CVP
IVC < 2.1 cm, with > 50% collapse	3 (range 0 – 5)
IVC < 2.1 cm, with < 50% collapse IVC > 2.1 cm, with > 50% collapse	8 (range 5 – 10)
IVC > 2.1 cm, with < 50% collapse	15 (range 10 – 20)

FOCUSED CARDIAC ULTRASOUND (FOCUS)

- Cardinal Views
  - Parasternal Long Axis (PLAX)
  - Parasternal Short Axis (PSAX)
  - Apical 4 Chamber (A4C)
  - Subcostal 4 Chamber (S4C)
  - Inferior Vena Cava (IVC)

FOCUSED CARDIAC ULTRASOUND (FOCUS)

- Cardinal Views
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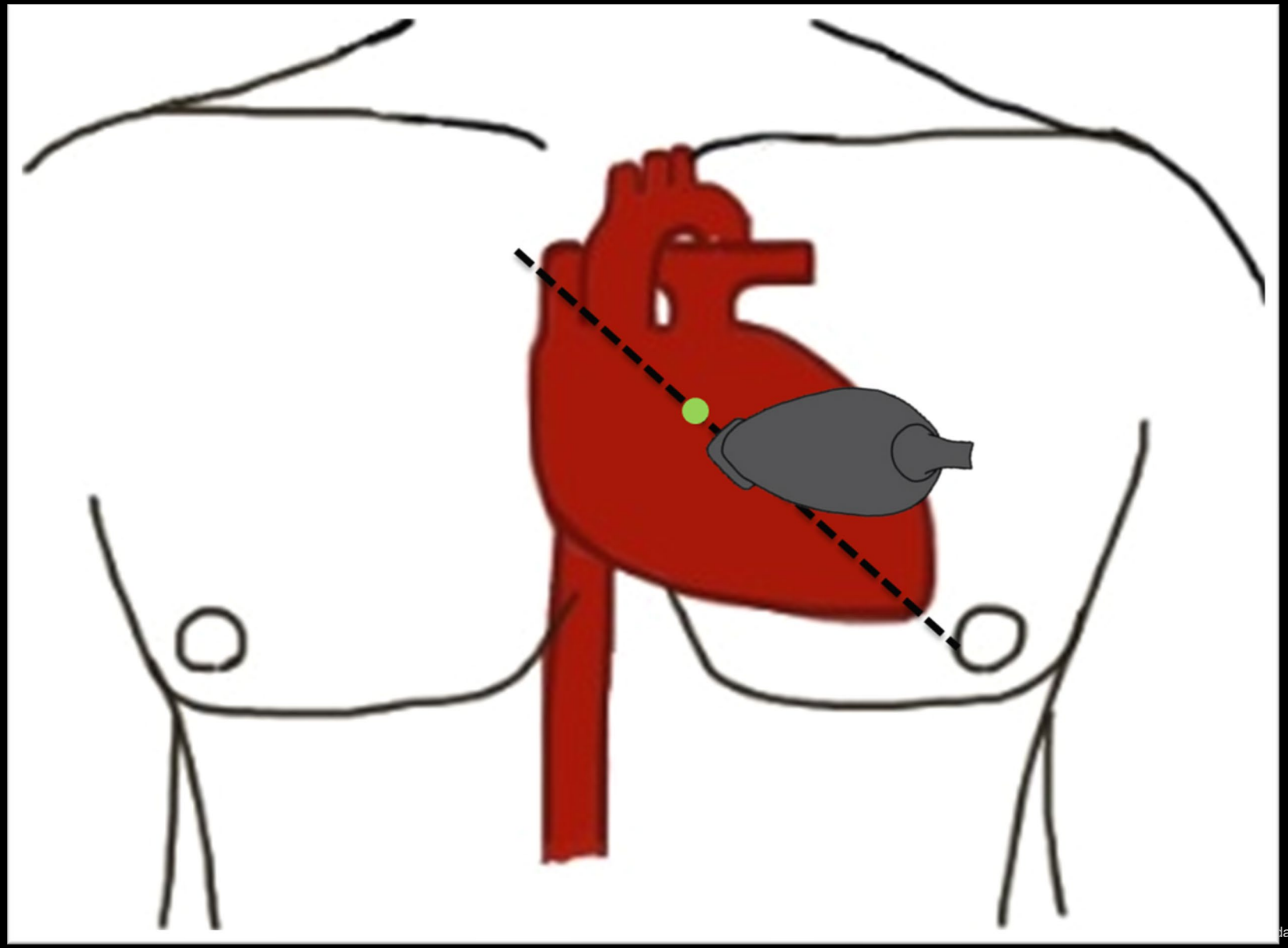
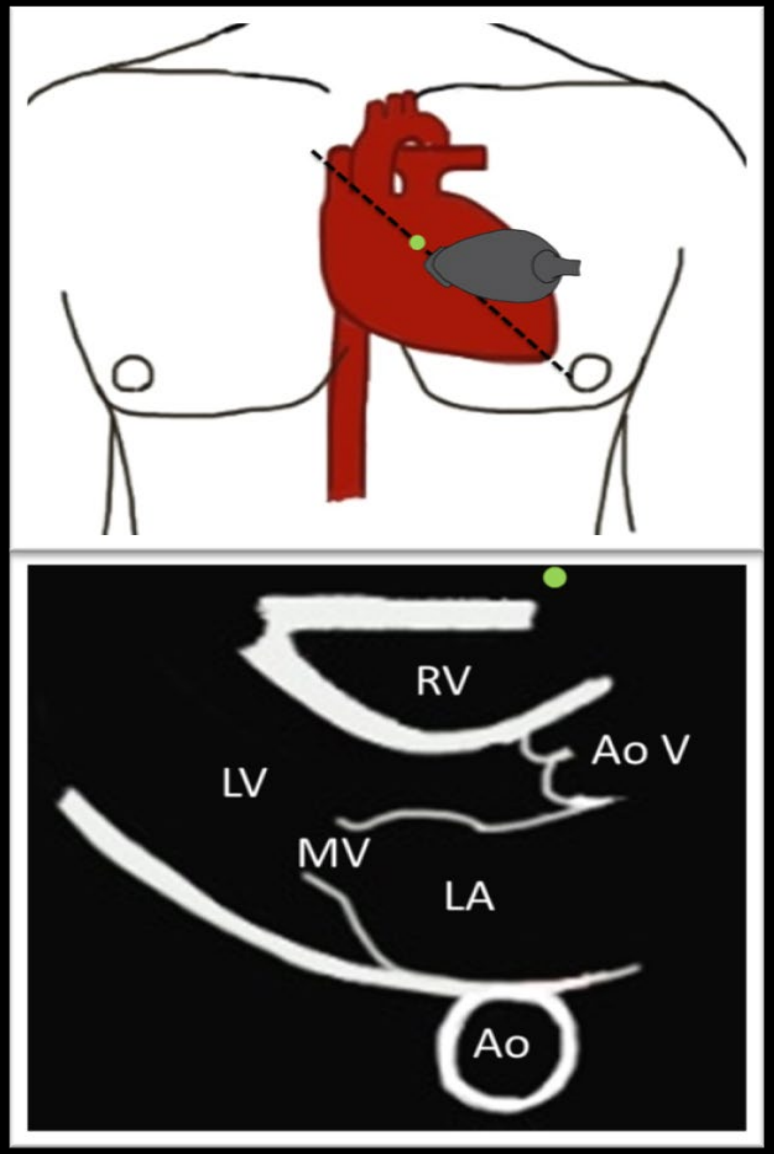
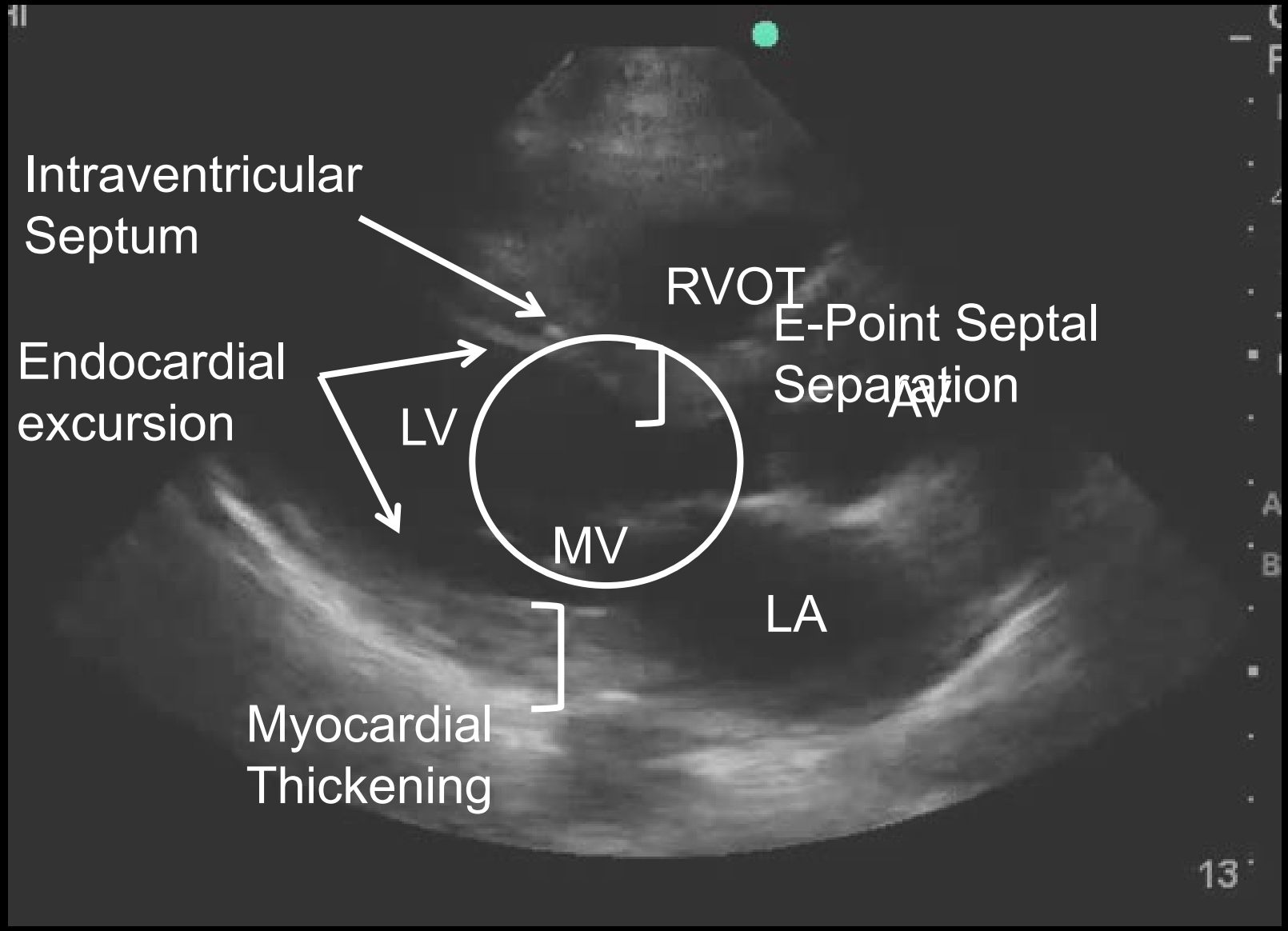
PARASTERNAL LONG AXIS (PLAX)

