

# WHAT'S THE DEAL WITH FLUID RESPONSIVENESS?

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## DISCLOSURES

▶ None

↑ Stroke volume of 10-15%

After

500 mL fluid  
bolus

OR

Passive leg  
raise

# FLUID RESPONSIVENESS?

1 Get baseline



3 Return to normal position



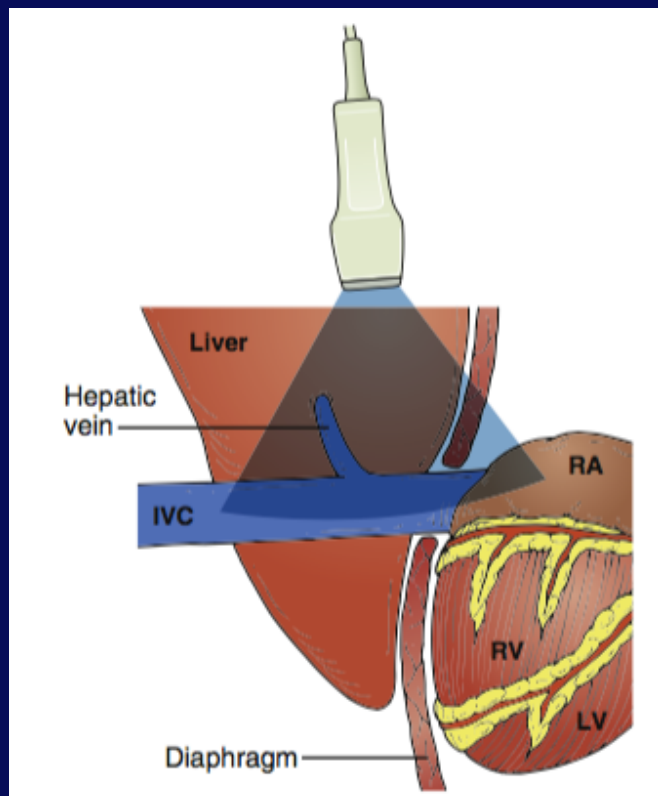
2 60 seconds challenge



# INDICATIONS:

- Volume status and responsiveness
- Shock
- Pericardial effusion

# ANATOMY



# STEPS:

- ▶ Patient position → dorsal decubitus
- ▶ Probe selection:

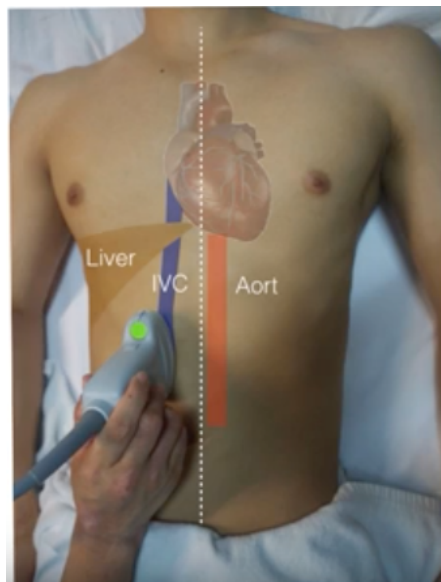


OR



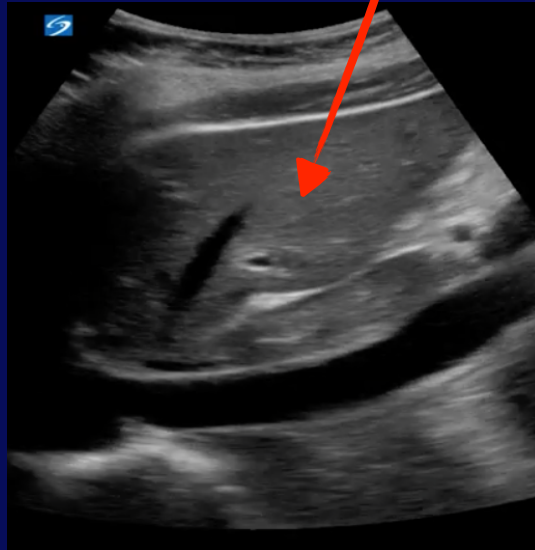
# STEPS:

