A Word Salad in the Treatment of CHF: BVA, ICG, BNP

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Abstract

The continuing problem of determining the etiology of shortness of breath was thought to have been obviated by the use of BNP (beta natriuretic peptide) testing. Although it has been pointed out that BNP is an indicator of left ventricular wall stress, it has become a surrogate marker for CHF (congestive heart failure.) We have therefore explored the actual measurement of blood volume in patients with CHF. Thirty-one patients were evaluated by comparison of BNP to BVA (blood volume analysis) as well as ICG (impedance cardiography).

BVA was determined by albumin-iodine 131 (HSA-131) tracer dilution technique. Results determined that there was no direct relationship between absolute blood volume status by BVA and BNP. BVA would appear to offer significant advantage over BNP testing in the determination of clinical volume status in patients with CHF. BVA identified the less recognized concept of plasma volume expansion compensating for clinical anemia.

Using ICG it was further determined that BVA when compared to TFC (thoracic fluid content) had a correlation coefficient of 0.71. BNP when compared to thoracic fluid content had a correlation coefficient of 0.43.

Based on the findings it would appear that BVA, as well as TFC, offer superiority in the clinical assessment of the status of congestive heart failure. BVA when added to TFC constitutes a better clinical choice in determining the volume status in patients with CHF. Additional studies would be desirable to determine the role of BVA in clinical settings of significant volume shifts such as those patients requiring dialysis.

Methods

A retrospective observational study was carried out on thirty-one patients admitted to the Southwest Texas Methodist Hospital with a clinical diagnosis of congestive heart failure.

Each patient had the following data collected, BVA (Blood volume analysis, using the BVA-100 by Daxor Corporation), BNP (beta-natriuretic peptide) using Triage Meter by Biosite and ICG (Impedance Cardiography) using the (Cardiodynamics-Bio Z). The BNP and ICG were collected within one hour of each other, and BVA was completed prior to initiation of diuresis or inotrophic therapy, if indicated.

Results

Overall, BNP and blood volume did not correlate highly with hemodynamic measurements. The findings are summarized in the chart below.

For consistency, the chart uses data from the 24 patients who had complete blood volume and BNP measurements. Patients with incomplete data or whose BNP was measured to be ">1300" were not included. Thus, the correlations for blood volume are somewhat different from those indicated on the graphs. Correlations above 0.30 are bolded.

Table 1. Correlation between various hemodynamic measurements and BNP, Deviation from Ideal Blood Volume (BV), Deviation from Ideal Plasma Volume (PV), and Deviation from Ideal Red Cell Volume (RCV)

	BNP	BV	PV	RCV
Hematocrit	-0.10	-0.25	**-0.51**	**0.44**
Heart Rate	0.15	-0.03	-0.08	0.09
Systolic Blood Pressure	-0.27	-0.12	-0.17	0.04
Diastolic Blood Pressure	0.01	0.15	0.03	**0.35**
Mean Blood Pressure	-0.12	0.02	-0.09	0.27
Cardiac Index	**-0.37**	0.09	0.15	-0.09
Stroke Index	**-0.34**	0.04	0.14	-0.17
Systemic Vascular Resistance Index	0.10	0.18	0.06	**0.37**
Acceleration Index	-0.13	-0.08	-0.02	-0.21
Velocity Index	-0.24	0.03	0.05	-0.06
Thoracic Fluid Content	**0.43**	**0.68**	**0.75**	0.28
Left Cardiac Work Index	**-0.42**	-0.03	-0.02	-0.03
Systolic Time Ratio	-0.01	0.17	0.02	**0.42**
Pre-Ejection Period	-0.12	0.19	0.03	**0.44**
Left Ventricular Ejection Time	-0.27	-0.12	-0.06	-0.22

The highest correlation is between plasma volume and thoracic fluid content, followed by the correlation between blood volume and thoracic fluid content. These are the only two correlations above 0.5.

Cardiac index, stroke index, and left cardiac work index correlate negatively with BNP. If the heart if pumping ineffectively, as measured by these parameters, the BNP tends to be higher. There is no relationship between these parameters and blood volume in this data.

The patients in this study are taking a variety of medications to treat heart failure, so there might be some interaction with treatment that obscures possible underlying relationships between volume and hemodynamics. It is difficult to get a sense of the connections between volume, BNP, hemodynamics, and their effects on heart failure at a single point in time.