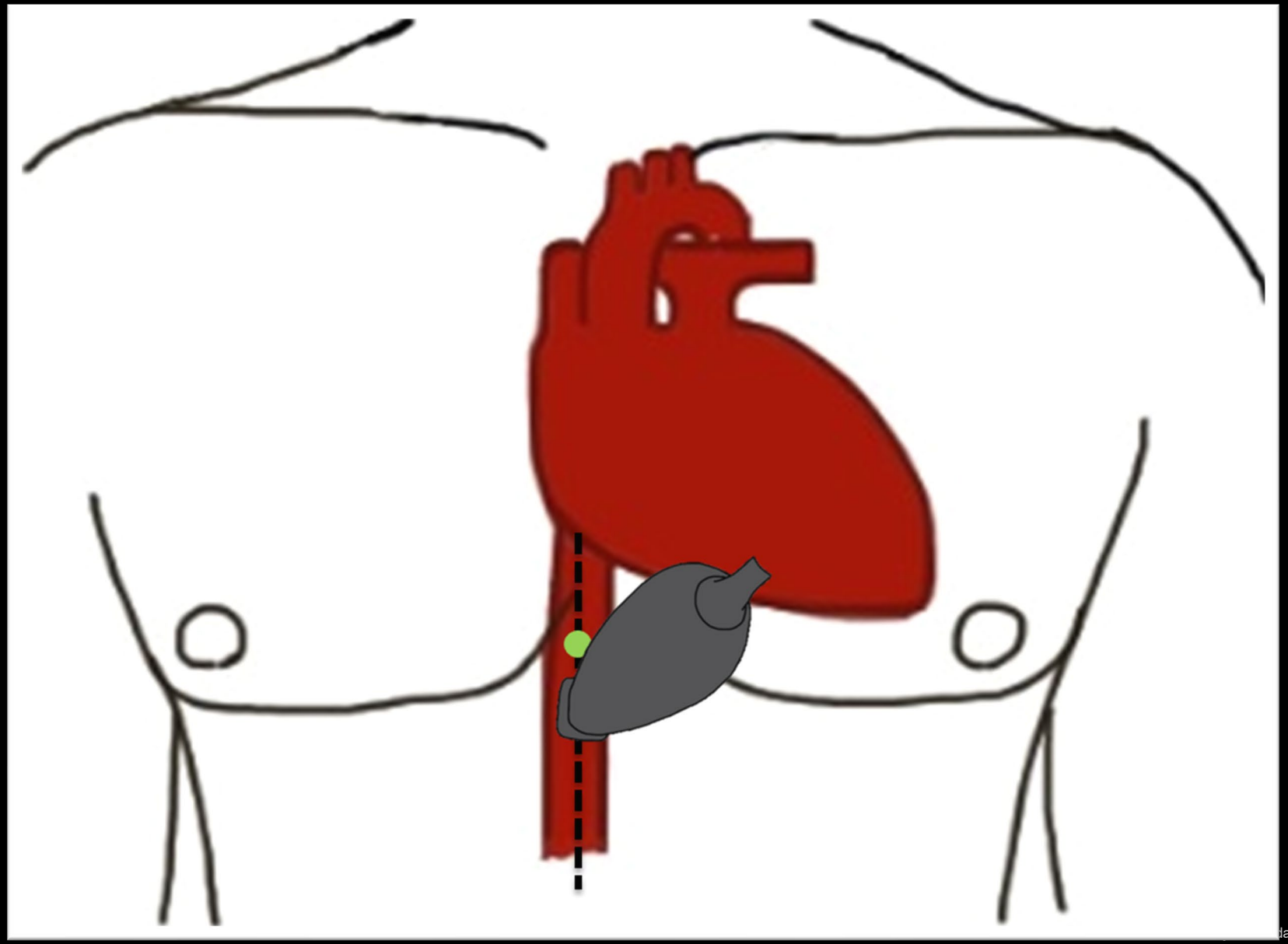


PARASTERNAL LONG AXIS (PLAX)

