

Ultrasound in Cardiac Arrest

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Ultrasound in Cardiac Arrest

- As a diagnostic tool
- As a prognostic tool
- Ethics

Ultrasound in Cardiac Arrest

- As a diagnostic tool
- **As a prognostic tool**
- Ethics

Ultrasound in Cardiac Arrest: as a diagnostic tool

- Is the endotracheal tube in the trachea?
- Is a pneumothorax present?
- Is there a pulse?
- Is there cardiac motion?
- Is LV contractility normal? hyper? hypo?
- Is RV size normal?
- Is pericardial fluid present? Signs of tamponade?

Ultrasound in Cardiac Arrest: as a diagnostic tool

- Using ultrasound in the peri-arrest patient
 - hypovolemia
 - pericardial tamponade
 - tension pneumothorax
 - pulmonary embolism
 - myocardial dysfunction/failure
 - distributive shock (anaphylaxis, sepsis, neurogenic)

Ultrasound in Cardiac Arrest: as a diagnostic tool

- 2001 UHP undifferentiated hypotensive patient US protocol
- 2007 FEER focused echocardiographic evaluation in resuscitation
- 2008 C.A.U.S.E. cardiac arrest ultrasound exam
- 2009 RUSH rapid ultrasound for shock and hypotension
- 2010 FEEL focused echocardiographic evaluation in life support
- 2010 FOCUS focused cardiac ultrasound in the emergent setting
- 2010 RUSH rapid ultrasound in shock
- 2011 EGLS echo-guided life support
- 2014 CORE concentrated overview of resuscitative efforts

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



- 2001, Blaivas and Fox in *Acad EM*
- All CPR pts had parasternal or subxiphoid US during pulse checks
- 169 patients
 - 38% asystole, 22% PEA, 39% VF
 - 136 had cardiac standstill on initial ultrasound (71 with a rhythm on the monitor, 65 with asystole)
 - All patients with initial cardiac standstill died in the ED

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 - **All patients with initial cardiac standstill died in the ED**

Can Cardiac Sonography and Capnography Be Used Independently and in Combination to Predict Resuscitation Outcomes?

- 2001, Salen et al. in *Acad EM*
- 102 patients, 1-5 US exams + capnography
- Overall survival to hosp. admission 27% vs 3%
- PEA patients survival to hosp. admission 26% vs 4%
- No pulse but cardiac activity present in 40%
- 100% of patients with cardiac motion on ***all*** US exams during resuscitation survived to hospital admission

Can Cardiac Sonography and Capnography Be Used Independently and in Combination to Predict Resuscitation Outcomes?

- 1 of 63 with no movement on initial US exam...
- 1 PEA pt and 1 asystole pt without sonographic contractions survived to admission
- 7% of patients with no sonographic contractions at some time during resuscitation survived to hospital admission

Can Cardiac Sonography and Capnography Be Used Independently and in Combination to Predict Resuscitation Outcomes?

