CARDIAC ARREST ULTRASOUND

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Northern Westchester Hospital
Northwell Health®

no financial disclosures
no conflicts of interest

notes @ phillipandrus.com/arrest

350,000 OOHCA

Anderson JAMA 2019

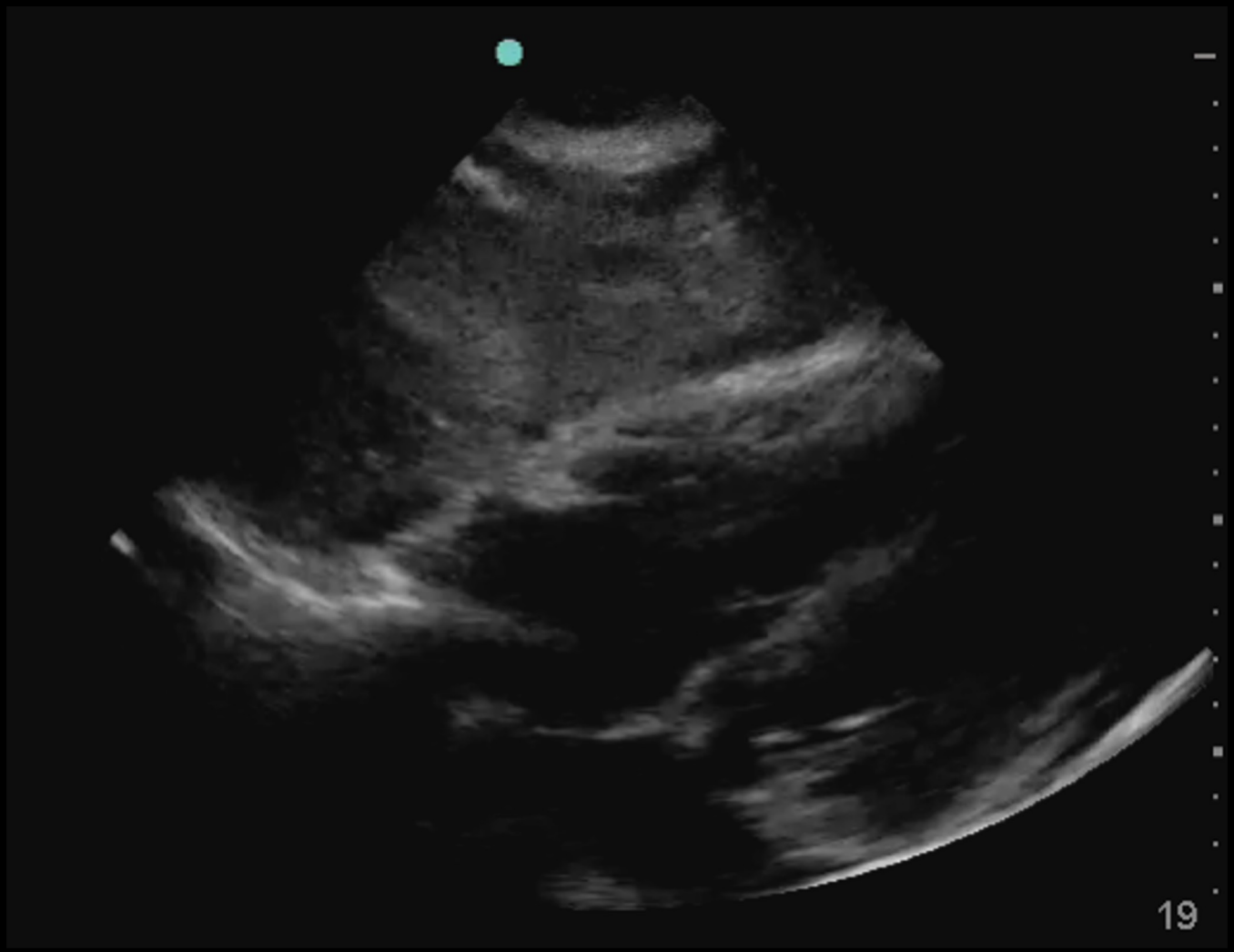
290,000 IHCA

Anderson JAMA 2019

prognostic
diagnostic
algorithms

prognostic
diagnostic
algorithms

STANDSTILL



Outcome in Cardiac Arrest Patients Found to Have Cardiac Standstill on the Bedside Emergency Department Echocardiogram

MICHAEL BLAIVAS, MD, JOHN CHRISTIAN FOX, MD

	Electrocardiographic Asystole & Sandstill	PEA & Standstill	PEA & Contractions	VF & Standstill	VF & Contractions
Survived	0	0	12 (67%)	0	8 (53%)
Died	65 (100%)	20 (100%)	6 (33%)	51 (100%)	7 (47%)

*Standstill = sonographic asystole; PEA = pulseless electrical activity; contractions = mechanical contractions on echocardiogram; VF = ventricular fibrillation.

- **169 patients**
- **No survivors of cardiac standstill**

Blaivas AEM 2001

Emergency echocardiography to detect pericardial effusion in patients in PEA and near-PEA states☆

Vivek S. Tayal*, Jeffrey A. Kline

- **20 patients - no standstill survivors**

Does the presence or absence of sonographically identified cardiac activity predict resuscitation outcomes of cardiac arrest patients?

Philip Salen MD[a,*], Larry Melniker MD, MS[b], Carolyn Chooljian MD[c], John S. Rose MD[d], Janet Alteveer MD[e], James Reed PhD[a], Michael Heller MD[a]

- **70 patients - no standstill survivors**

Tayal Resuscitation 2003 • Salen AJEM 2005

Bedside Focused Echocardiography as Predictor of Survival in Cardiac Arrest Patients: A Systematic Review

	ROSC (Positive Outcome)	No ROSC (Negative Outcome)
Cardiac contractility seen on echo (positive test)	98	92
No cardiac contractility seen on echo (negative test)	9	369

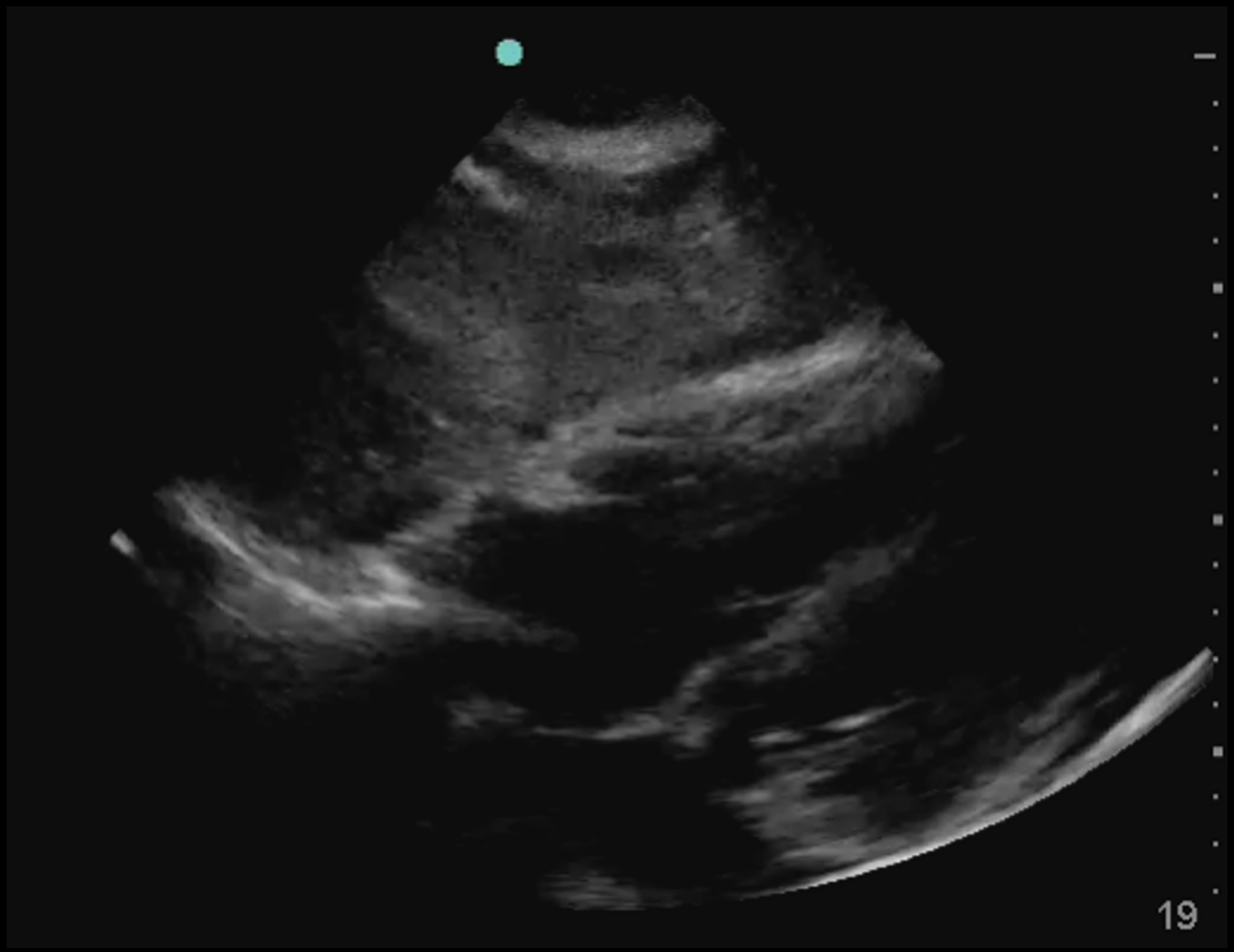
Blyth AEM 2012

Study	Definition of Cardiac Activity
Bocka JJ, 1988[11]	"Synchronous change in chamber diameter" or "synchronous change in the echocardiographic density of the myocardium"
Blaivas M, 2001[1]	"Visible cardiac contractility"
Salen P, 2001[12]	Not defined. Mentions "contractions" in "Results" section.
Tayal VS, 2003[2]	"Presence of ventricular wall motion"
Salen P, 2005[13]	"Any detected motion within the heart: atrial, valvular or ventricular"
Schuster KM, 2009[14]	"Organized contractile activity with a decrease in chamber size"
Breitkreutz R, 2010[15]	"Cardiac motion"
Tomruk O, 2012[6]	Not defined
Bolvardi E, 2016[16]	"Presence of any heart activity including the ventricles, galleries, valves, etc"

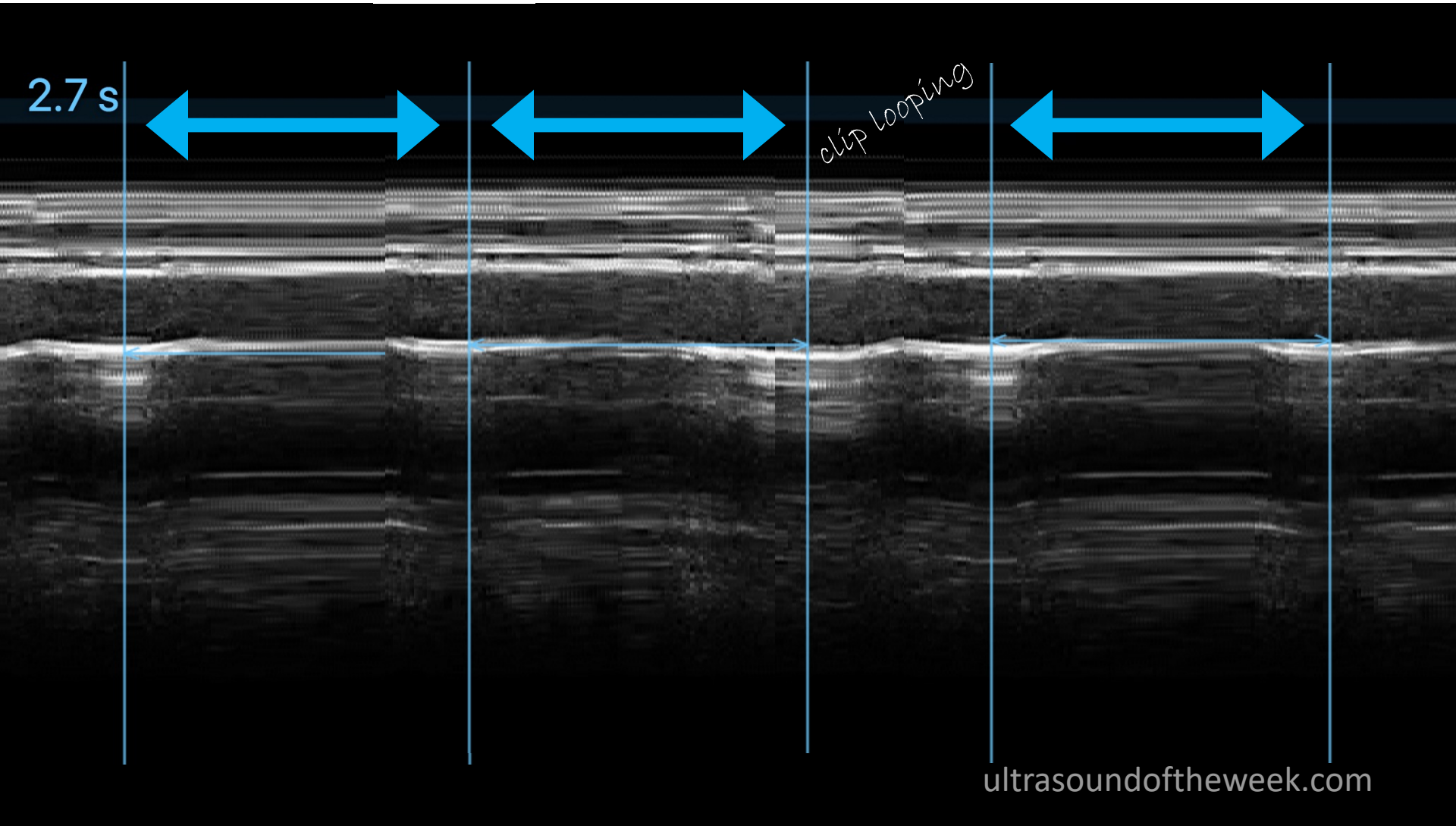
REASON DEFINITION

Any visible movement of the myocardium, excluding movement of blood within the cardiac chambers or isolated valve movement