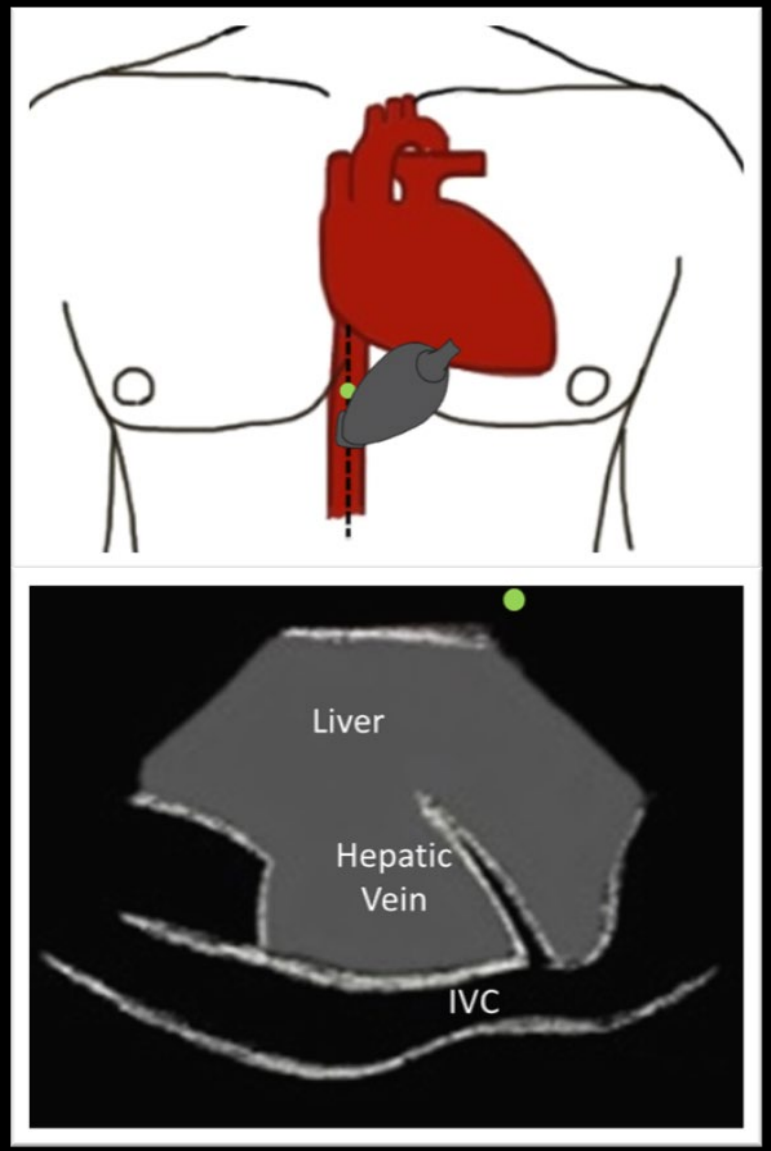


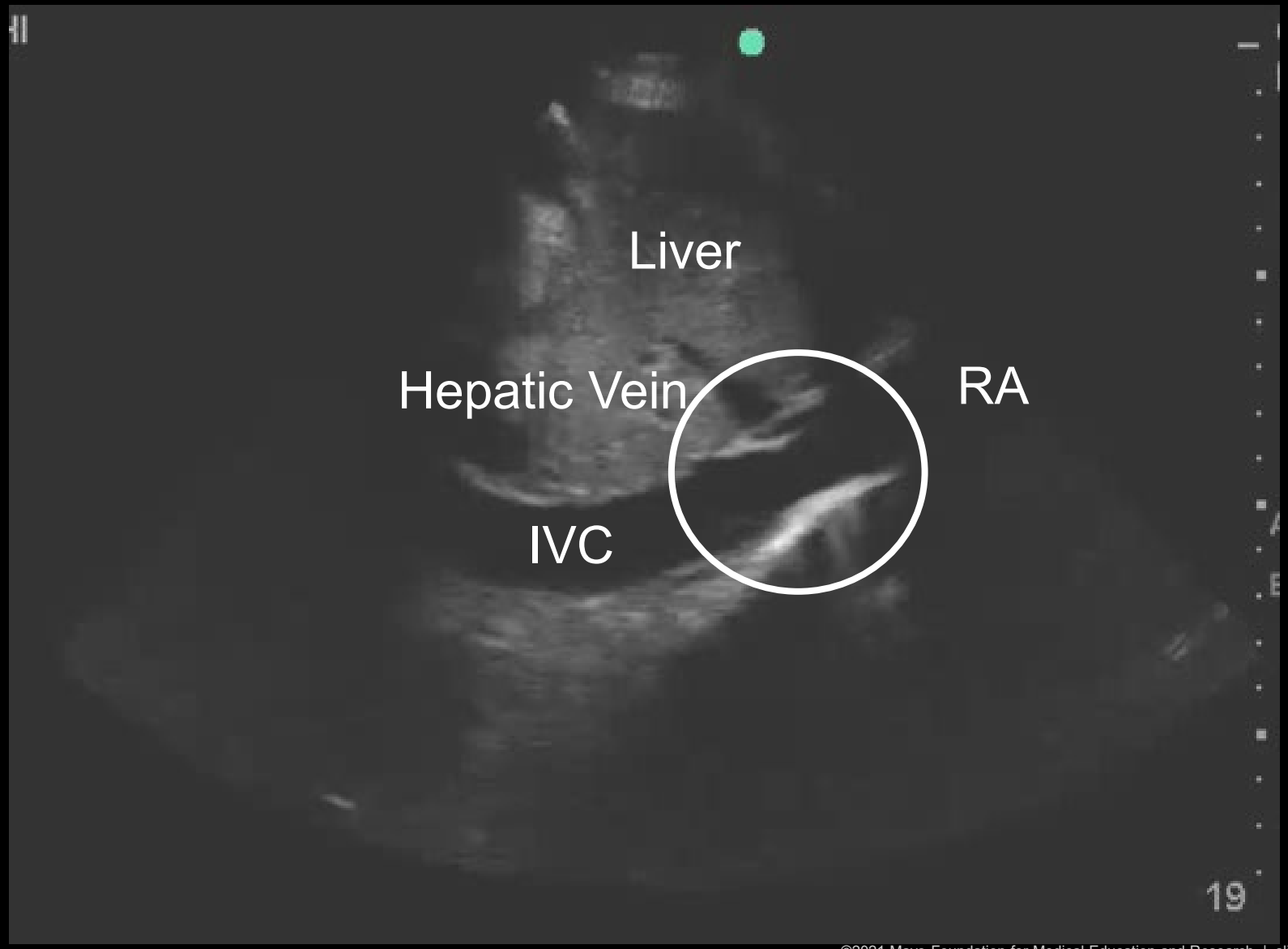


INFERIOR VENA CAVA (IVC)

