PREDICTING HYPOVOLEMIA DURING MECHANICAL VENTILATION: A PROSPECTIVE, CLINICAL TRIAL OF DOPPLER VARIATIONS OF AORTA AND AXILLARY ARTERIAL VELOCITIES TO IDENTIFY SYSTOLIC PRESSURE VARIATION

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Methods to non-invasively diagnose hypovolemia in mechanically ventilated patients in the ICU or Operating Room have significant appeal. Systolic pressure variation (SPV) from an arterial line pressure trace quantifies the difference of systolic arterial pressure between expiration and inspiration. It correlates with both echocardiography and the pulmonary artery catheter as a predictor of hypovolemia in sepsis [1], acute hemorrhage [2], and general ICU patients [3]. Doppler echocardiography, measuring the velocity of aortic flow, can effectively estimate cardiac output [4]. We hypothesized that Doppler velocity patterns from the aorta or axillary arteries could non-invasively identify a pattern of systolic pressure variation (i.e. Doppler velocity variation or DVV) - providing a surrogate, non-invasive marker for predicting hypovolemia.

Methods: This IRB approved study evaluated mechanically ventilated patients (n = 19) admitted to the Surgical Intensive Care Unit. One investigator measured SPV and obtained maximal Doppler velocities from the ascending aorta at the suprasternal notch as well as right and left axillary arteries in triplicate, using the HP 5500 echocardiography machine. Another investigator, blinded to the patients and SPV, measured DV during ventilatory cycles at the aorta (AO), right axillary artery (RAA), and left axillary artery (LAA). SPV and DVV's were compared using linear regression.

Results: The mean APACHE 2 score was 21 $\pm$ 2 SE. Most patients (12/19) showed a SPV > 10 mm Hg. The mean SPV was 17 mm Hg $\pm$ 1.5 SE with a range of 6-53 mm Hg. DVV (> 10 cm/sec) was seen in 10/19 from AO, 7/19 from the LAA, and 5/19 from the RAA. Doppler velocity measurements showed significant respiratory variation at the 3 anatomic sites by paired *t* testing ($p < 0.05$). The mean absolute values of DV from AO, LAA, and RAA were 5.9 cm/sec $\pm$ 1.8 SE, 9.5 cm/sec $\pm$ 1.0 SE, and 9.0 cm/sec $\pm$ 0.9 SE, respectively. Linear regression showed, however, that SPV correlated poorly with DVV of AO, RAA, and LAA with r^2 values of 0.23, 0.24, and 0.30, respectively. Three patients showed a SPV > 30 mm Hg. Only 1 of 3 in this group showed significant DVV.

Summary: Doppler velocities from the aorta and axillary arteries appear to show variations with mechanical ventilatory breaths similar in pattern to arterial line waveforms. The magnitude of Doppler velocity variations of aortic and axillary arterial flow, however, does not appear to correlate with systolic pressure variation -- suggesting limited value for predicting hypovolemia.

References:

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