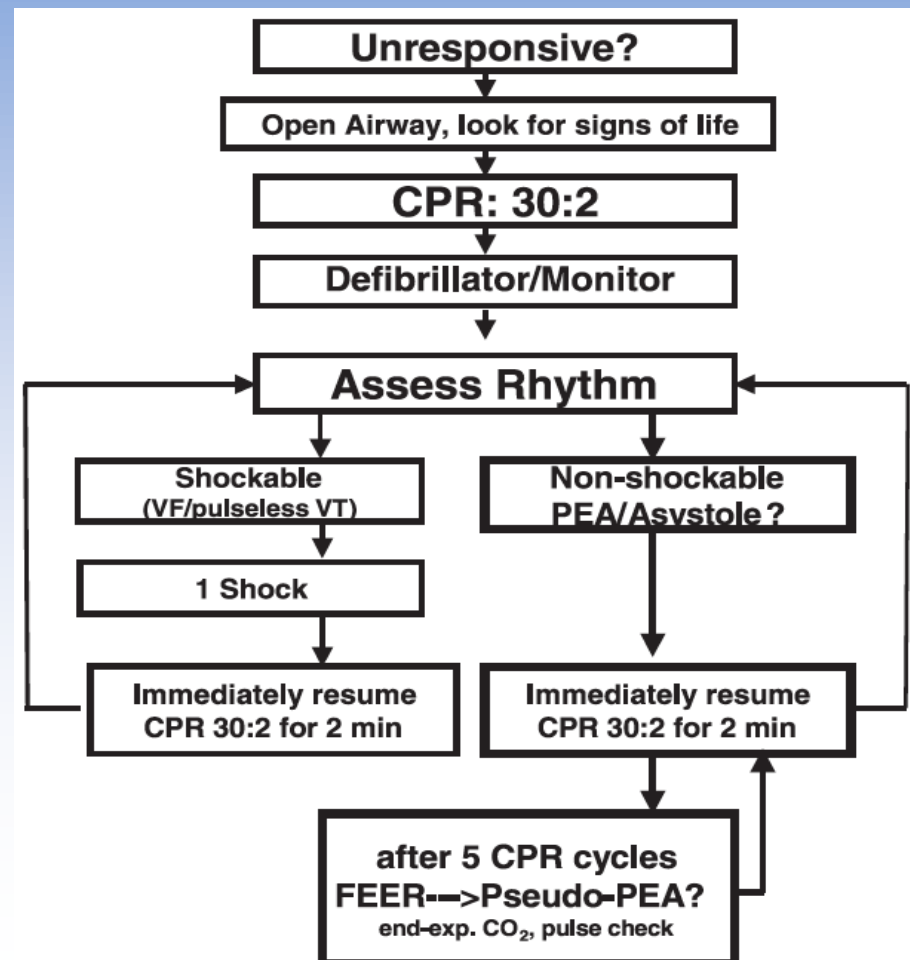
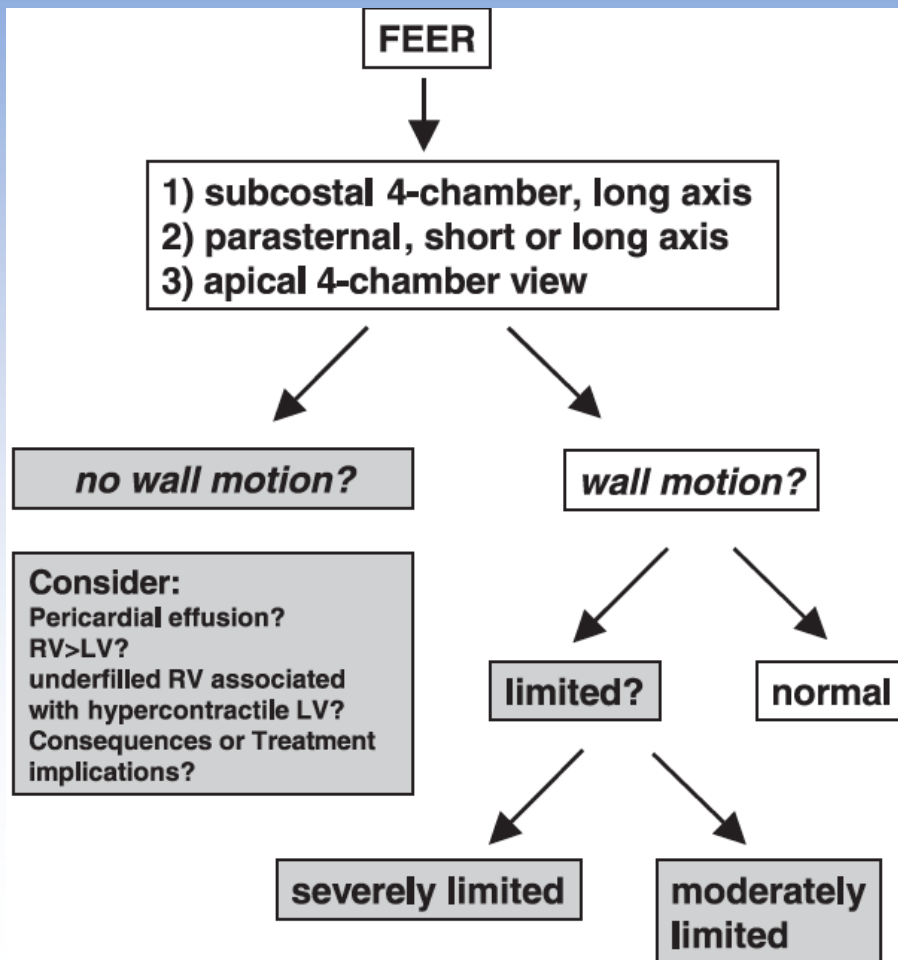
- 2001, 102 patients, 1-5 US exams + capnography
- Overall survival to hosp. admission 27% vs 3%
- PEA patients survival to hosp. admission 26% vs 4%
- No pulse but cardiac activity present in 40%
- If movement present on *all* US exams, 100% survival to hosp. admission
- very easy or moderately easy in 73% of cases
- helpful in 96% of cases

Can Cardiac Sonography and Capnography Be Used Independently and in Combination to Predict Resuscitation Outcomes?

- 2001, 102 patients, ultrasound + **capnography**

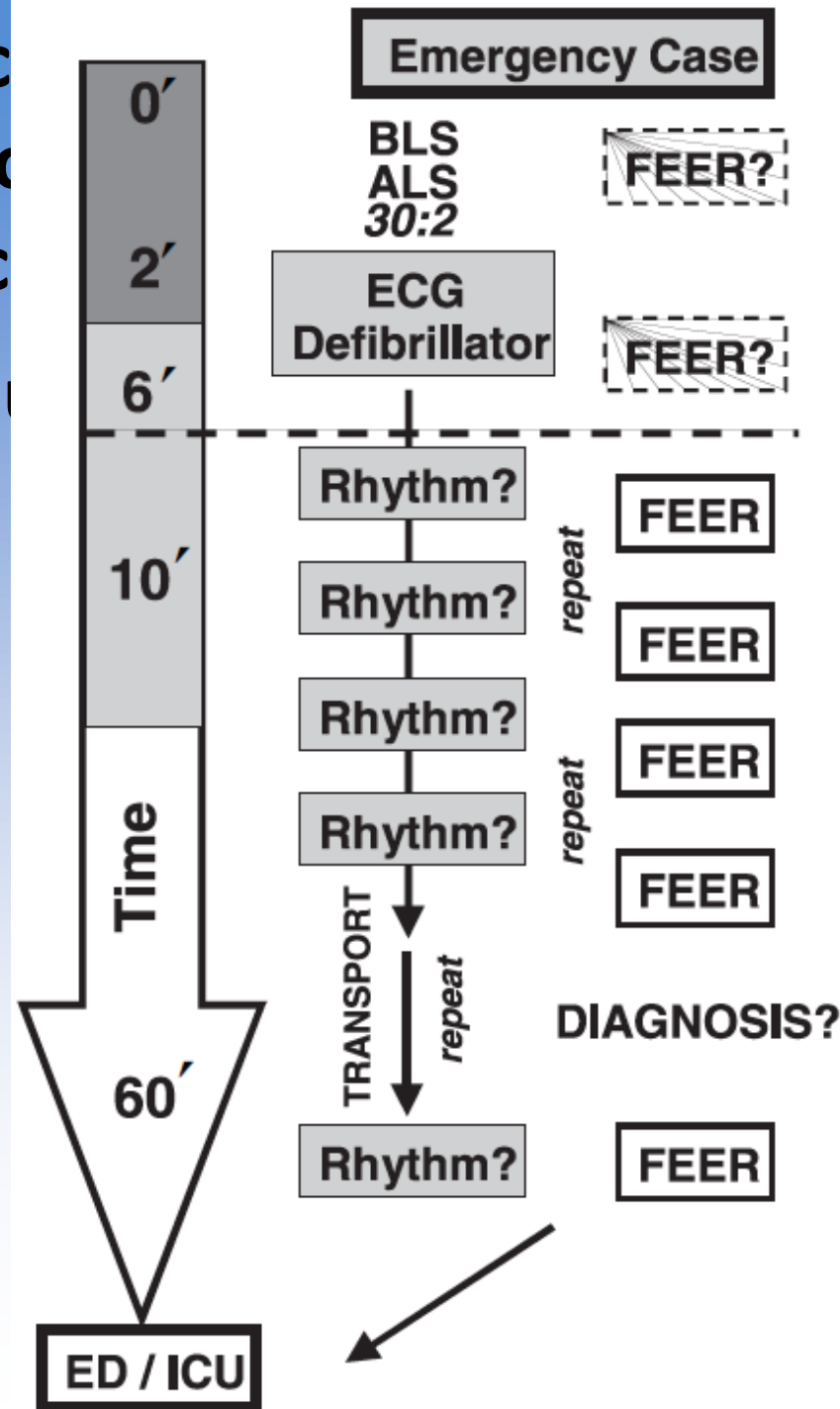
Focused echocardiographic eval. in resuscitation management: Concept of an advanced life support–conformed algorithm