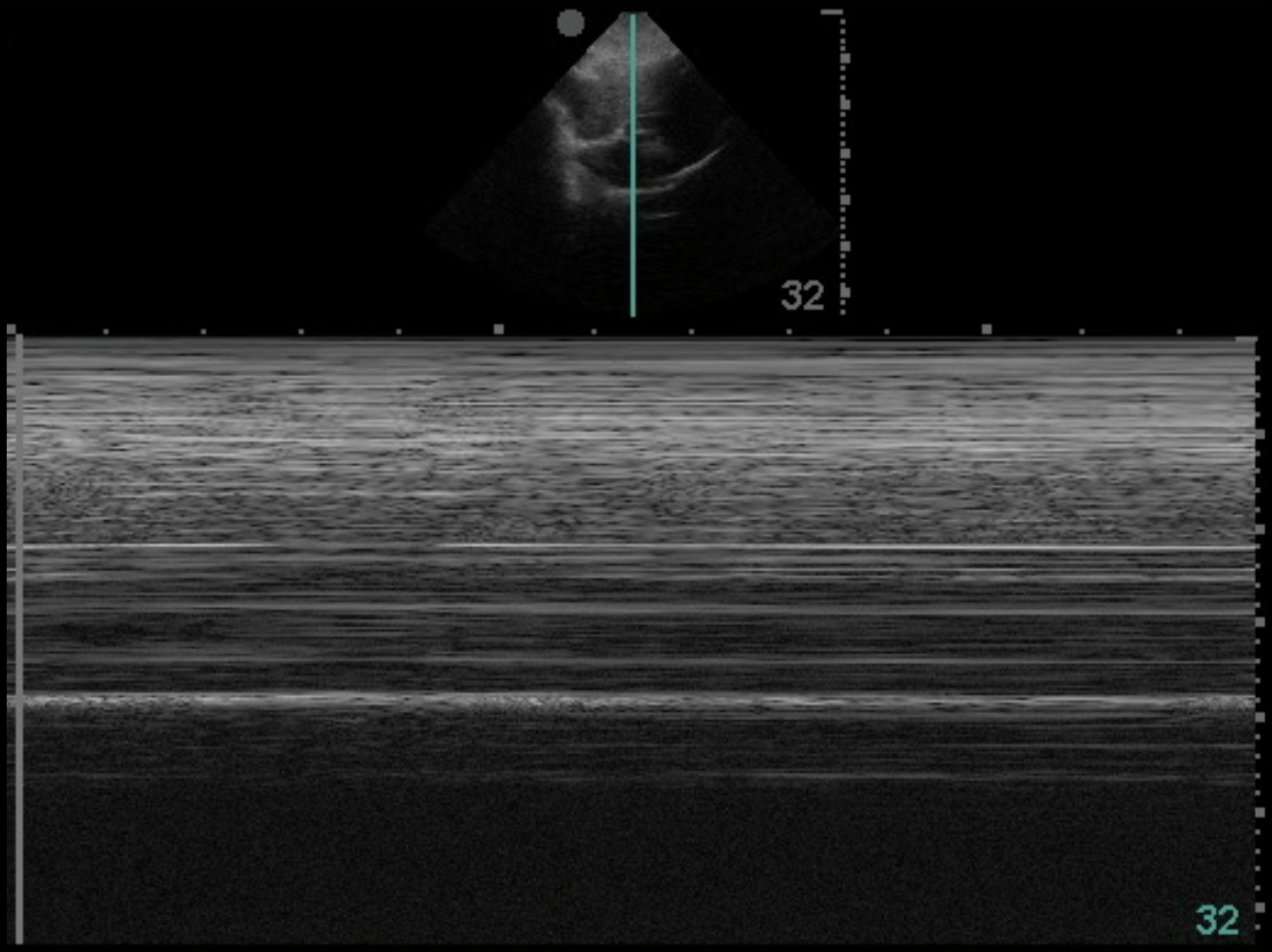
NO VISIBLE MOVEMENT



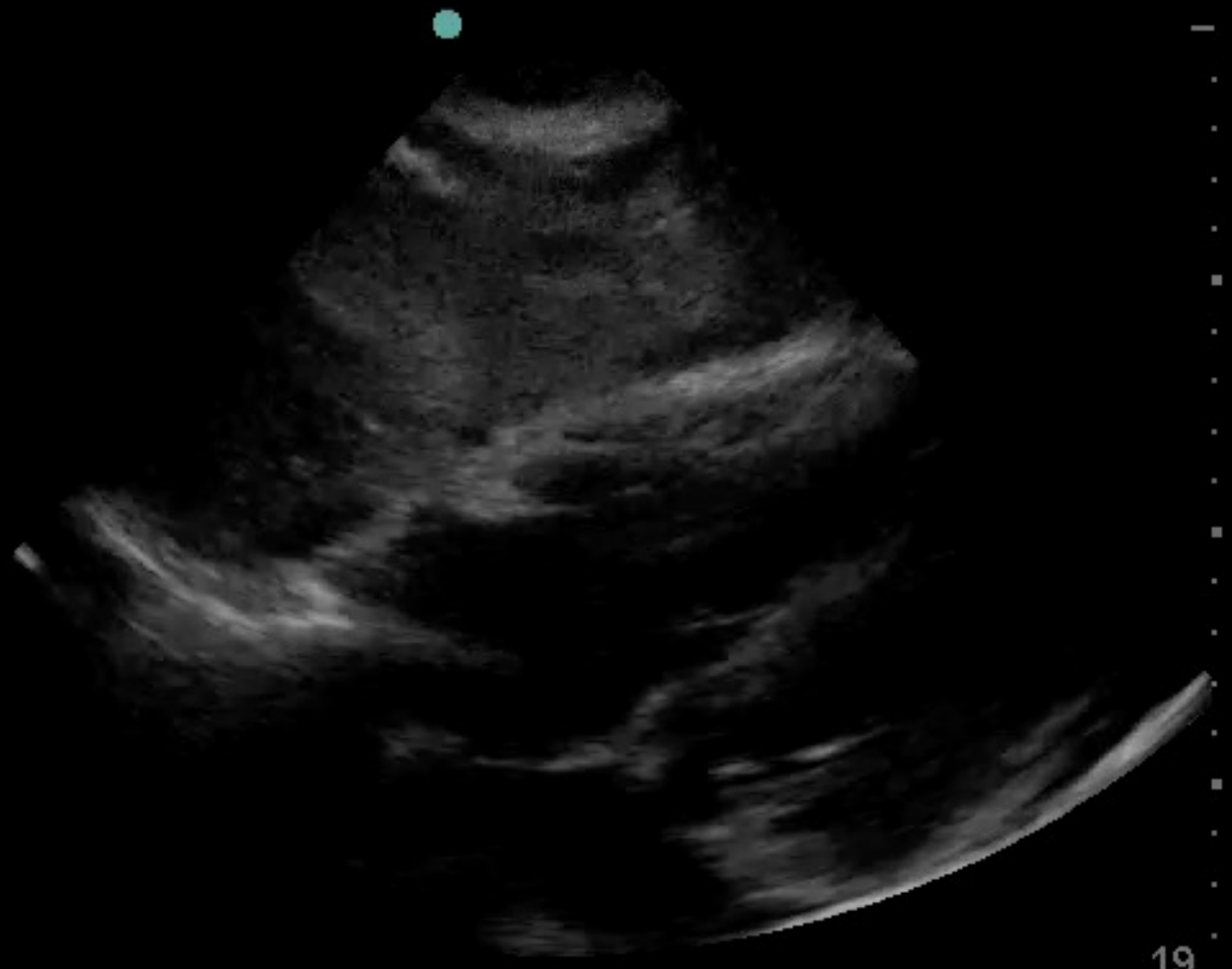
m.mode.ify



M-Mode Standstill

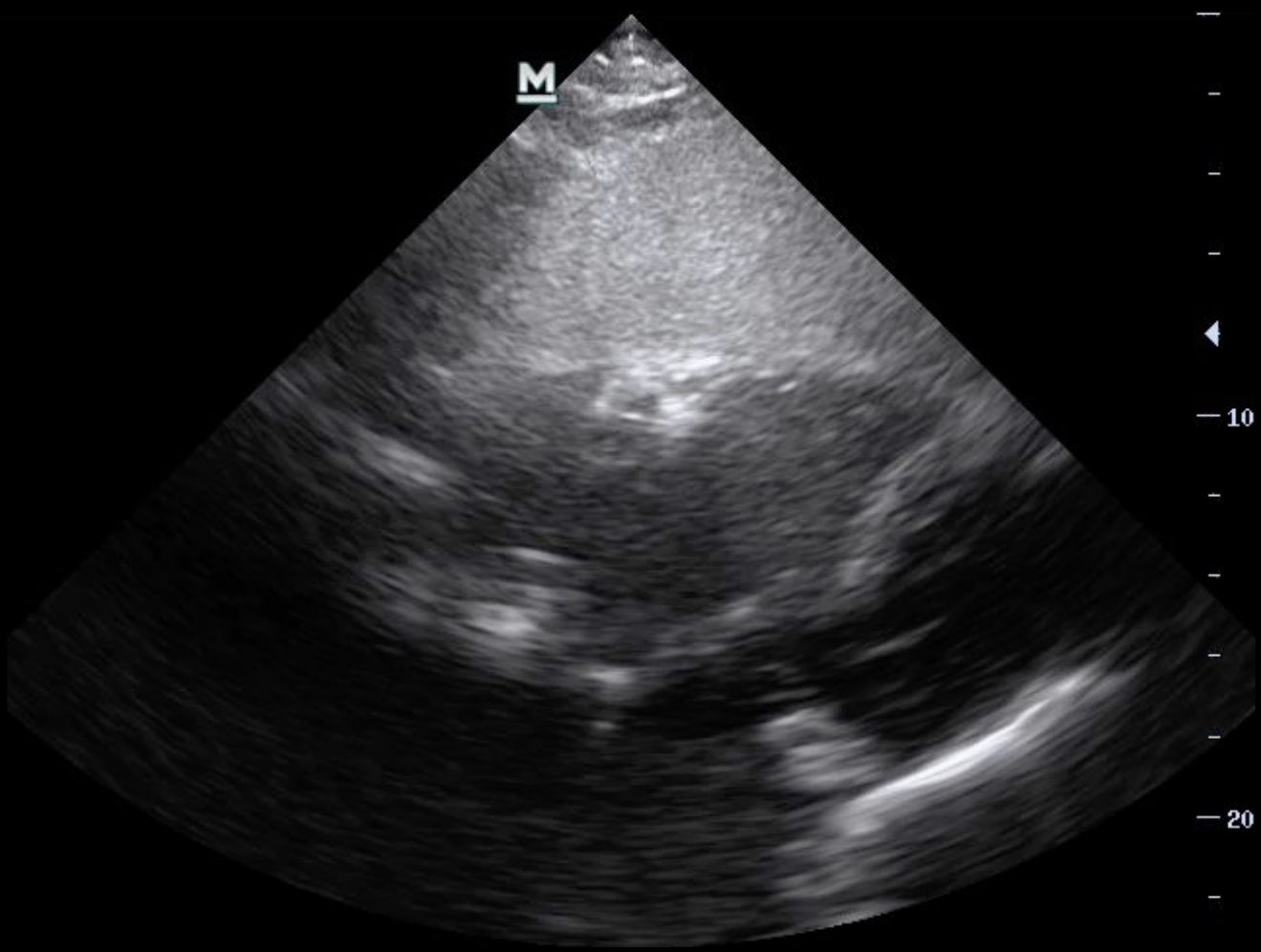


STANDSTILL

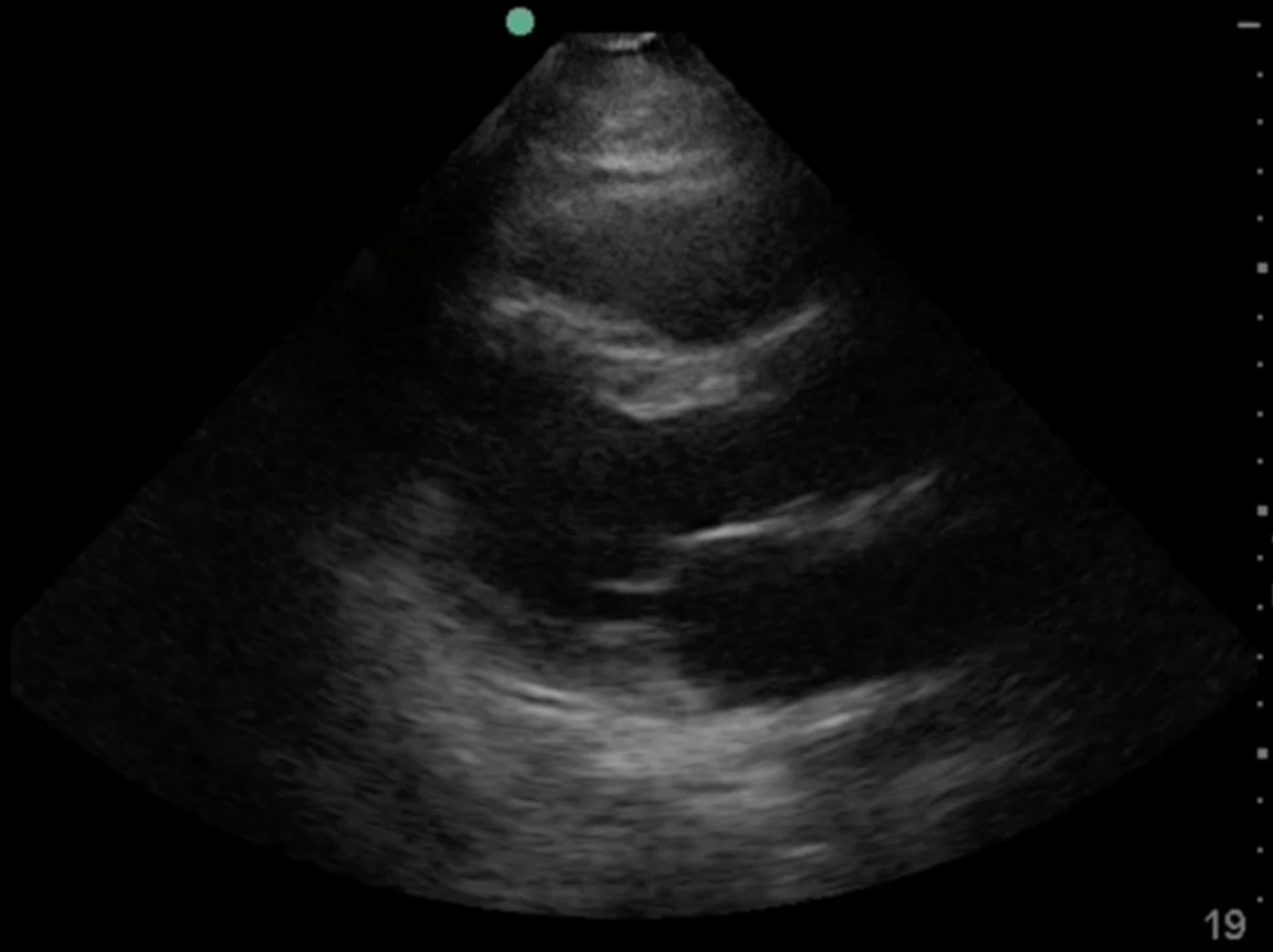


PSEUDO-PEA

DISORGANIZED PSEUDO-PEA

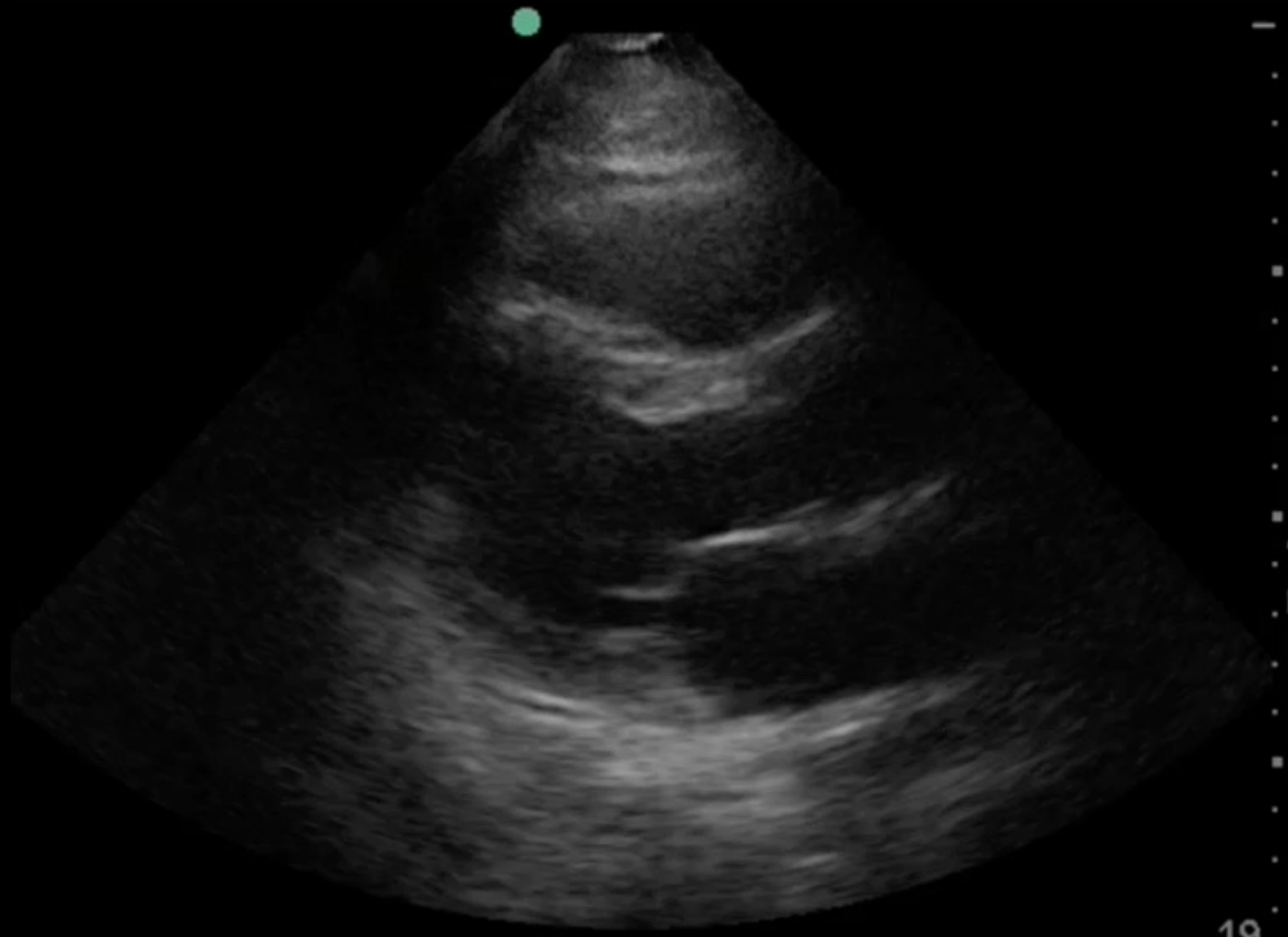


ORGANIZED PSEUDO-PEA

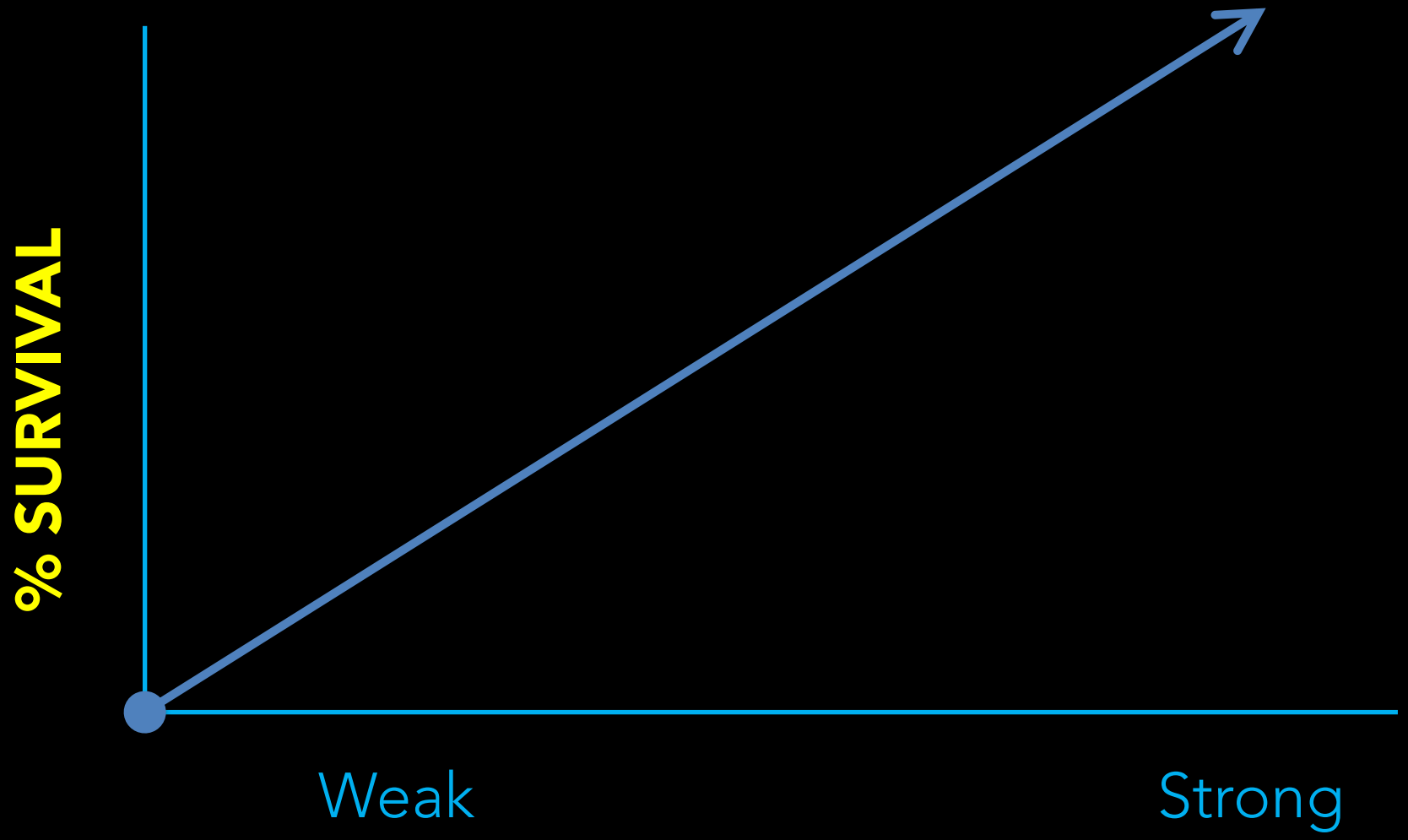


REASON2: Gaspari 2017 Resuscitation

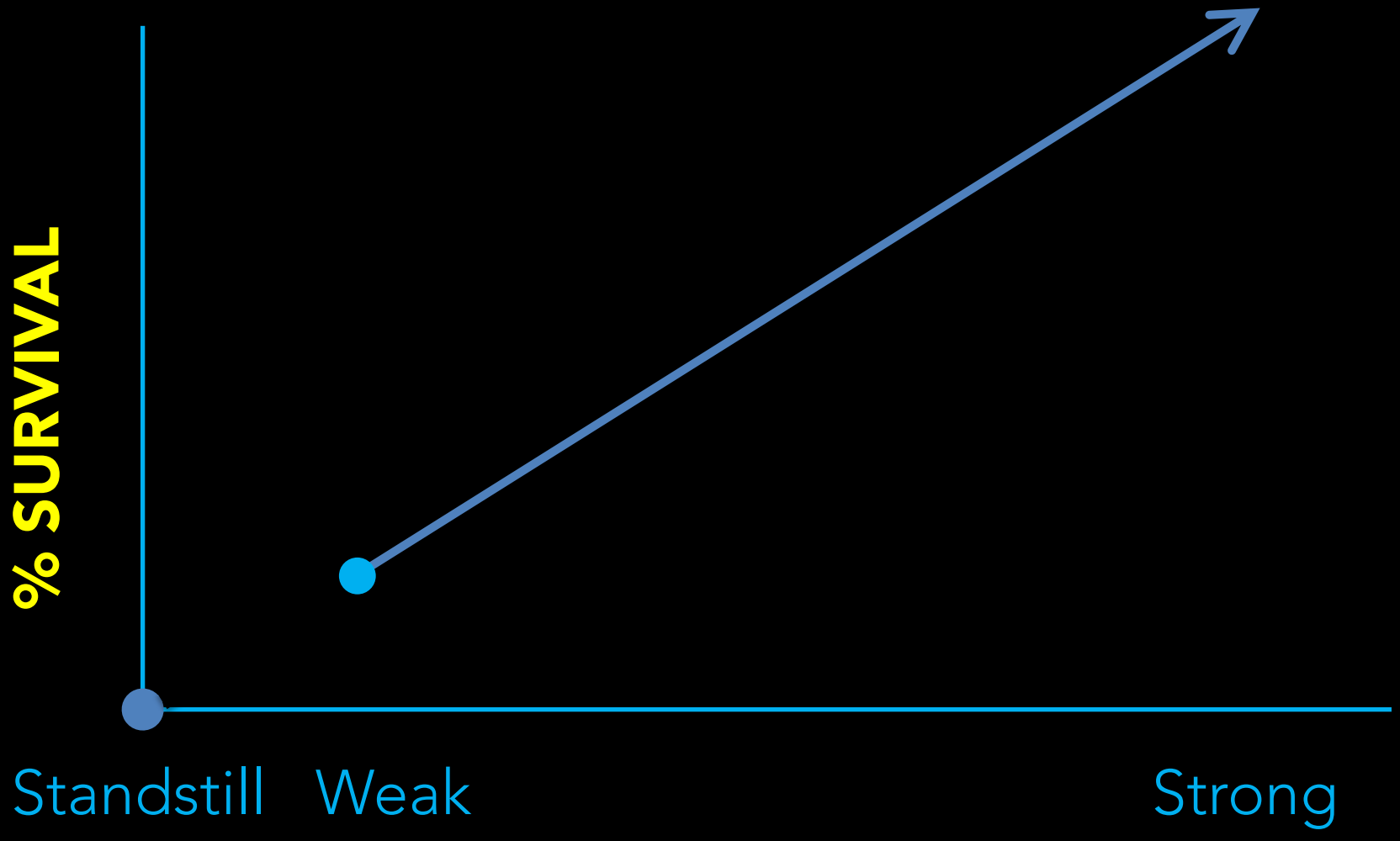
PROFOUND SHOCK



CARDIAC ACTIVITY



CARDIAC ACTIVITY



PITFALLS

FALSE POSITIVE

(LOOKS LIKE CARDIAC ACTIVITY BUT ISN'T)