## Probe placement – longitudinal



# STEPS:

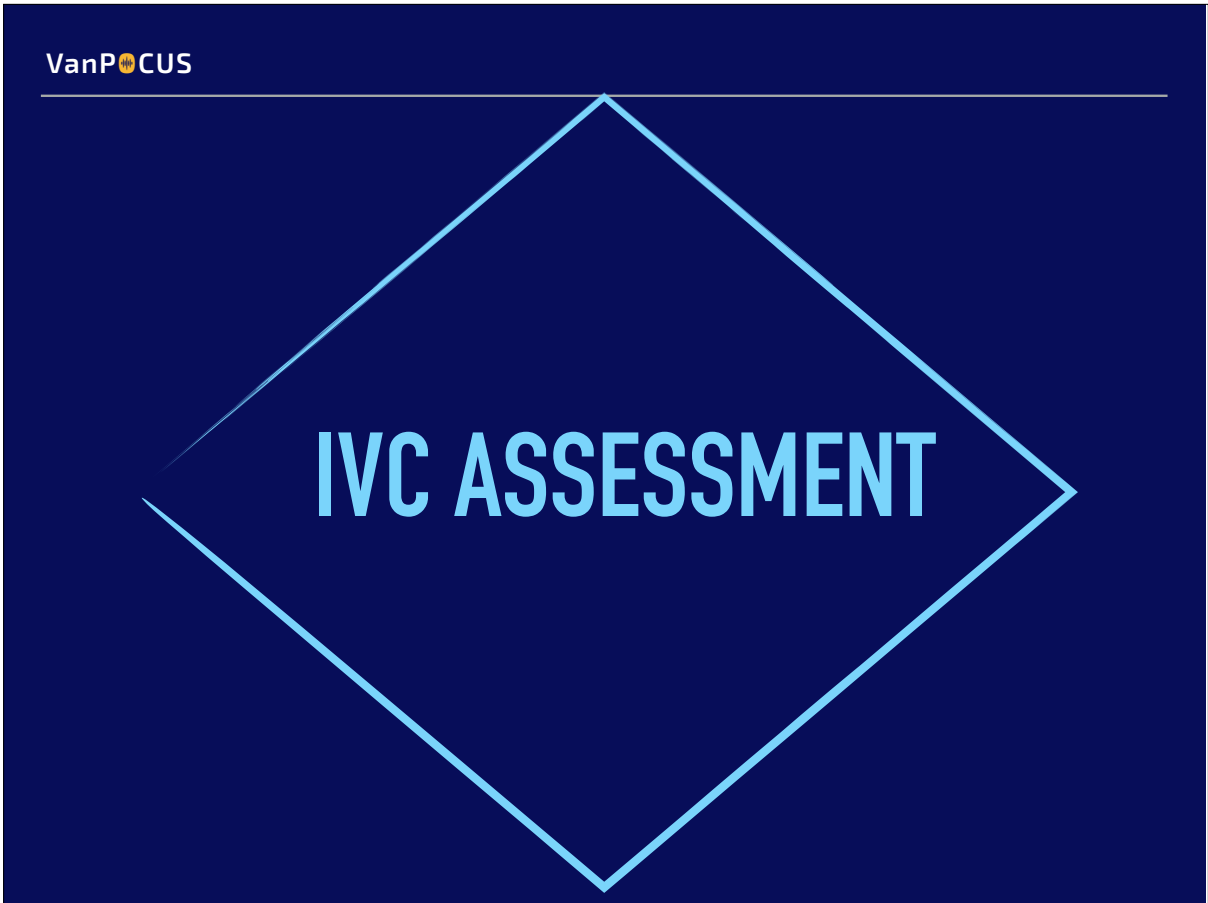