- 2007, Breitkreutz et al. in *Crit Care Med*



Focused echocardiography in cardiac arrest management: Current evidence

- 2007, Breitkreutz et al

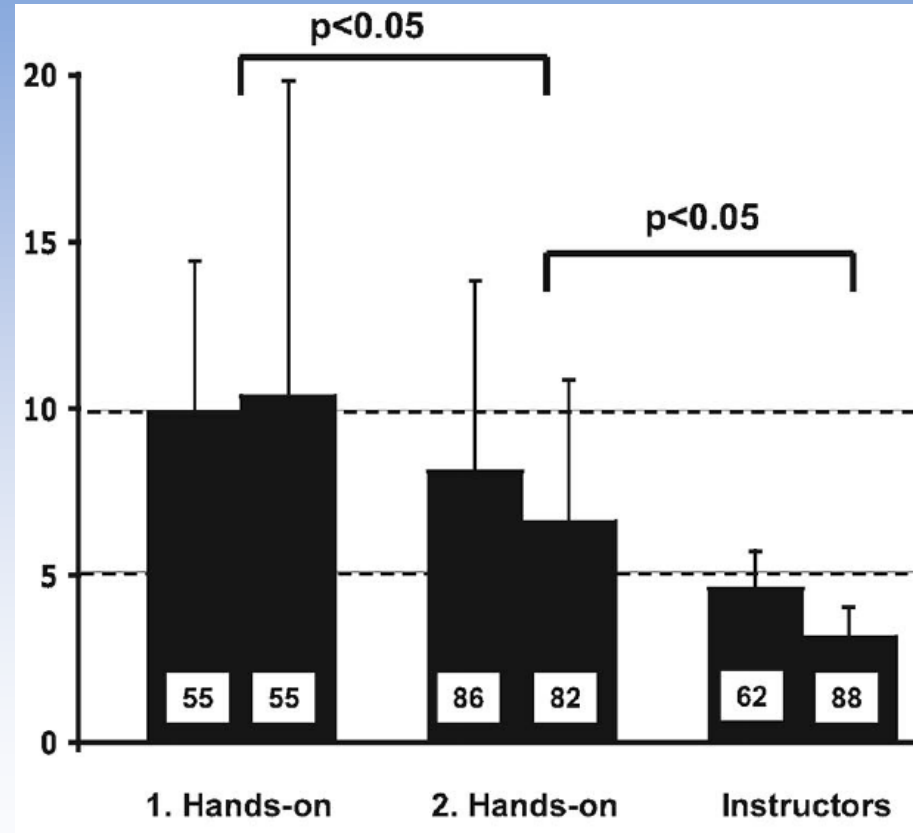


uscitation
fe support–

Duration and success in obtaining a subcostal view after 1st and 2nd training sessions

