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Correlation of central venous pressure with venous blood gas analysis parameters; a diagnostic study

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ABSTRACT

Objective: This study was conducted to assess the correlation between central venous pressure (CVP) and venous blood gas (VBG) analysis parameters, to facilitate management of severe sepsis and septic shock in emergency department.

Material and methods: This diagnostic study was conducted from January 2014 until June 2015 in three major educational medical centers, Tehran, Iran. For patients selected with diagnosis of septic shock, peripheral blood sample was taken for testing the VBG parameters and the anion gap (AG) was calculated. All the mentioned parameters were measured again after infusion of 500 cc of normal saline 0.9% in about 1 h.

Results: Totally, 93 patients with septic shock were enrolled, 63 male and 30 female. The mean age was 72.53 ± 13.03 and the mean Shock Index (SI) before fluid therapy was 0.79 ± 0.30. AG and pH showed significant negative correlations with CVP, While HCO3 showed a significant positive correlation with CVP. These relations can be affected by the treatment modalities used in shock management such as fluid therapy, mechanical ventilation and vasopressor treatment.

Conclusion: It is likely that there is a significant statistical correlation between VBG parameters and AG with CVP, but further research is needed before implementation of the results of this study.

1. Introduction

Shock is a true emergency medical condition, defined as inadequate blood perfusion to the body's tissues. This situation causes an imbalance between oxygen demand and supply, and leads to serious damage.[1] Therefore, it definitely needs prompt diagnosis and management, and serial assessments.[2] There are some major categories for better understanding and proper approach to shock including distributive, cardiogenic, hypovolemic, obstructive, and combined.[3,4] To emphasize the importance of this topic, it should be mentioned that shock usually needs treatment before finding out the exact underlying cause. Septic shock, which is a subgroup of the distributive category, is considered as a common cause of emergency department (ED) visits all around the world.[5] This type of shock needs adequate fluid therapy alongside antibiotic and probably corticosteroid administration. Assessment of the severity of circulatory fluid depletion in these patients, and reassessment of the situation during treatment is crucial and needs a ruler for better performance. Central venous pressure (CVP), along with some other parameters, has been used in this regards in ED. To measure the CVP, an invasive procedure should be performed to insert a central venous catheter (CVC). This procedure needs special preparation, including proper equipment, knowing the coagulation profile of the patient, and an expert physician. It is clear that these properties cannot be prepared in all EDs. If other less-invasive and routine parameters can estimate CVP, management of septic shock

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will be facilitated. Venous blood gas (VBG) analysis provides some parameters that are useful in this regard.[2] Detailed explanation pathophysiologically connection between tissue hypoxia, hypoperfusion and acidosis with CVP might help for better understanding the aspect. It is obvious that tissue hypoxia resulted from hypoperfusion happens in early stages of septic shock. The anticipated result should be acidosis that could be finding out by VBG analysis parameters.[5,6] CVP measures the perfusion, so it is conceivable to be a correlation between CVP and VBG analysis parameters. This study was conducted to assess the correlation between CVP and VBG analysis parameters to facilitate septic shock management in ED.

2. Material and methods

2.1. Study design

This diagnostic study was conducted from January 2014 until June 2015 in three major educational medical centers, Tehran, Iran.