VALVE FLUTTER

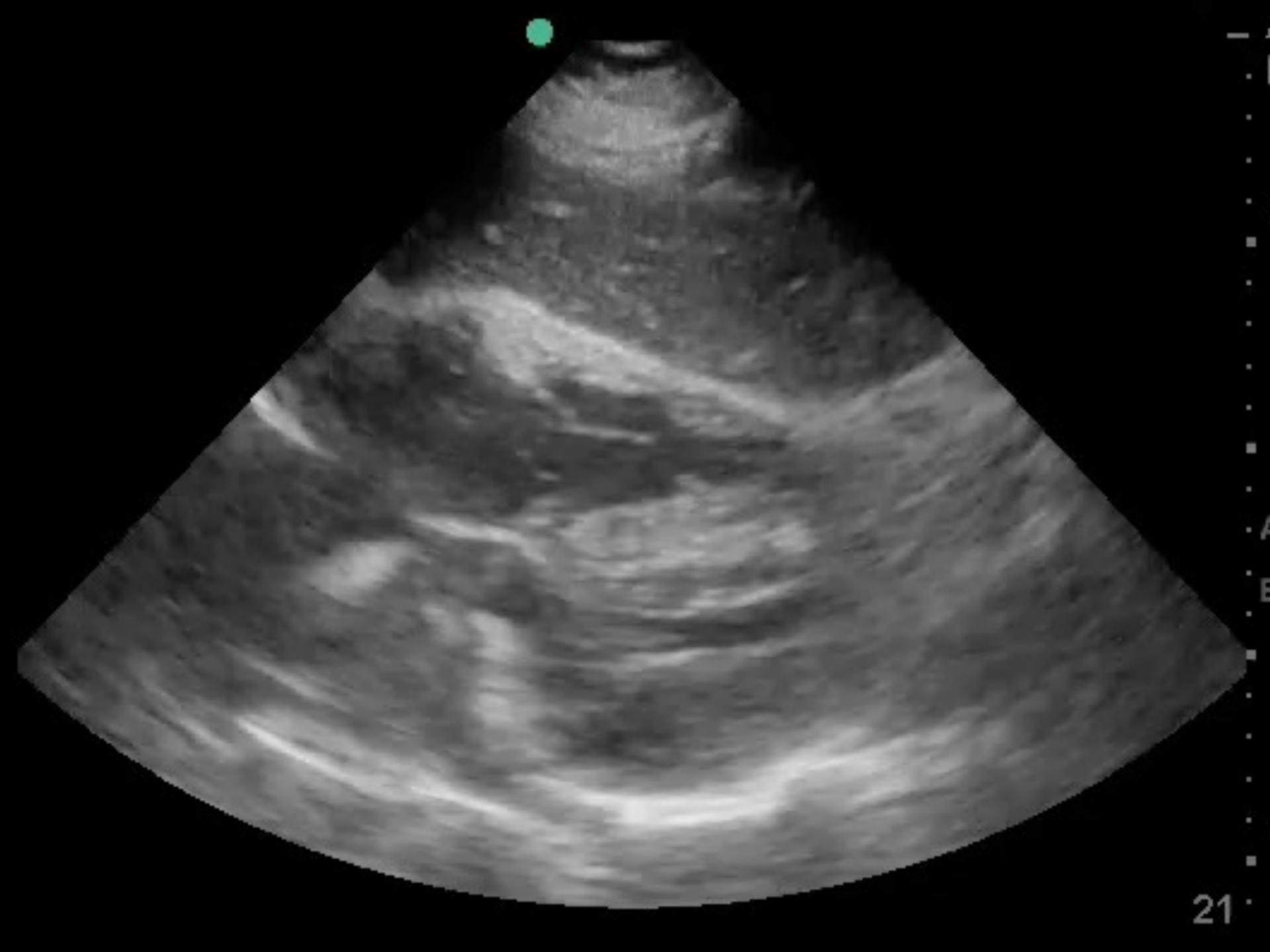
POSITIVE PRESSURE VENTILATION

FALSE NEGATIVE

(LOOKS LIKE STANDSTILL BUT ISN'T)

PROFOUND BRADYCARDIA

WEAK CONTRACTIONS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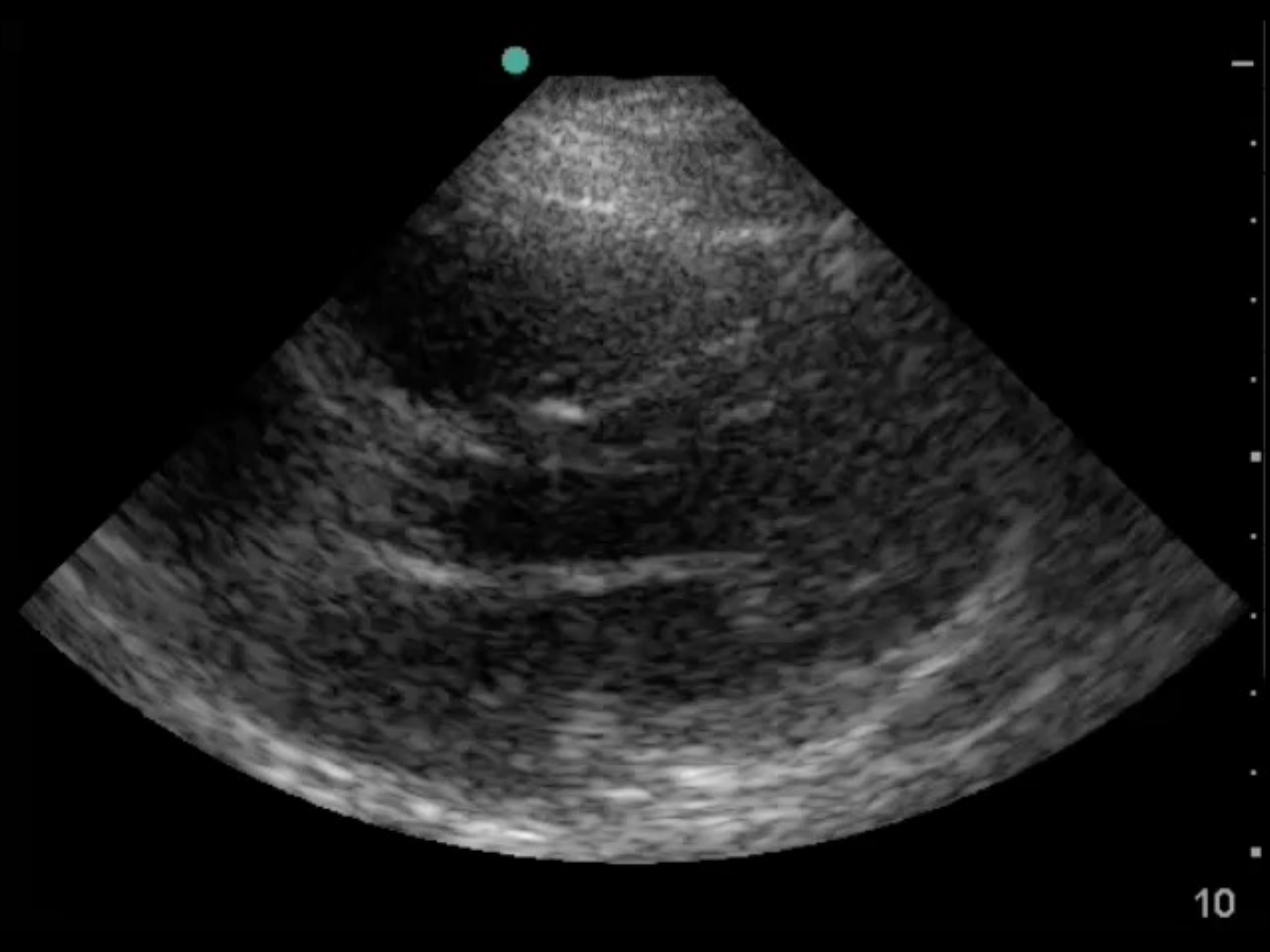
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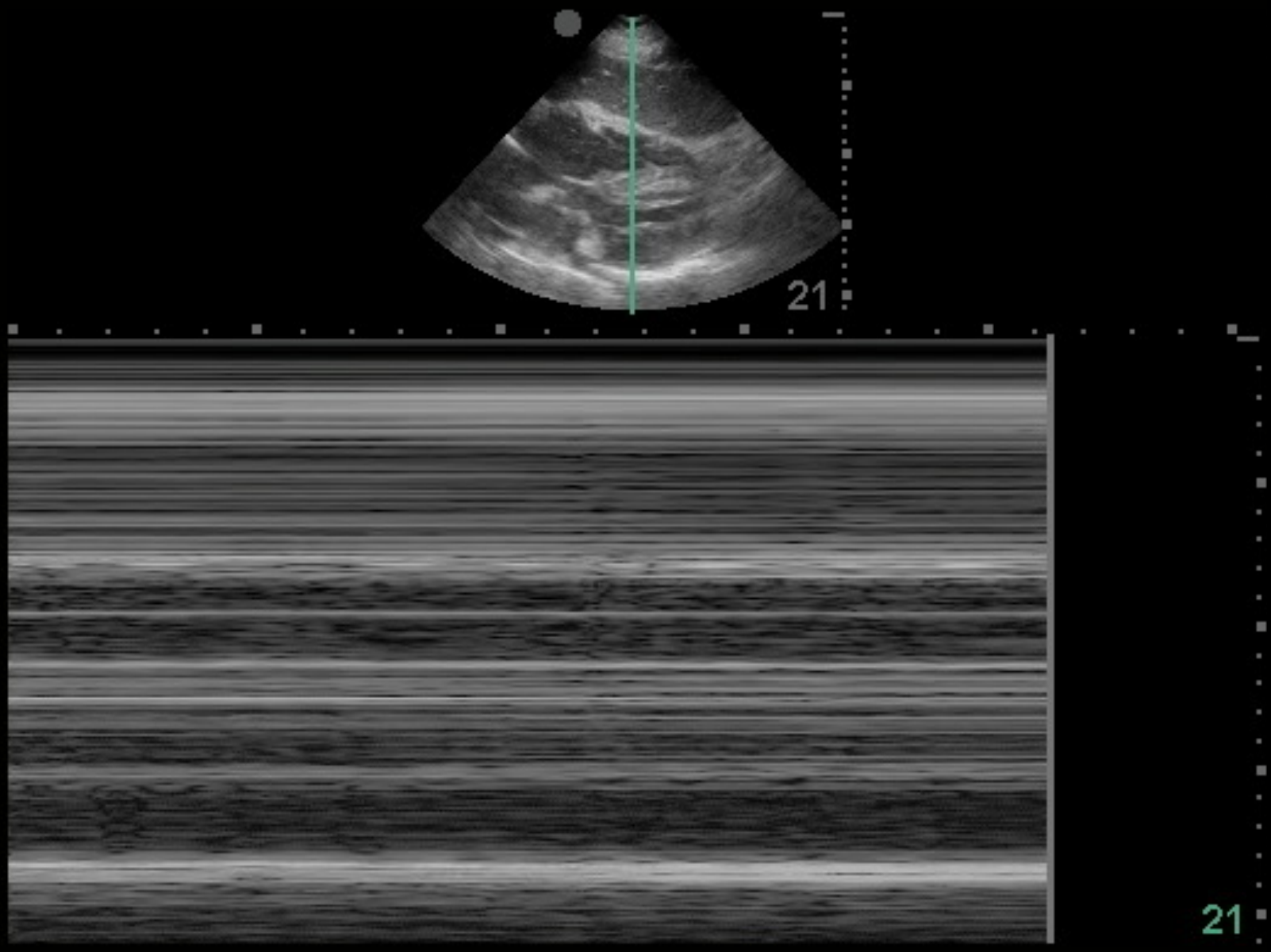
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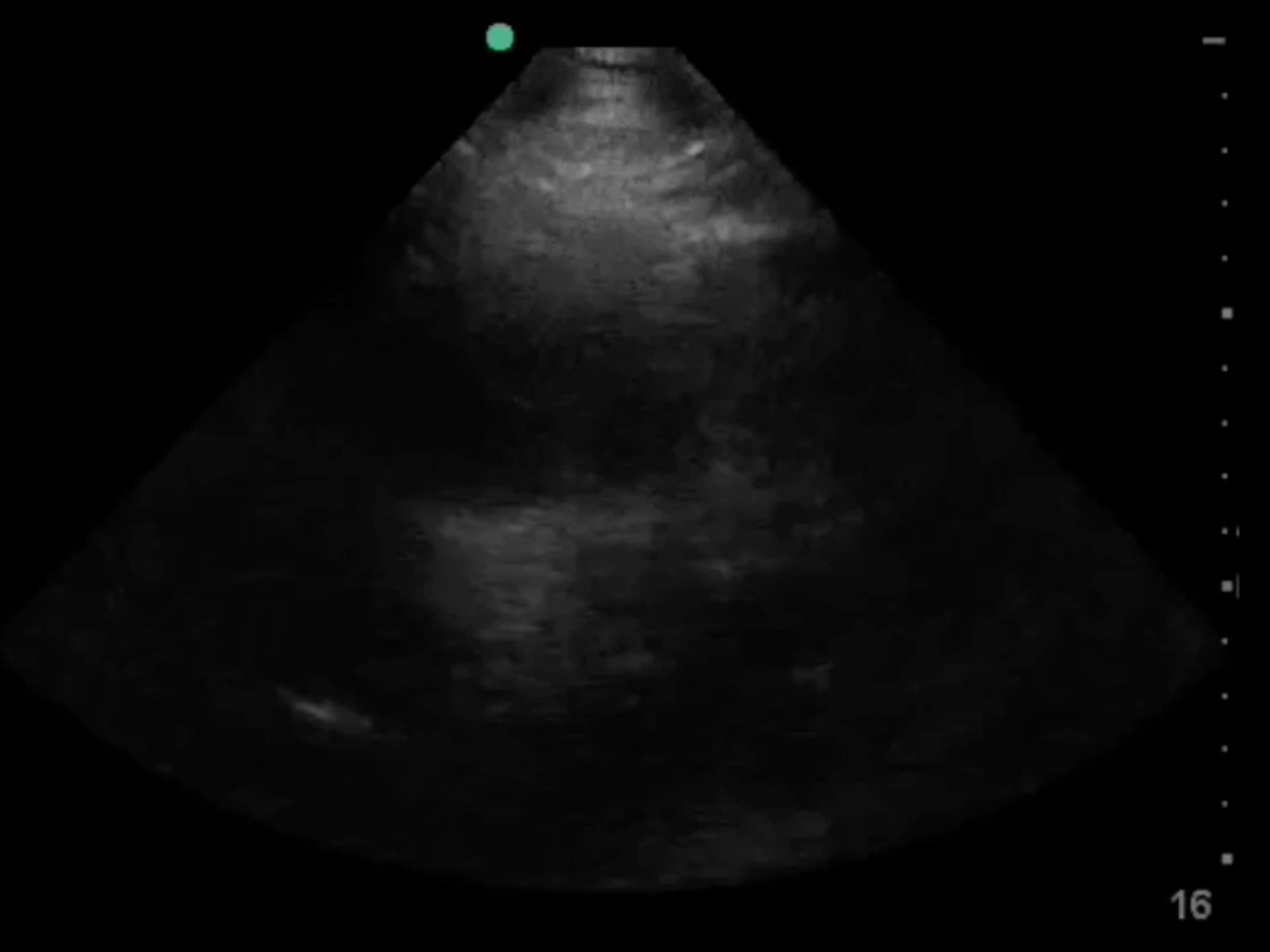
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CAN WE USE STANDSTILL TO TERMINATE RESUSCITATION?

B
E.M.T.
LIFEPAK

END-TIDAL CARBON DIOXIDE AND OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST

ROBERT L. LEVINE, M.D., MARVIN A. WAYNE, M.D., AND CHARLES C. MILLER, PH.D.

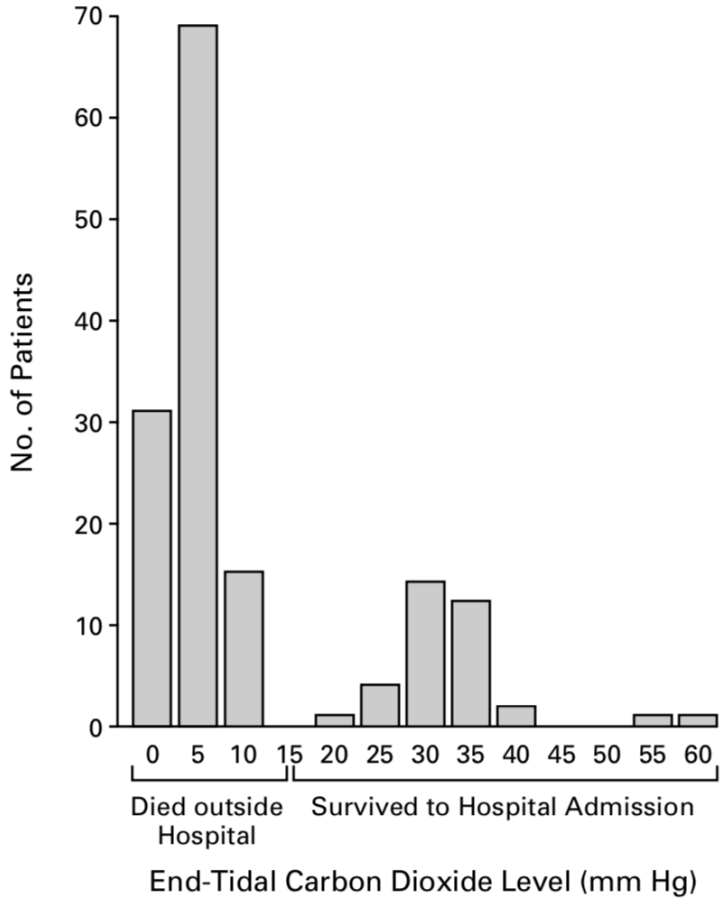


TABLE 1. END-TIDAL CARBON DIOXIDE VALUES IN PATIENTS WHO SURVIVED TO HOSPITAL ADMISSION AND IN THOSE WHO DID NOT.

VARIABLE	NONSURVIVORS (N=115)	SURVIVORS (N=35)	P VALUE*
	mean ±SD (range)		
Age (yr)	68.0±13.8 (31–95)	71.5±13.0 (27–90)	0.19
End-tidal carbon dioxide (mm Hg)†			
Initial	12.3±6.9 (2–50)	12.2±4.6 (5–22)	0.93
Final	4.4±2.9 (0–10)	32.8±7.4 (18–58)	<0.001

TABLE 2. END-TIDAL CARBON DIOXIDE VALUES IN PATIENTS WHO DIED IN THE HOSPITAL AND IN THOSE WHO SURVIVED TO DISCHARGE FROM THE HOSPITAL.

VARIABLE	DIED IN HOSPITAL (N=19)	SURVIVED TO DISCHARGE (N=16)*	P VALUE†
	mean ±SD (range)		
Age (yr)	76.8±6.9 (64–89)	65.2±15.7 (27–90)	0.009
End-tidal carbon dioxide (mm Hg)‡			
Initial	11.9±5.1 (5–20)	12.5±4.1 (7–22)	0.68
Final	31.8±7.3 (18–56)	34.0±7.7 (24–58)	0.28

Levine, Wayne, Miller, NEJM 1997

WHAT ABOUT THOSE SURVIVIORS?

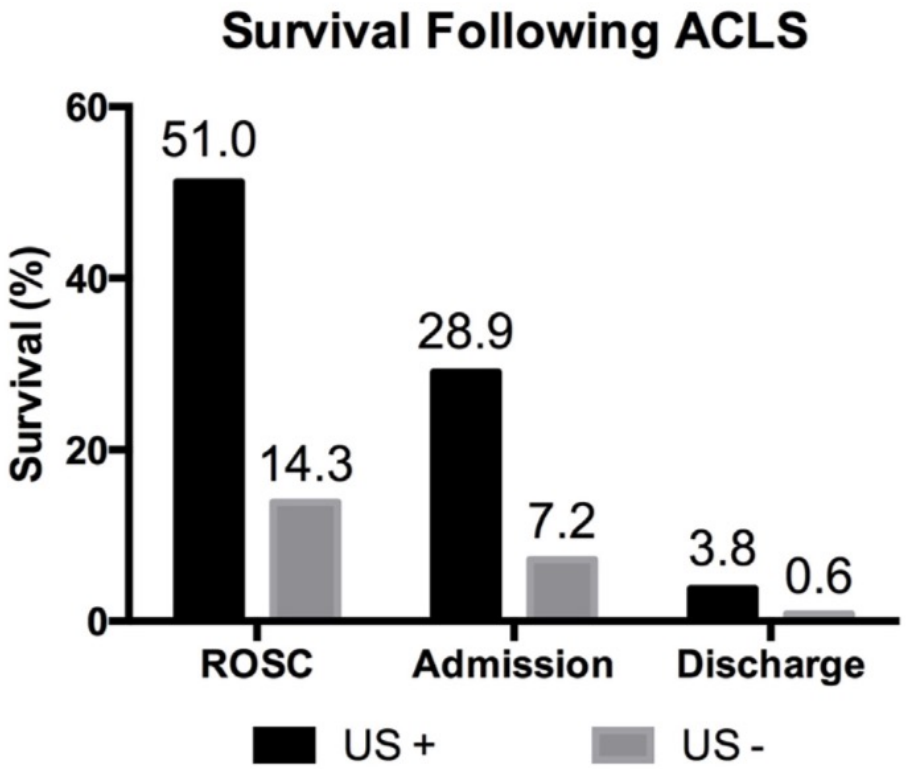
Bedside Focused Echocardiography as Predictor of Survival in Cardiac Arrest Patients: A Systematic Review

	ROSC (Positive Outcome)	No ROSC (Negative Outcome)
Cardiac contractility seen on echo (positive test)	98	92
No cardiac contractility seen on echo (negative test)	9	369

Blyth AEM 2012

Emergency department point-of-care ultrasound in out-of-hospital and in-ED cardiac arrest☆

Romolo Gaspari[a,*], Anthony Weekes[b], Srikar Adhikari[c], Vicki E. Noble[d],



REASON 1: Gaspari Resuscitation 2016

Stellate Ganglion Nerve Block by Point-of-Care Ultrasonography for Treatment of Refractory Infarction-Induced Ventricular Fibrillation

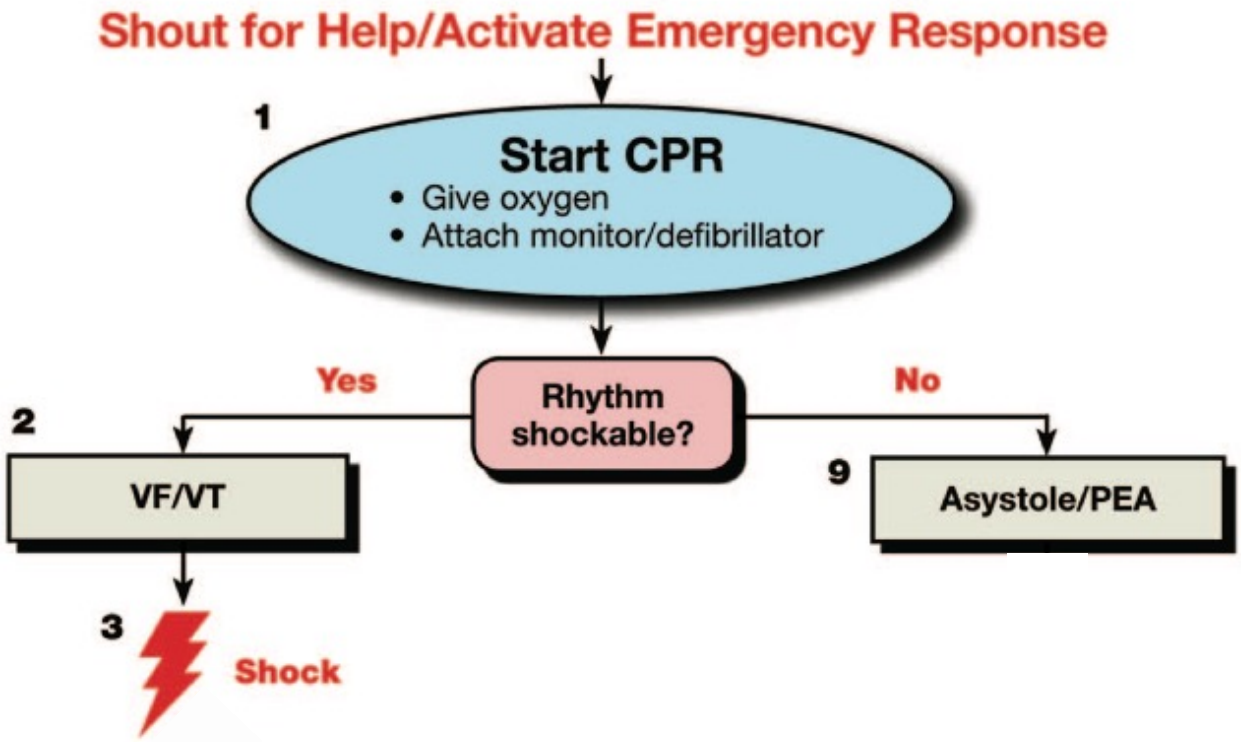
physicians as a last-ditch attempt at resuscitation. In our case, we were able to terminate the otherwise almost certainly fatal ventricular arrhythmia and ultimately save our patient's life. He has intact neurologic function and is progressing slowly, but reliably, in his recovery.