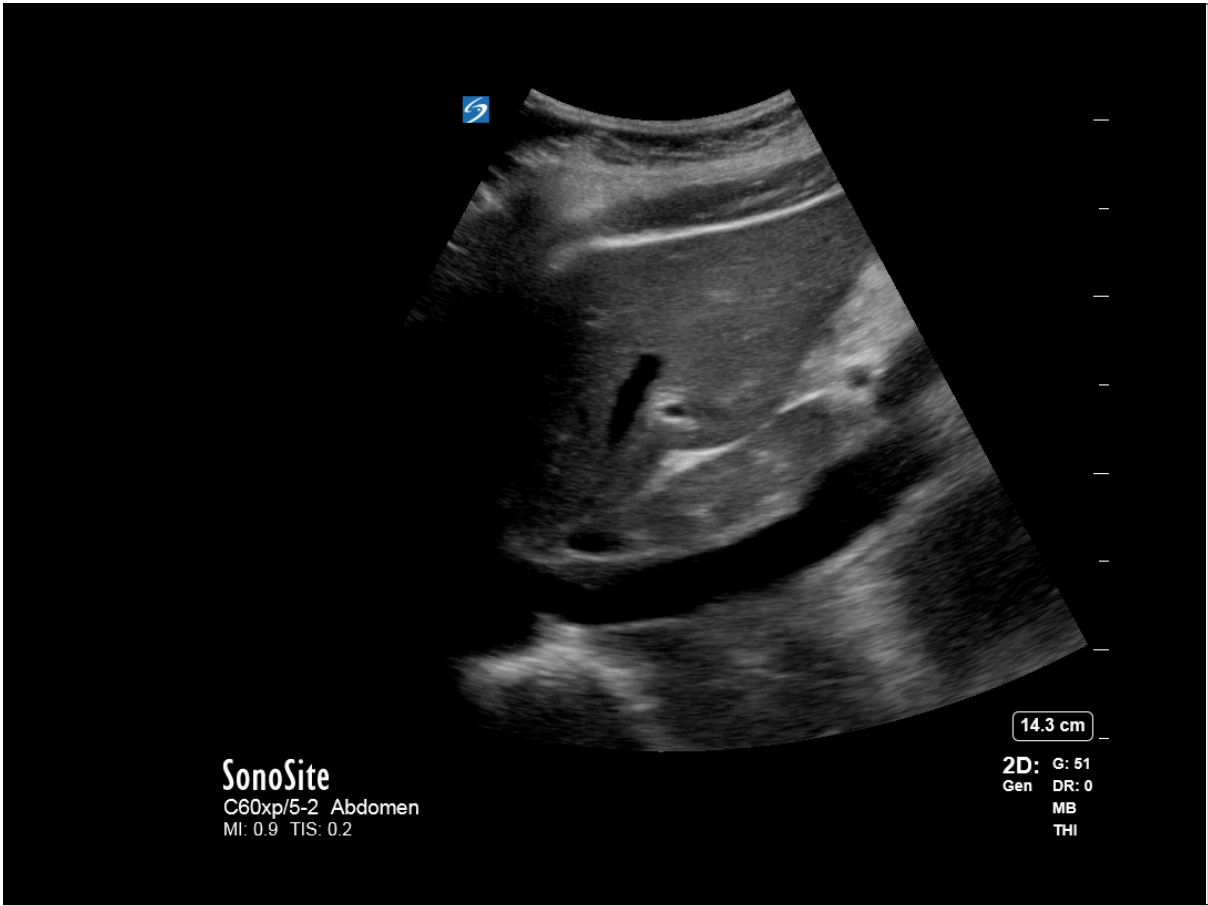
## Identify the LIVER



