Echocardiography
Volume assessment

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Volume assessment and the intensivist

- **Hypovolaemic shock**
- **“Fluid tolerance”**

Optimising cardiac output

Avoiding overloading

Guided fluid removal

“Add it to the list”

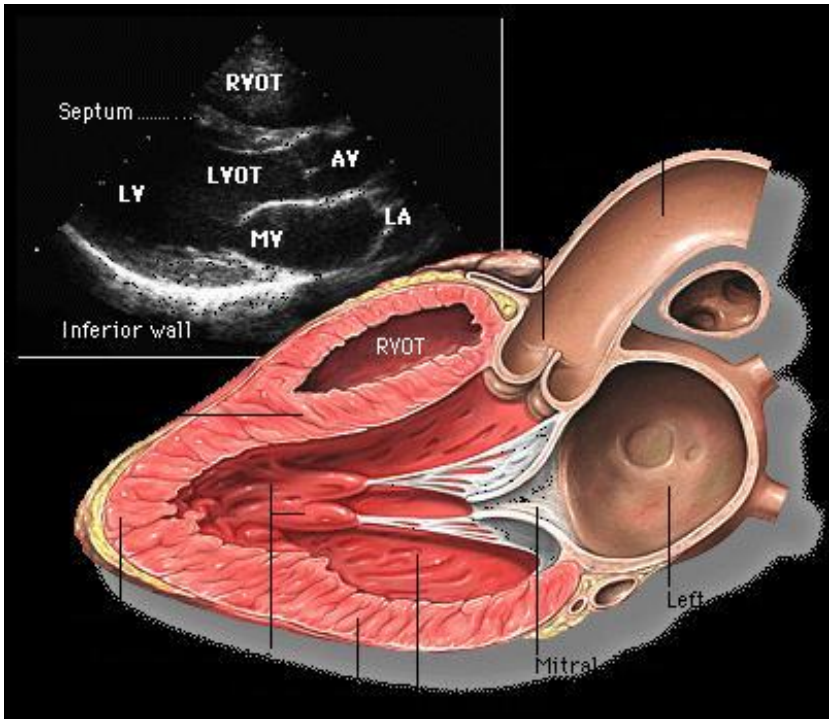
Look for as many markers of volume status as you can find

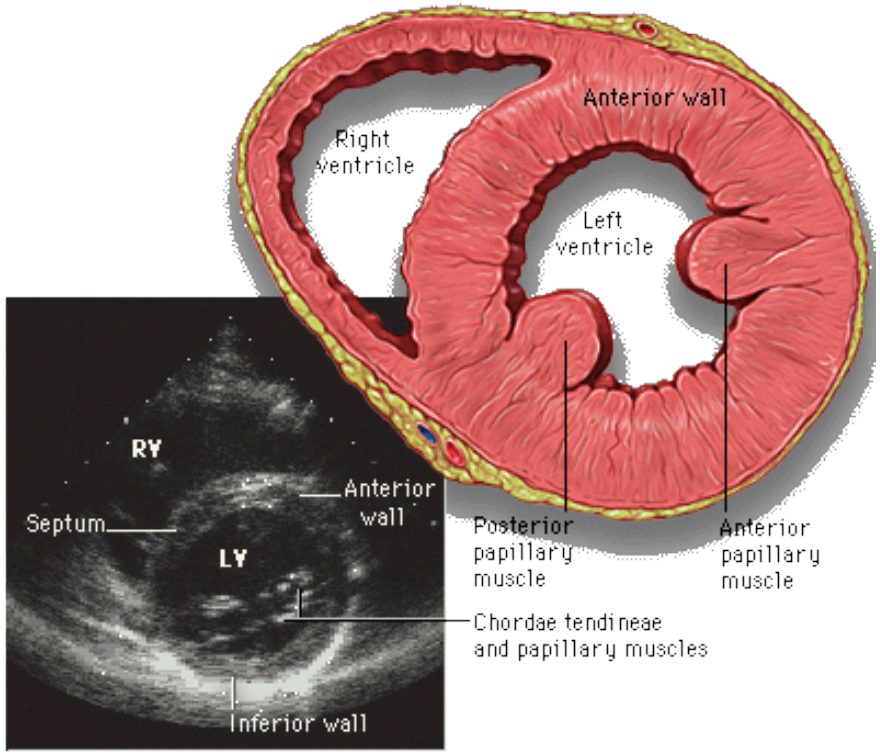
Check whether there are patient factors that might confound these markers

Assess whether your impression fits with the clinical scenario

Arrive at a management decision

Normal echocardiography





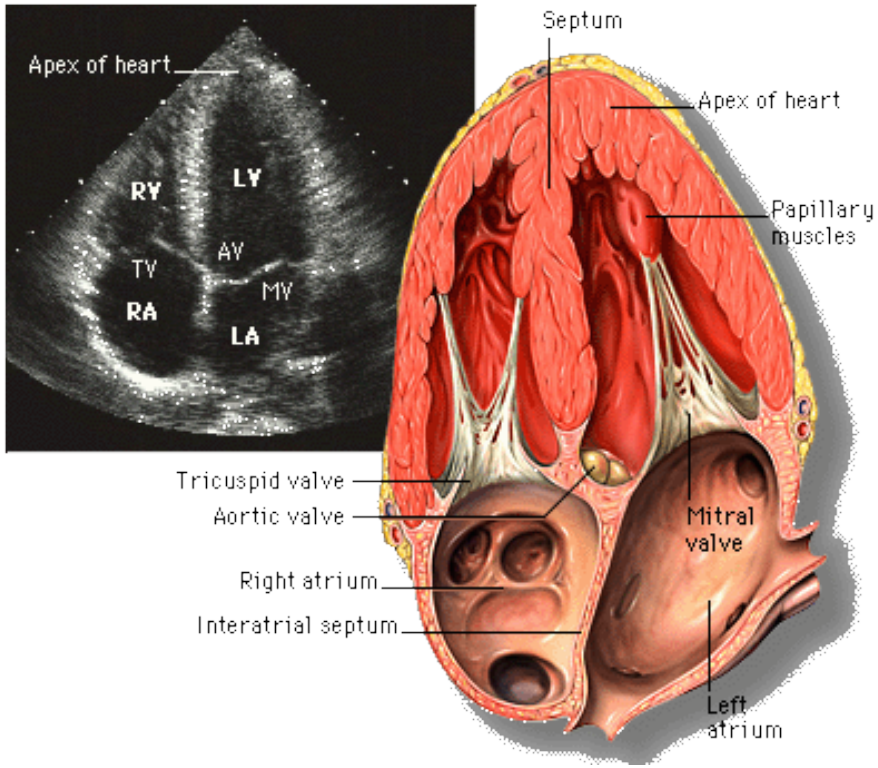
Notice:

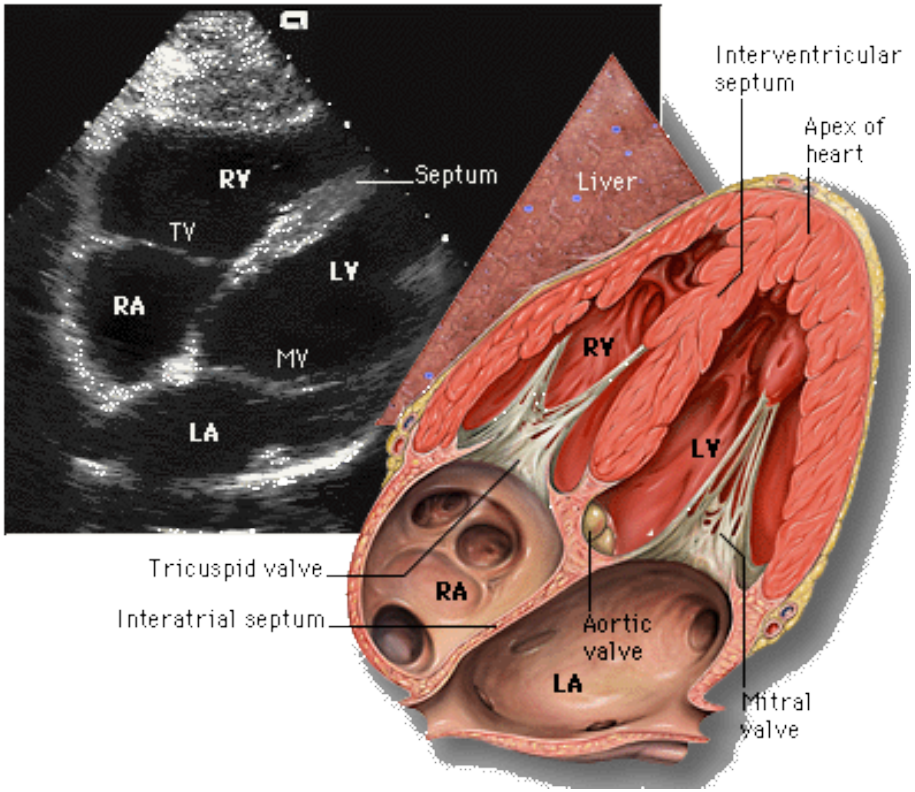
LV internal dimensions – 6cm is too big.

E-point septal separation – the MV anterior leaflet usually doesn't touch the septum.

RV size – bigger than the LV is definitely too big.

Normal echocardiography





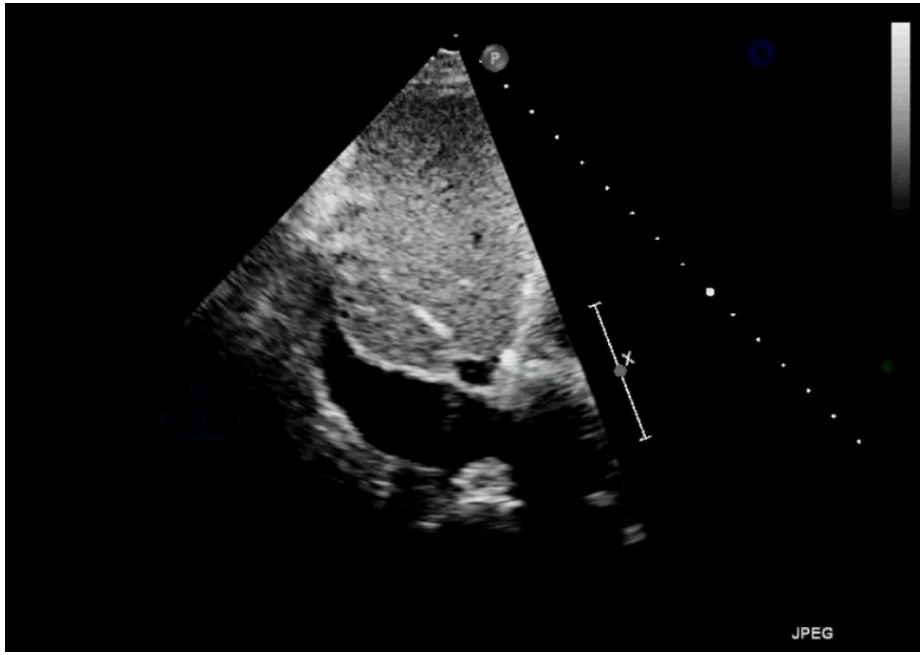
Notice:

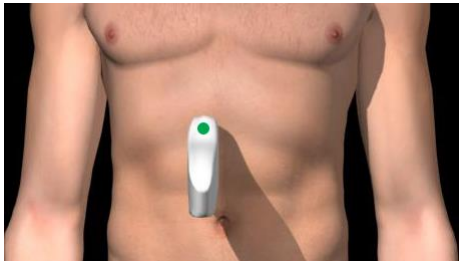
LV internal dimensions – visual assessment

RV size – usually 2/3 the LV or less

RA size – gives a clue as to the RAP/CVP

Normal Echocardiography





IVD diameter and variation with respiration

- correlates with CVP in the spontaneously breathing patient
- >2.5cm is definitely dilated
- Complete collapse during non-forced breathing suggests fluid tolerance (at least)

