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Measuring Aortic Volume with a Modified Esophageal Doppler

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Hemodynamic monitoring is a safe and minimally invasive tool with the use of esophageal Doppler monitors (EDM) systems. However, a multitude of information, regarding vascular function, can be extrapolated by modifying current technology to include an additional Doppler transducer. By combining measurements of pulse wave velocity, and Doppler blood flow dynamics, aortic volume can be predicted with the Bramwell-Hill equation. Experimentally, this can be modeled by measuring flow through an elastic tube, at two sites simultaneously, using two Doppler transducers. A thin-walled latex tube is used to approximate an arterial segment through which a viscous fluid is pumped, at a set rate, in a pressurized fluid loop. Stiff tubes, constructed within the apparatus, produce reflected waves within the elastic portion. A reasonable pulse waveform is then generated which simulates human aortic physiology. Combining measurements of pulse wave velocity and compliance yields a volume measurement that represents the static volume. Thus, the maximum volume, held within the elastic segment during the distension of systole, can be measured with noninvasive means. When applied clinically, this technique may quantitatively monitor aortic volume status as a function of pulse wave velocity, blood pressure and stroke volume. Thus, a dual-Doppler method may enable researchers and clinicians to extract aortic volume information, by pulse wave analysis, as it is projected by the left ventricle and subjected to the hemodynamic effects of the vasculature. Determination of aortic volume may have great clinical impact by detecting initial changes in vascular volume and peripheral perfusion.

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