Margus, AEM 2020

19

prognostic
diagnostic
algorithms

prognostic
diagnostic
algorithms


Shout for Help/Activate Emergency Response
1
Start CPR
• Give oxygen
• Attach monitor/defibrillator
Rhythm shockable?
Yes
No
2
VF/VT
9
Asystole/PEA
3
Shock

REVERSIBLE CAUSES OF PEA

Hypovolemia

Hypoxia

H+ Ion (Acidosis)

Hypo/Hyperkalemia

Hypothermia

Tension Pneumothorax

Tamponade (Cardiac)

Toxins

Thrombosis (PE)

Thrombosis (ACS)

REVERSIBLE CAUSES OF PEA

Hypovolemia

Hypoxia

H+ Ion (Acidosis)

Hypo/Hyperkalemia

Hypothermia

Tension Pneumothorax

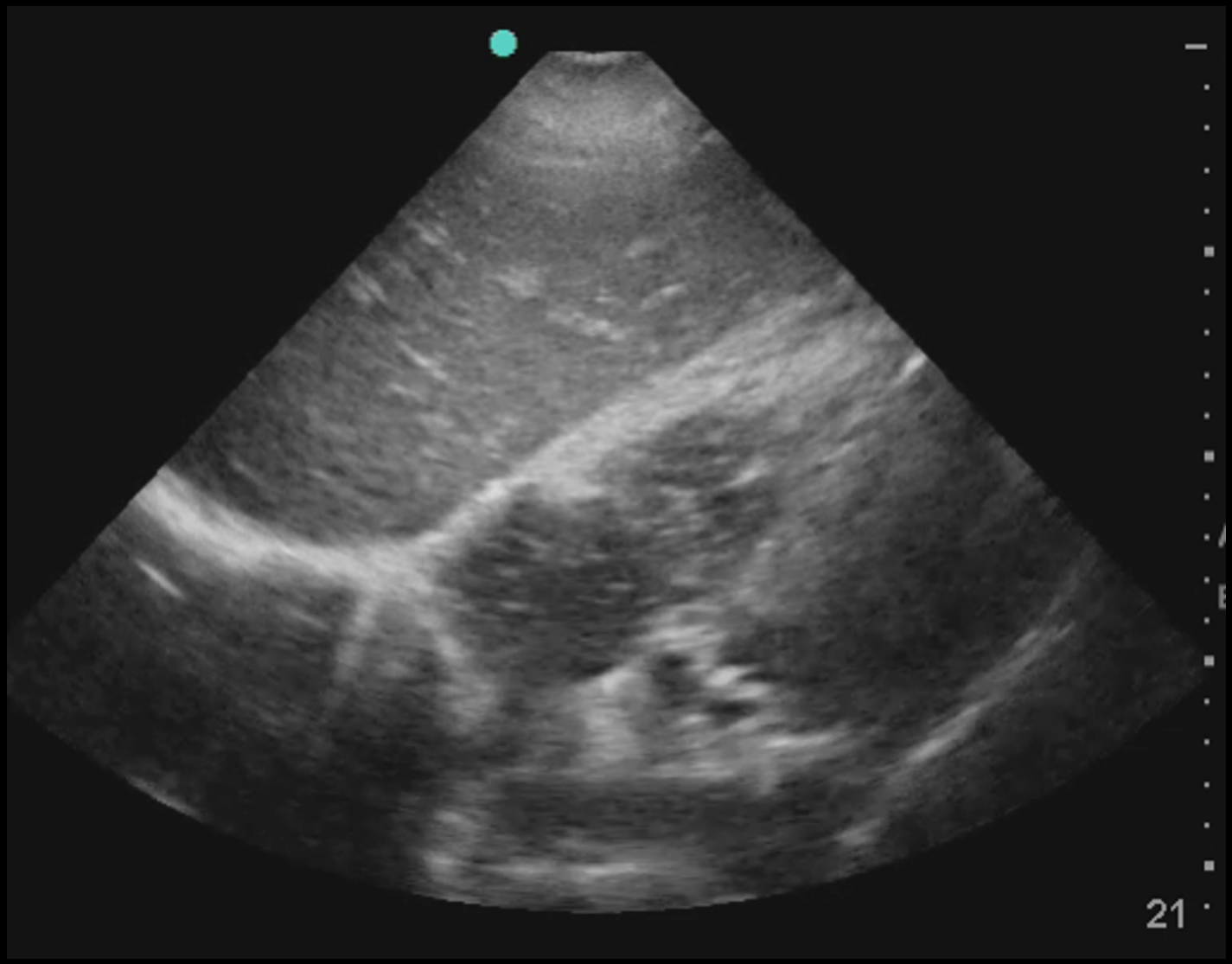
Tamponade (Cardiac)

Toxins

Thrombosis (PE)

Thrombosis (ACS)

TAMPONADE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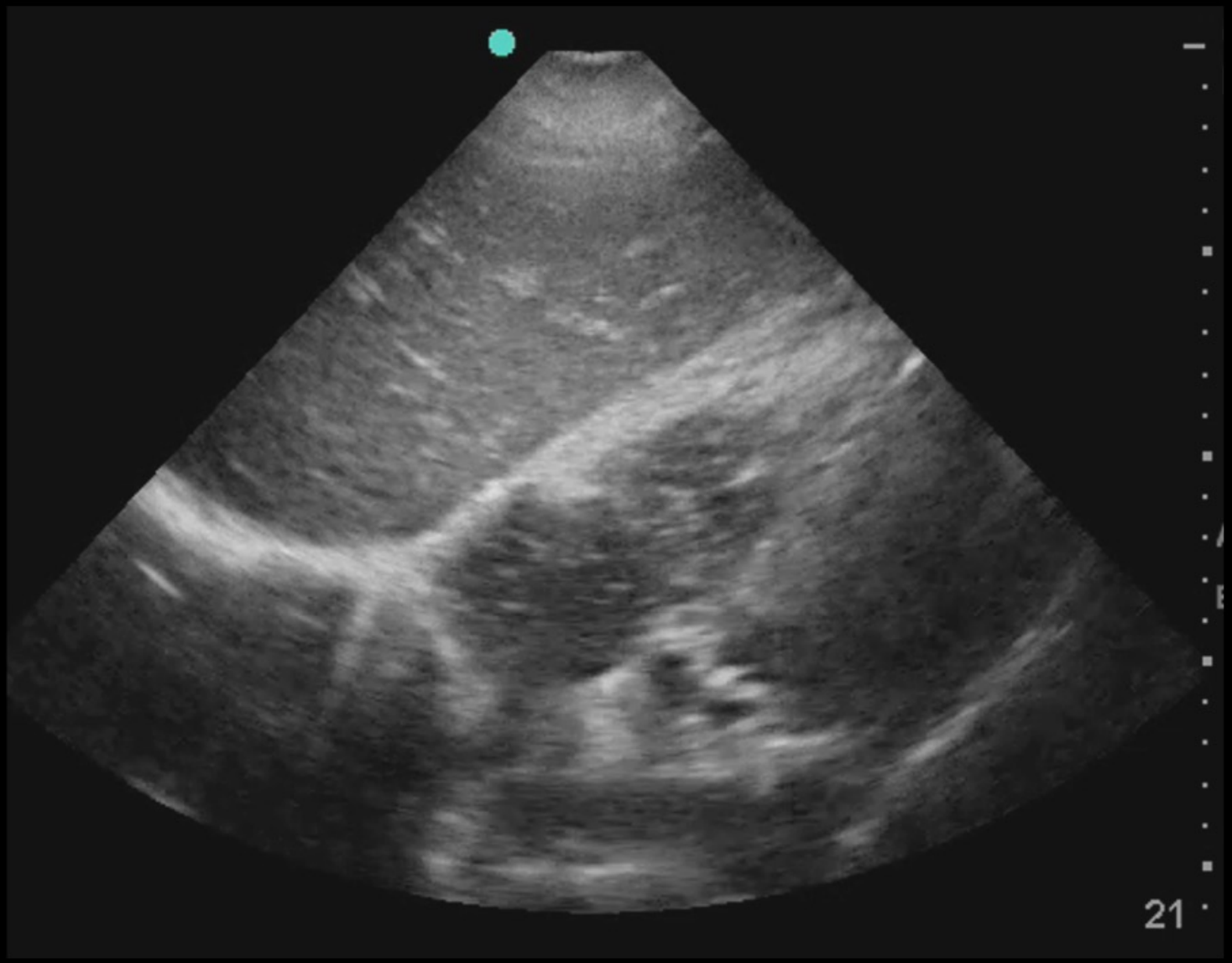
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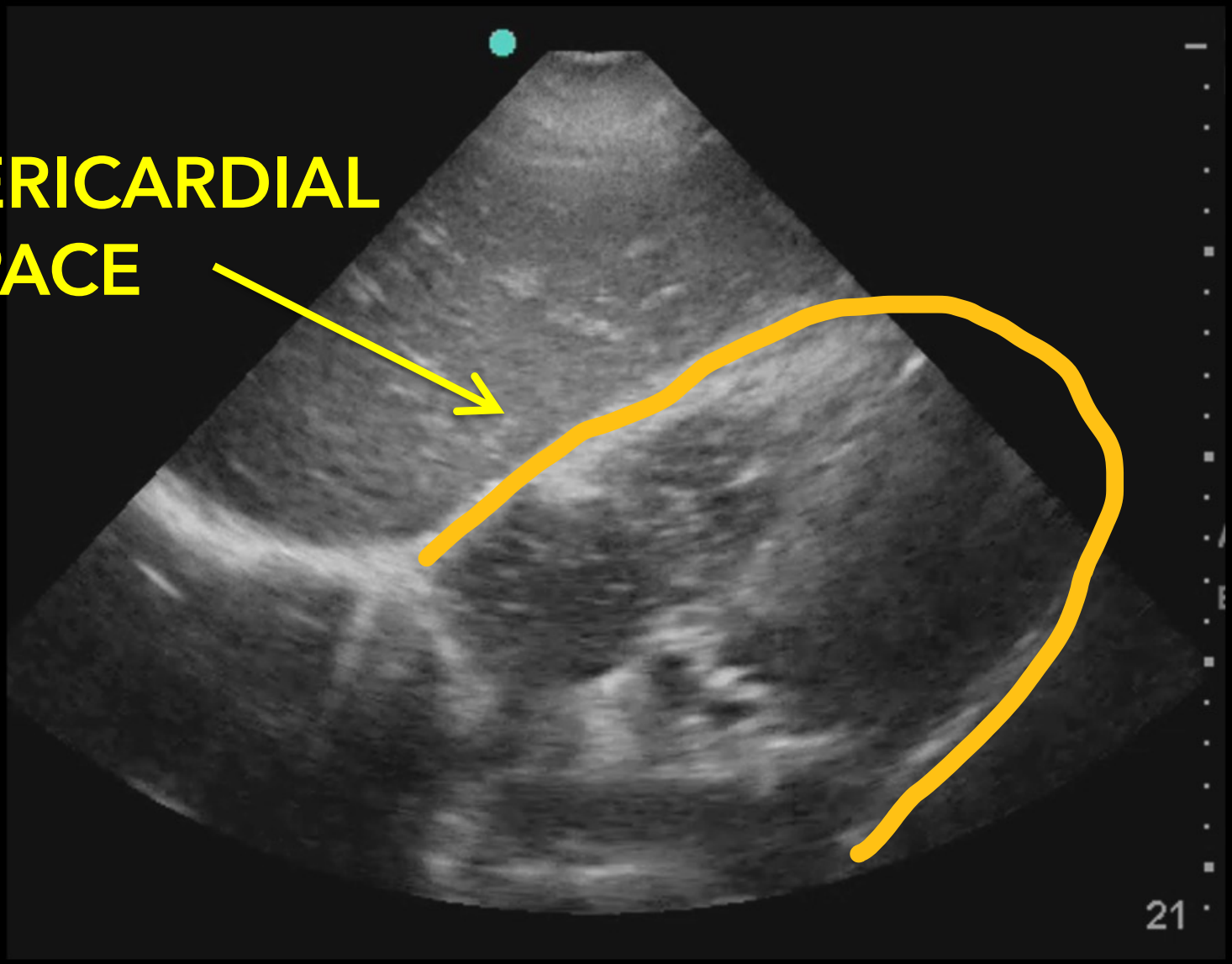
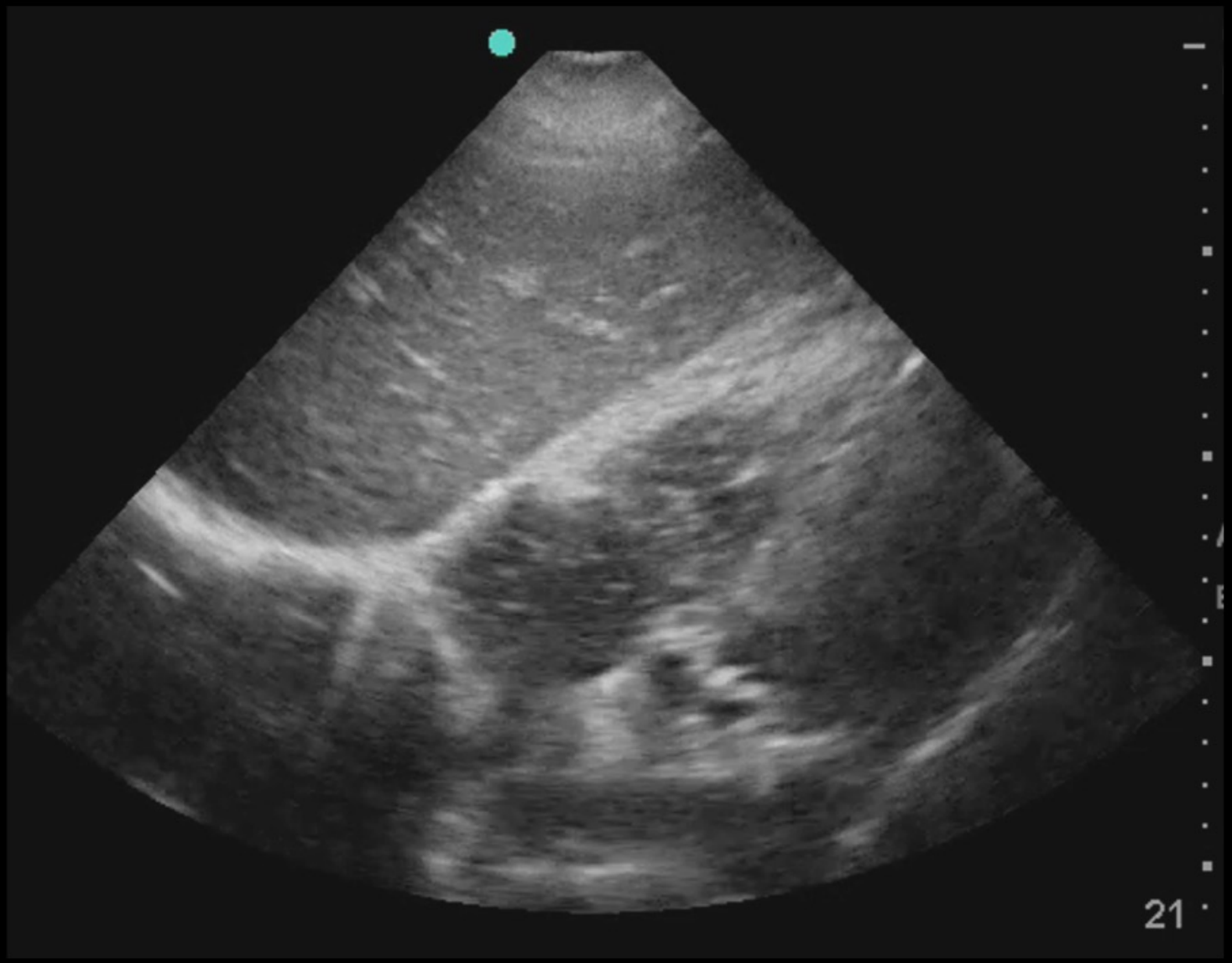
NO EFFUSION