LV

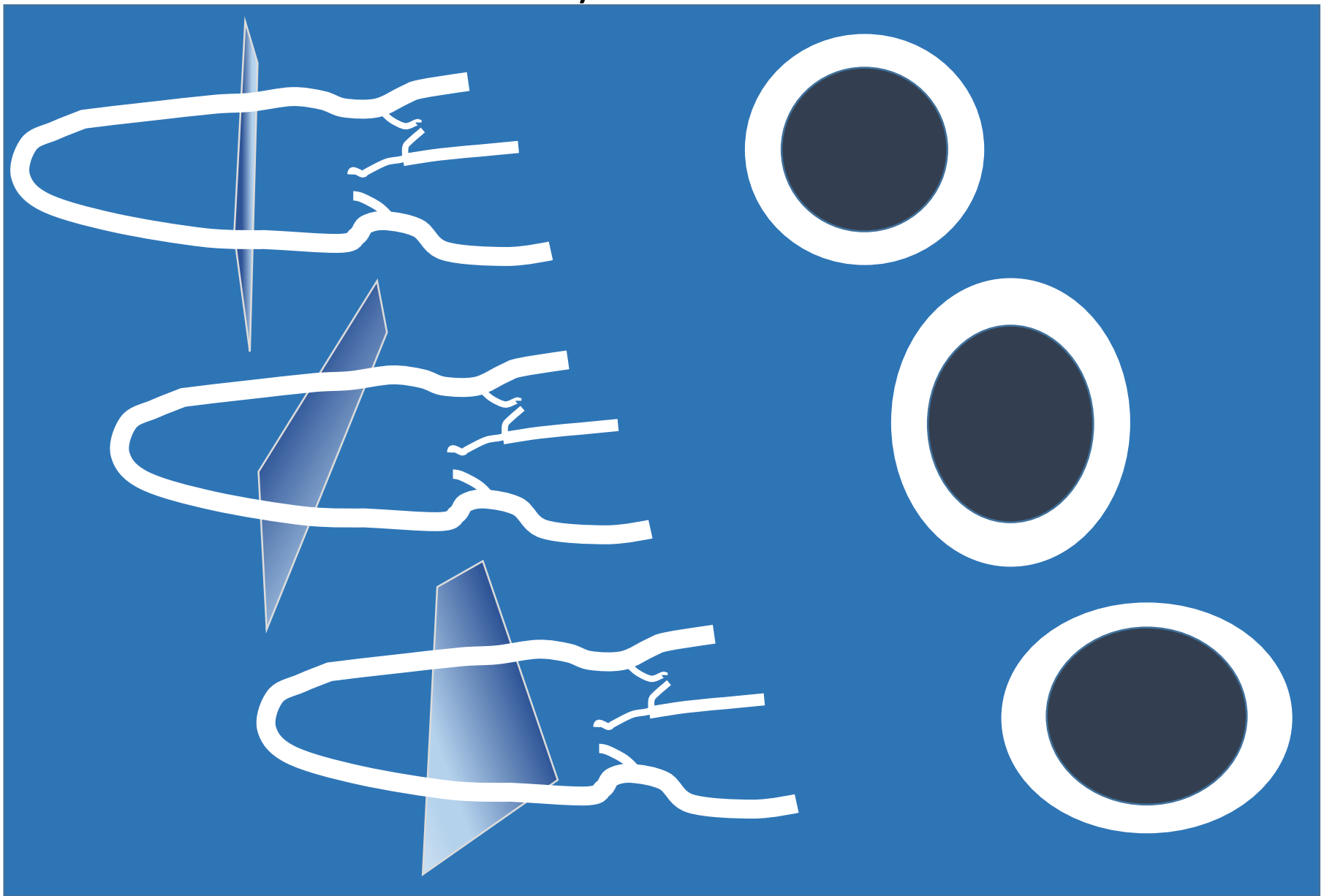
Looking for hypovolaemia

British Society of EchoCardiography
EchoCalc

LV dimension, women				
LVIDd (cm)	3.9–5.3	5.4–5.7	5.8–6.1	≥6.2
LVIDd / BSA (cm/m²)	2.4–3.2	3.3–3.4	3.5–3.7	≥3.8
LV dimension, men				
LVIDd (cm)	4.2–5.9	6.0–6.3	6.4–6.8	≥6.9
LVIDd / BSA (cm/m²)	2.2–3.1	3.2–3.4	3.5–3.6	≥3.7
LV volume, women				
LV diastolic volume (ml)	56–104	105–117	118–130	≥131
LV systolic volume (ml)	19–49	50–59	60–69	≥70
LV volume, men				
LV diastolic volume (ml)	67–155	156–178	179–201	≥202
LV systolic volume (ml)	22–58	59–70	71–82	≥83
LV volume index				
LV diastolic volume/BSA (ml/m²)	35–75	76–86	87–96	≥97
LV systolic volume/BSA (ml/m²)	12–30	31–36	37–42	≥43

A low end diastolic volume is suggestive of hypovolaemia – add it to the list!

Get on axis before you assess or measure!