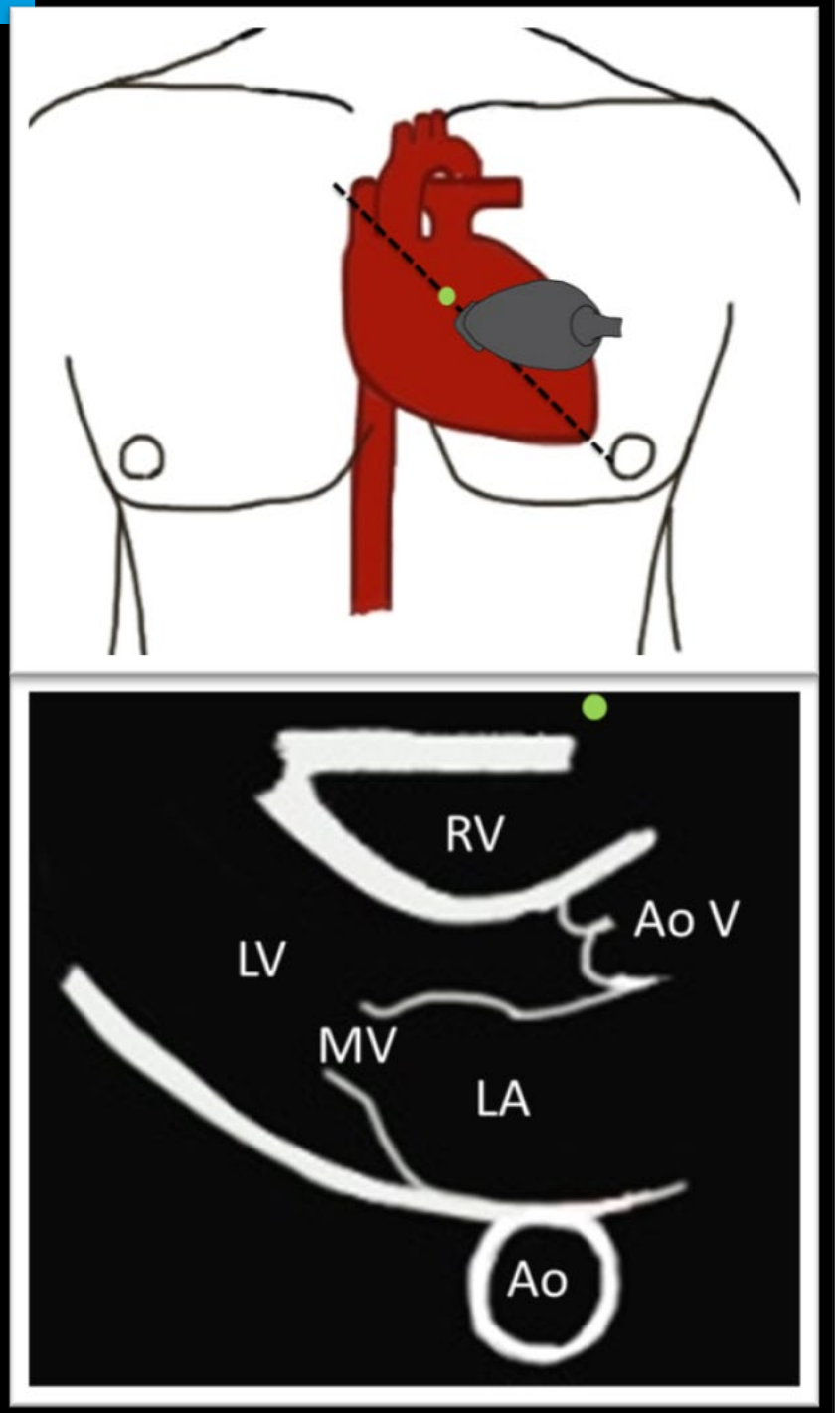


INFERIOR VENA CAVA (IVC)

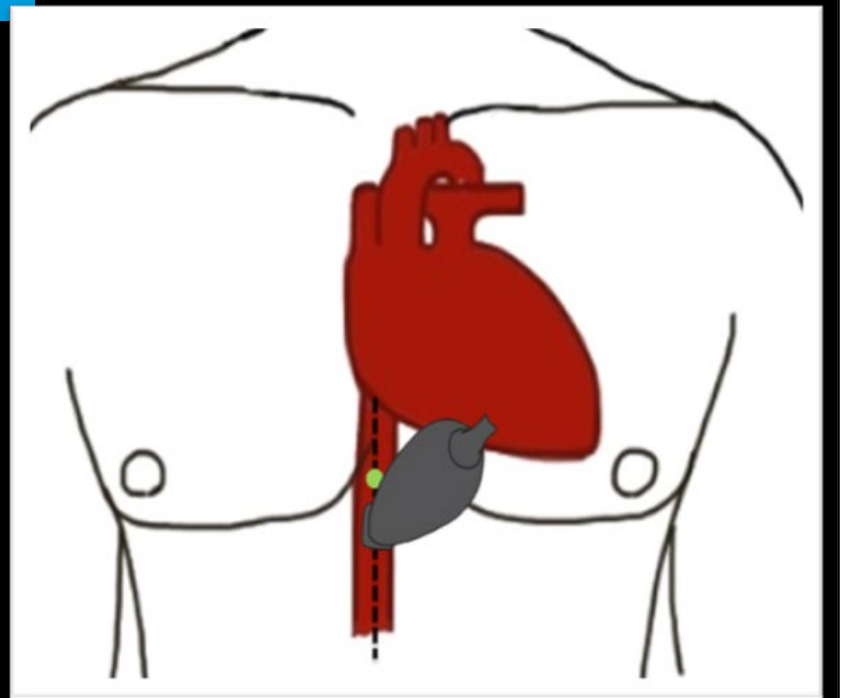


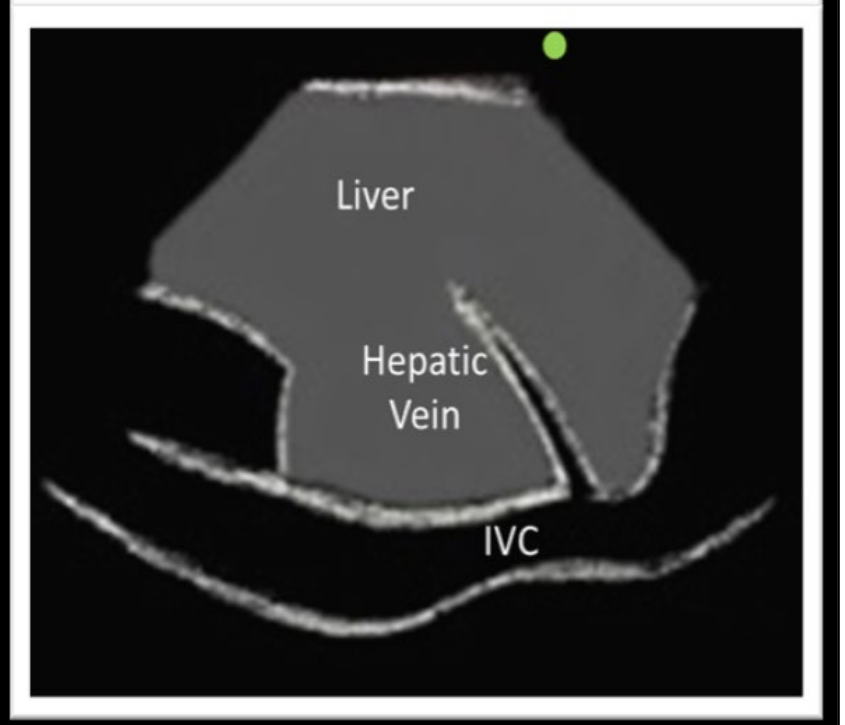


PARASTERNAL LONG AXIS (PLAX) – CASE 2



INFERIOR VENA CAVA (IVC) – CASE 2





CASE 2

Evaluation

- Sars-Cov-2 PCR +
- Lymphopenic; inflammatory markers elevated
- Chest X-ray largely unremarkable.