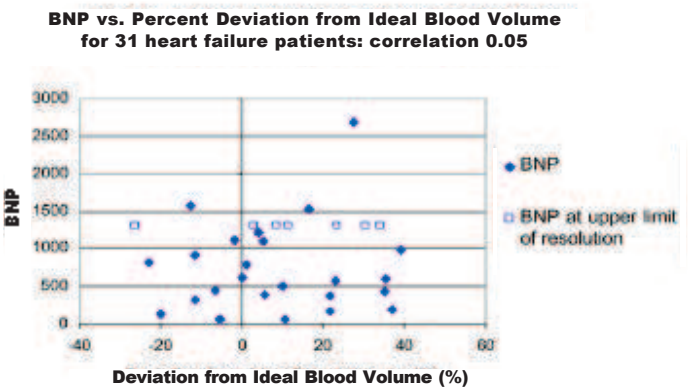

Figure 1. BNP versus Percent Deviation from Ideal Blood Volume

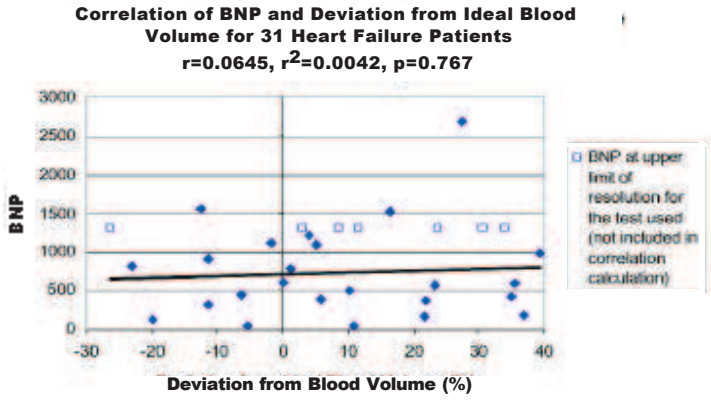

Figure 2. Correlation BNP versus Percent Deviation from Ideal Blood Volume

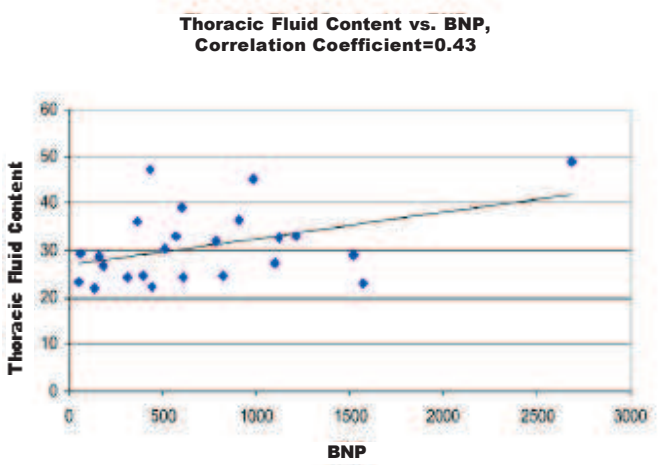

Figure 3. Correlation TFC versus BNP

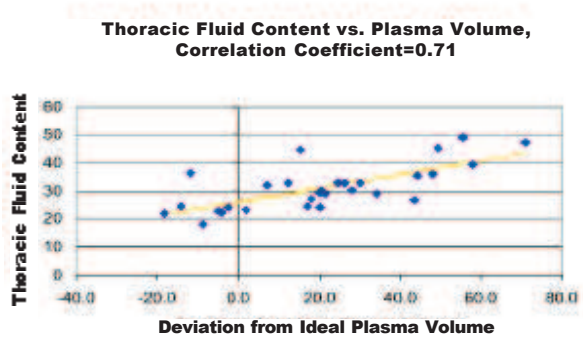

Figure 4. Correlation TFC versus Plasma Volume

Conclusion

Based on the findings it appears that BVA (blood volume analysis), measuring ideal plasma volume as well as TFC (thoracic fluid content) measured by ICG (impedance cardiography) offer superiority to BNP (beta natriuretic peptide) in the clinical assessment of the status of congestive heart failure.

BVA when added to TFC constitutes a better clinical choice in determining the volume status in the complicated heart failure patient. Additional studies would be desirable to determine the role of BVA in clinical settings of significant volume shifts as in those requiring dialysis.