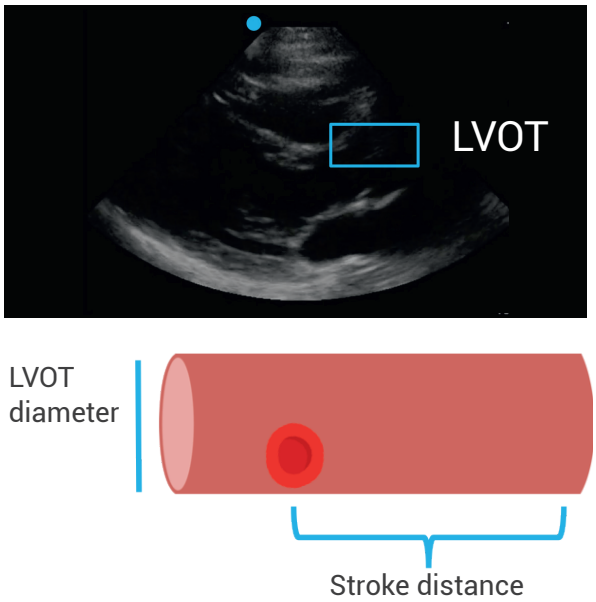
Volume status and fluid responsiveness

ESTIMATING CARDIAC OUTPUT

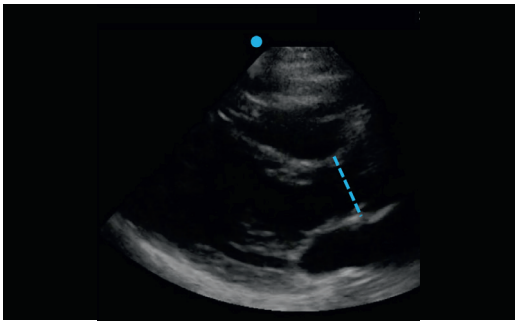
Cardiac output is the product of heart rate and stroke volume.

Stroke volume can be estimated by treating the left ventricular outflow tract (LVOT) as a cylinder, and calculating the volume of blood ejected through the LVOT with each heartbeat. The cylinder base is the LVOT diameter and the stroke distance that blood travels is the velocity-time integral (VTI).

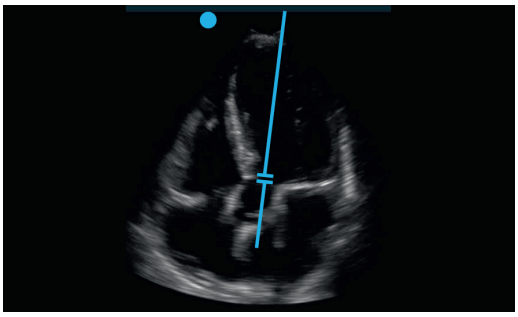


(VTI = velocity-time integral)

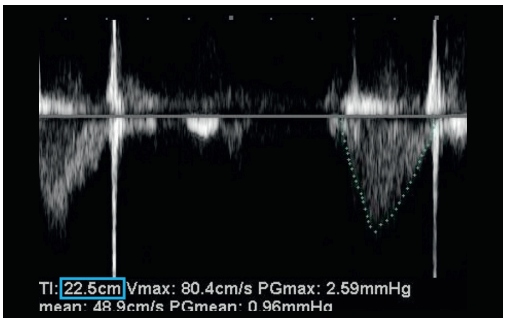
First, obtain a parasternal long-axis view of the heart to measure the LVOT diameter.



Then obtain an apical five-chamber view of the heart. Start from a four-chamber view, then tilt the transducer anteriorly towards the chest wall. Place a pulse wave Doppler sample gate in the LVOT.



Obtain a Doppler tracing. Use the ultrasound system software to calculate the area under the curve of the flow; this is the VTI. A typical VTI is 18–22 cm. Use the average of several waveforms.



Calculate stroke volume,

$$\text{Stroke volume} = \frac{((\text{LVOT diameter})^2 \times 3.14)}{4} \times \text{VTI}$$

Now you can calculate cardiac output,

$$\text{Cardiac output} = \text{stroke volume} \times \text{heart rate}$$