Treatment

- Required Supplemental O2
- Prednisone
- Remdesivir
- IVF

CASE 3

HPI

- A 62 year-old female was admitted to your service overnight from the ED for complaints of fevers and rigors over the last 2 days.
- She endorses:
  - Dysuria
  - Urinary frequency
  - Urinary urgency

HISTORY

- Past Medical / Surgical History:
  - Pseudomonas aeruginosa UTI (~3 months prior).
  - Hypertension
  - Left ventricular diastolic heart failure
- Social History:
  - No alcohol, tobacco or illicit drug use. Lives independently.
- Family History:
  - Noncontributory.

OBJECTIVE DATA

- Labs:
  - Hgb 15.2 g/dL.
  - WBC **16.7** x 109 /L
  - Creatinine **2.6** mg/dL
  - Lactate **3.1** mmol/L
- Urinalysis
  - Many gram negative bacilli on Gram stain.
  - WBC > 100 / hpf.

CLINICAL COURSE

- Emergency Department Course:
  - Diagnosis: Sepsis due to UTI
  - IVF: LR 30 ml/kg.
  - Antibiotics: Cefepime.
- Hospital Admission:
  - Continued on cefepime.
  - Placed on maintenance fluids.

CLINICAL COURSE

- PM Vital Signs:
  - HR **112**, BP **98/55**, RR **24**, SpO2 **88**% on room air, Tmax **39.0**.
- AM Labs:
  - WBC **15.9** x 10^9 /L
  - Creatinine **2.2** mg/dL
  - Lactate **2.4** mmol/L
- I/O's:
  - Net fluid +2.5 L
- Physical Exam:
  - No acute distress. CAM negative for delirium. Flushed and diaphoretic, warm to the touch.
  - Tachycardic, with a regular rhythm. Lungs clear to auscultation.
  - Abdominal exam normal, no CVA tenderness

POCUS IN SEPSIS

- Accuracy of point of care ultrasound to identify the source of infection in septic patients: a prospective study

Standard of Care (History / Physical / Basic labs)

vs

Standard of Care + Targeted POCUS (Kidneys, soft tissues, lungs, gallbladder, etc.)

POCUS IN SEPSIS

- Accuracy of point of care ultrasound to identify the source of infection in septic patients: a prospective study

	Standard of Care	Standard of Care + POCUS
Sensitivity	48%	73%
Specificity	86%	95%
LR+	3.54	16.1
LR-	0.59	0.28
Diagnostic Accuracy	53%	75%

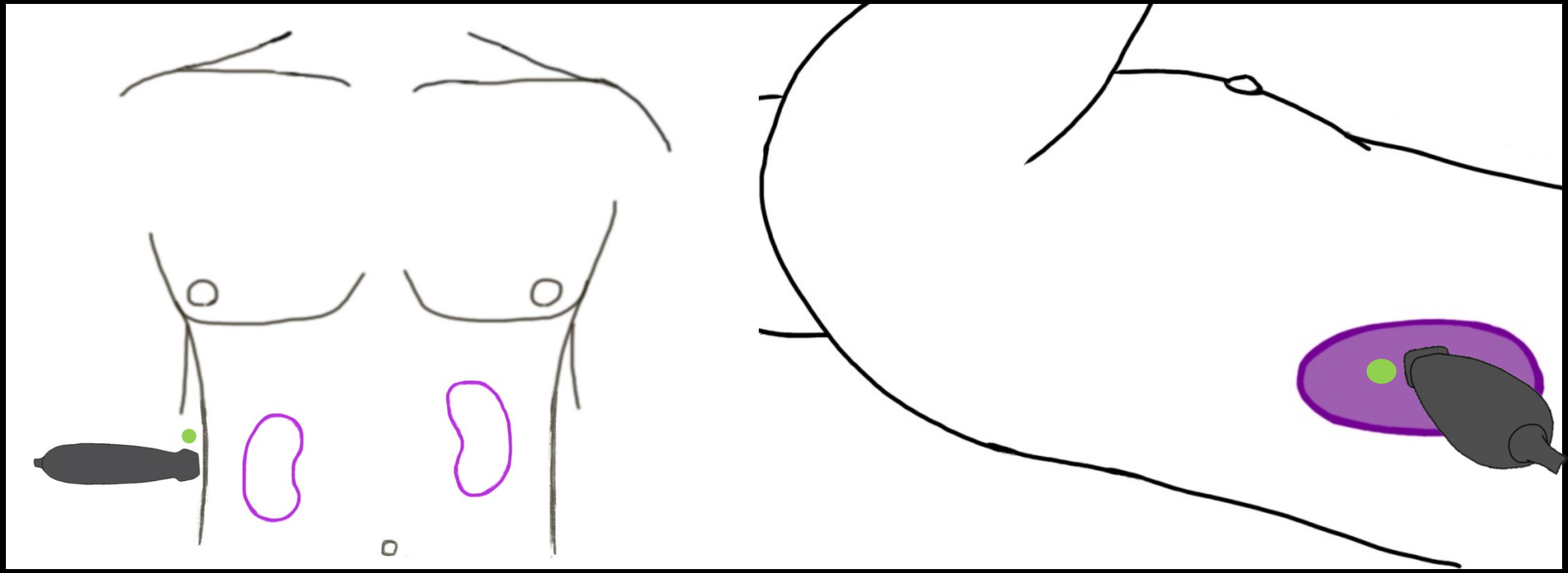
POCUS IN SEPSIS

- Accuracy of point of care ultrasound to identify the source of infection in septic patients: a prospective study
  - Antibiotic Regimen altered in 24% of cases
  - Diagnosis made substantially quicker

FOCUSED RENAL ULTRASOUND

- Scope:
  - Nephrolithiasis
  - Hydronephrosis
- Indications:
  - AKI
  - UTI with Sepsis
  - Renal colic