# STEPS:

## Identify the IVC

- ▶ **Tubular structure**
  - ▶ **Thin-walled**
  - ▶ **Compressible**
  - ▶ **Biphasic pulsatility**
- ▶ **Below the liver**
  - ▶ **Connects with:**
    - ▶ **Right atrium**
    - ▶ **Hepatic veins**



# SPONTANEOUS RESPIRATION

## Inspiration

Negative intrathoracic pressure



↑ Venous return to RA



IVC collapse

## Expiration

Positive intrathoracic pressure



↓ Venous return to RA



IVC expansion

# MECHANICAL VENTILATION

## Inspiration

Positive intrathoracic pressure



↓ Venous return to RA



IVC expansion

## Expiration

↓ Intrathoracic pressure



↑ Venous return to RA



IVC collapse

# SPONTANEOUS RESPIRATION

## Collapsibility index

$$\frac{\text{IVC max} - \text{IVC min}}{\text{IVC max}} \times 100\%$$

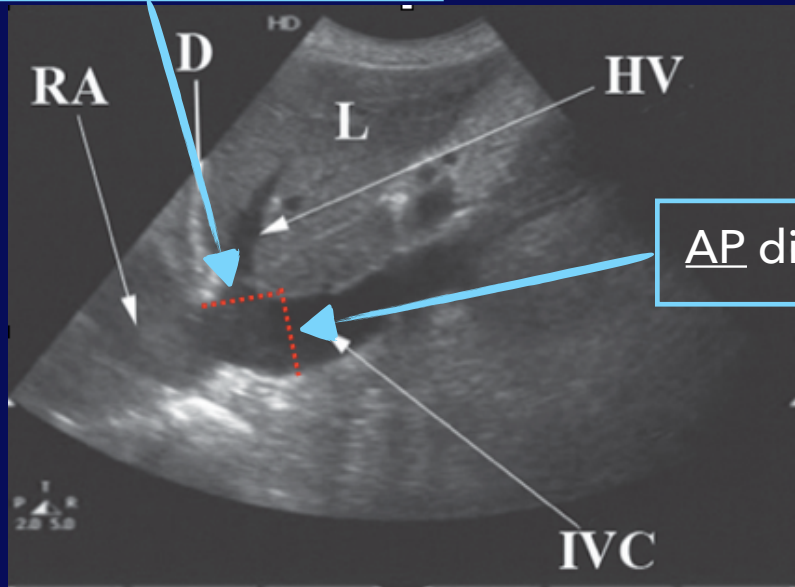
# MECHANICAL VENTILATION

## Distensibility index

$$\frac{\text{IVC max} - \text{IVC min}}{\text{IVC min}} \times 100\%$$

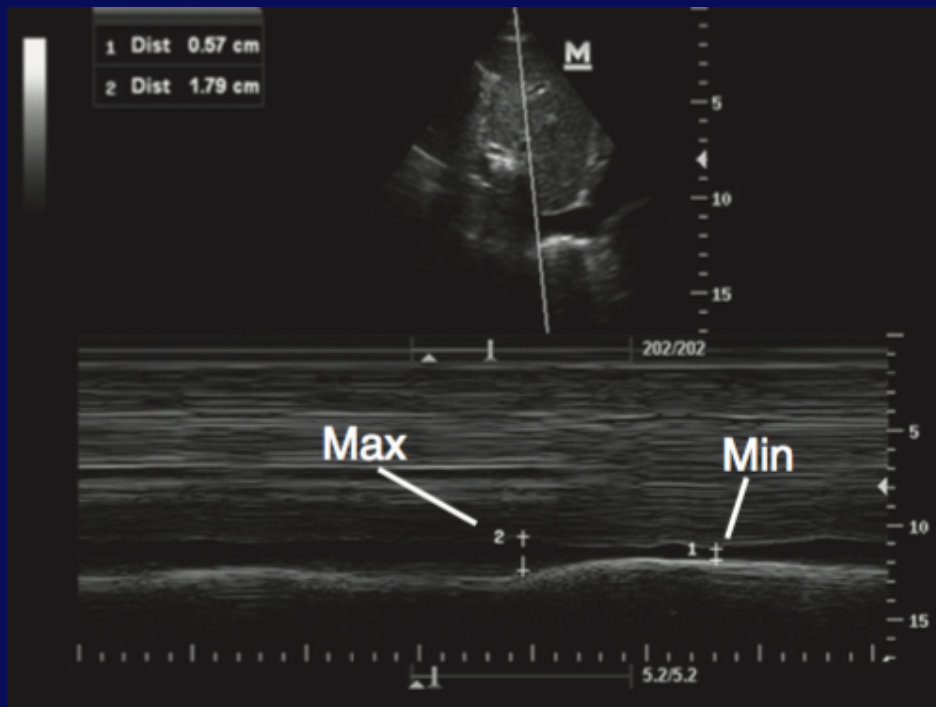
# IVC MEASUREMENT

2 cm from RA-IVC junction



Source: Carmody KA, Moore CL, Feller-Kopman D: *Handbook of Critical Care and Emergency Ultrasound*: www.accessanesthesiology.com

