My Patient is Hypotensive...

Sonography in Hypotension and Cardiac Arrest - The SHoC Protocol
Objectives

- Define indications for PoCUS in hypotension
- Describe focused vs. protocol approach
- Overview of SHoC protocol
35 year old female with dyspnea and chest pain

- Meds: OCPs
- SH: smoker
- HR: 148  BP: 70/38  RR: 38
- Chest: NAD
- Cardiac: Sinus tachycardia, no murmurs
• Hypotensive female with PE risk factors
ACES

- Evaluation of Non-Traumatic Undifferentiated Hypotension
- Early Diagnosis
- Goal-Directed focused therapy

U/S Evaluation Includes:
- Cardiac
- Peritoneal
- Thoracic
- IVC
- Aorta
• The Pump
• The Tank
• The Pipes
Central Core Views:
- Subxiphoid/Parasternal
- Pleural/Pulmonary views
- IVC

Outer Core Views:
- Cardiac views
- Abdominal/Pelvic Views for Peritoneal Fluid for women of childbearing age

Additional Views:
- Aorta
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Fluid? Form? Function? Filling?
SHoC - APPROACH

+ WHAT DO I NEED TO SEE?

+ “Eye-ball” assessment vs “accurate” measurement

  • FLUID? (PERICARDIAL / PLEURAL EFFUSION? PULMONARY EDEMA?)

  • FORM (SIZE & SHAPE)

  • FUNCTION

    • WALL THICKENING

    • CHAMBER CONTRACTING

    • VALVE MOVEMENTS

  • FILLING (IVC)
Core views

- Cardiac
  - Subxiphoid/Subcostal
  - Parasternal long axis
- Lung (& Pleura)
- Inferior Vena Cava
Normal Cardiac

- Either probe (cardiac/abdominal)
- Excellent for supine patients
- Good all around imaging window
- Good for identification of:
  - Circumferential pericardial effusion
  - Overall wall motion
  - IVC
- Easy to obtain
  - Liver is the acoustic window
- Away from airway and neck/chest procedures
Parasternal long axis
Parasternal long axis
ASSESSMENT FOR PATHOLOGY

- FLUID?
  - PERICARDIAL EFFUSION?

- FORM
  - SIZE and SHAPE

- FUNCTION
  - WALL THICKENING
  - CHAMBER CONTRACTING
  - VALVE MOVEMENTS

- FILLING
  - IVC SIZE and VARIABILITY
Can emergency physicians detect pericardial effusions?

- 515 patients at ‘high risk’ for pericardial effusions were enrolled, 103 of whom had pericardial effusions
- EPs detected pericardial effusions with an overall sensitivity of 96%, specificity of 98% and accuracy of 97%
Pericardial Tamponade is a clinical diagnosis in a patient with a known Pericardial Effusion.
Tamponade
Tamponade
FORM

CHAMBER SIZE & SHAPE

• Assess LV geometry (both shape & size)
• A ‘big heart is a bad heart’
DILATED, HYPODYNAMIC
DILATED, HYPODYNAMIC
LOOK at the LV...

Normal

Dilated
LOOK at the LV...

Normal

Dilated
LOOK at the LV...

Small LV Chamber Volumes
LOOK at the LV...

Small LV Chamber Volumes
LOOK at the LV...

Normal

Severe Dysfunction

CARDIOGENIC SHOCK
LOOK at the LV...

Normal

Severe Dysfunction

CARDIOGENIC SHOCK
A NOTE ABOUT PULMONARY EMBOLUS

- In general, ultrasound is not a sensitive test for pulmonary embolus.

- In PEA or peri-arrest ultrasound ultrasound becomes more sensitive and specific and can serve as a useful adjunct to clinical diagnosis.
FoCUS aims to identify:-

- RV dilatation
  - RV hypokinesis
  - Paradoxical septal motion

- IVC distention

- (Leg veins for DVT)
PE - in context!!
IVC and B-lines

- **Fluid Resuscitation?**
  - Hypovolemia vs. Fluid Overload
  - Fluid Responsiveness

- **Heart Failure?**
  - B-lines
  - Pleural Effusion
Fluid Responsiveness

- Fundamentally, the only reason to give a patient a fluid challenge is to increase cardiac output (stroke volume)
  - volume responsiveness

- If the fluid challenge does not increase stroke volume, volume loading serves the patient no useful benefit (may be harmful).
Shocked patient

- elderly hypotensive breathless patient
- initial resuscitation questions:
  - under/over filled?
  - fluids / pressors
Fluid Responsiveness

• Only 40-50% of hypotensive patients respond to fluid resuscitation

• How do we identify them?
The IVC
Ventilation and the IVC

Expiration  Inspiration  Exp

Spontaneous breathing

IVC

Normo or hypervolemic patient

IVC

Hypovolemic patient

IVC

Positive pressure ventilation
SHoC - IVC

Lung

Parasternal

Lung

Lung

Lung

IVC
IVC Windows

- 1. Sub-xiphoid
- 2. Transthoracic
1a. Sub-xiphoid transverse
1. Obtain a subxiphoid cardiac view

2. Centre the right atrium

3. Slowly lift the probe handle towards
1. Obtain a subxiphoid cardiac view

2. Centre the right atrium

3. Slowly lift the probe handle towards a perpendicular position

4. The IVC should appear within the liver just “below” the right atrium
IVC

AORTA

Vertebral Body Shadow
1b. Sub-xiphoid longitudinal
1b. Sub-xiphoid longitudinal
1b. Sub-xiphoid longitudinal
2. Transthoracic
Non-collapsing IVC
Non-collapsing IVC
Non-collapsing IVC
Non-collapsing IVC

IVC

Aorta
Collapsing IVC
Collapsing IVC
Non collapsing IVC
Non collapsing IVC
1. does the IVC correlate with Volume Status?
2. IVC ultrasound can predict Fluid Responsiveness?
3. IVC ultrasound can predict Fluid Tolerance?
Collapsibility index

\[ C_{\text{max}} - C_{\text{min}} \]

C_{\text{max}}

- Self ventilating patients

- IVC CI > 50% … CVP <8mm (Nagdev 2010)

- IVC CI <50% … CVP ≥10mm Hg (Kircher et al 1990)
Distensibility index

\[
\frac{D_{\text{max}} - D_{\text{min}}}{D_{\text{min}}}
\]

- Ventilated patients
- DI predicts fluid responsiveness
  - over 18% has sens and spec of 90% (Barbier et al)
  - over 12% has PPV 93% and NPV 92% (Feissel et al)
IVC ultrasound: what do we really know?

• We don’t know exactly where to measure it, or how to measure it.

• We don’t know if a sniff test helps.

• We do know everyone’s IVC is different, and that there are many confounding factors...

Patient size & position
Manner of breathing
Measurement site
Simplified IVC ultrasound

• IVC dilated and does not vary in size
  • unlikely to respond to fluids

• IVC small and varies
  • more likely to respond to fluids

• Serial assessment likely to be useful
Figure 4 Proposed algorithm for integration of point-of-care ultrasound of the inferior vena cava (IVC) into clinical assessment of the hypotensive patient. VTE, venous thromboembolism.
• In the critically ill patient, can echo help with early detection of pulmonary edema?
Pulmonary Edema

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Pulmonary Edema

- In the critically ill patient, can echo help with early detection of pulmonary edema?
Alveolar-interstitial syndrome

• ‘B-lines’ appear as shining vertical lines arising from the pleural line and reach the edge of the screen.

• The number of these vertical B-lines depends on the degree of lung aeration loss
Pleural Effusion...
Vertebral (V) Line
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