FOCUSED RENAL ULTRASOUND



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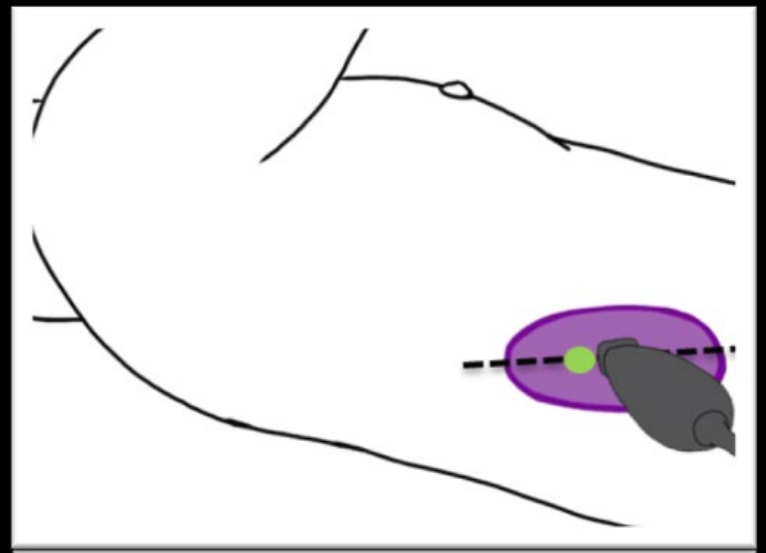
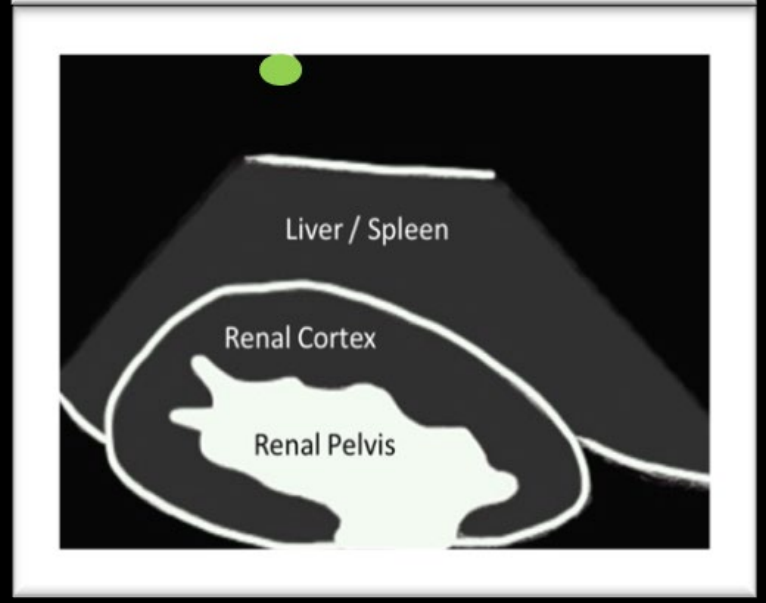
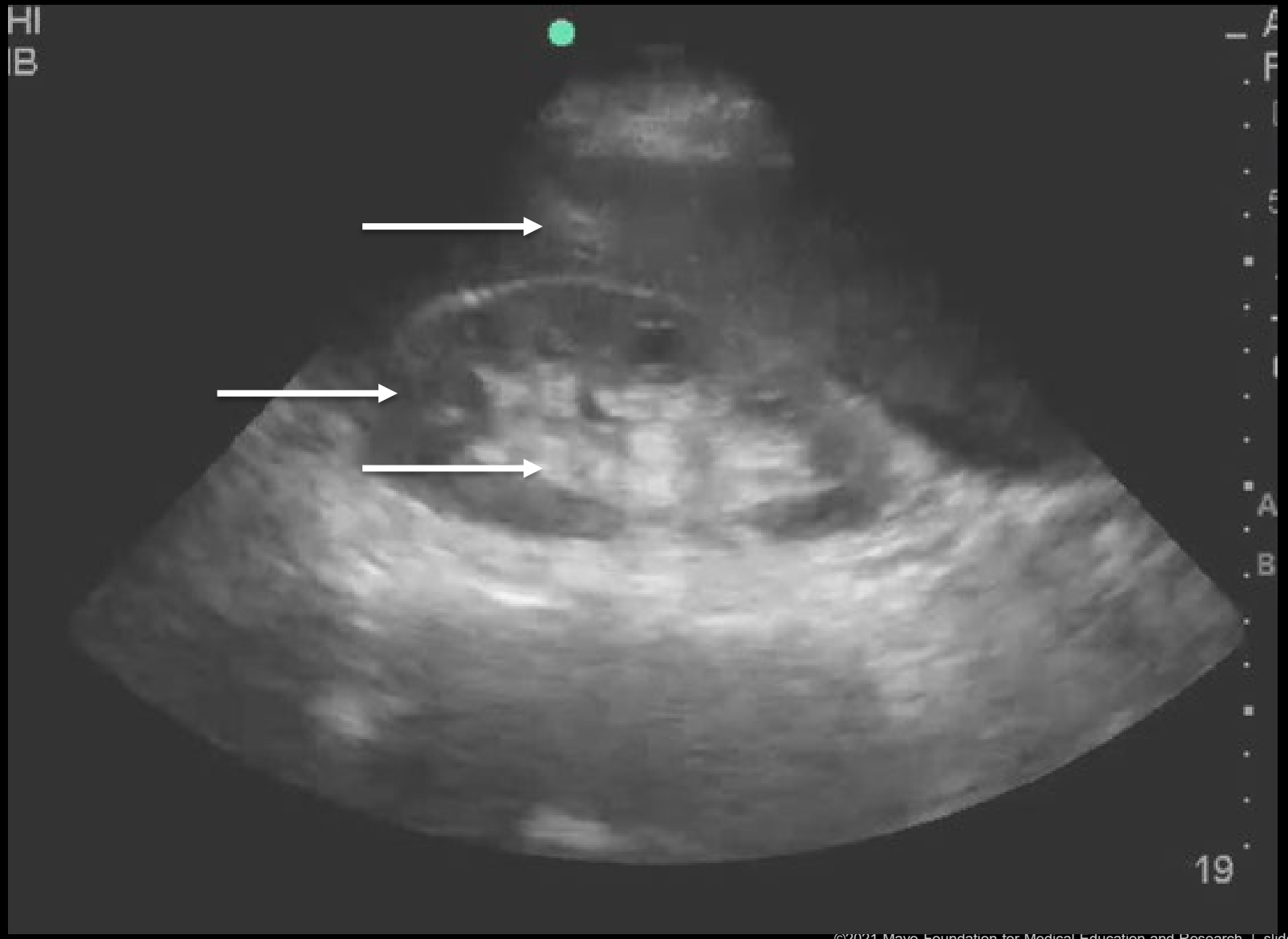
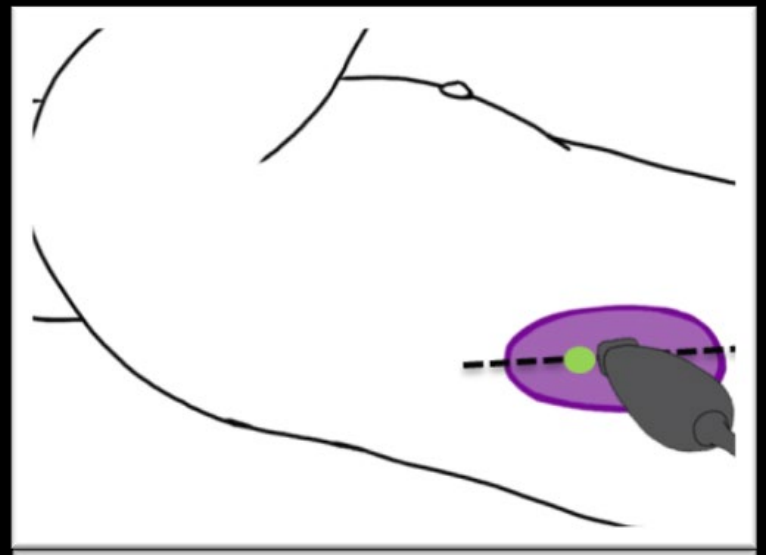
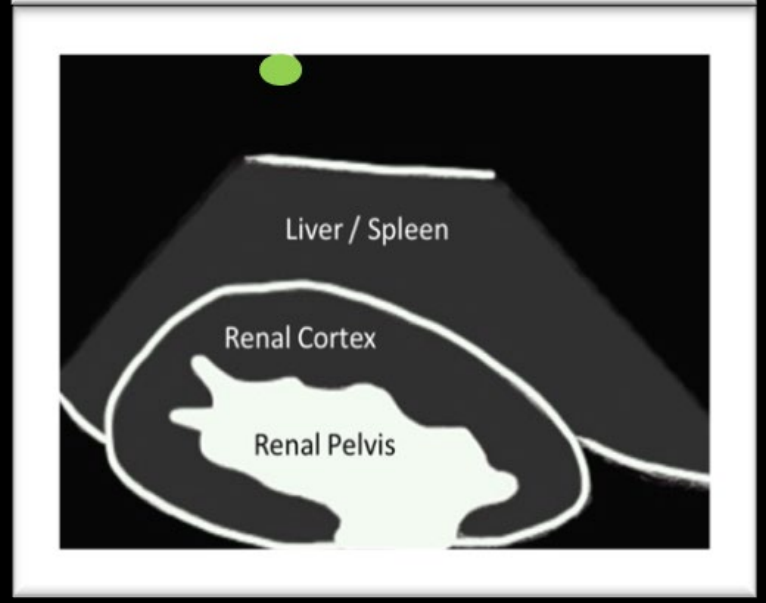