# M-MODE



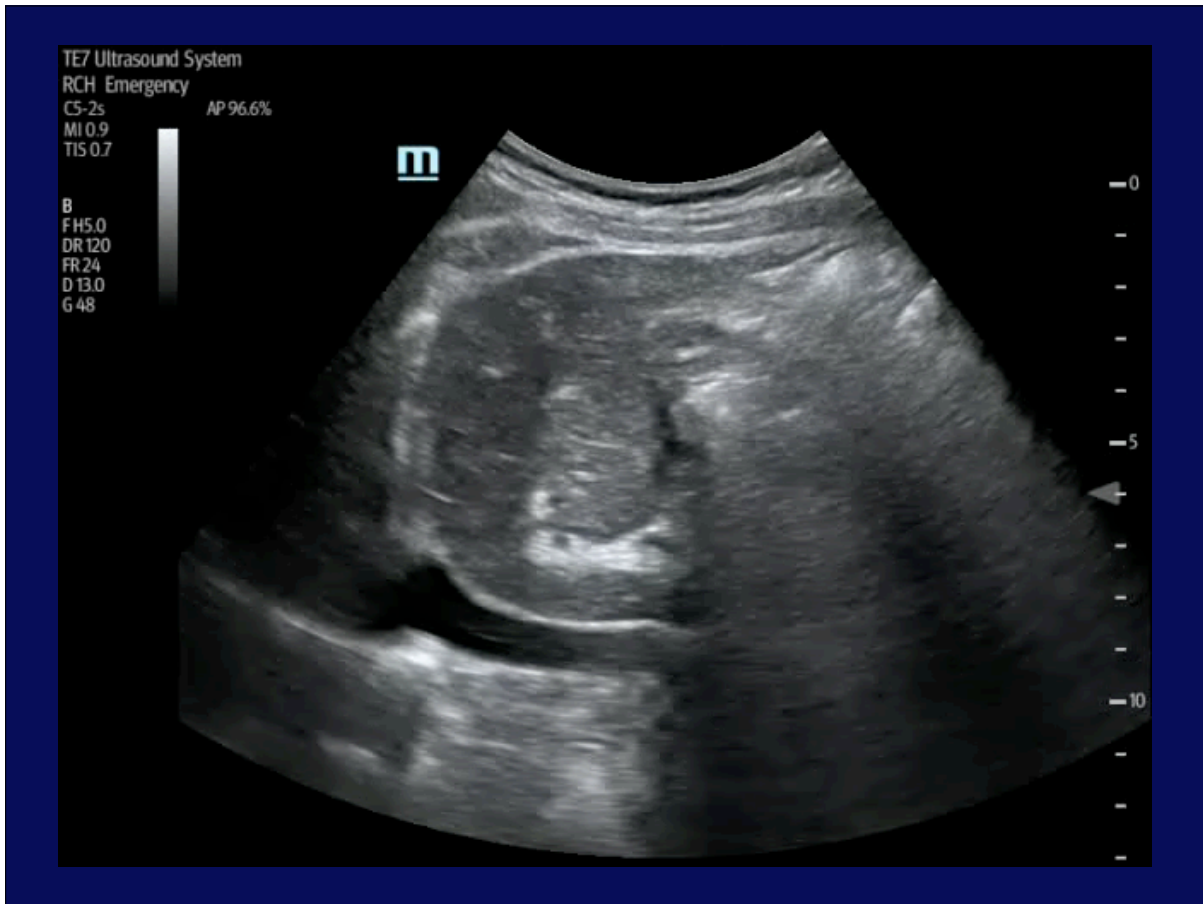
# PATHOLOGY

## VOLUME DEPLETION – FLUID RESPONSIVENESS

### Positive if:

- ▶ **Collapsibility** > 40 - 50%
- ▶ *Absolute AP diameter* < 1.0 cm

## SPONTANEOUS RESPIRATION



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## VOLUME DEPLETION – FLUID RESPONSIVENESS

