



# 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/compliance) [1]. 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 utilizing 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

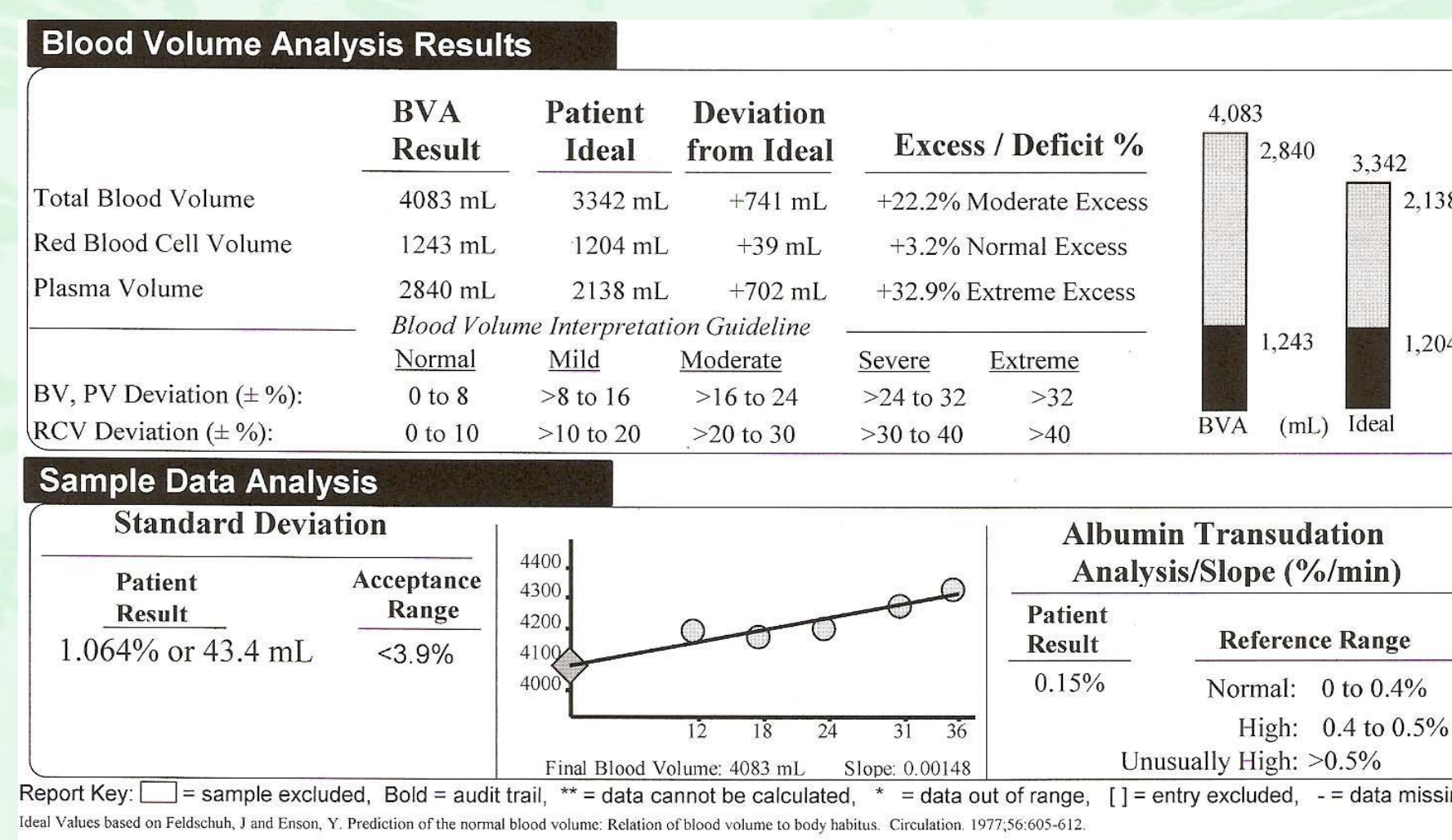
Critically ill surgical patients had simultaneous measurements of blood volume using radioactive labeled iodine, with recordation of arterial blood pressure.