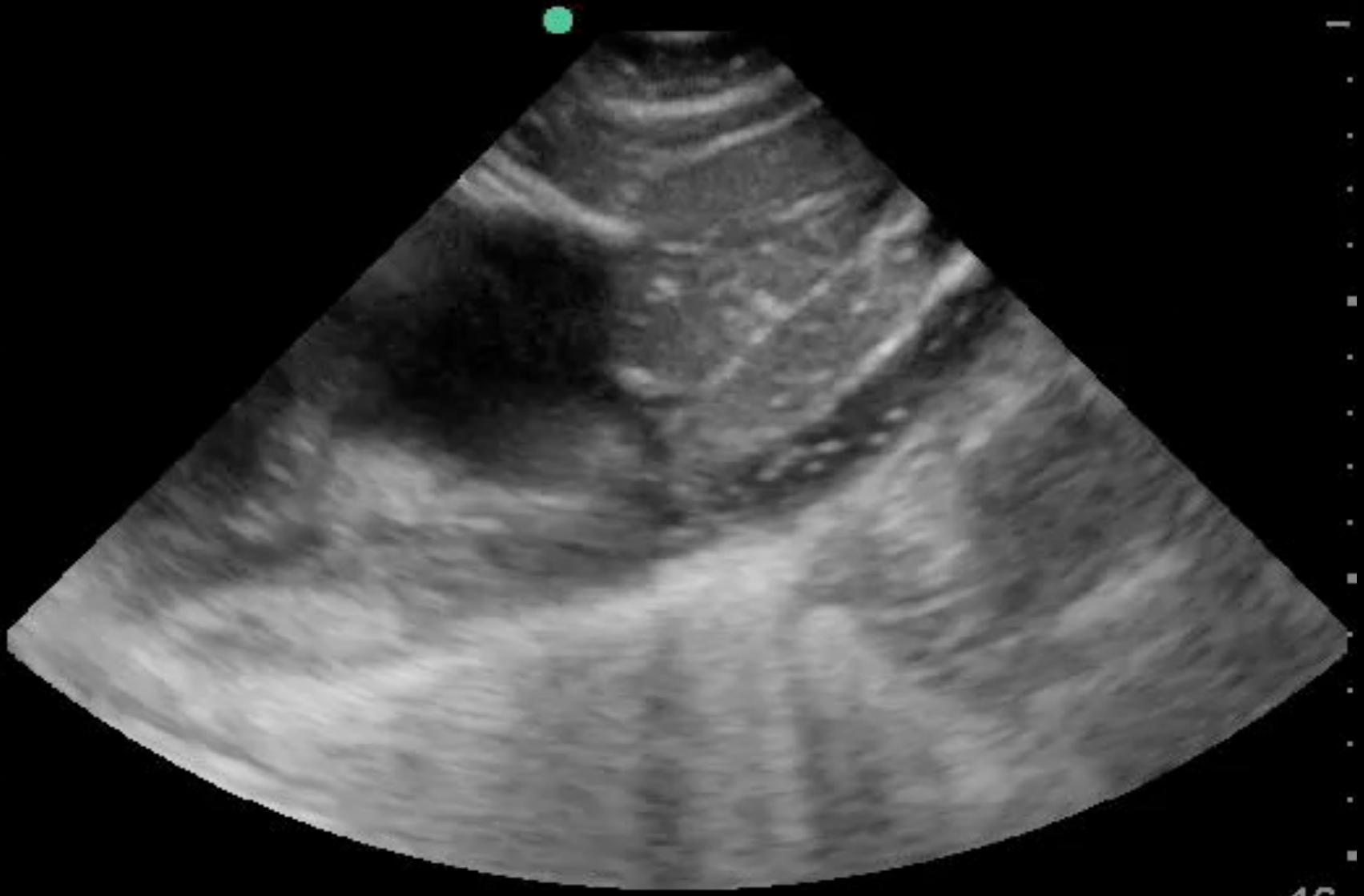
NO EFFUSION



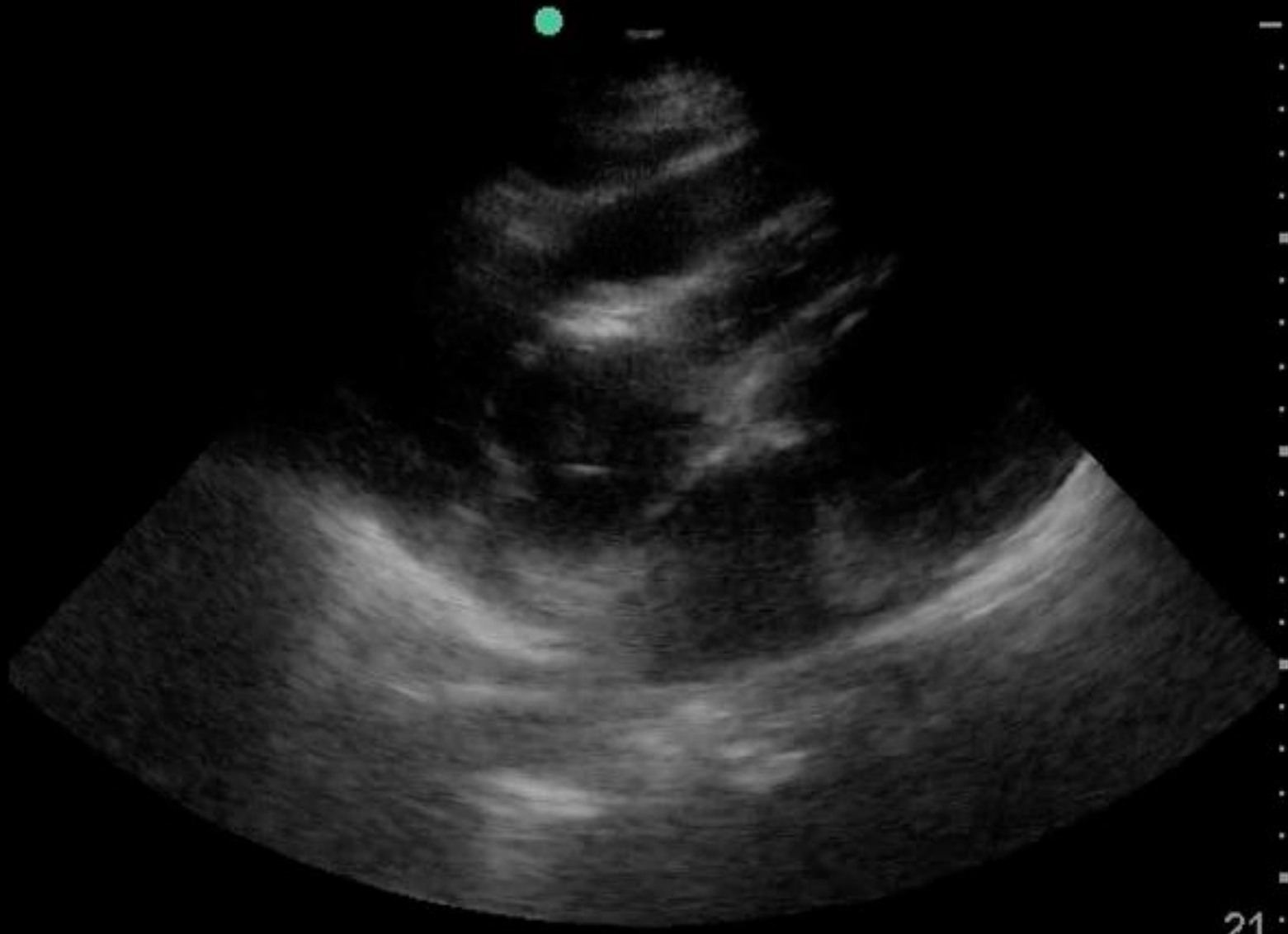
PEA ARREST

RIGHT ATRIUM

IVC



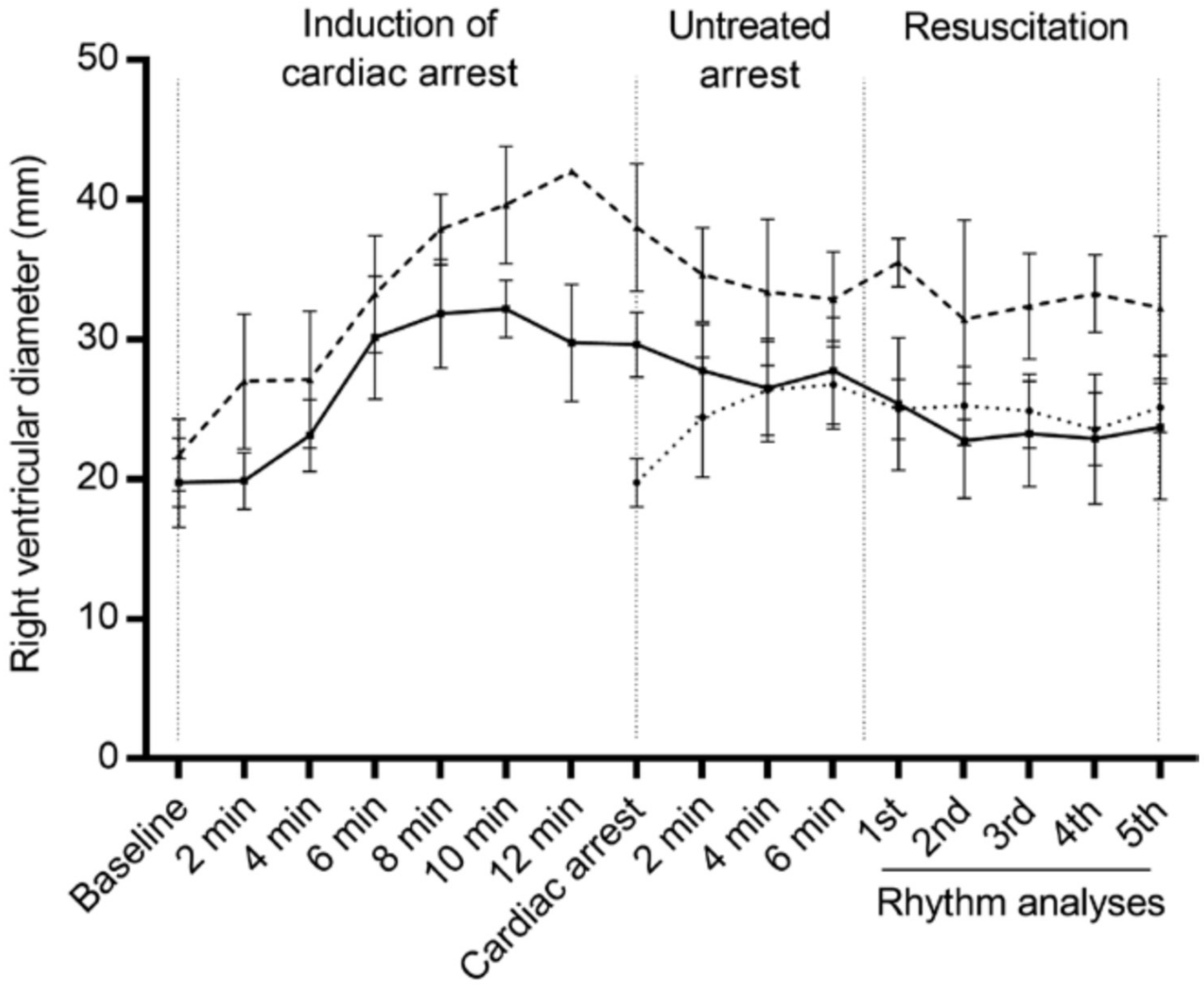
CONFIRMATION



ROSC

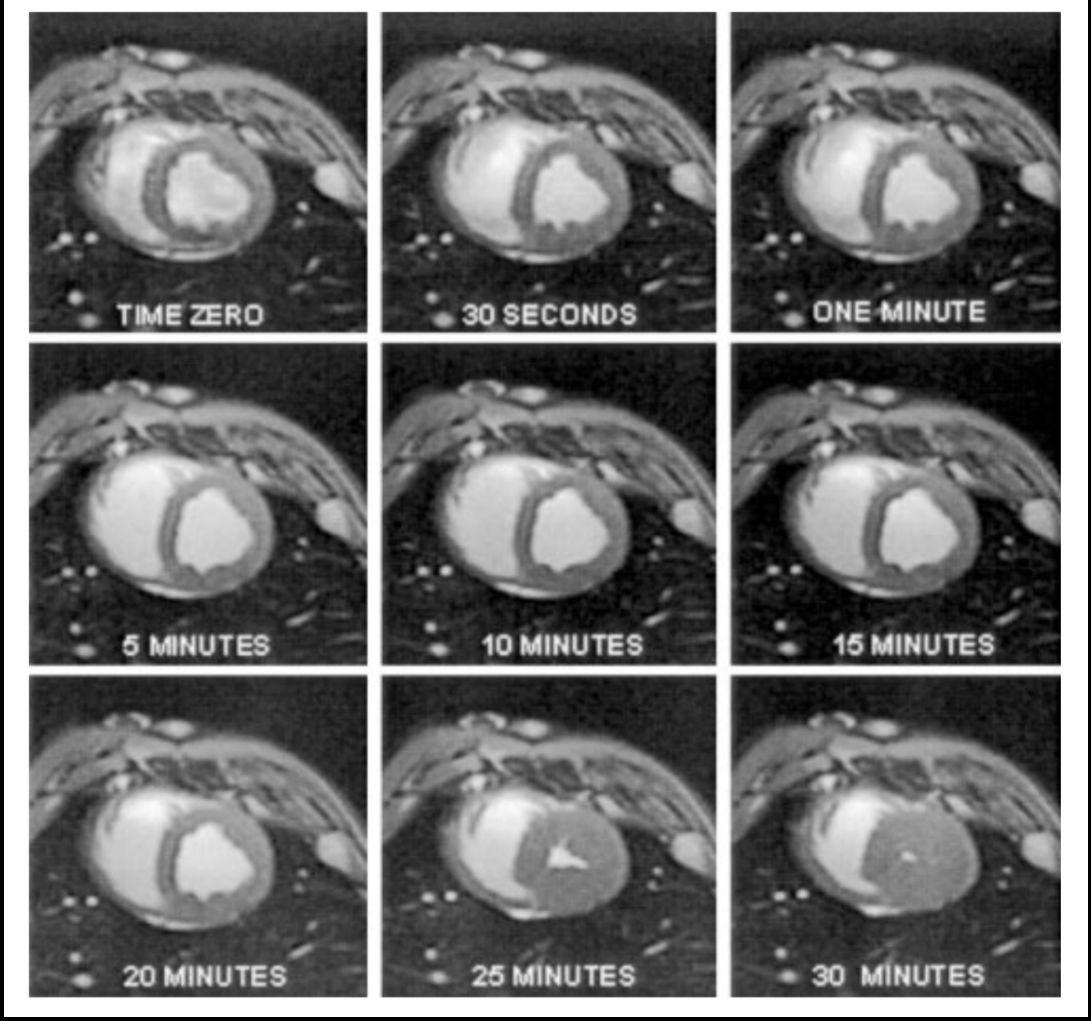
PULMONARY EMBOLISM

RV in ARREST

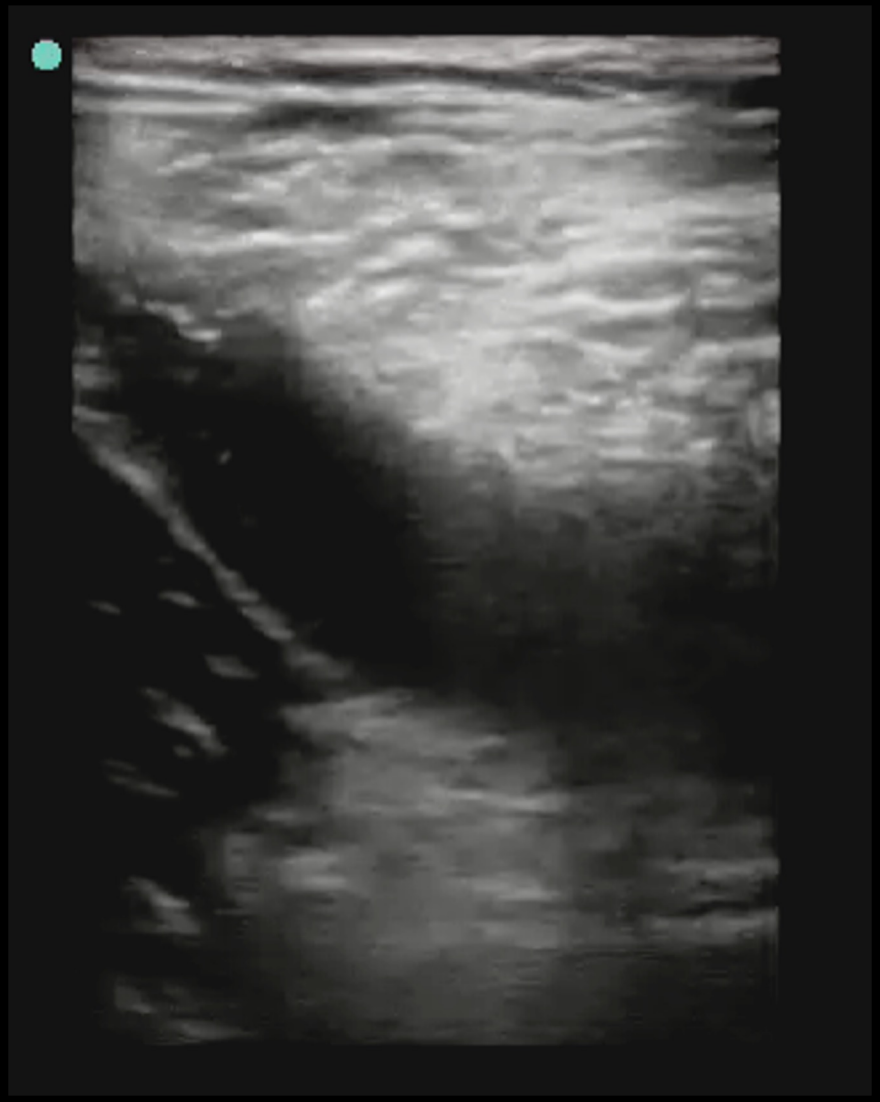


Aagard Critical Care Medicine 2017

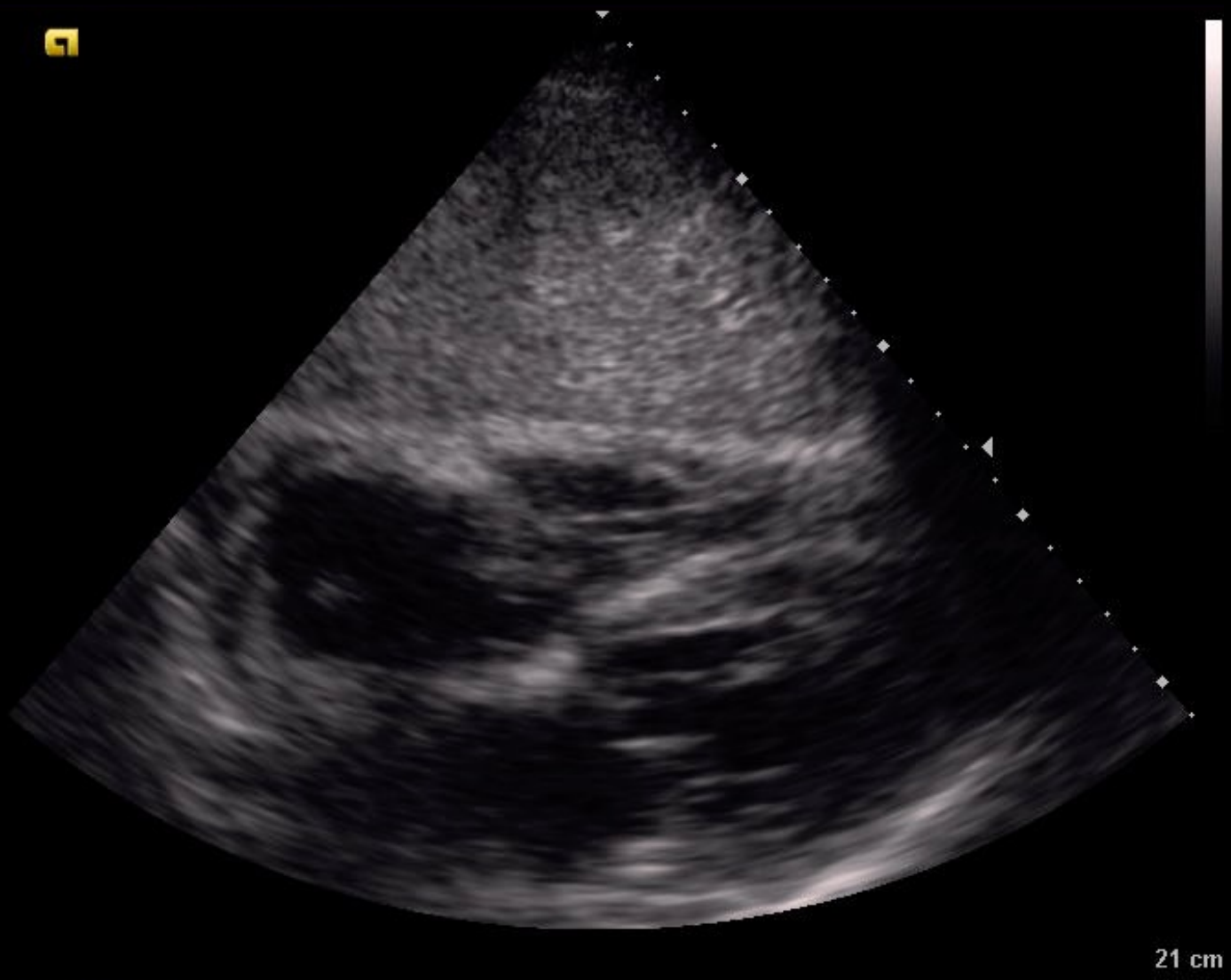
RV in VFIB ARREST



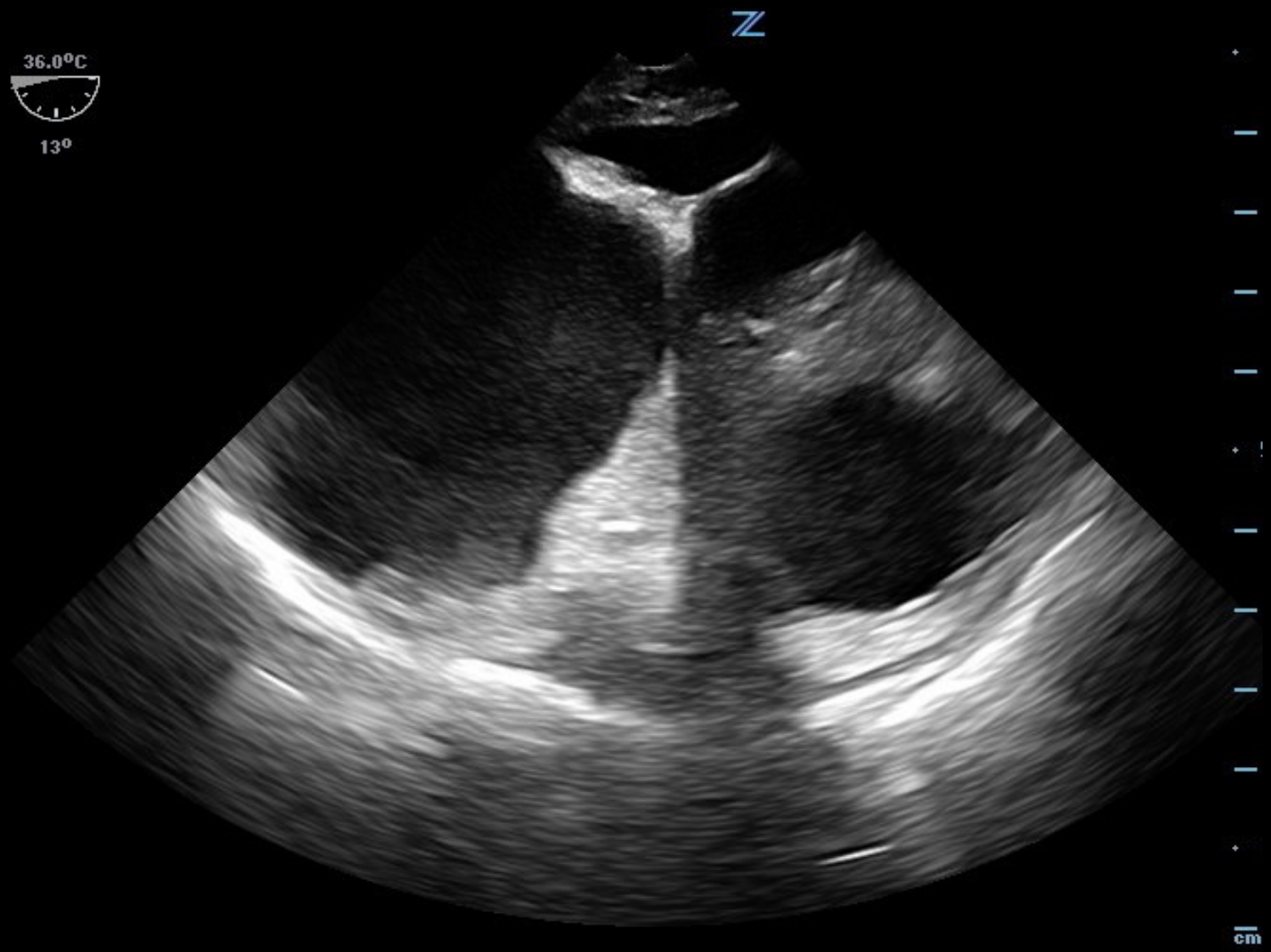
Berg Circulation 2005



CLOT IN TRANSIT



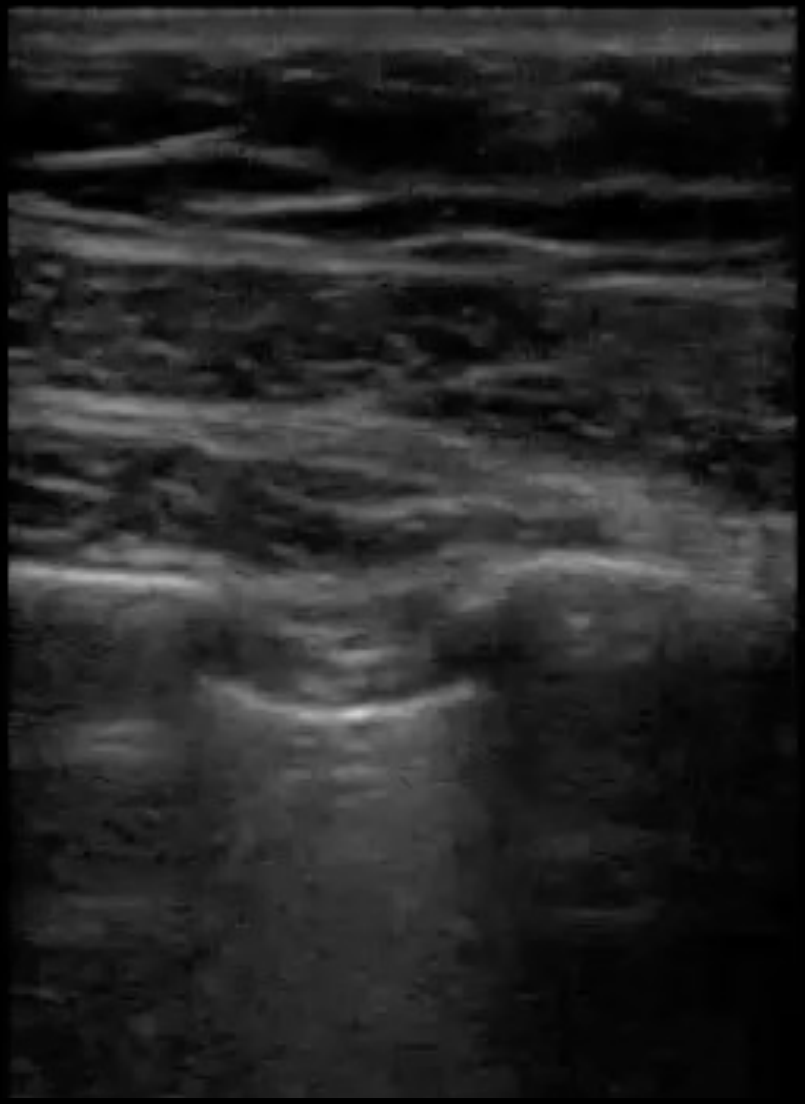
TEE CLOT IN TRANSIT