**Positive if:**

- ▶ **Distensibility** > 12 -18%
- ▶ *Absolute AP diameter* < 1.2 cm

**MECHANICAL VENTILATION**

- ▶ Hypovolemia
- ▶ Distributive shock
- ▶ ↑ Intra-abdominal pressure
- ▶ External compression

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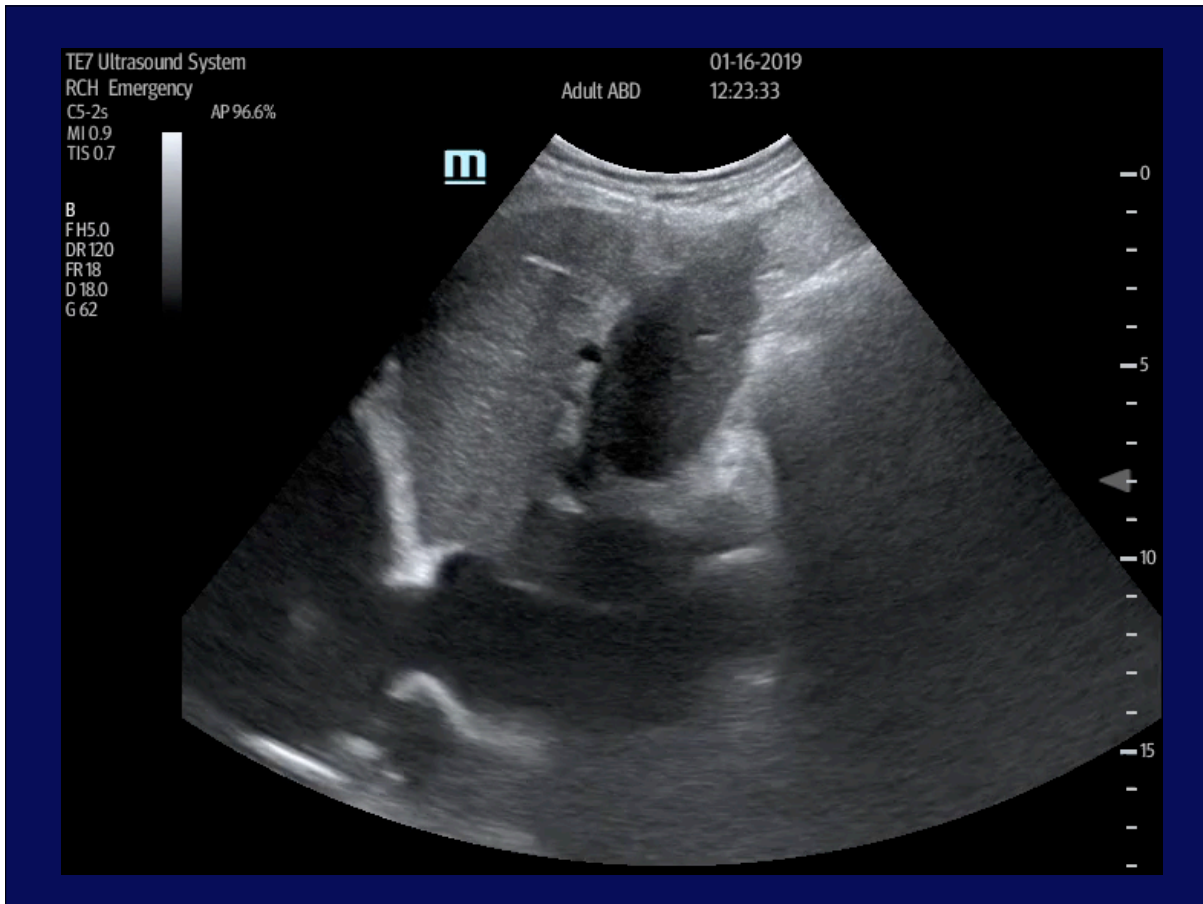
## DIFFERENTIAL DIAGNOSIS