- 2007, Breitkreutz et al. in *Crit Care Med*
- EM & ICU physicians

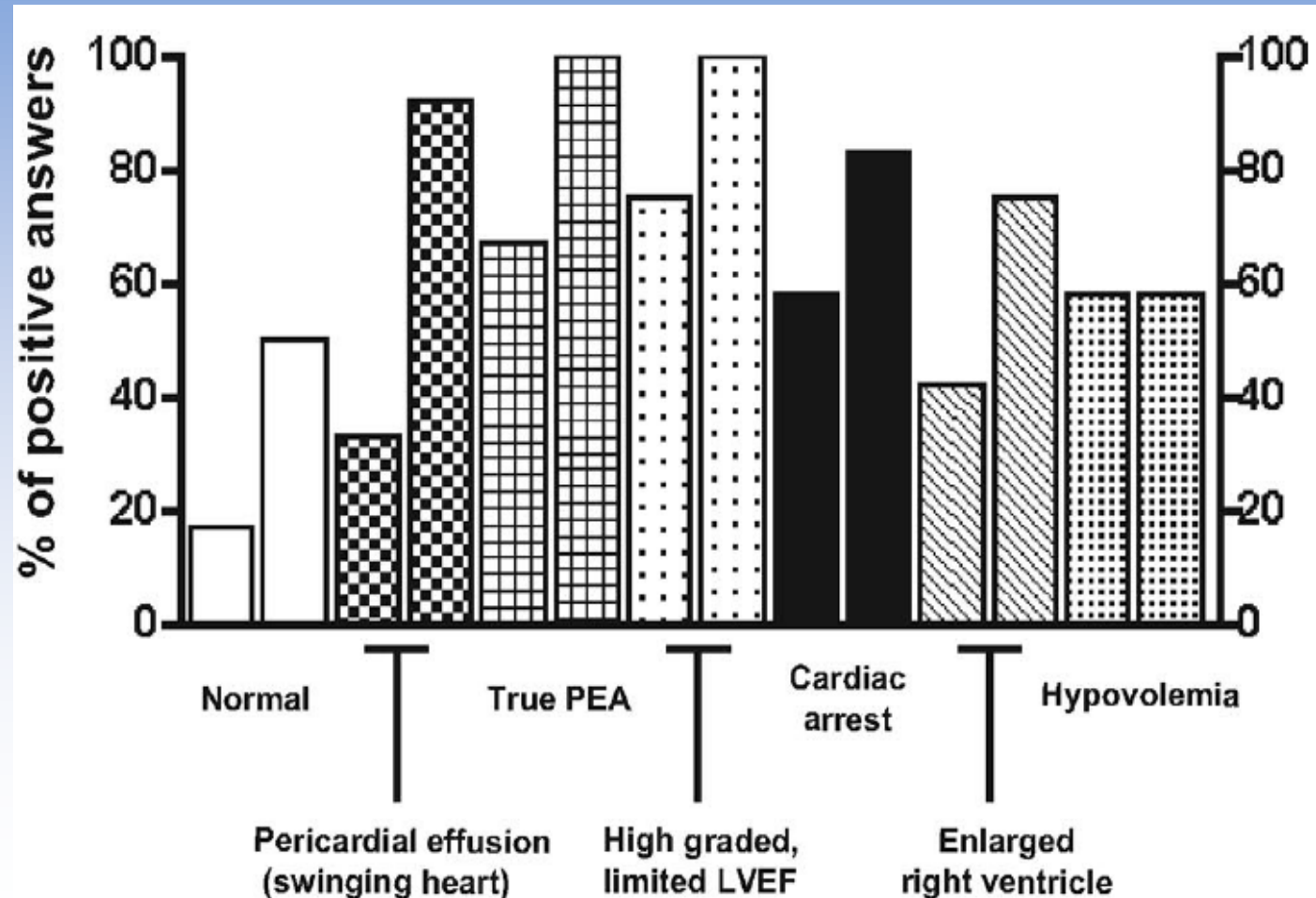
seconds



success

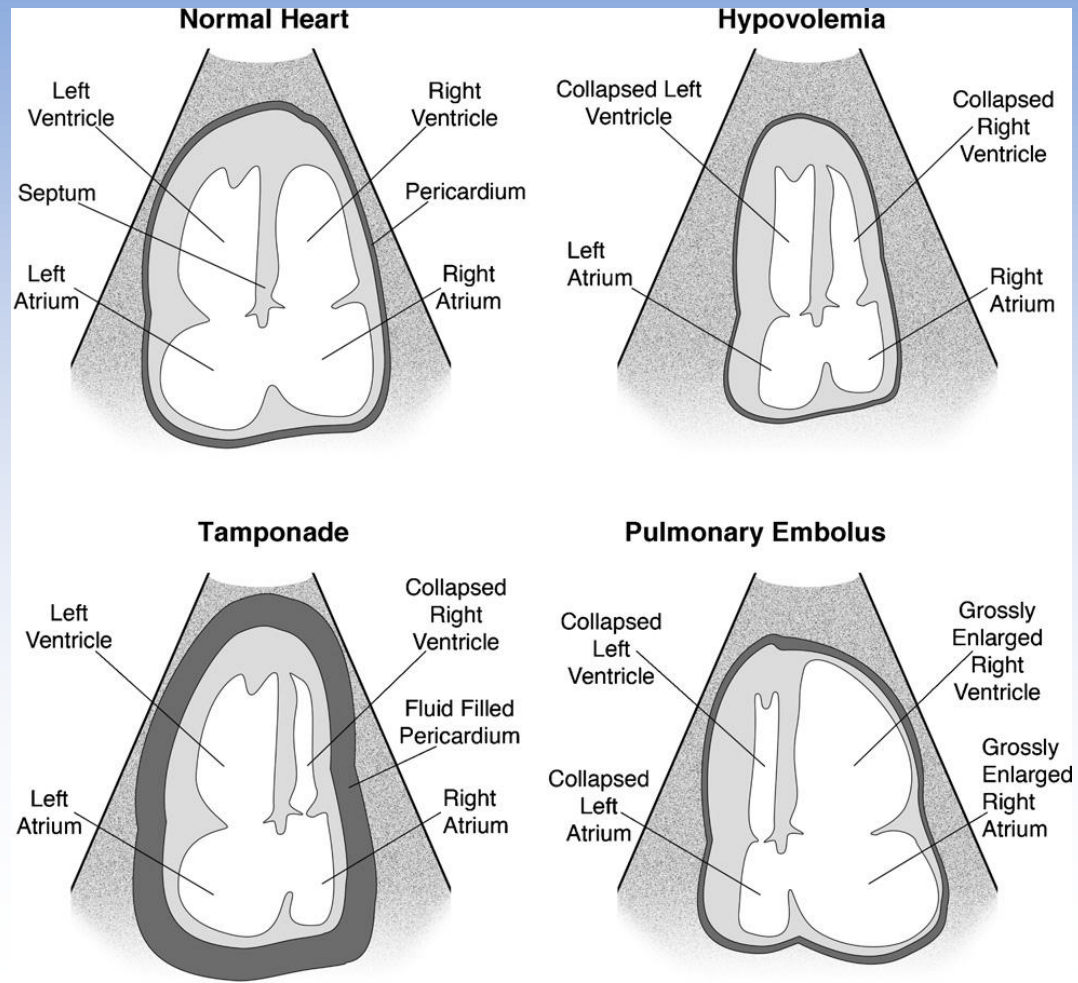
Ability to recognize an echo finding in a 5-second videoclip