Actilyse® 50 mg
For fibrinolytic therapy
For i.v. infusion
Protect from light
Store below 30 °C
Storage of reconstituted solution:
see instructions on carton and in leaflet
Boehringer Ingelheim
Sterile Water for Injection
50 ml to be used to reconstitute
Actilyse®
50 mg
Boehringer Ingelheim

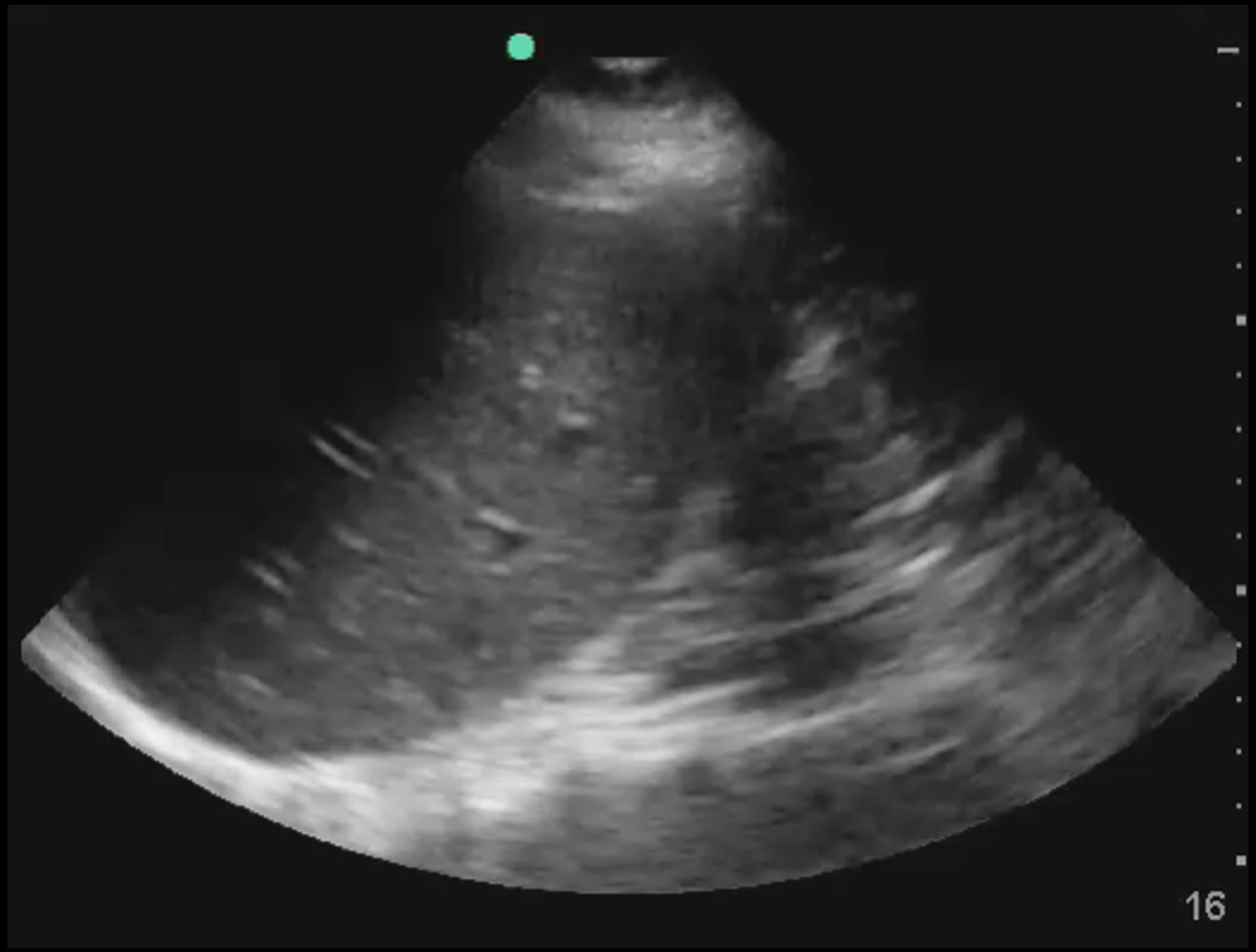
PNEUMOTHORAX

CHEST COMPRESSIONS



RHYTHM CHECK

HYPOVOLEMIA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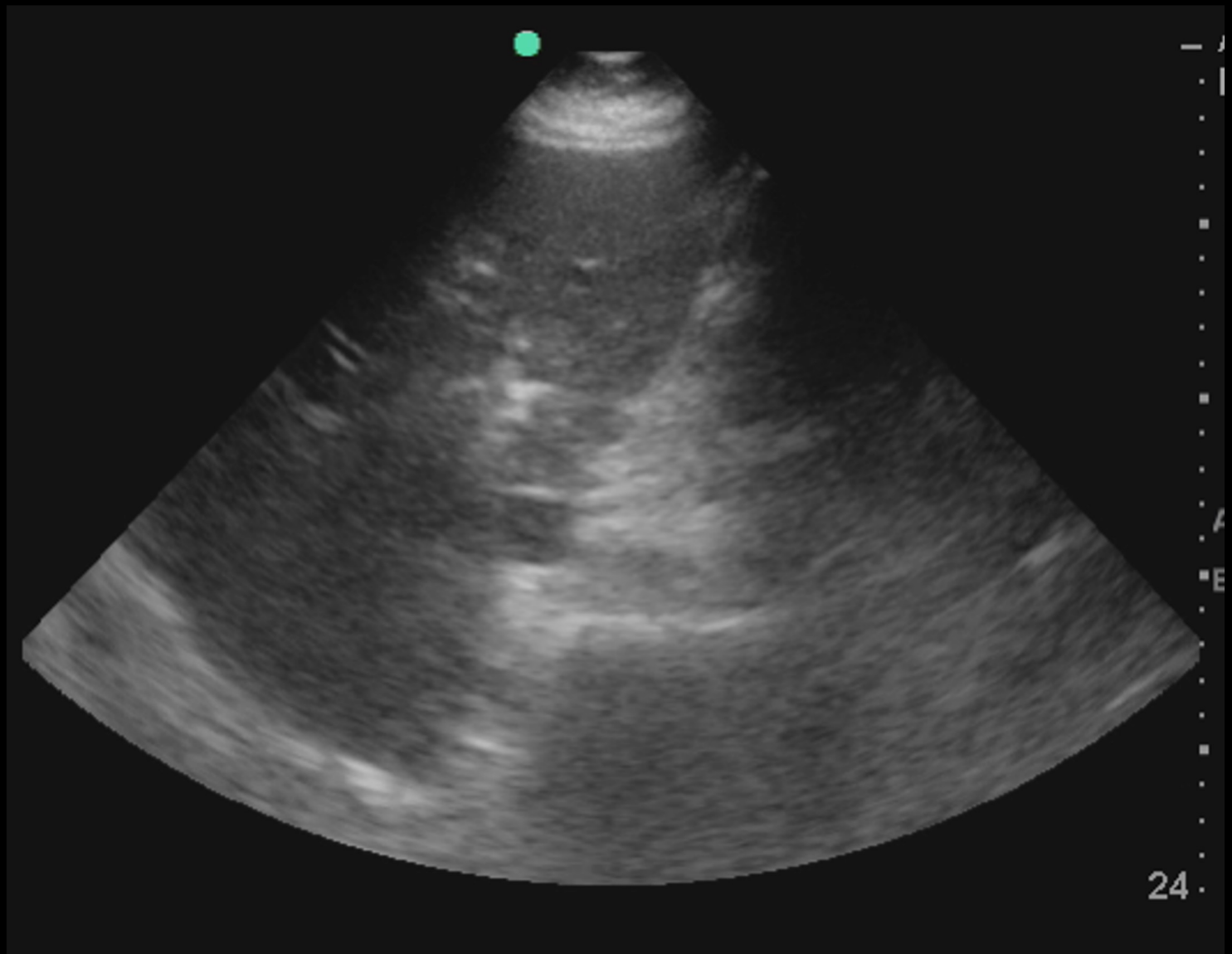
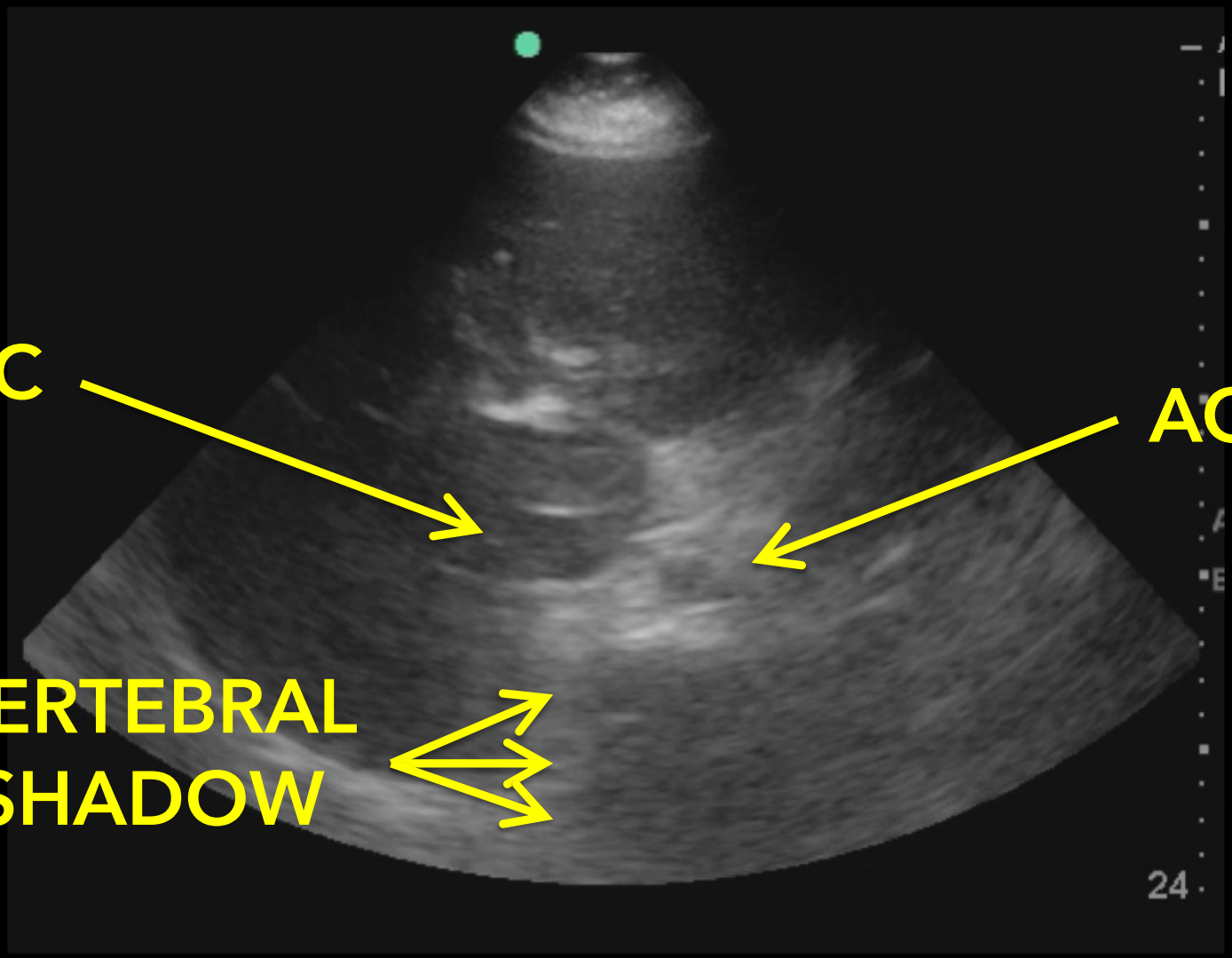
ABDOMINAL AORTA