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### PLETHORIC IVC

- ▶ Minimal/no collapsibility
- ▶ Absolute AP size > 2.1 cm

- ▶ Volume overload
- ▶ Cardiogenic shock
- ▶ Obstructive shock
- ▶ ↑ Right-sided pressures



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## PERICARDIAL EFFUSION

If IVC collapsibility > 40-50%  
with deep inspiration



r/o tamponade

## Use IVC US findings in association with:

- Clinical context
- Lung and cardiac US:
  - B lines/pleural effusions
  - Pericardial effusion
  - LV and RV function

## EVIDENCE – IVC US

- ▶ **Limited ability to predict fluid responsiveness**
  - ▶ Especially with spontaneous respiration
  - ▶ Not enough high quality evidences
- ▶ **Extremes** of IVC diameter/collapsibility = more useful
- ▶ Always consider **clinical context**
- ▶ **Serial evaluations** of IVC after fluid bolus

DOES **RESPIRATORY VARIATION** IN INFERIOR VENA CAVA DIAMETER  
**PREDICT FLUID RESPONSIVENESS** A SYSTEMATIC REVIEW AND  
META-ANALYSIS **2017**

**17 studies, 533 patients with acute  
circulatory failure**

Sensitivity: 63%  
Specificity: 73%

**Better predictor with  
mechanically ventilated  
patients**



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**TROUBLESHOOTING**

# CANNOT SEE THE IVC?

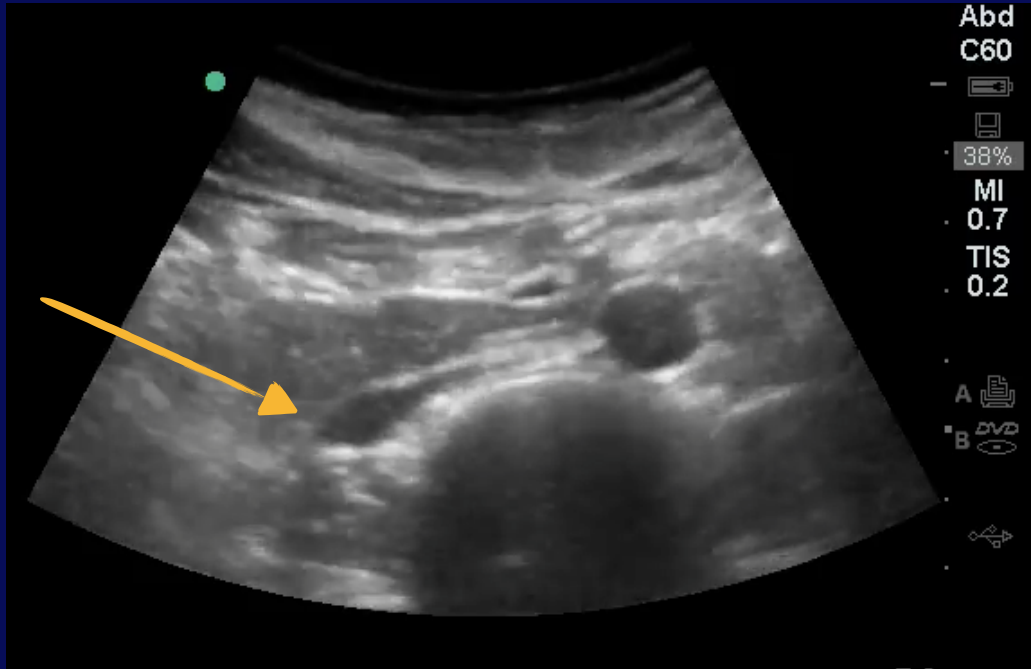
- ▶ Tissue harmonics (ON)
- ▶ Adjust depth + focus
- ▶ ↓ Compression
- ▶ US beam more cephalad
- ▶ Subcostal view centered on RA
- ▶ Other views:
  - ▶ Transverse
  - ▶ Coronal
  - ▶ Right intercostal