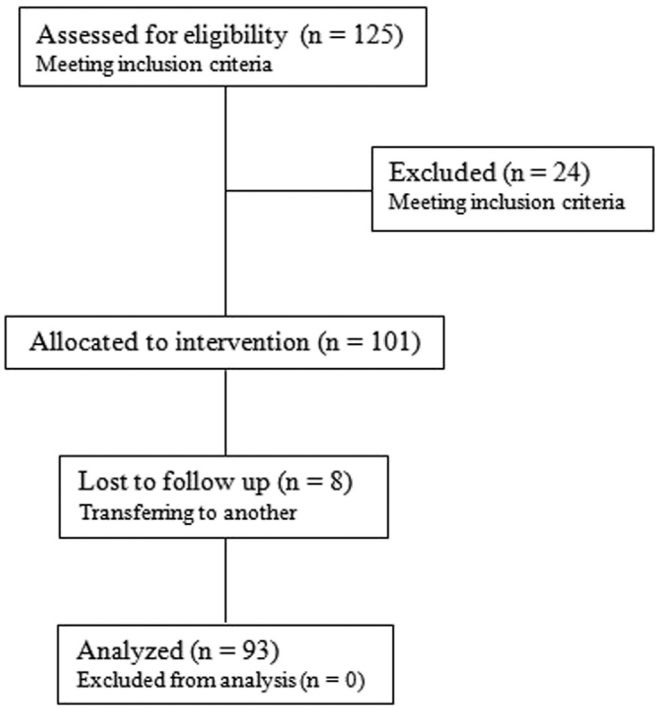

Fig. 1. Patient flow diagram.

2.2. Population and intervention

All patients with diagnosis of severe sepsis were enrolled in the study.[5] Those with known history of heart failure and/or renal failure were excluded. Following initial resuscitation of 20 cc/kg of crystalloid solutions, if the patient was still hypotensive and/or had serum level lactate of more than 4 mmol/l, central venous line was inserted in the internal jugular vein and those with initial CVP more than 8 cmH2O were excluded from the study[7] and those with CVP less than 8 cmH2O considered as eligible cases. For selected patients, peripheral blood sample was taken for testing VBG (measurement of pH, base excess (BE), and HCO3), sodium (Na) and chloride (Cl), and also the anion gap (AG) was calculated. These data along with demographic data were registered in a prepared checklist. Fluid challenge test [8,9] with infusion of 500 cc of normal saline 0.9% in about 1 h was performed and those with more than 3 cmH2O raise in CVP were excluded. All mentioned parameters were measured again for remained patient. Fig. 1 showed the patient flow diagram in this study.

2.3. Statistical analysis

SPSS version 21 with McNamara and kappa tests, statistical analysis was performed. Descriptive baseline variables are mentioned as mean ± standard deviation. For all comparative analysis p-value and r was calculated. P-value ≤ 0.05 was considered significant. For better understanding the comparisons bivariate and multivariate analysis were also conducted and related results are showed with tables and graphs.

2.4. Ethical issues

The study protocol was approved by the ethical committee of Shahid Beheshti University of Medical Sciences. The authors adhered to the Helsinki ethical principles throughout this research.

3. Results

Totally, 93 patients with a diagnosis of septic shock were enrolled in this study. The mean age was 72.53 ± 13.03 and 63 cases (67.7%) were male. The mean Shock Index was 0.79 ± 0.30 before fluid administration and 0.82 ± 0.74 after (normal range = 0.5–0.7). Table 1 shows the baseline characteristics of the sample patients including vital signs, VBG parameters, AG, and CVP before and after fluid administration and their changes in details.

Bivariate analysis Pearson correlation tests revealed that pH and AG had significant negative correlation (r = −0.21 and −0.18 respectively; %95 CI) with CVP, while HCO3 had significant positive correlation (r = 0.35; %95 CI) with CVP (P value < 0.05), as shown in

Table 1
Vital signs, VBG parameters, SI, AG, and CVP before and after fluid administration as well as their changes.

Variable	Before fluid administration	After fluid administration	The changes (Δ)
SBP	117.99 ± 30.00	120.76 ± 28.78	1.81 ± 15.76
DBP	67.28 ± 18.96	72.25 ± 17.94	5.04 ± 16.76
MAP	85.26 ± 22.04	89.34 ± 21.27	3.81 ± 15.90
PR	87.06 ± 19.19	84.22 ± 19.44	−1.36 ± 14.81
SI	0.79 ± 0.30	0.82 ± 0.74	−0.02 ± 0.17
pH	7.35 ± 0.10	7.34 ± 0.14	0.00 ± 0.14
HCO3	24.36 ± 6.76	25.87 ± 24.45	−0.47 ± 5.64
BE	0.25 ± 8.26	1.73 ± 7.99	1.19 ± 7.51
AG	11.71 ± 9.25	13.85 ± 9.38	2.19 ± 8.61
CVP	6.90 ± 5.07	8.41 ± 4.54	2.34 ± 3.74

SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; PR: pulse rate; SI: shock index; BE: base excess; AG: anion gap; CVP: central venous pressure.

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