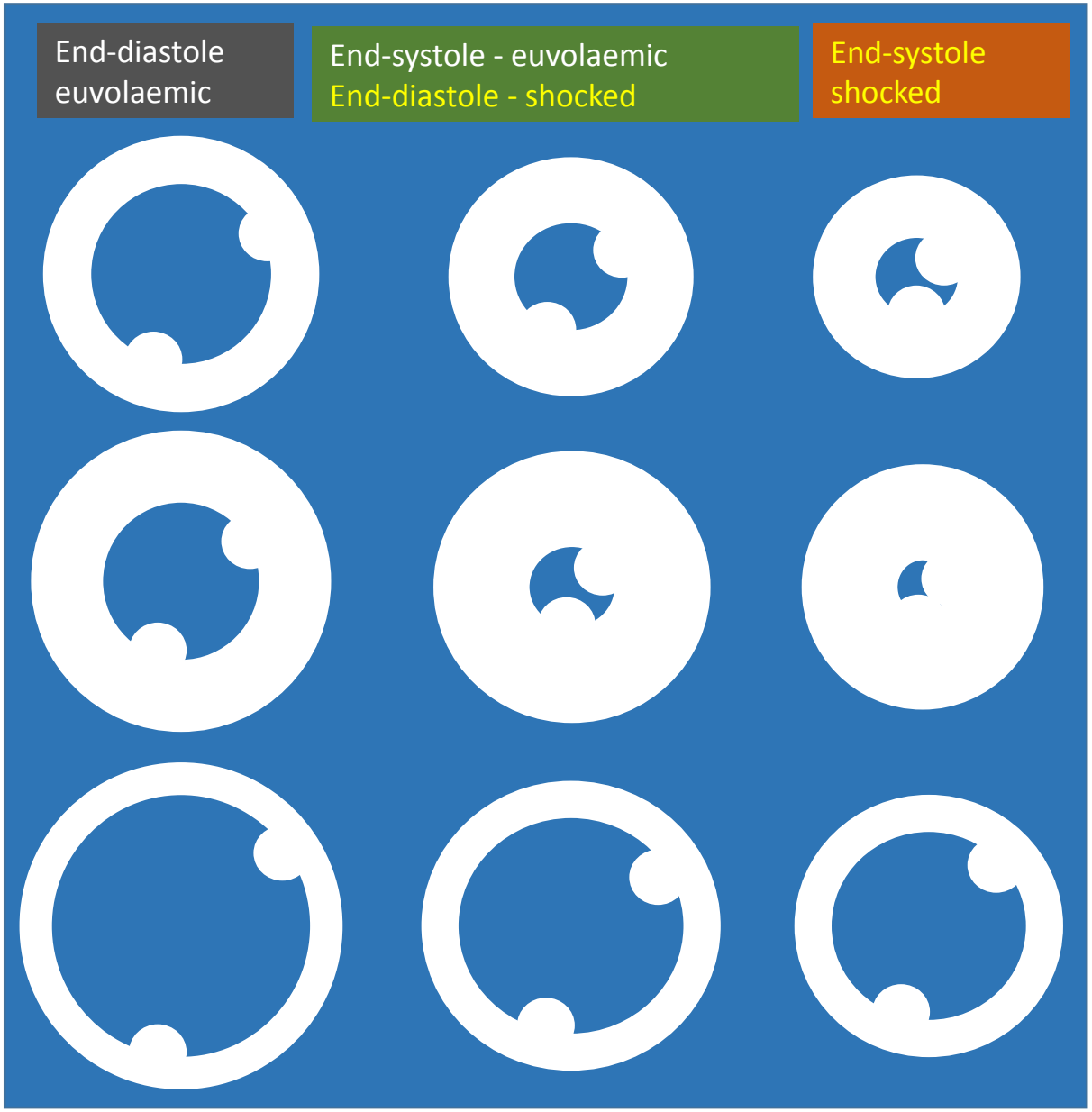


LV size

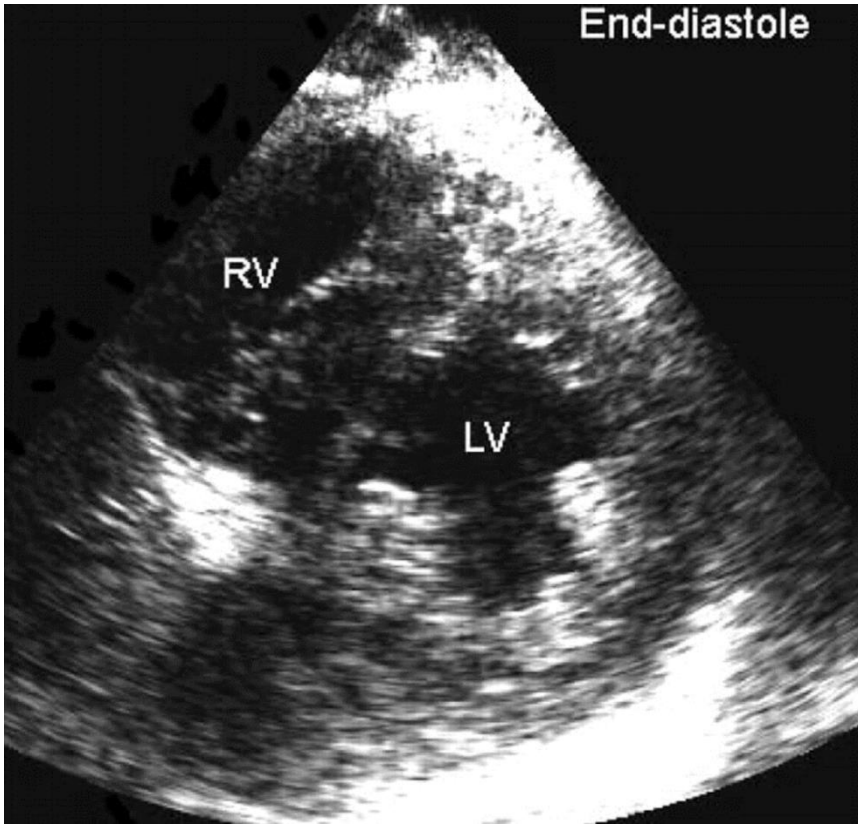
Normal

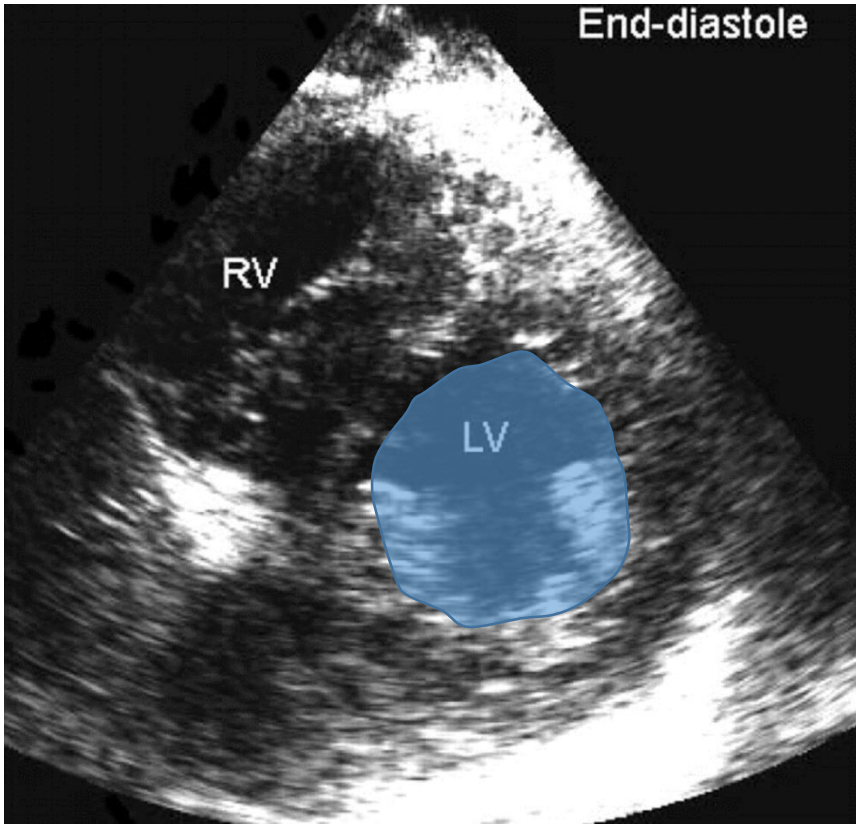
LVH

Dilated cardiomyopathy



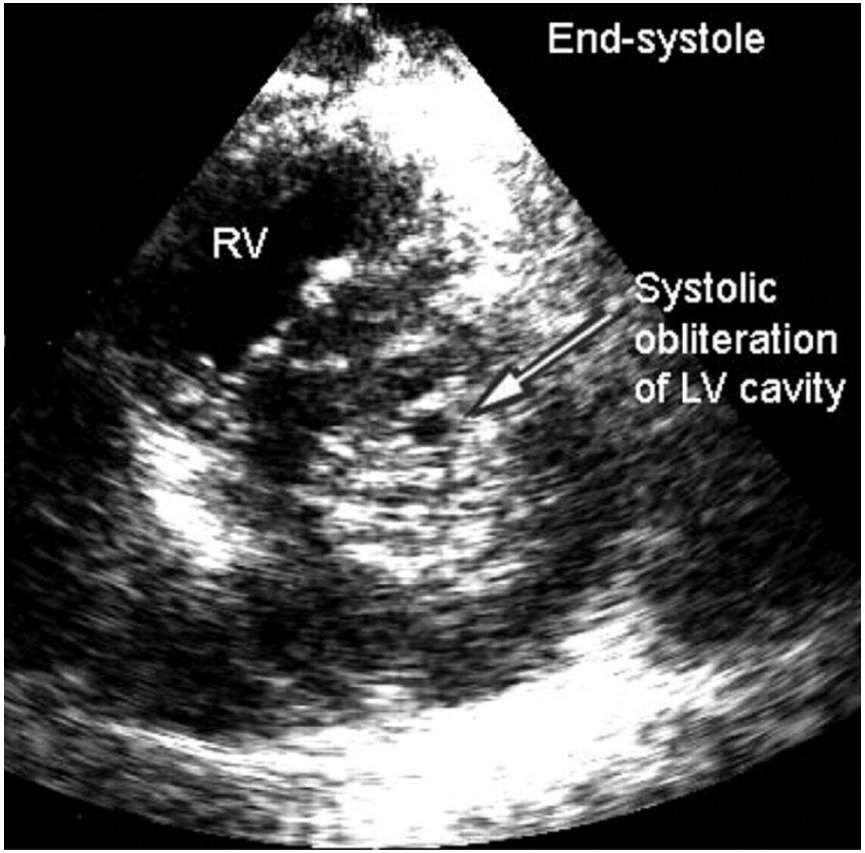
LV assessment





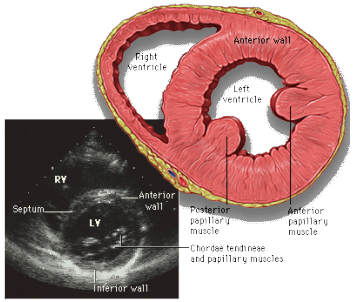
End-diastolic area – can be used to assess response to volume loading