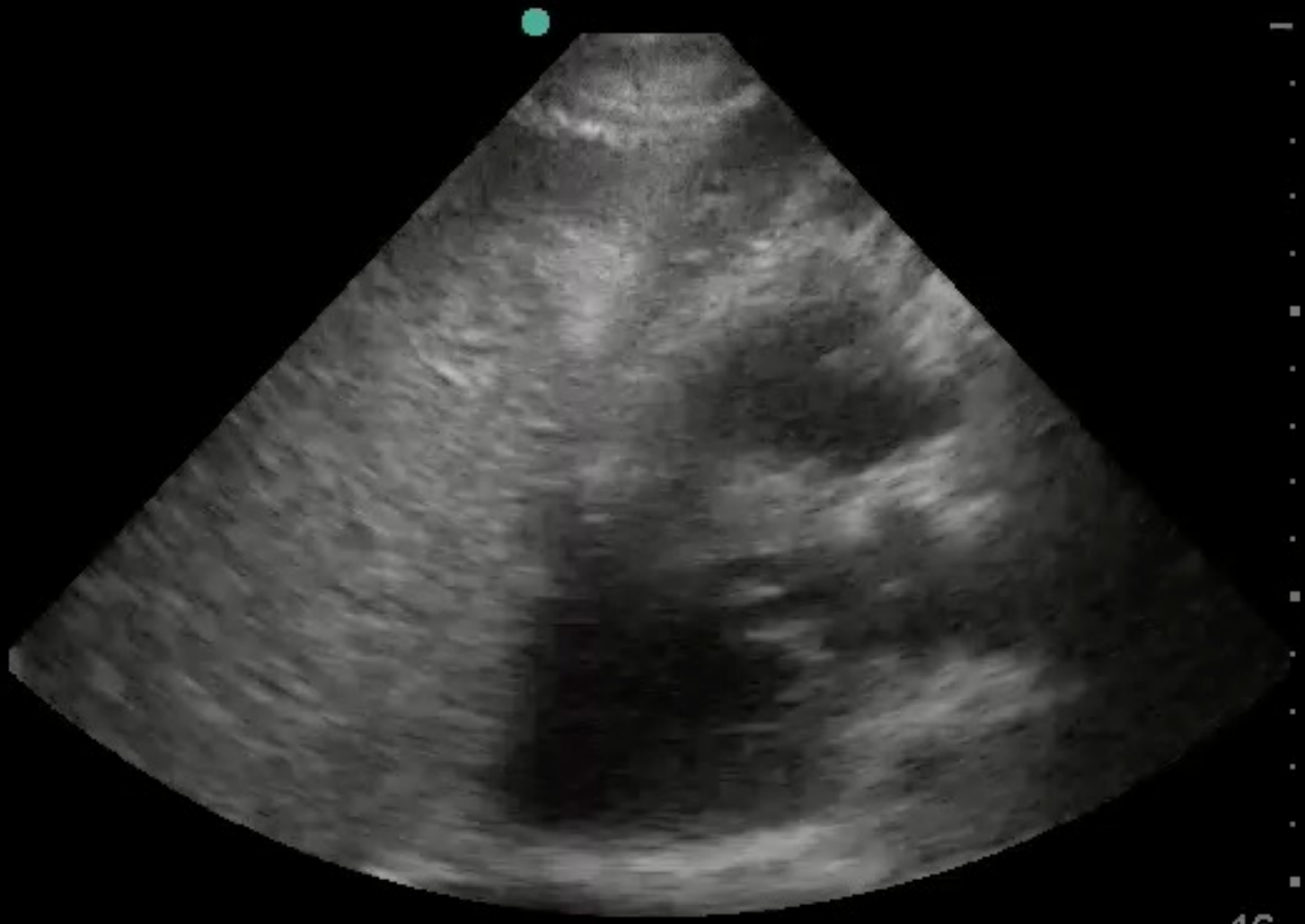
ABDOMINAL AORTA



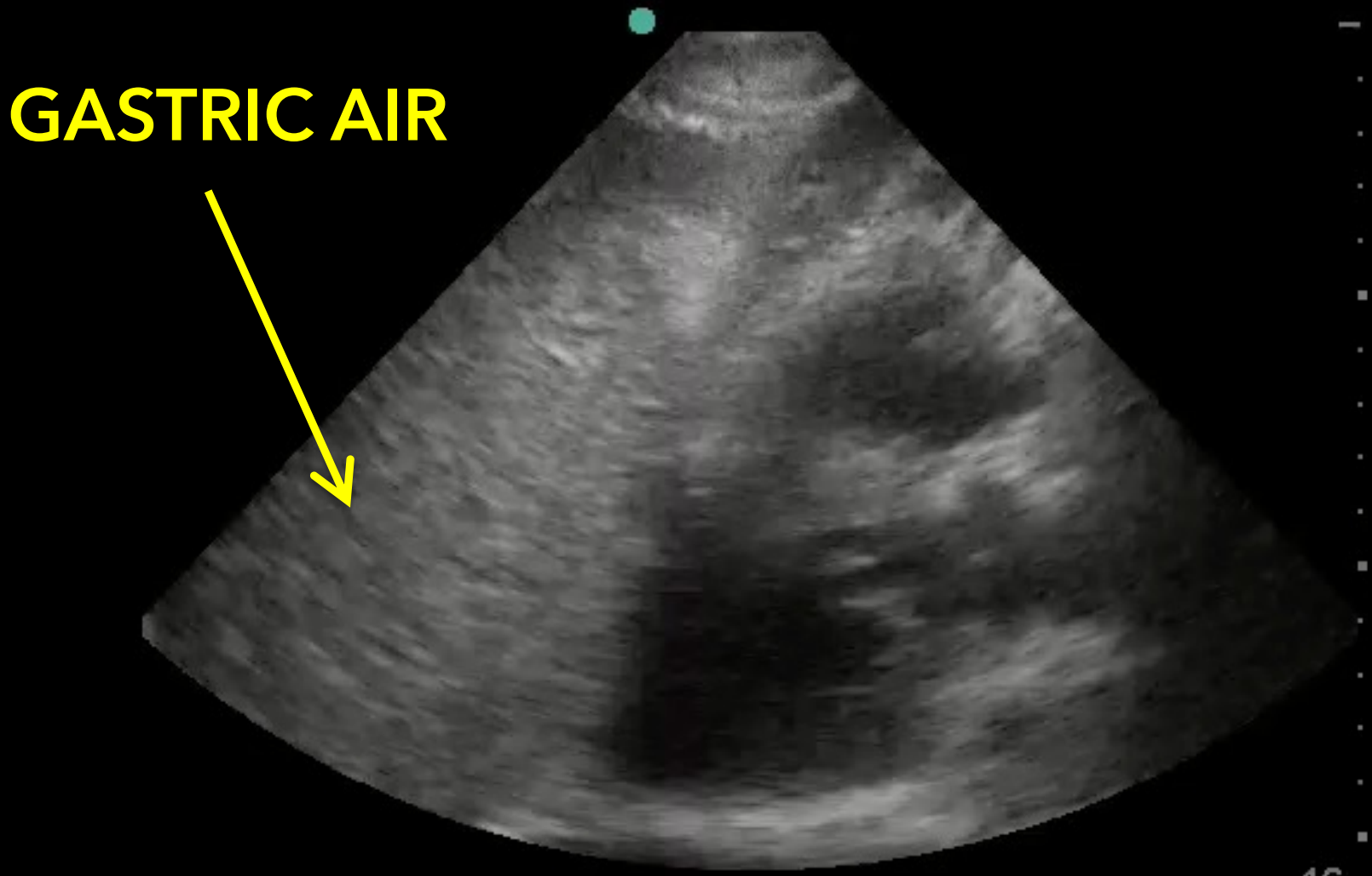
CTA PE STUDY

PSLA RHYTHM CHECK

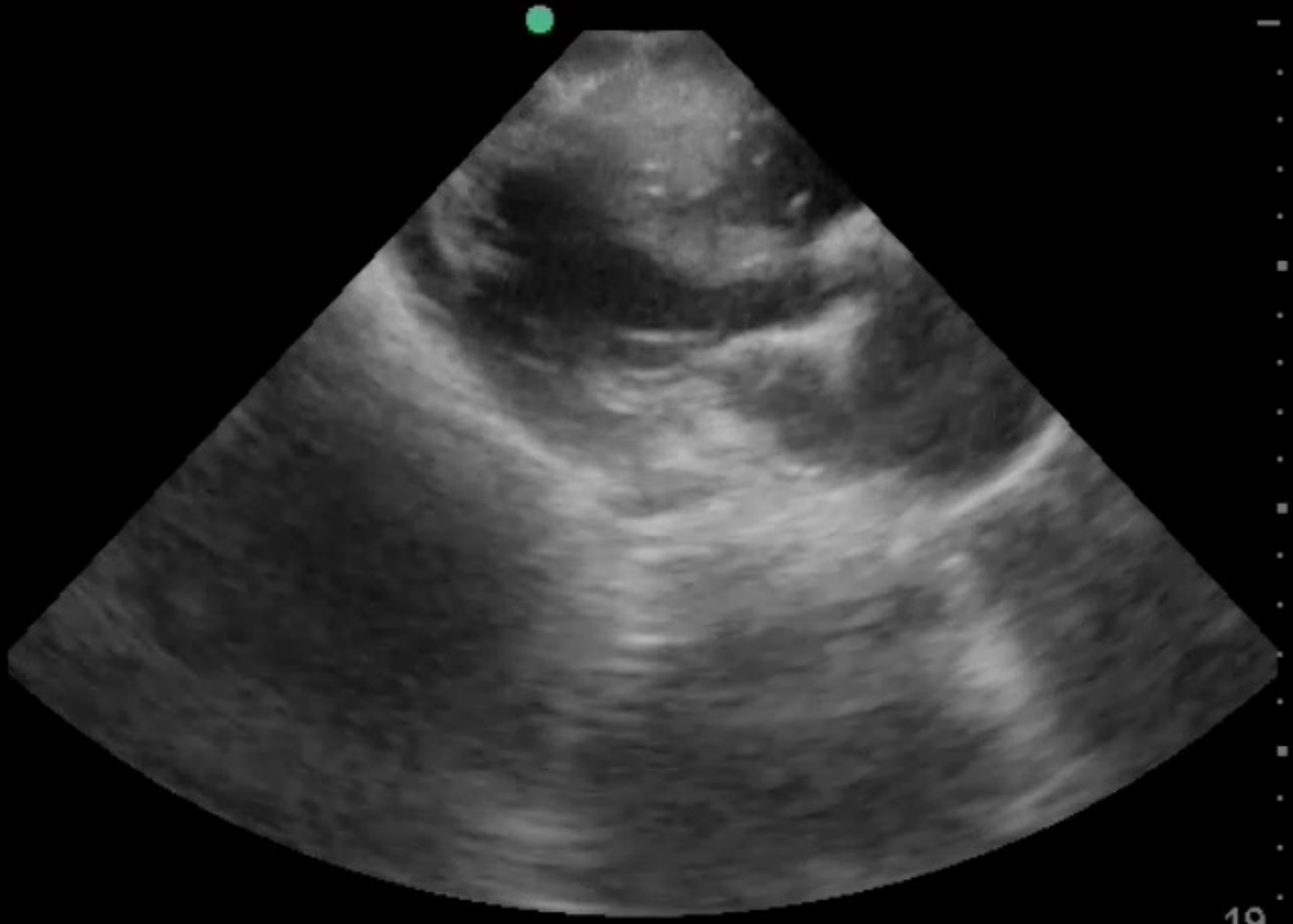
CONFUSING LUQ



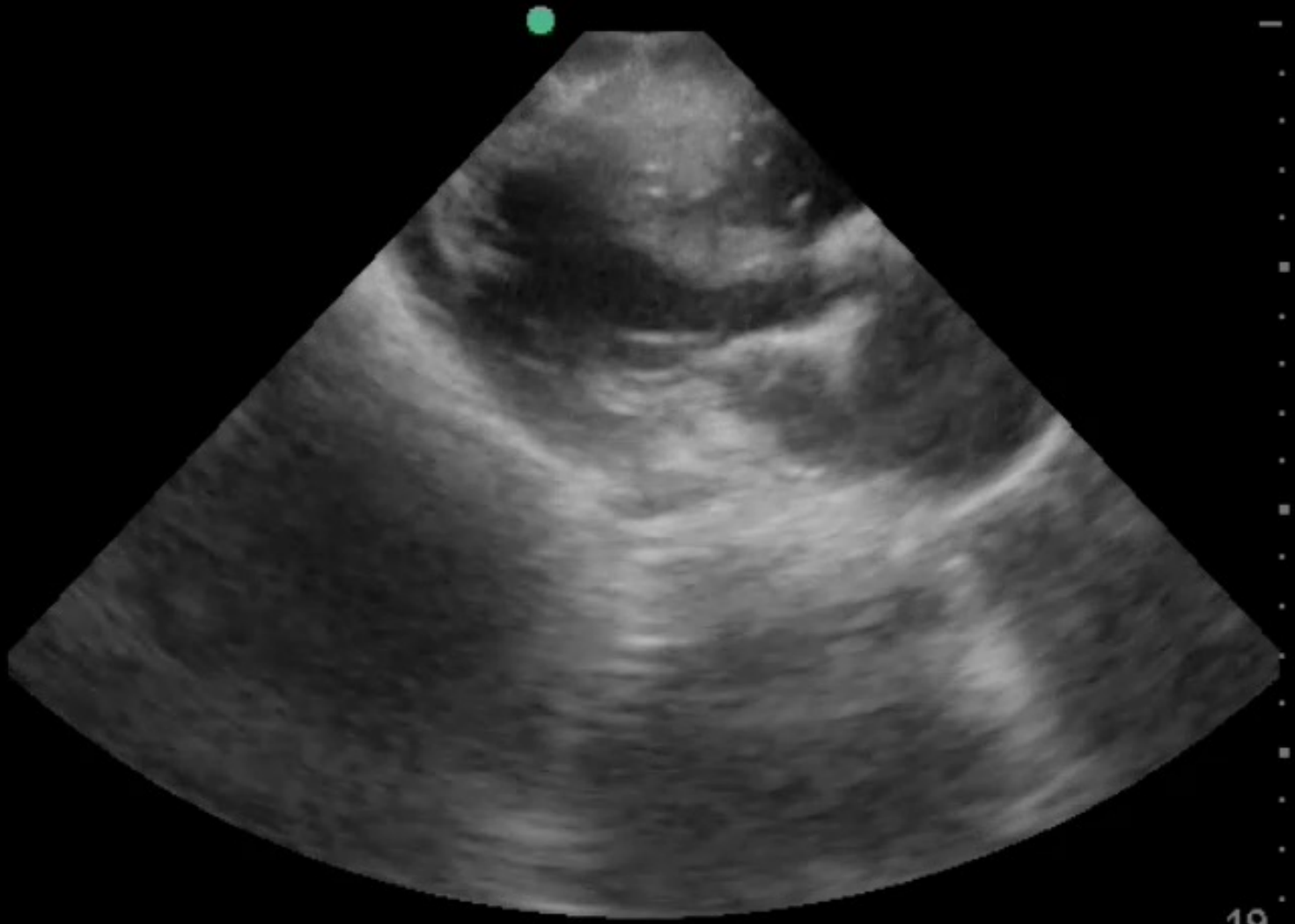
CONFUSING LUQ



ASYSTOLE ON MONITOR



FINE VFIB



CPR QUALITY ASSESSMENT

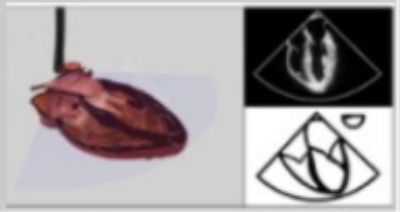
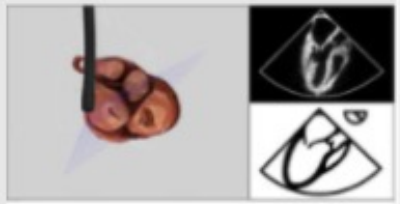
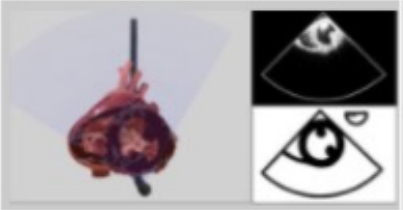
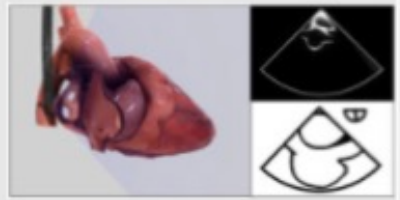
TEE IN ARREST

Transesophageal Echocardiography: Guidelines for Point-of-Care Applications in Cardiac Arrest Resuscitation

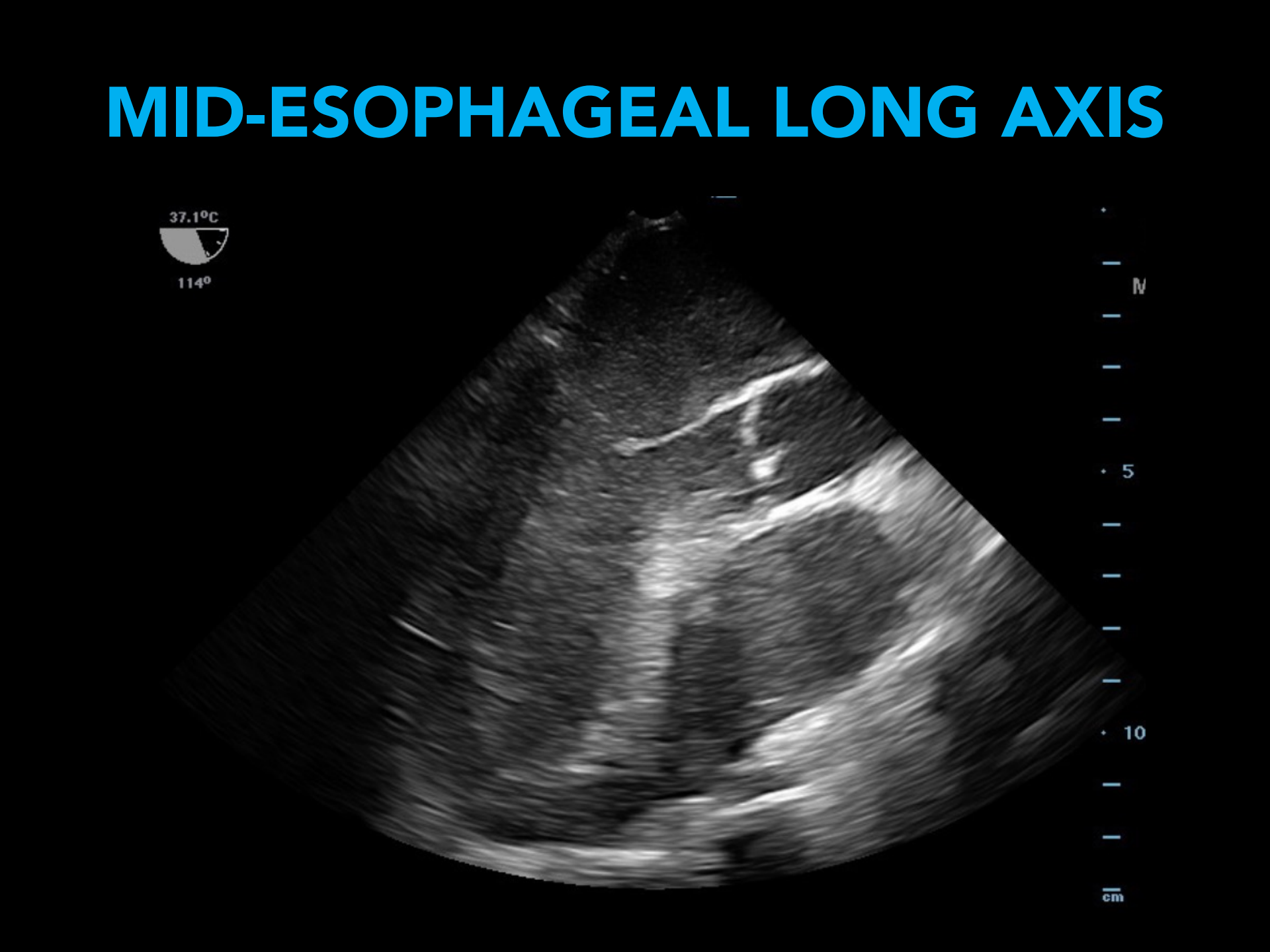
James Fair, MD*; Michael Mallin, MD; Haney Mallemat, MD; Joshua Zimmerman, MD; Robert Arntfield, MD; Ross Kessler, MD; Jonathan Bailitz, MD; Michael Blaivas, MD

Fair Annals of Emergency Medicine 2017

RESUSCITATIVE TEE VIEWS

Focused TEE view		Cardiac structures	TTE equivalent	Clinical Application
Mid-esophageal 4 chamber (ME4C)		Four chambers, mitral and tricuspid valves and pericardium	Apical four chamber	Pericardial effusion Intra ventricular thrombus LV/RV function Valve lesions and dysfunction
Mid-esophageal long axis (MELAX)		Left ventricle, left atrium, mitral and aortic valves	Parasternal long axis	Quality of CPR LV function Pericardial effusion Mitral / aortic valve dysfunction
Transgastric short (TG)		Left ventricle	Parasternal short axis	Left ventricular function (RWMA) Pericardial effusion
Mid-esophageal Bicaval (ME Bicaval)		Simultaneous view of IVC, RA and SVC	N/A	Procedural guidance Volume responsiveness

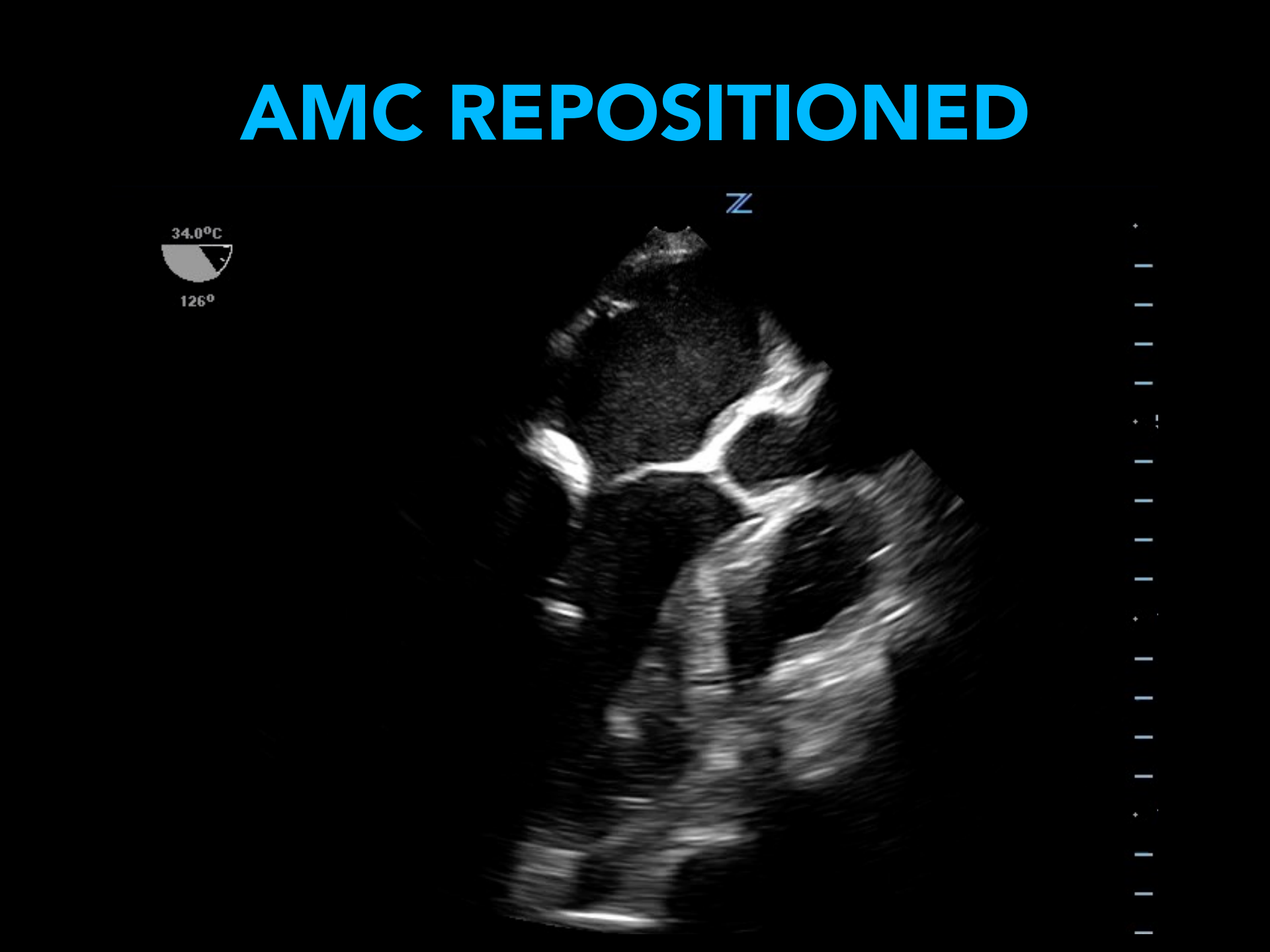
MID-ESOPHAGEAL LONG AXIS



DEPTH OF COMPRESSION

LVOT COMPRESSION

AMC REPOSITIONED



prognostic
diagnostic
algorithms

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diagnostic
algorithms

B
E.M.T.
LIFEPAK

Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions☆

Maite A. Huis in 't Veld[a], Michael G. Allison[b], David S. Bostick[a], Kiondra R. Fisher[c], Olga G. Goloubeva[d], Michael D. Witting[e], Michael E. Winters[e,*]

Type of pulse check	Mean duration in seconds	95% CI
Without POCUS	13	12–15
With POCUS	21	18–24

- **23 patients total**
- **US = 8 second longer pulse checks**

Huis in 't Veld Resuscitation 2017

Point-of-care ultrasound use in patients with cardiac arrest is associated prolonged cardiopulmonary resuscitation pauses: A prospective cohort study