# TRANSVERSE VIEW

- ▶ Indicator: patient's **right**
- ▶ IVC **anterior** to the spine
- ▶ **Liver** around IVC



# TRANSVERSE VIEW



# CORONAL VIEW

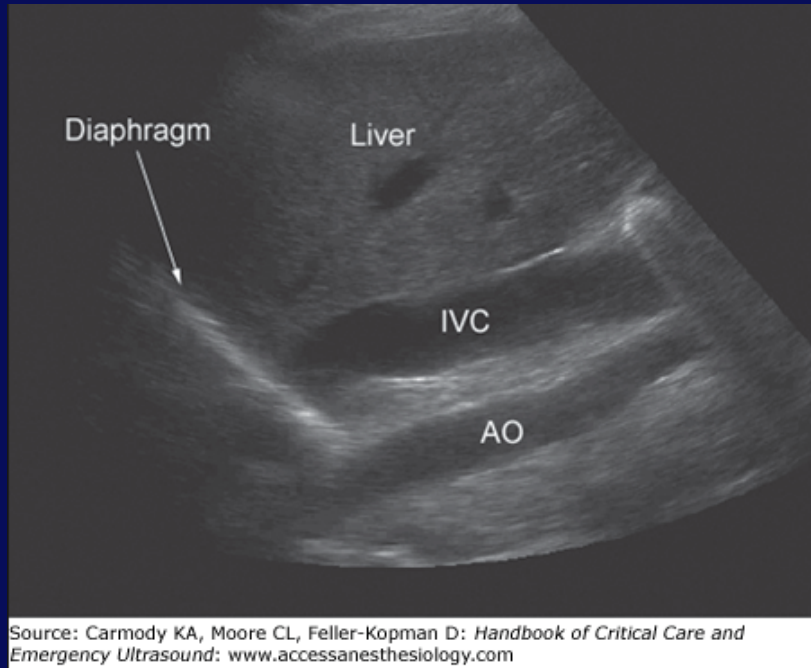
▶ Indicator: patient's **head**

▶ IVC **anterior** to aorta

▶ **Liver** around IVC



# CORONAL VIEW

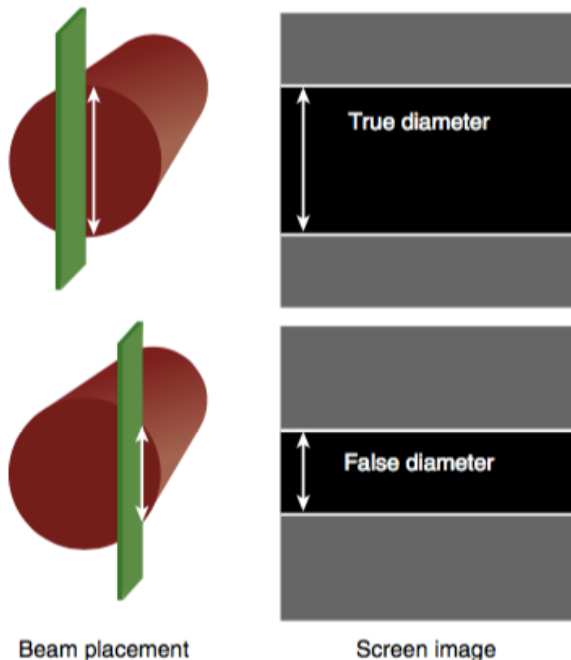


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**PITFALLS**

- ▶ **Off-axis/oblique images**
  - ▶ **Too much pressure on probe**
  - ▶ **Misidentification:**
    - ▶ **Aorta**
- ▶ IVC displacement with respiration
  - ▶ **High intra-abdominal pressures**
  - ▶ **↑ Right-sided pressures**

## OFF-AXIS



# BOTTOM LINE

- Do not use IVC interpretation in isolation
- Less reliable with spontaneous ventilation
- A negative test cannot be used to r/o fluid responsiveness
- Extreme results are more useful
- Serial assessments after fluid bolus

Thank you!