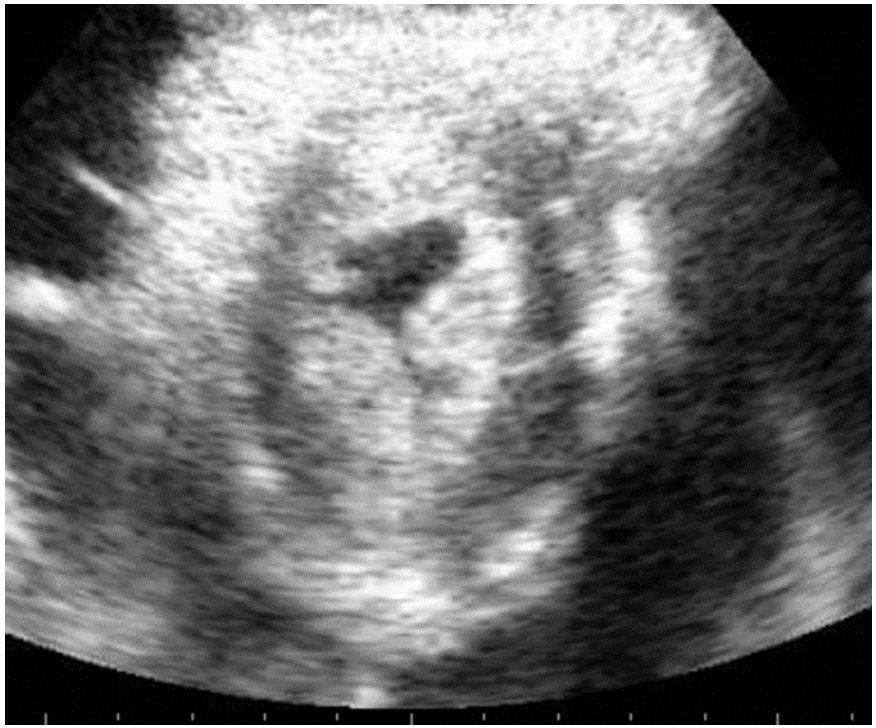
LV assessment



A very low end-systolic volume!

Hypovolaemic shock





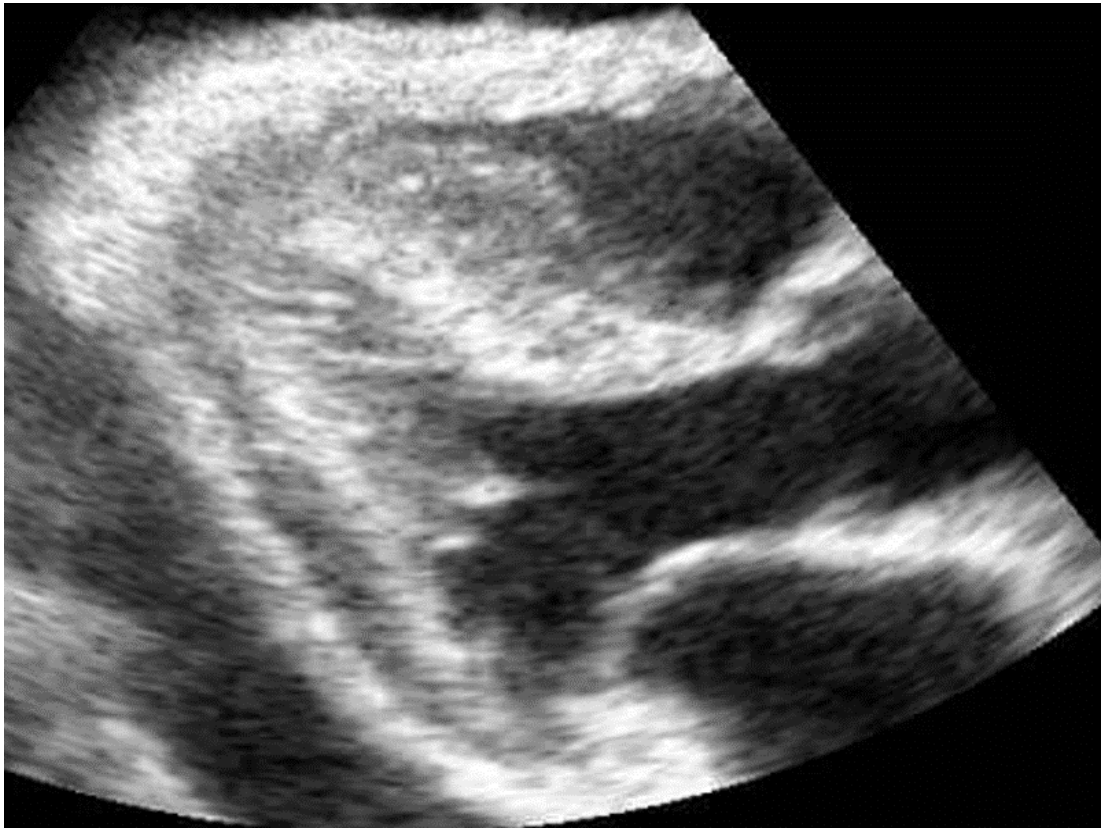
Papillary apposition or 'kissing'

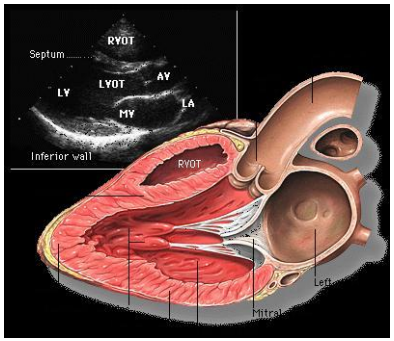
- Moderately under-filled with too much inotrope
- Usually markedly hyperdynamic

Usually markedly hyperdynamic

<u>NB</u> Look at the RV too – obstructive shock (PE etc) will lead to an empty LV, and the management's quite different!

Hypovolaemic shock





Hyperdynamic – unless in extremis
Low end-systolic volume
Low end-point septal separation – MV leaflet touches septum

Caution!

Assessment of the LV may be confounded by:

- Pre-existing cardiac state
- Inotrope use
- Significant vasodilatation
- Pulmonary embolism
- Tamponade
- Scanning technique