- 2007, Breitkreutz et al. in *Crit Care Med*



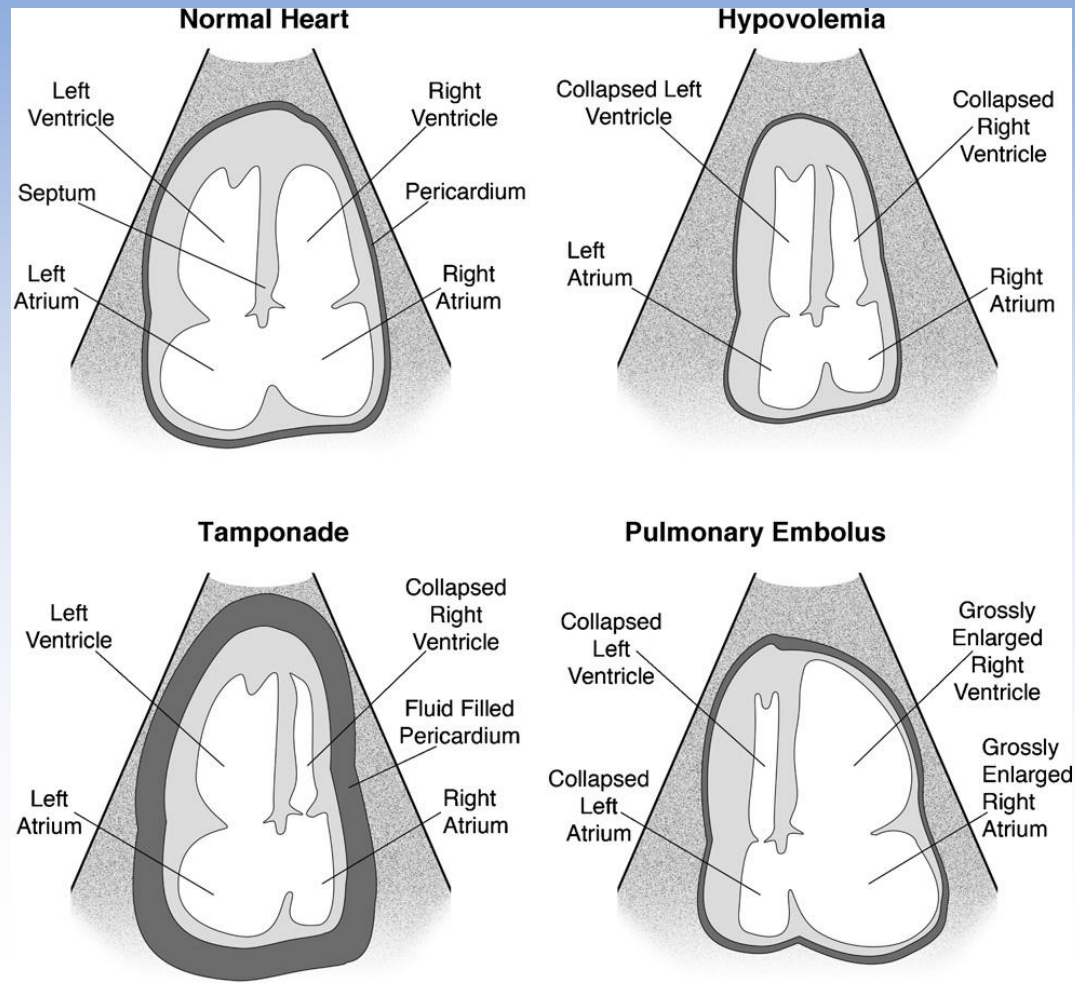
C.A.U.S.E.: Cardiac arrest ultra-sound exam— A better approach to managing patients in primary non-arrhythmogenic cardiac arrest