### 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.

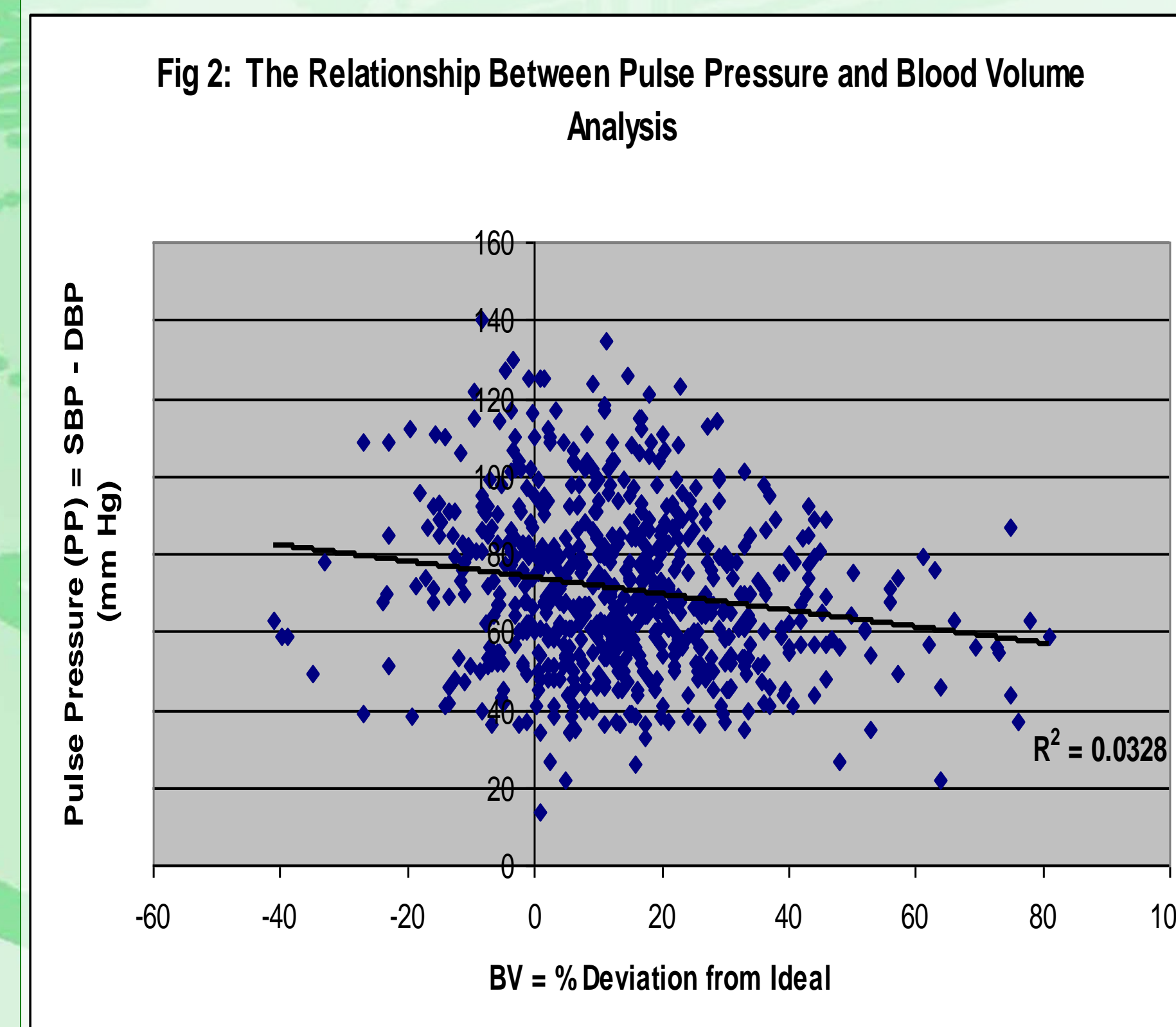
**Blood Volume = (plasma volume (PV) + red cell volume (RBCV))**  
Plasma volume (PV) was measured using the BVA-100 (Daxor, NY, NY). After obtaining a baseline sample of 5 mL of blood, 1 mL of I-131 labeled albumin was injected over 1 minute. After 12 minutes to allow complete mixing, 5 blood samples were collected at 6 minute intervals and extrapolated to time 0 to account for albumin extravasation from the intravascular space. Simultaneous Hct [RBCV/(RBCV + PV)] measurement allowed calculation of RBCV, with BV being RBCV + PV. PV, RBCV, and BV results are reported 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 vascular volume expansion, hypovolemia was defined as any value less than 0% deviation from ideal blood volume. Euvolemia was defined as 0-8% deviation from ideal BV, and hypervolemia was defined as >8% deviation from ideal BV. BVA was done after initial resuscitation on days 1, 2, 3, and 5-7 if the patients remained in the ICU.

Fig 1: Example of Blood Volume Analysis Results.



## Results

100 surgical patients contributed 674 data points. Demographics were: age 62±16 years, Male:female (61:39), APACHE II score 27±3, septic shock (n=57), severe sepsis (n=11), ARDS (n=37). The correlation coefficient between PP and BV was r=-0.18, and r<sup>2</sup>=0.03 (See Fig. 2).



## Results

The relationship between PP and BV analysis is presented in Table 1. Of 674 measurements, 141 demonstrated hypovolemia. All 141 measurements were associated with either normal or high PP and none demonstrated low PP.

	BV<0% n=141	BV 0-8% n=126	BV>8% n=407
PP<30 mm Hg (n=6)	0	3	3
PP 30-50 mm Hg (n=103)	17	23	63
PP>50 mm Hg (n=565)	124	100	341

Table 1: Study patients specified by pulse pressure and intravascular volume (BV).

## 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 BVA (hypovolemia) was associated with normal or high PP.

The endpoint of fluid management in the critically ill patients continues to be complex, specially 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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