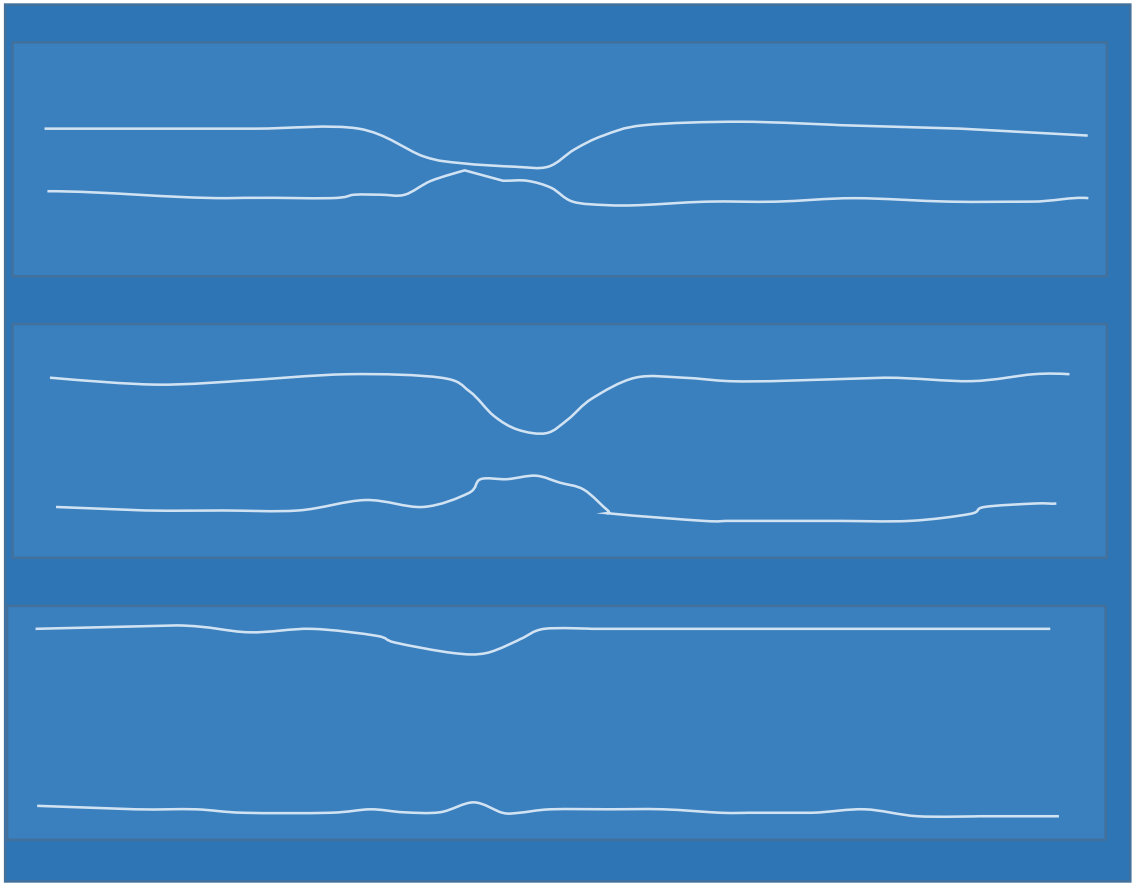
IVC

IVC response –
spontaneously breathing patient

Low CVP
Definitely fluid tolerant

Moderate CVP
Probably fluid tolerant

High CVP
Probably fluid intolerant

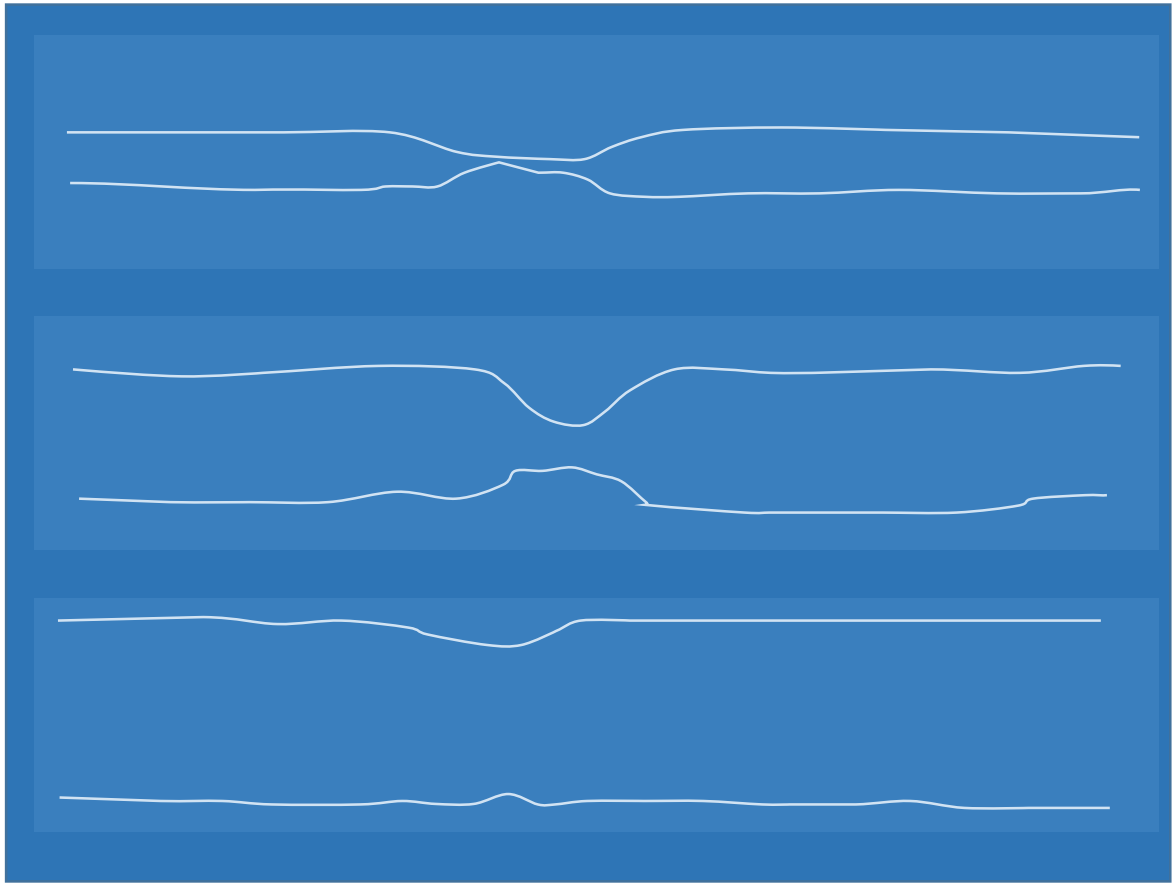


IVC response –
Fully mechanically ventilated

Hypovolaemic

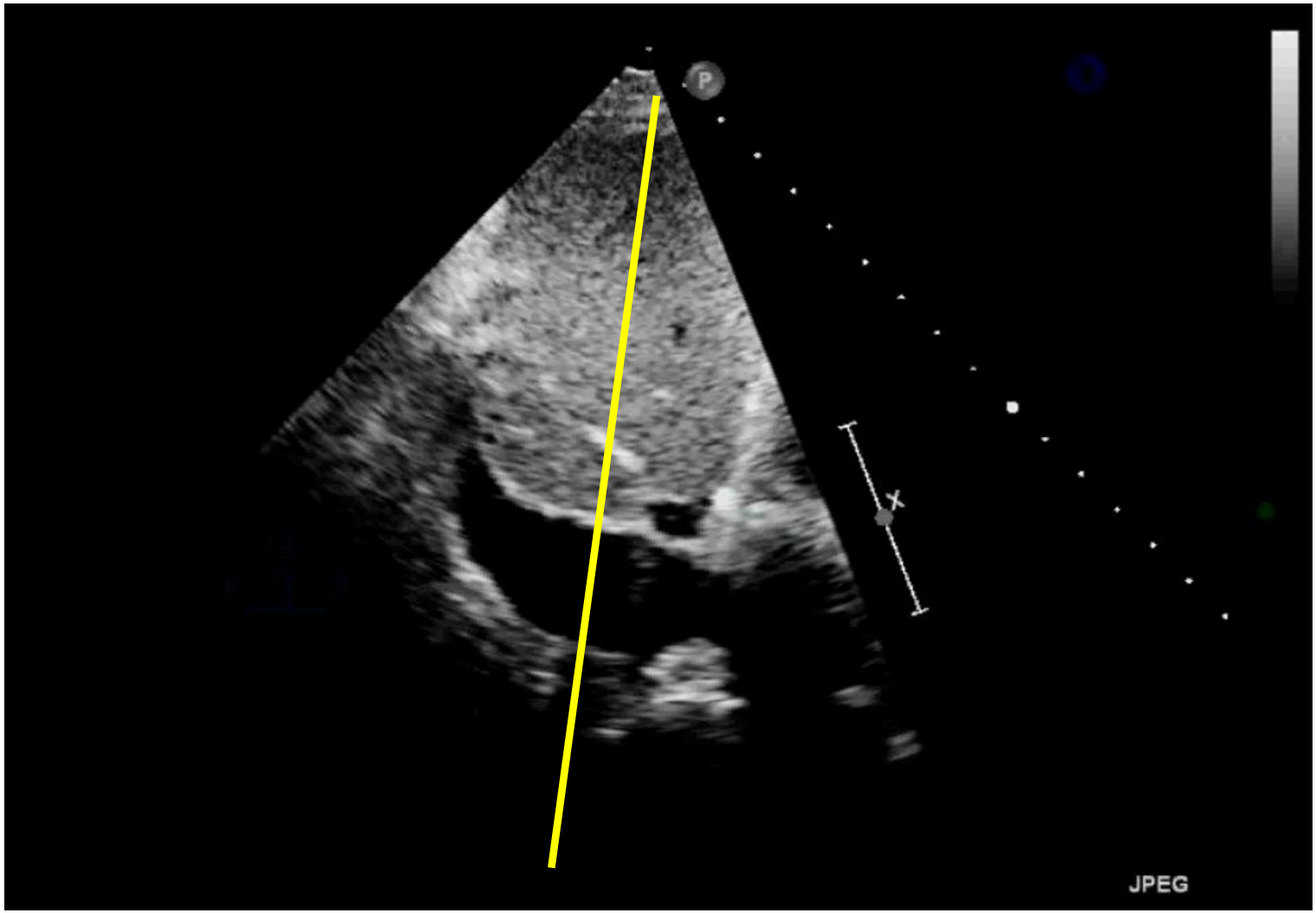
Fluid responsive

Not fluid responsive

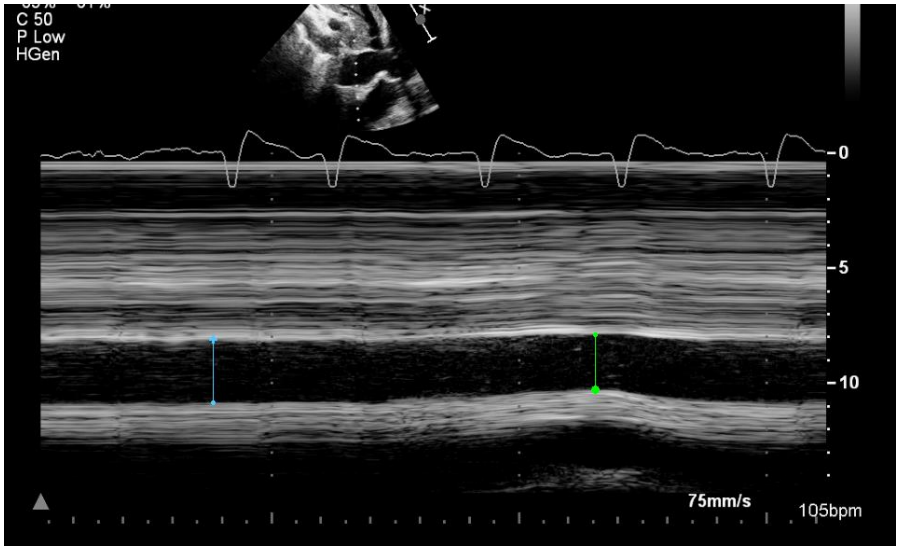


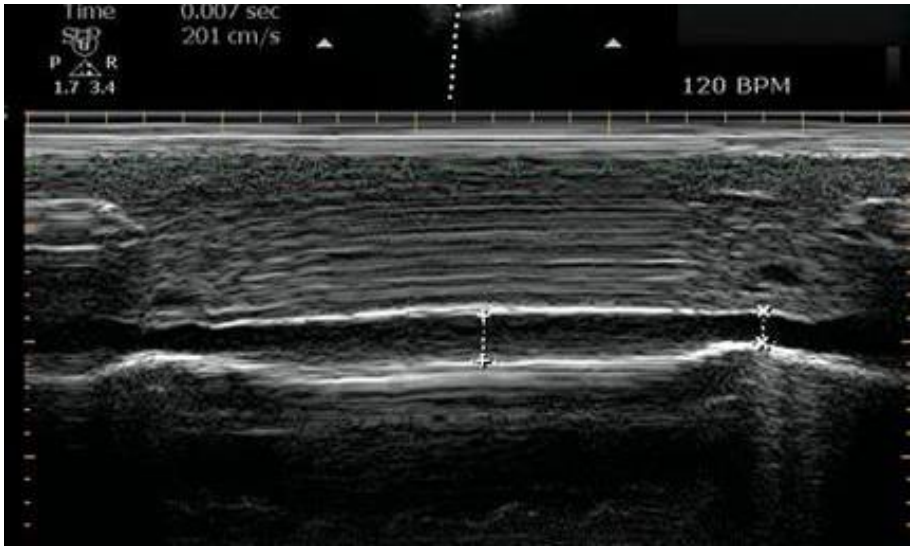
More than 18% variation predicts volume responsiveness

IVC variation



IVC Variation





Almost no variation ‘v’ about 50% variation