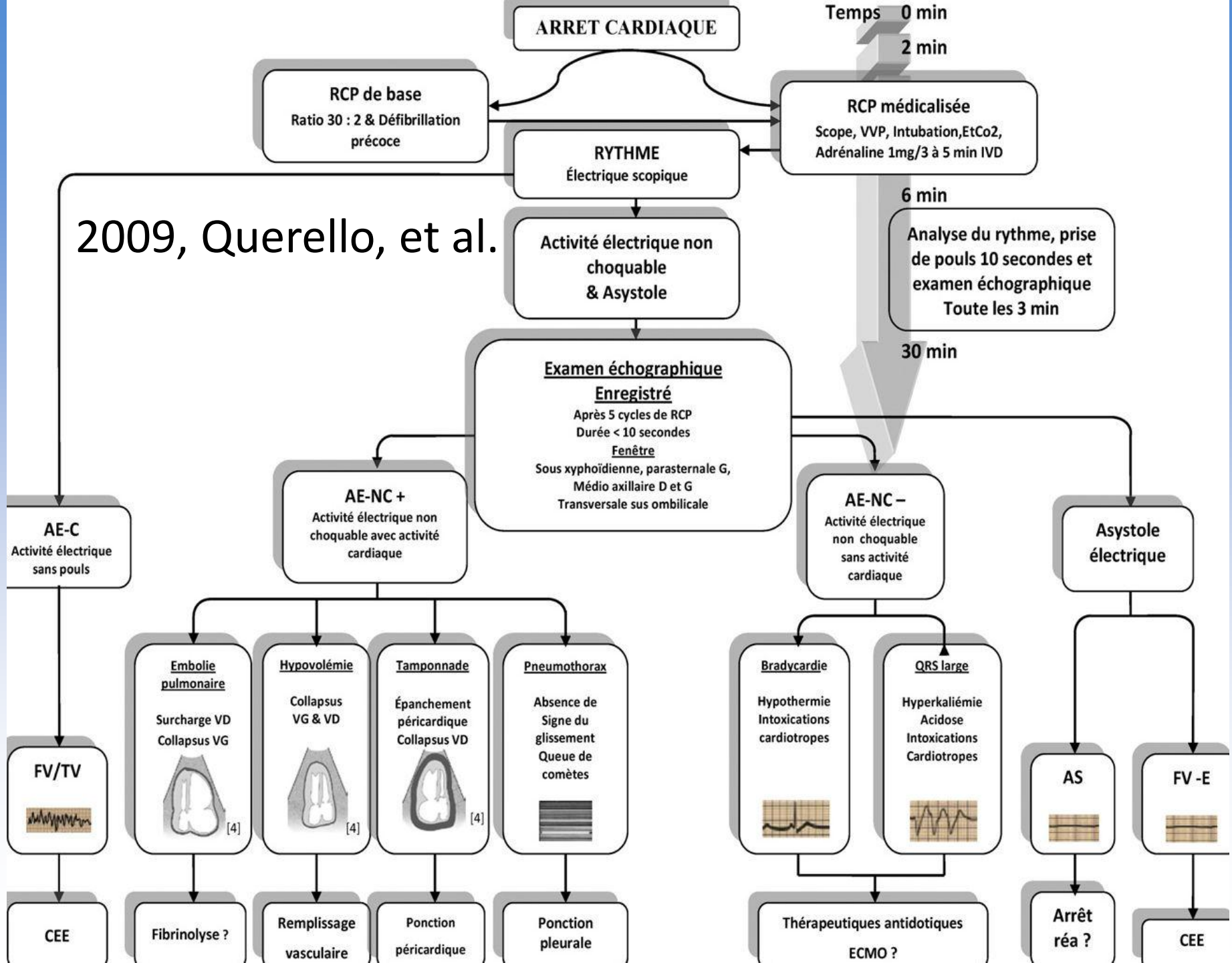
- 2008, Hernandez et al. in *Resuscitation*
- Look for one of four shapes:



C.A.U.S.E.: Cardiac arrest ultra-sound exam— A better approach to managing patients in primary non-arrhythmogenic cardiac arrest

- 2008, Hernandez et al. in *Resuscitation*
- Look for one of four shapes:
- If 'normal', think of MI, toxins, acidosis, hypothermia,





Focused echocardiographic evaluation in life support and peri-resuscitation of emergency patients: a prospective trial

- 2010, Breitkreutz et al. in *Resuscitation*
- Pre-hospital phase, physicians (Germany)
- **FEEL**: motion, LV function, RV size, pericard. fluid
- 204 patients: **100 cardiac arrest**, 104 shock

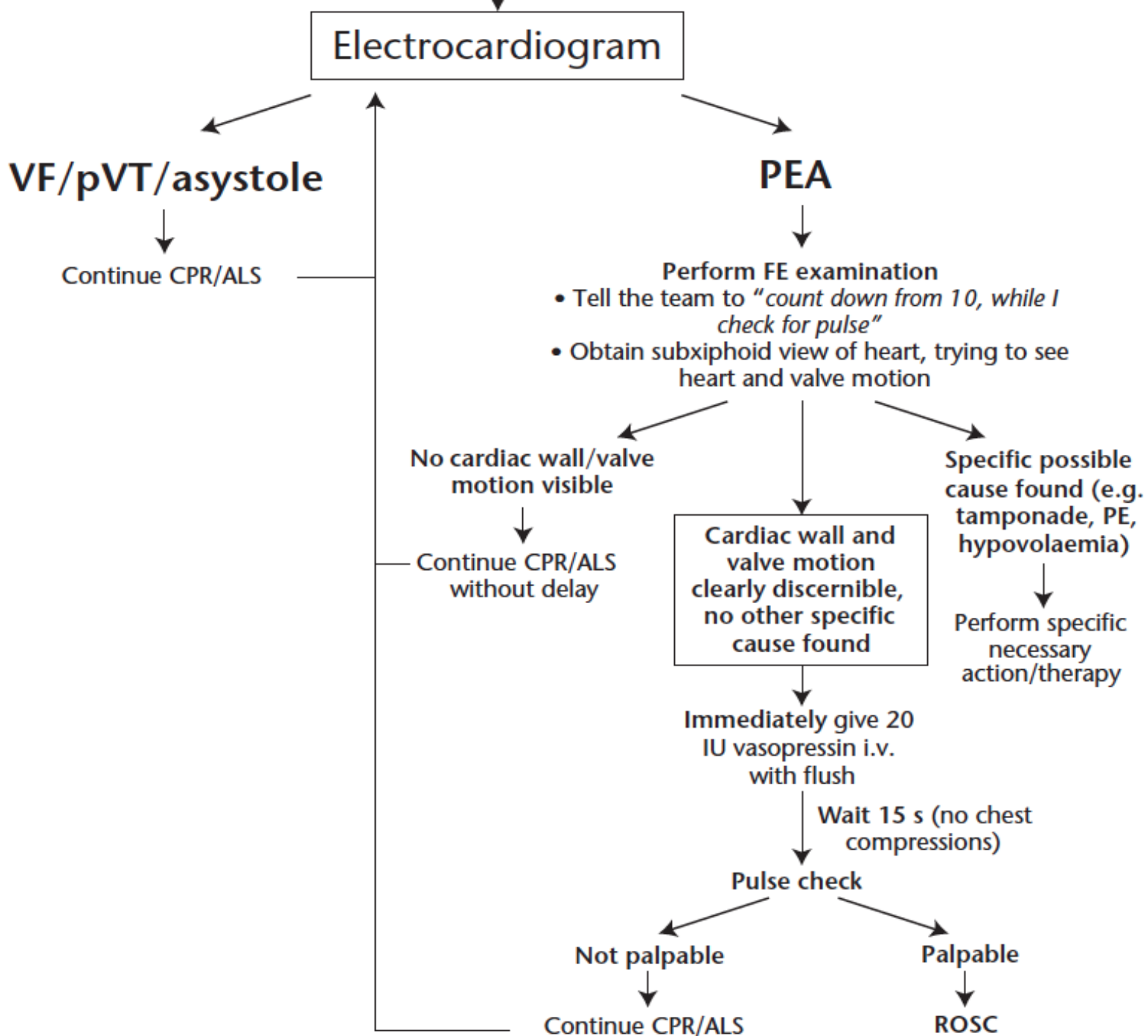
<u>pre-FEEL</u>	<u>post-FEEL</u>	<u>survival to admission</u>
PEA	pseudo-PEA	55%
	true-PEA	8%
asystole	pseudo-asystole	24%
	true-asystole	11%

