A COMPARISON OF PULSE PRESSURE AND BLOOD VOLUME MEASUREMENT
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Introduction
Assessment of intravascular status continues to be a challenge due to capillary leak and edema. Administering fluids is the first line of therapy in shock to augment and improve patient hemodynamics, and the endpoint of fluid resuscitation continues to be debated.

Pulse pressure (PP) is a hemodynamic parameter defined as systolic blood pressure (SBP) minus diastolic blood pressure (DBP). PP depends mainly on left ventricular (LV) stroke volume and arterial stiffness (1/Tcompliance). In patients with cardiogenic, hypovolemic, or hemorrhagic shock, decreased stroke volume results in a lower PP and a narrow PP can be used as a surrogate marker of hypovolemia (2,3).

Blood volume (BV) can be measured using a radioactive-labeled iodine technique. Blood volume analysis (BVA) provides information on intravascular, circulating volume and its component volumes (plasma volume + red cell volume). Assessment of intravascular blood volume in critically ill patients may be useful to guide clinicians in administering fluid therapy.

This study describes the relationship between pulse pressure (a surrogate marker of cardiac fluid responsiveness to fluid infusion) and BVA (a measurement of intravascular volume).

Hypothesis
There is no relationship between PP and BVA.

Methods
Critically ill surgical patients had simultaneous measurements of blood volume using radioactive labeled iodine, with recording of arterial blood pressure.

Pulse Pressure
Systolic and diastolic arterial pressures were measured using automated sphygmomanometry and pulse pressure (PP) was calculated as the difference between systolic and diastolic pressure (SBP-DBP). Normal PP ranges from 30-50 mm Hg. Low PP was defined as <30 mm Hg, and high PP was defined as >50 mm Hg.

Blood Volume
Blood volume (BV) was calculated as a percentage deviation from the patient’s ideal (See Fig 1). Predicted normal values were derived from a formula based on patient height, weight, and % deviation from ideal weight (4). For these critically ill patients with sepsis, severe sepsis (n=11), ARDS (n=37). The correlation coefficient between PP and BV was r=0.18, and r²=0.03 (See Fig 2).

Results
100 surgical patients contributed 674 data points. Demographics were: age 62 ±16 years, Male:female (61:39), APACHE II score 27 ±8, sepsis (n=57), sepsis shock (n=565), severe sepsis (n=57), ARDS (n=37). The correlation coefficient between PP and BV was r=0.18, and r²=0.03 (See Table 1).

<table>
<thead>
<tr>
<th>BV % Deviation from Ideal</th>
<th>PP &gt;50 mm Hg (n=565)</th>
<th>PP 30-50 mm Hg (n=102)</th>
<th>PP &lt;30 mm Hg (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV &lt;0%</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>BV 0-8%</td>
<td>3</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>BV &gt;8%</td>
<td>124</td>
<td>100</td>
<td>341</td>
</tr>
</tbody>
</table>

Fig 1: Example of Blood Volume Analysis Results.

Fig 2: The Relationship Between Pulse Pressure and Blood Volume Analysis

Conclusions
There was no relationship between PP and blood volume. Although PP is clinically easy to calculate, PP may not reflect true intravascular status in this group of patients with sepsis and ARDS. This poor relationship may be due to the underlying disease such as sepsis/ARDS with a decrease in systemic vascular resistance. Of concern is that all of the 141 instances of low BV (hypovolemia) was associated with normal or high PP.

The endpoint of fluid management in the critically ill patients continues to be complex, especially with capillary leak and edema. 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

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