Interpretation depends on ventilation state and clinical context

Caution!

IVC response is confounded by

- Arrhythmias
- LV failure
- RV failure
- Pulmonary embolism
- Pulmonary hypertension
- Tamponade
- Intra-abdominal hypertension

More advanced

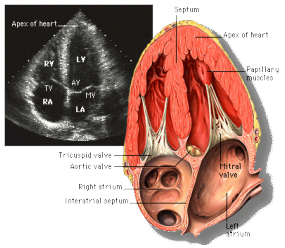
Fine tuning
Experts only!

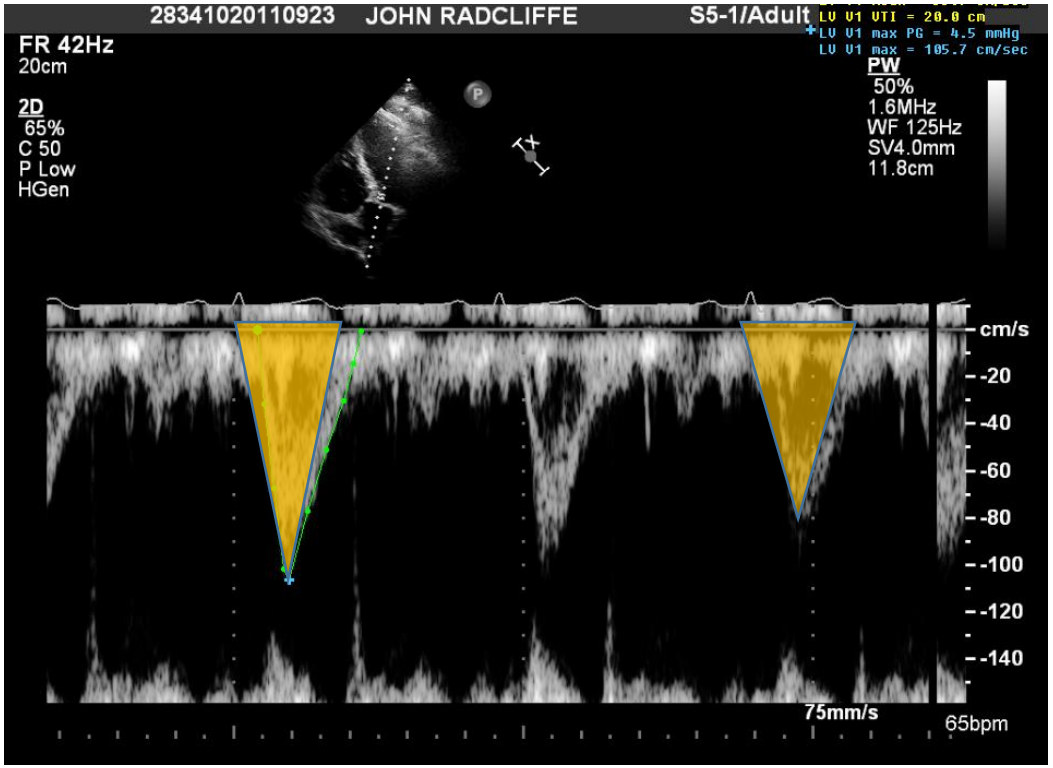
- Optimising cardiac output
  - Dynamic markers (predict and confirm fluid responsiveness)
    - IVC variation (if no spontaneous breathing)
    - Flow variation (if no spontaneous breathing)
    - Passive leg raising