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- **FEEL**: motion, LV function, RV size, pericard. fluid
- 204 patients: **100 cardiac arrest**, 104 shock
- **Altered management in 78% of cases**

Impact of Modified Treatment in Echocardiographically Confirmed Pseudopulseless Electrical Activity in Out-of-hospital Cardiac Arrest Patients with Constant End-tidal Carbon Dioxide Pressure during Compression Pauses

- 2010, Prosen et al. in *J Int Med Research*
- Before and after study, modified treatment of PEA
- 15 of 16 PEA patients had ROSC
- 8 of 16 PEA patients had good neuro outcome



Echo-guided Life Support

- 2011, Lanctôt in Crit Ultras. J

1. Is there a pneumothorax?

Thoracic views for: B-Lines or lung sliding as it excludes pneumothorax
Lung point(?)

YES

NO

2. Is tamponade present?

Subcostal window for: Pericardial effusion
RA and RV diastolic collapse
Plethoric IVC without respiratory variation

YES

NO

3. Is the patient hypovolemic?

Subcostal window for: Dynamic LV function
LV walls kissing
Small or collapsing IVC
Clear lungs

YES

NO

**Drain and administer fluid
Perform EFAST if trauma patient**

Consider sepsis, occult blood loss, distributive shock

**Administer aggressive fluid resuscitation, antibiotics, steroids if indicated
Ultrasound search for specific causes**

Complete focused echocardiography

Echo-guided Life Support

- 2011, Lanctôt
in Crit Ultras. J

Complete focused echocardiography
(parasternal long/short axis, apical view)

4. If poor LV function noted: Is it the
main cause of hypotension?

Look for: Association with
B-Profile plus
Plethoric IVC without
respiratory variation

YES

Consider myocardial infarction,
intoxication, electrolytes and
acid-base disturbances

Perform EKG
Consider revascularisation
Consider antidotes
Early intubation

NO

5. Are there signs of RV strain?

Look for: Dilated RV
“D-shape” left ventricle
in short axis view
Paradoxical septal wall
movement
Plethoric IVC without
respiratory variation

YES

Consider massive pulmonary
embolism, RV infarction, chronic
disease,

Perform EKG
Consider thoracic CTA
Consider thrombolysis

Assessment of Cardiac Ultrasonography in Predicting Outcome in Adult Cardiac Arrest

- 2012, Tomruk et al. in *J Int Med Research*
- 149 adult cardiac arrest patients
- subxiphoid view with a curved 7 mHz probe

		successful resusc.	
		+	–
initial cardiac activity by US	+	27	19
	–	122	55
		8	67

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Initial rhythm ^a	Cardiac activity ^b	Total	Successful resuscitation ^c	Unsuccessful resuscitation
PEA	Standstill	42 (28.2)	20 (47.6)	22 (52.4)
	Contractions	22 (14.8)	15 (68.2)	7 (31.8)
Asystole	Standstill	72 (48.2)	31 (43.1)	41 (56.9)
	Contractions	5 (3.4)	4 (80.0)	1 (20.0)
VF/VT	Standstill	8 (5.4)	4 (50.0)	4 (50.0)
	Contractions	0	0	0

Transesophageal echocardiography during cardiopulmonary arrest in the emerg. dept.

- 2008, Blaivas in
- 6 cases in which TEE greatly helped
 - 35 y/o OD?, TTE–, CPR ended, TEE placed, EF 15%
 - 73 y/o dyspnea, asystole, TEE placed, showed VF...
 - 73 y/o syncope, pulses+ but TTE–, TEE placed, standstill then thrombus seen
 - 45 y/o with PICC, arrest, VF, TTE standstill, TEE placed, PICC line hitting wall of RA, PICC pulled back...
 - 37 y/o hx PE, dyspnea, TTE showed EF 5%, presumed PE, tPA ready, TEE placed, aortic dissection seen...

Transesophageal echocardiography during cardiopulmonary arrest in the emerg. dept.

- Advantages:
 - images are not affected by body habitus, COPD or subcutaneous emphysema
 - probe can be left in place throughout the resuscitation
 - chambers, wall motion, and valves are seen in greater detail
 - quality of CPR can be monitored
- Disadvantages
 - cost (machine/probe/training)

Does the Absence of Cardiac Activity on Ultrasonography Predict Failed Resuscitation in Cardiac Arrest? (meta-analysis)

- 2013, Cohn in *Annals of EM*
- 8 studies, 568 patients

Return of spontaneous
circulation

+

–

Cardiac activity on ultrasound + 98 92

– 9 369

(2.4%)

Ultrasound in Cardiac Arrest: ethics

- To obtain sufficient US images, how long will CPR be interrupted?
- Physicians are not 100% accurate in diagnosing cardiac problems...
- 7% of patients with ROSC had cardiac standstill on at least one ultrasound during their resusc.