Eben J Clattenburg[a,*], Peter Wroe[a], Stephen Brown[b], Kevin Gardner[a], Lia Losonczy[a], Amandeep Singh[a], Arun Nagdev[a,b]

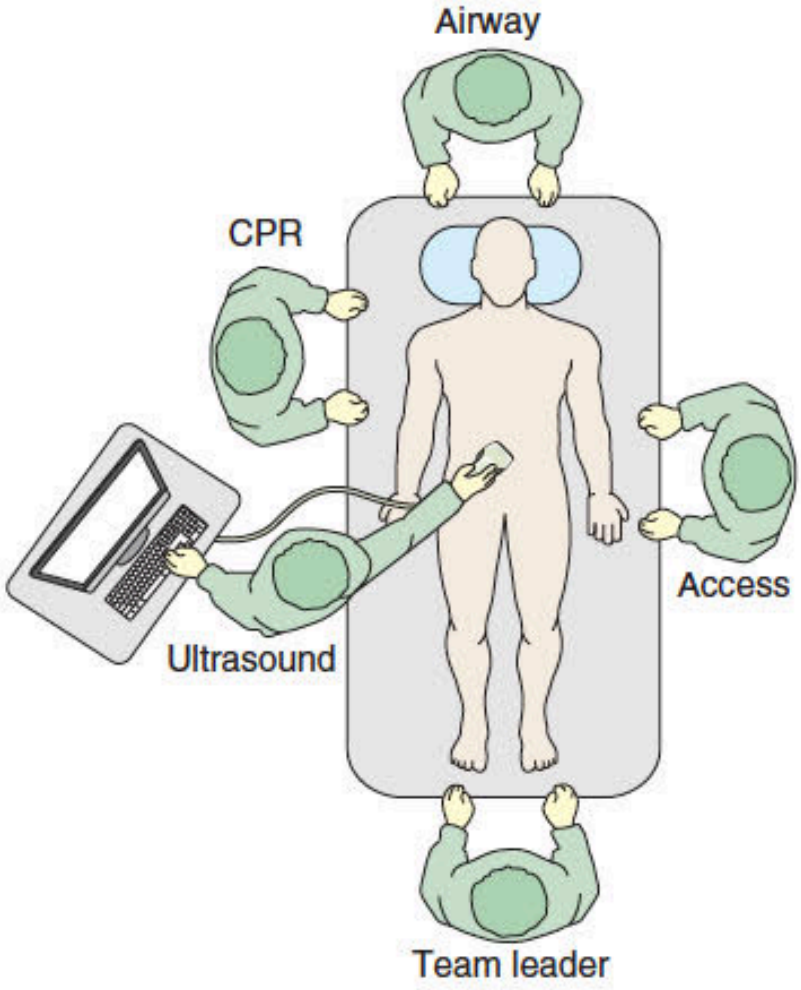
[a] *Department of Emergency Medicine, Highland Hospital—Alameda Health System, Oakland, CA, United States*
[b] *School of Medicine, University of California, San Francisco, CA, United States*

	Univariable		
Predictor variable[b]	β (sec)	SE	p-value
POCUS performed	5.0	2.1	0.02
Resident year			
PA	REF		
2	4.1	5.4	0.45
3	7.3	5.7	0.21
4	12.8	5.6	0.02
Intubation performed	2.5	3.5	0.49
Automated cardiac compression device	−1.0	2.1	0.64
Attending ultrasound fellowship trained	−3.9	2.3	0.09
Same provider performs POCUS and leads code	6.1	2.8	0.04

Clattenburg Resuscitation 2017

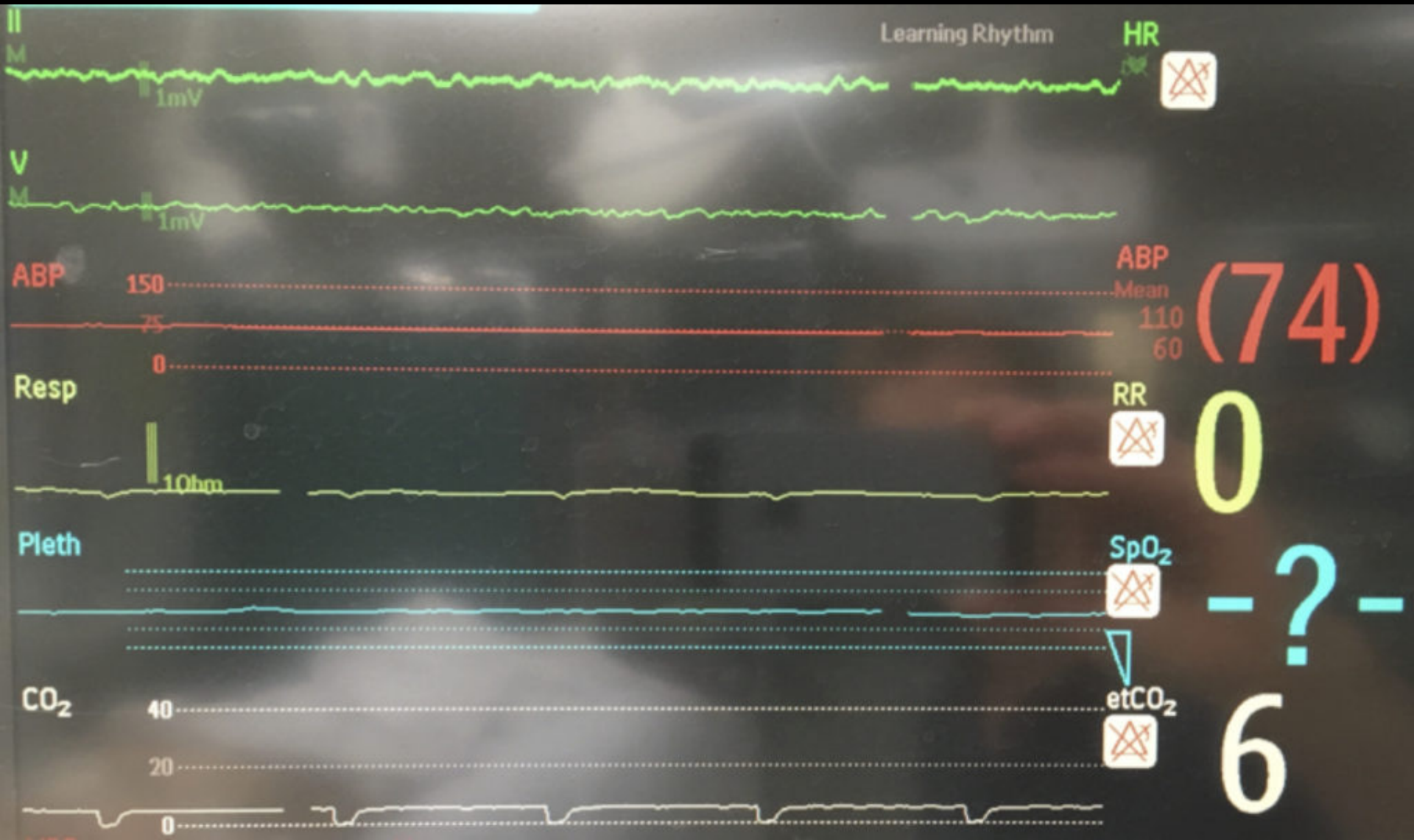
KEY FACTORS?

SET ROLES & POSITIONS



AVOID CHEST AND A4C VIEWS

6 SEC RHYTHM CHECK CLIP



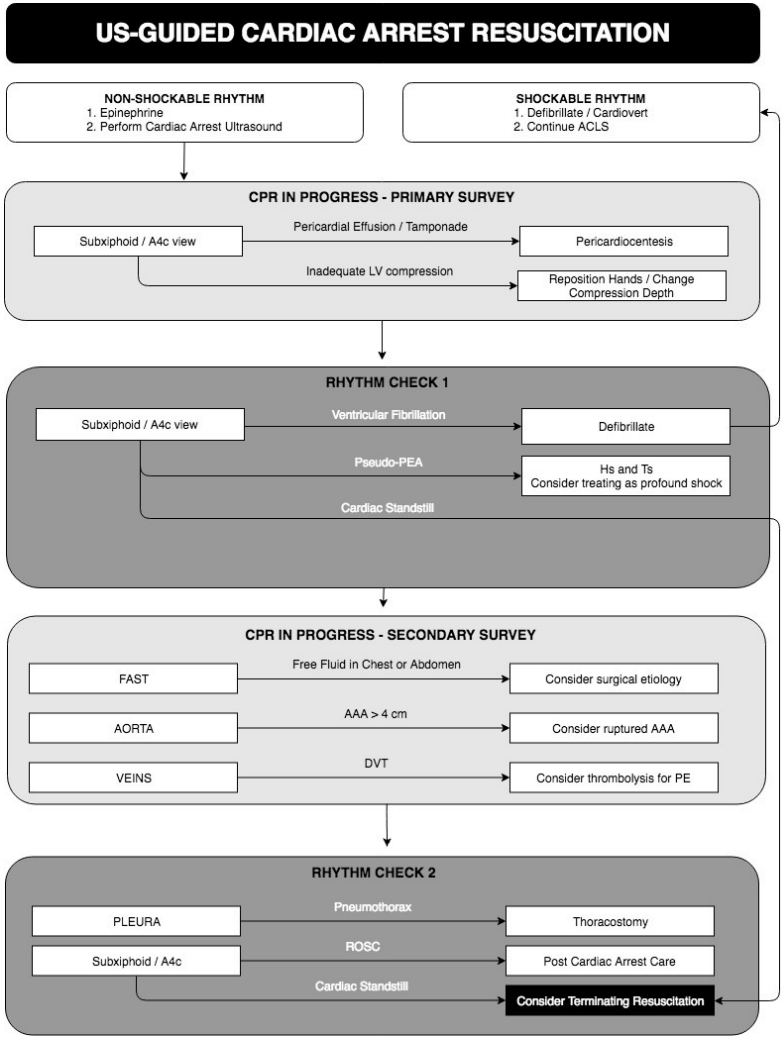
DICHOTOMIZE

CPR

RHYTHM CHECK

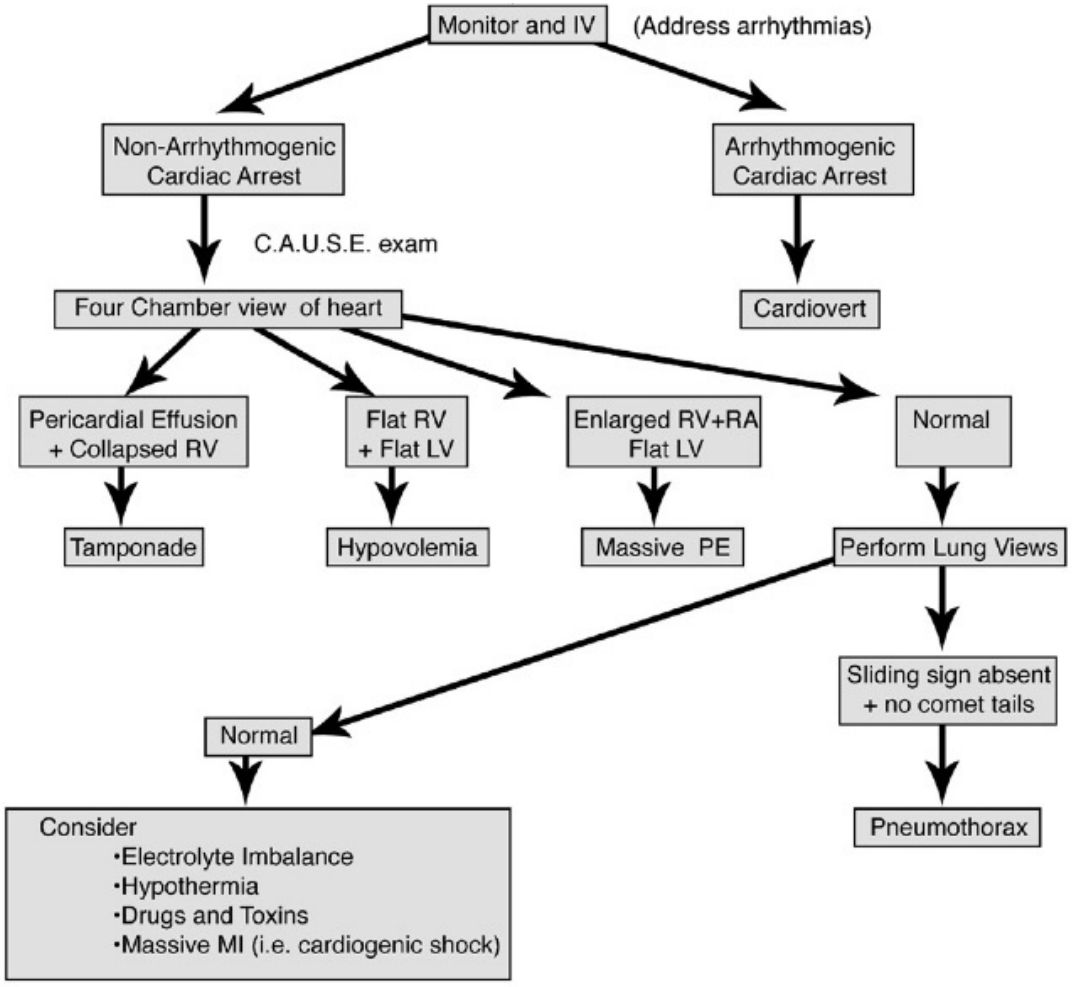
CPR

RHYTHM CHECK



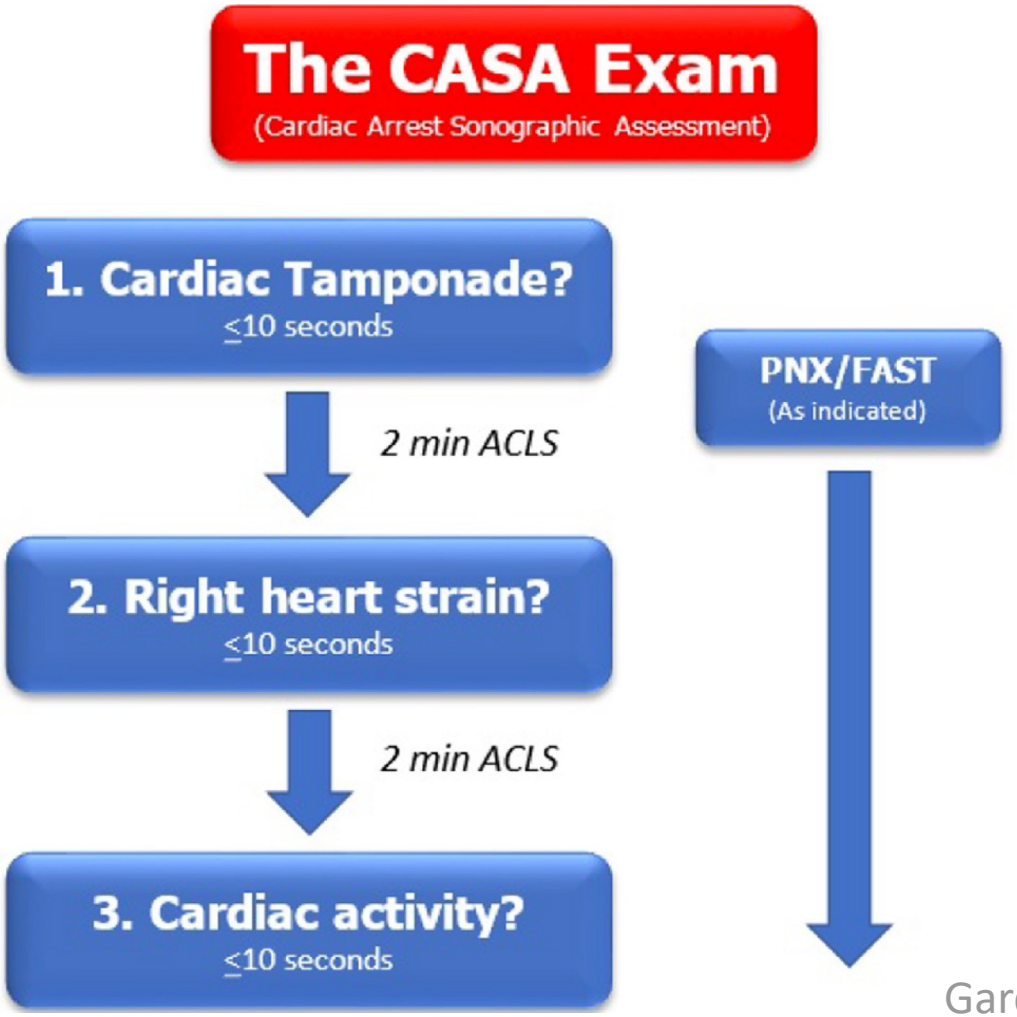
ALGORITHMS

CAUSE



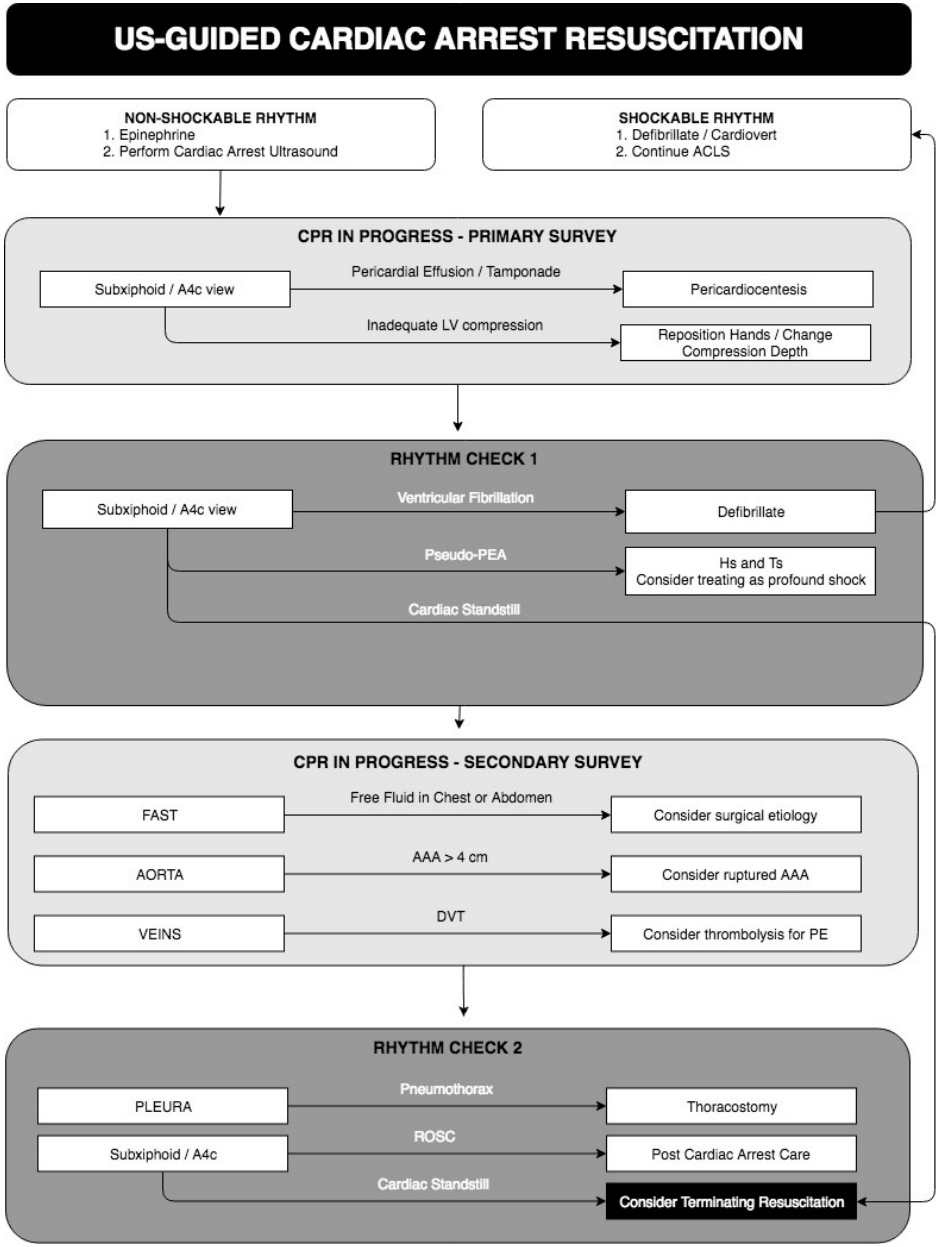
Hernandez 2008 Resuscitation

CASA



Gardner 2017 AJEM

US-GUIDED CARDIAC ARREST RESUSCITATION



SUMMARY

Optimizing Cardiac Arrest Care with Ultrasound

1. use the REASON definition of cardiac activity

2. Pseudo-PEA = profound shock

3. Be vigilant for confounders when assessing cardiac activity

Optimizing Cardiac Arrest Care with Ultrasound

4. You can use cardiac standstill to terminate resuscitation.

5. Use ultrasound to search for reversible etiologies in these patients.

6. Use presence of thrombus rather than chamber size comparison to assess for PE.

CARDIAC ARREST ULTRASOUND

7. To assess CPR Quality learn to use resuscitative TEE

8. Dichotomize your diagnostic search

9. An algorithmic approach will minimize interruptions to CPR

@pandrus