VIDEOS

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Measurement of Cardiac Output by Point-of-Care Transthoracic Echocardiography

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ABSTRACT

Traditionally measured with invasive methods or specialized equipment, stroke volume and cardiac output can be determined reliably with transthoracic echocardiography. This video guides the viewer in a step-by-step fashion through the technical aspects of Doppler echocardiographic assessment of cardiac output.

Conceptually, stroke volume can be approximated to the volume of a cylinder. The base of the cylinder is the cross-sectional area of the left ventricular outflow tract (LVOT), and the height of the cylinder is the distance the blood travels during one beat. As velocity is the first derivative of distance, the height of the cylinder can be estimated from the LVOT velocity time integral (LVOT VTI).

PROCEDURE

The diameter of the LVOT is measured from the parasternal long axis view to calculate the LVOT radius (typical LVOT diameter = 1.8–2.2 cm). Next, the LVOT VTI is measured from both the apical five-chamber view and the apical three-chamber view, along with the heart rate (typical LVOT VTI = 18–22 cm). Stroke volume is calculated by the formula

$$(\pi)(\text{LVOT radius})^2 \times (\text{LVOT VTI}).$$

$$\text{Cardiac ouput} = (\text{stroke volume})(\text{heart rate}).$$

PITFALLS AND CAVEATS

1. Small errors in the measurement of LVOT diameter can lead to substantial

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The video can be viewed in the online version of this article.

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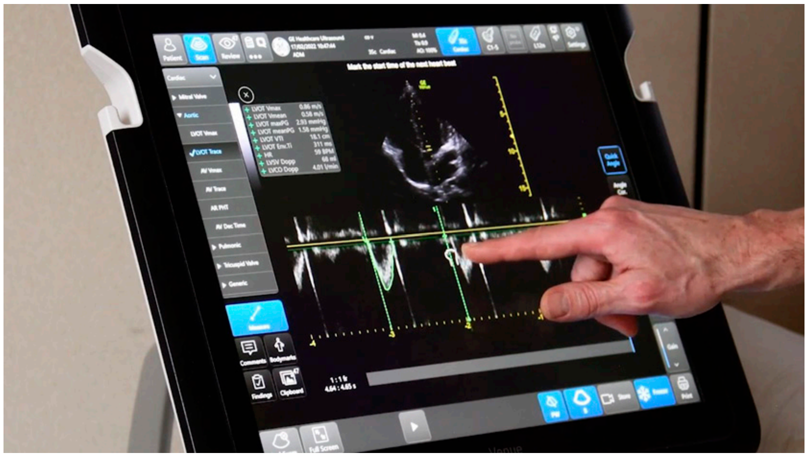

Video 1. Measurement of the left ventricular outflow tract velocity time interval.

errors in cardiac output (CO), as this value is squared in the formula. To avoid this, LVOT VTI can be trended alone for any individual patient, assuming LVOT diameter will not change between measurements.

2. A Doppler angle (the angle between the blood flow and the Doppler signal) of over 20 degrees can lead to substantial underestimation of CO. To avoid this, measure LVOT VTI from both the apical five-chamber and the apical three-chamber views. The smaller Doppler angle will result in a larger VTI, which should be used for the CO calculations.
3. Correct placement of the Doppler sample volume is critical. Placement too far from the aortic valve will lead to underestimation of CO. Inadvertent placement into the aortic valve will lead to overestimation.
4. In patients with irregular heart rhythms, stroke volume will vary from beat to beat. In this case, VTI can be averaged over 5–10 cardiac cycles.
5. Proper clinical integration of the measured CO requires knowledge of the clinical context and understanding of the patient's hemodynamics.

Advanced Critical Care Echocardiography, including this described technique, is a skill that requires deliberate practice and is operator-dependent. Measurements should always be interpreted within the clinical context of any individual patient.

Author disclosures are available with the text of this article at www.atsjournals.org.

RECOMMENDED READING

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