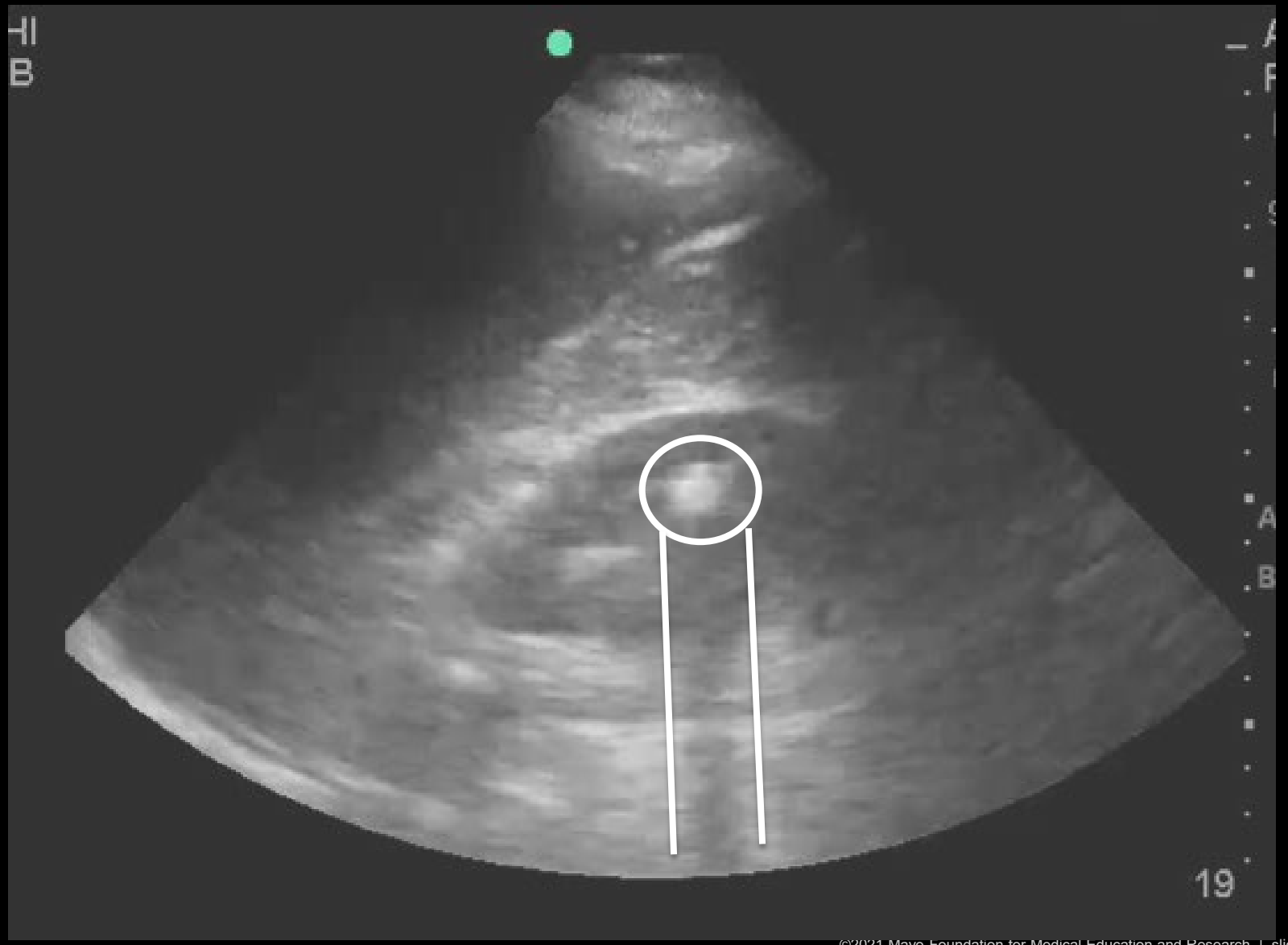




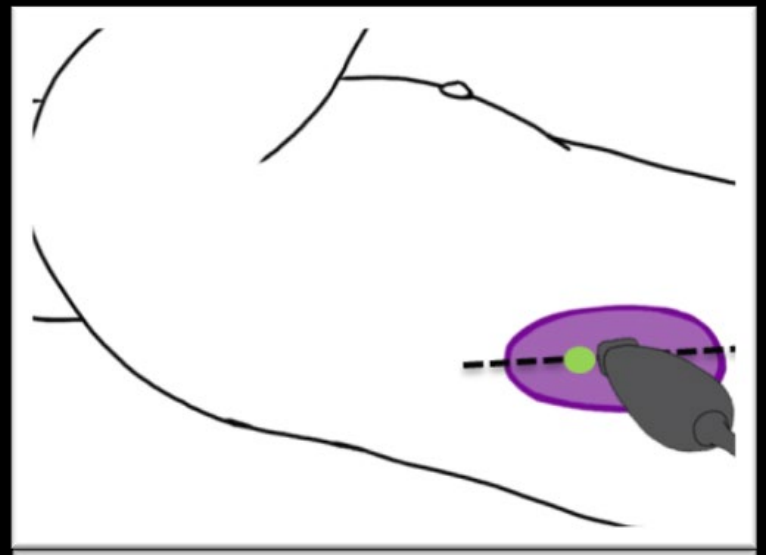
FOCUSED RENAL ULTRASOUND

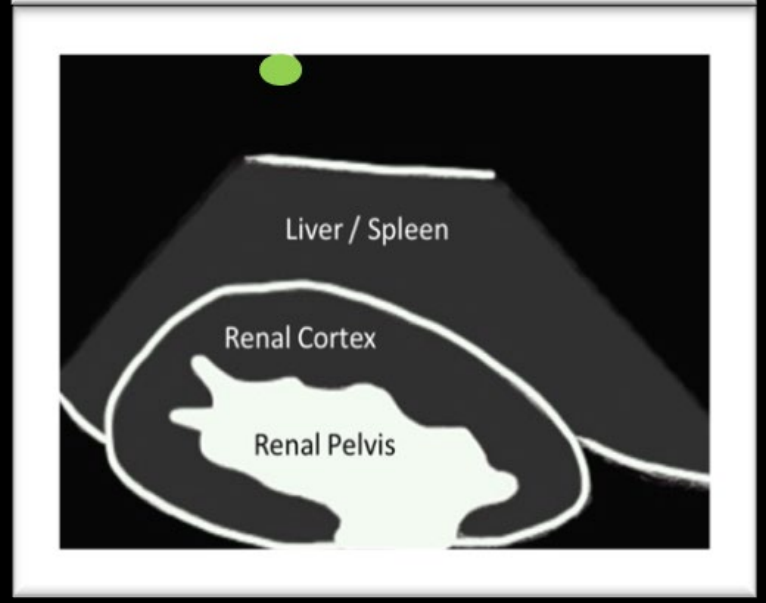




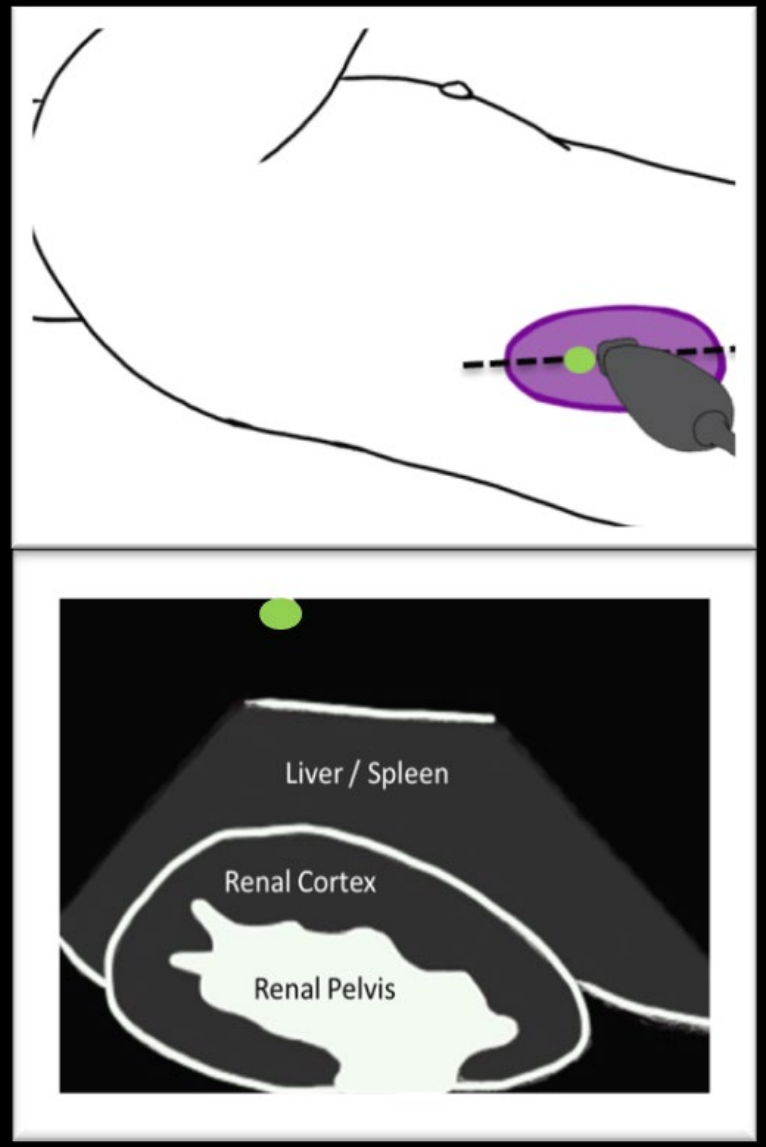


FOCUSED RENAL ULTRASOUND





CASE 3



CASE 3

- Focused Renal Ultrasound demonstrates unilateral hydronephrosis, concerning for distal obstruction.
  - CT abdomen/pelvis confirms obstructive stone.
  - Emergent urostomy tube placed.

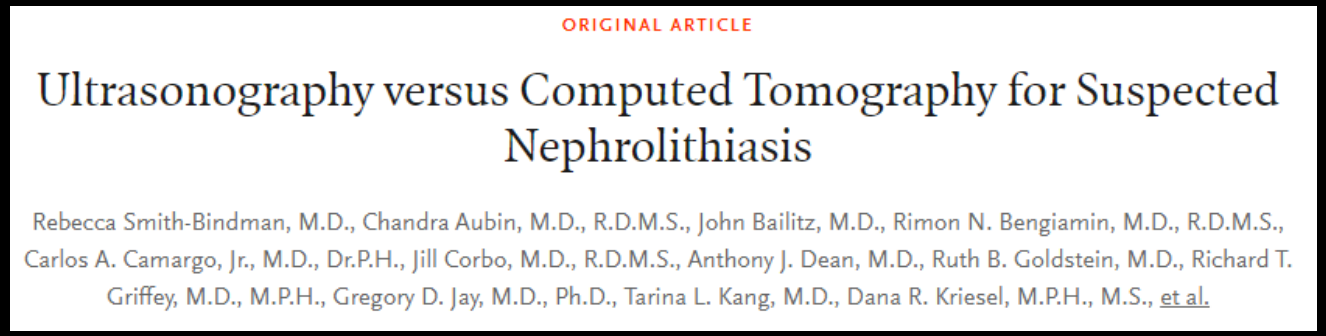
LITERATURE REVIEW – CASE 3

	Sensitivity	Specificity
Nephrolithiasis	19 – 62%	90 – 98%
Hydronephrosis	72 – 97%**	73 – 93%

**Sensitivity improved with IV fluid resuscitation.

- Yilmaz S, Sindel T, Arslan G, Ozkaynak C, Karaali K, et al. Renal colic: Comparison of spiral CT, US, and IVU in detection of ureteral calculi. Eur Radiol. 1998;8:212-217.
- Sheafor DH, Hertzber BS, Freed KS, Carroll BA, Keogan MT, Paulson EK, DeLong DM, Nelson RC. Nonenhanced Helical CT and US in the Emergency Evaluation of Patients with Renal Colic: Prospective Comparison. Radiology. 2000;217:792–797.