- Lung ultrasound

- Very advanced!
  - Diastology

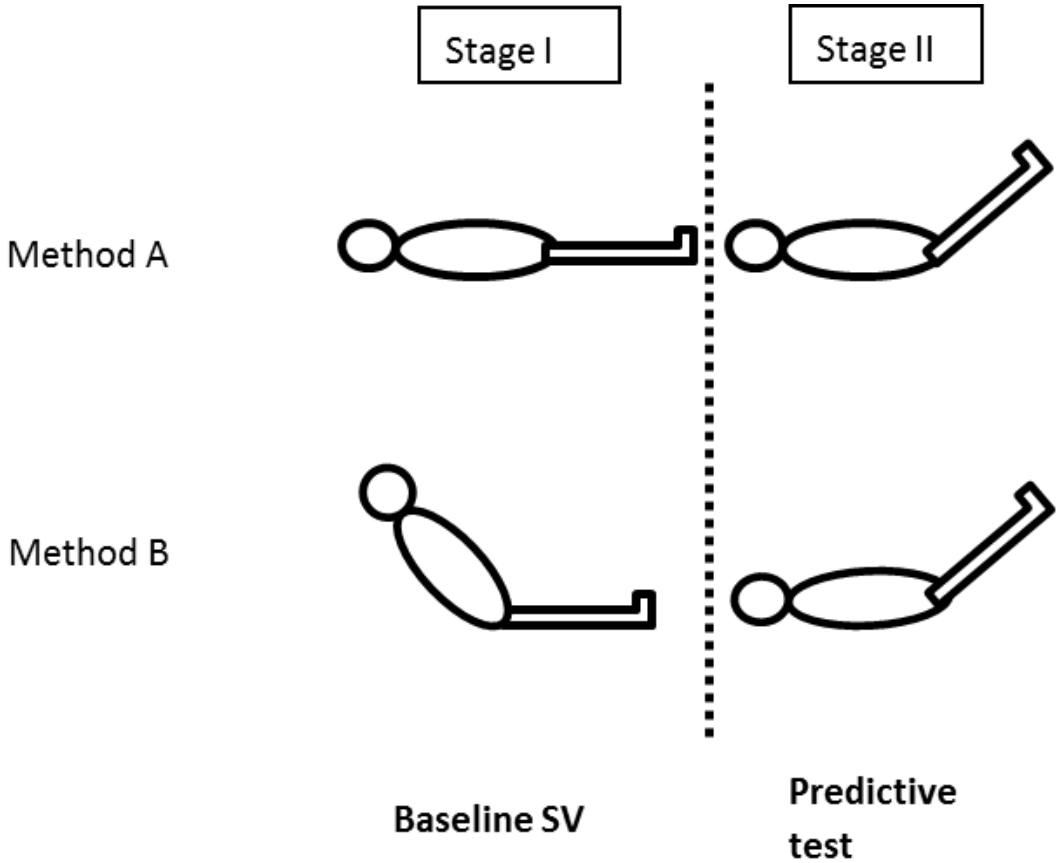
Optimising cardiac output





The variation in area under the flow-time curve (using pulsed-wave Doppler) can be used to predict or confirm volume response. Variation >12-15% suggests volume responsiveness.

Passive leg raising

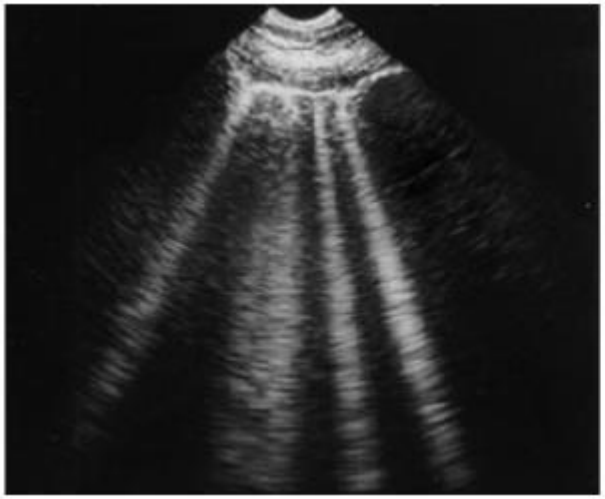


Passive leg raising provides a reversible ‘autotransfusion’ of approximately 300ml after 90 seconds.
Echo before and at about 90 secs.

Lung ultrasound

Normal

- ‘A’ predominance



Pulmonary oedema

- ‘B’ predominance

Predicting volume responsiveness

	Likely volume responsive	**Probably not**	
IVC variation $\frac{(Dmax-Dmin)}{Dmin}$	>20%	<14%	Fully ventilated only!
Flow variation	>15%	<12%	
SV or CO increment of 10% after ***passive leg raise***	Present	Absent	?Anyone

Supporting evidence

	Normal Range	Suggests hypovolaemia
IVC diameter & response	1-2.5cm Collapsing 25-75% (Fluid tolerant if >50%)	<1 cm and collapsing
LVIDs	>3 cm	Papillary apposition
EPSS	>0.5cm	<0.5m
LVIDd **Absolute** **Indexed (/BSA (cm/m^2))**	3.9-5.3 4.2-5.9 2.4-3.2 2.2-3.1	<3.9 F <4.2 M <2.4 F <2.2 M
LVEDAI (PSAX)	5.5-10	<5.5

Summary

Decide the question:

- What is the cause of acute shock?
- Will the patient be fluid tolerant?
- Will fluid improve the cardiac output?

Look at as many indicators as possible

Findings must be put in context:

- Patient's pre-existing cardiac disease
- Ventilation type
- Confounding conditions

Useful texts

- *Echocardiography (Oxford Specialist Handbooks*). Leeson et al. 2012 OUP.

- Mandeville JC, Colebourn CL. *Can Transthoracic Echocardiography Be Used to Predict Fluid Responsiveness in the Critically Ill Patient?* A Systematic Review. Critical Care Research and Practice. 2012;2012:1–9.

- Levitov A, Marik PE. Echocardiographic Assessment of Preload Responsiveness in Critically Ill Patients. Cardiology Research and Practice. 2012;2012:1–7.

- Lichtenstein DA, Mezière GA, Lagoueyte J-F, Biderman P, Goldstein I, Gepner A. *A-Lines and B-LinesLung Ultrasound as a Bedside Tool for Predicting Pulmonary Artery Occlusion Pressure in the Critically Ill*. Chest. 2009;136(4):1014–20.