A COMPARISON OF PULSE PRESSURE VARIATION AND BLOOD VOLUME MEASUREMENT

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Introduction
The assessment of intravascular volume status in critically ill patients continues to challenge clinicians. It is an important aspect that determines whether or not patients will benefit from volume expansions. Administering fluids is the first line of therapy in shock to augment and improve patient hemodynamics.

Pulse pressure variation is a hemodynamic parameter that may be used to guide volume infusion. Aortic pulse pressure (systolic-diastolic pressure) is directly proportional to left ventricular (LV) stroke volume and inversely related to aortic compliance (5). Therefore, the respiratory changes in LV stroke volume have been shown to be reflected by changes in peripheral pulse pressure during the respiratory cycle (4).

A systematic review by Michal et al. concluded that dynamic measures of preload responsiveness (ie, systolic pressure variation (SPV), pulse pressure variation (PPV), respiratory decrease in central venous pressure (CVP), and respiratory changes in aortic blood velocity) were superior to static preload parameters (ie central venous pressure (CVP), pulmonary artery occlusion pressure (PAOP), and left ventricular and diastolic area (LVEDA) when used to guide fluid management (1). Of these parameters, PPV was a good predictor of fluid responsiveness, with a value of 13% having the highest sensitivity and specificity in predicting an increase in cardiac output (CO) in response to fluid administration in a group of septic patients (2).

It is unclear whether cardiac responsiveness to fluids has a relationship to circulating blood volume.

Methods

Patients were enrolled into the study with the following admission criteria: sepsis or septic shock, surgical patients requiring pressor support, and patients with ARDS.

Exclusion criteria included pregnancy, head injury with GCS <12, age >18, and non-survivable conditions. Critically ill surgical patients had simultaneous measurements of blood volume using radioactive labeled iodine, with calculation of RBCV, with BV being RBCV + PV.

Methods of assessing intravascular volume status, clinicians must use caution when extrapolating surrogate markers such as hemodynamic parameters to determine intravascular blood volume status.

Results

29 surgical patients contributed 84 data points. Among these patients, APACHE II score 25+, septic shock (n=18), severe sepsis (n=7), ARDS (n=15). The correlation coefficient between PPV and BV was r=0.34, and R2=0.29.

In 69 instances when PPV was <13%, 13 of 69 BV measurements demonstrated hypervolemia. In 15 instances when PPV was >13%, 13 of 15 BV measurements demonstrated hypovolemia. In 57 of 84 times, the information from PPV and BV values was congruent.

Conclusions

There was no relationship between PPV and blood volume. Although PPV has been shown to be an accurate indicator of fluid responsiveness in mechanically ventilated patients with acute circulatory failure related to sepsis, PPV may not reflect true intravascular status. In 69 instances when PPV was <13%, 14 of 69 BV measurements demonstrated hypervolemia. These situations are designated fluid non-responders by PPV and yet are hypovolemic by blood volume measurement.

In 15 instances with PPV>13%, 13 of 15 instances demonstrated high BV and would have received fluids if PPV was used to guide fluid therapy. Fluid management in the critically ill surgical patient continues to be complex. While there is no ideal method of assessing intravascular volume status, clinicians must use caution when extrapolating surrogate markers such as hemodynamic parameters to determine intravascular blood volume status.

References