- Fowler KA, Locken JA, Duchesne JH, Williamson MR. US for Detecting Renal Calculi with Nonenhanced CT as a Reference Standard. Radiology. 2002; 222:109–113.
- Kanno T, Kubota M, Sakamoto H, Nishiyama R, Okada T, Higashi Y, Yamada H. Determining the Efficacy of Ultrasonography for the Detection of Ureteral Stone. Urology. 2014;84:533-537.

LITERATURE REVIEW – CASE 3



ORIGINAL ARTICLE

Ultrasonography versus Computed Tomography for Suspected Nephrolithiasis

Rebecca Smith-Bindman, M.D., Chandra Aubin, M.D., R.D.M.S., John Bailitz, M.D., Rimon N. Bengiamin, M.D., R.D.M.S., Carlos A. Camargo, Jr., M.D., Dr.P.H., Jill Corbo, M.D., R.D.M.S., Anthony J. Dean, M.D., Ruth B. Goldstein, M.D., Richard T. Griffey, M.D., M.P.H., Gregory D. Jay, M.D., Ph.D., Tarina L. Kang, M.D., Dana R. Kriesel, M.P.H., M.S., et al.

- POCUS vs Radiology Ultrasound vs CT for initial evaluation.
- No statistical difference in:
  - Serious adverse events
  - Average pain score (at day 7)
  - Return ED visits or Hospitalizations
  - Overall diagnostic accuracy.

Smith-Bindman R, Aubin C, Bailitz J, et al. Ultrasonographyversus computed tomography for suspected nephrolithiasis. NEngl J Med. 2014;371(12):1100-1110.

QUESTIONS?