Areas for further study:

- What is the accuracy of ultrasonography *during* chest compressions?

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- Should we be using TEE instead of TTE?

Areas for further study:

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- How much time is spent doing the ultrasound?
- To what extent is CPR interrupted when ultrasound is performed?
- Should we be using TEE instead of TTE?
- Does seeing cardiac standstill help/hurt the family?

Summary: bedside ultrasound...

- Is a valuable diagnostic tool in cardiac arrest patients, **changing management in >70%**
- Is easy to perform
- Does not interrupt resuscitative efforts
- But, it is perhaps only 80% accurate

Summary: bedside ultrasound...

- Is a valuable diagnostic tool in cardiac arrest patients, **changing management in >70%**
- Is easy to perform
- Does not interrupt resuscitative efforts
- But, it is perhaps only 80% accurate
- **Cannot be used alone to make the decision to terminate resuscitative efforts**

Ultrasound in Cardiac Arrest

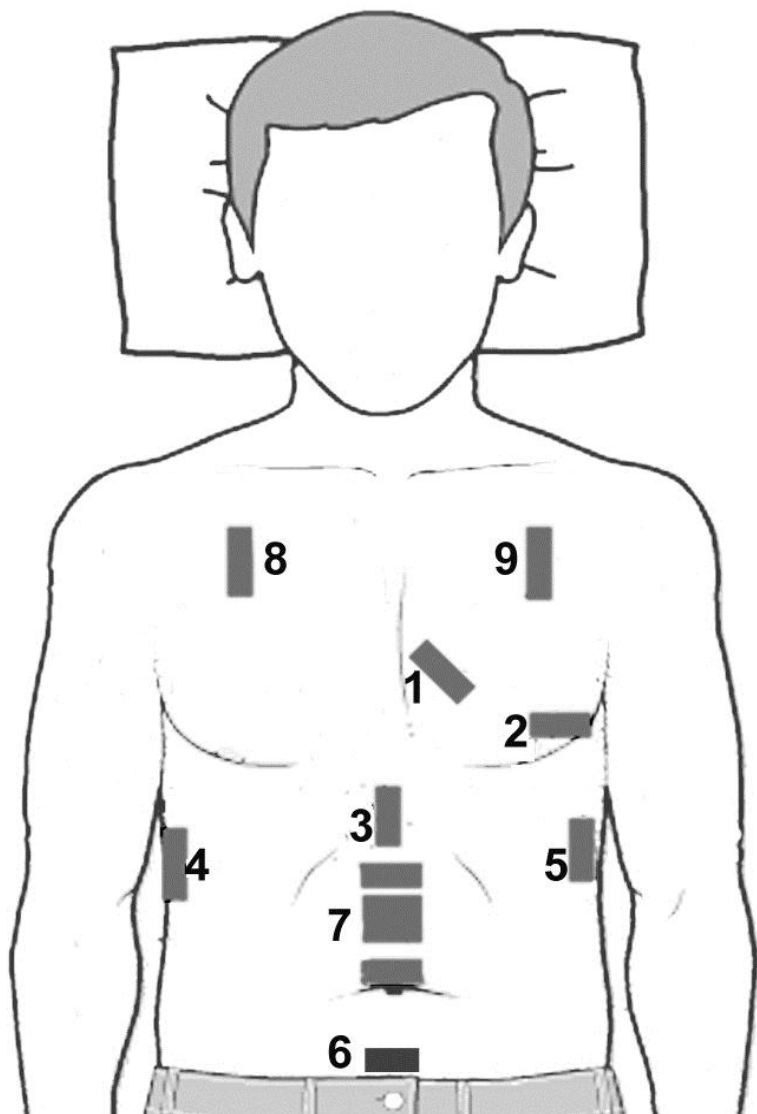
Questions? Comments?

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Rapid Ultrasound for Shock and Hypotension

- HI-MAP (2 minutes)
- Hheart: parasternal long axis, subcostal, (apical) pericardial effusion? LV contractility? RV strain?
- IVC with same probe (cardiac or abdominal)
- Morison's, LUQ, L&R thorax (fluid?), suprapubic
- Aorta with same probe (abdominal)
- Pneumothorax? with same probe or linear probe

Rapid Ultrasound for Shock and Hypotension



RUSH Exam Sequencing

1. Parasternal Long Cardiac View
2. Apical Four-Chamber Cardiac View
3. Inferior Vena Cava View
4. Morison's with Hemothorax View
5. Splenorenal with Hemothorax View
6. Bladder View
7. Aortic Slide Views
8. Pneumothorax View
9. Pneumothorax View

Use Curvilinear Array for 1-7

Use High-Frequency Array for 8 & 9

Rapid Ultrasound for Shock and Hypotension

RUSH Evaluation	Hypovolemic Shock	Cardiogenic Shock	Obstructive Shock	Distributive Shock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart	Hypercontractile heart Pericardial effusion Cardiac tamponade RV strain Cardiac thrombus	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Flat IVC Flat jugular veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended jugular veins Lung rockets (pulmonary edema) Pleural fluid Peritoneal fluid (ascites)	Distended IVC Distended jugular veins Absent lung sliding (pneumothorax)	Normal or small IVC (early sepsis) Peritoneal fluid (sepsis source) Pleural fluid (sepsis source)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

Rapid cardiac ultrasound of *inpatients* suffering PEA arrest performed by nonexpert sonographers

- 2005, 5 patients

Rapid cardiac arrest per

- 2005,
5 patients

