The Relationship Between IVC Collapsibility Ratio and Measured Whole Blood Volume in Surgical Critical Care Patients

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Introduction

Bedside echocardiography of inferior vena cava (IVC) collapsibility during the respiratory cycle has been used to estimate ventral venous pressure (CVP) in critically ill patients (1). This procedure can be taught to personnel who are not cardiologists or professional echocardiographers. However, CVP is an imperfect correlate of intravascular volume status since the central pressure measurements reflect pressure in relationship to heart function, and not the circulating volume. Whole blood volume (BV), directly reflective of intravascular volume, may be measured by using a semi-automated method (BVA-100; Daxor Corporation, NY, NY). If IVC colappsibility gives similar information about intravascular volume as that measured by the BVA-100, volume status could be estimated much more rapidly and at a lesser cost. This study was done to evaluate the relationship between IVC collapsibility and measured blood volume.

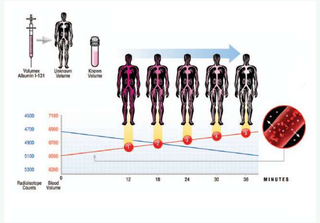

Figure 1. Human figures represent distinct unadjusted blood volumes at six-minute intervals at which blood samples are taken. Red line is the regression analysis to time zero indicating true total intavascular blood volume. The blue line represents the radioisotopic count. Reprinted with permission from Daxor.

Methods

This was a retrospective, observational study. After approval from the research and institutional review committee, the electronic medical records of patients admitted to a surgical or cardiac intensive care unit were searched to find those who had blood volume studies and echocardiograms on the same day. Blood volume measurements were obtained by a nuclear medicine technician and performed by the BVA-100 using an indicator dilution technique (fig 1). The results are reported as a percentage deviation from ideal volume based on height and weight (fig 2). Echocardiograms were performed by a trained technician and interpreted by a cadiologist. The collapsibility is measured using the maximum and minimum diameter of the IVC and is reported as greater than or less than 50% (fig 3).

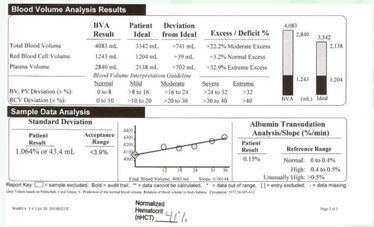

Figure 2. Blood volume is reported as a percentage deviation from ideal. Hypovolemia was defined as BV<0%.

Results

Forty-three patients had 48 same-day studies. Twenty-two were male and 21 were female. The average age was 64.5 (range 21 to 92). Diagnoses included trauma, sepsis, and patients with complications after cardiac, abdominal, or thoracic operations. An equal number of patients (8) who were hypovolemic by BV had IVC collapsibility greater than or less than 50%. Seventeen patients whose BV were ≥ 0% had IVC collapsibility < 50% and 15 were > 50% (table 1). There was no correlation between BV measurements and IVC collapsibility.

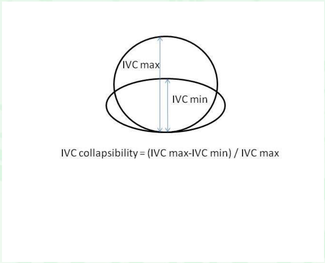

Figure 3. Measurement of IVC collapsibility

Results

		Blood volume	
		≥0%	<0%
IVC	<50%	17	8
collapsibility	>50%	15	8

Chi-square 0.042, p=0.84

Discussion

This retrospective observational study did not find a relationship between measured blood volume and IVC collapsibility. However, there are several limitations. The patients were selected based on having studies done the same day without regard to the fluid administration or diuresis that may have occurred between the measurements, which could have been hours apart. We combined ventilated and spontaneously breathing patients, whose IVC and right atrial pressure correlation depends on the sonographic measurement used and the timing of the measurement in the cardiac cycle (3). This study also only separated patients into two BV categories, < 0% or ≥ 0% and two IVC collapsibility categories, < or > 50%, whereas the relationship may be better shown at the more extreme ends of hyper- or hypovolemia.

Conclusions

Although IVC collapsibility is readily available and is shown to correlate with other measures of central venous pressure, in our inhomogeneous sample of critically ill patients, it does not correlate with circulating blood volume. Previous studies have confirmed the difficulty in assessing volume status using central pressure measurements (1) or clinical signs (4). Further investigation will be needed to determine if IVC collapsibility correlates with measured BV in certain patient populations or at the extreme ends of volume status.

References

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