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UTILITY OF SHOCK INDEX TO PREDICT HEMODYNAMIC COLLAPSE AND FLUID RESPONSIVENESS IN SEPTIC SHOCK PATIENTS – A CROSS SECTIONAL STUDY

Anaesthesiology

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ABSTRACT

Sepsis is the most common cause of death in intensive care unit patients. Shock index (SI) is a quick and useful indicator that can alert clinicians of potential underlying problems related to occult bleeding, haemorrhage or sepsis. Assessing a patient's volume status and fluid responsiveness, and monitoring patient's response to fluid administration is critical in maintaining the balance between meeting a patient's fluid needs vs. contributing to complications of volume overload. Therefore, in the present we aimed to assess utility of shock index to predict hemodynamic collapse and fluid responsiveness in septic shock patients. This is a cross-sectional study conducted with total of 90 patients aged > 15 years with SBP<100mm Hg and with a positive blood culture. SI was calculated after initial resuscitation for the patients presenting with septic shock. Patients were divided into two groups viz. Group A (n=45) with SI < 0.87 and Group B (n=45) with SI ≥0.87. Percentage of patients who were fluid responsive was calculated in both groups. Results revealed that majority of the patients i.e., 48.90% were belonged to age group of 56-70 years with female predominance (56.70%) as compared to male (43.30%) patients. There was a statistically significant ($p<0.01$) & non-significant ($p = 0.288$) association found between age groups & gender and responsiveness to fluid administration respectively. Furthermore, statistically significant ($p<0.001$) association found between SI and responsiveness to fluid administration between the groups i.e., 80% of patients in Group A (SI<0.87) responded to administration of fluid whereas only 33% of patients in Group B (SI≥0.87) were fluid responders. In conclusion, our study results clearly demonstrated the use of SI to predict hemodynamic collapse and fluid responsiveness in septic shock patients. The SI appears to be an accurate screening modality for assessing hemodynamic collapse in septic shock patients when used with a cut-off value of 0.87.

KEYWORDS

Sepsis, Septic shock, Shock index. Hemodynamic collapse, Fluid responsiveness

INTRODUCTION

Sepsis is the most common cause of death in intensive care unit patients.[1] Sepsis is defined as a syndrome that involves biochemical, physiological and pathological abnormalities caused by an infection.[2] More recently, sepsis was defined in a consensus report published in 1992 and approved in 2003 as the systemic inflammatory response syndrome (SIRS) to infection.[3] A recent study from the Institute for Health Metrics and Evaluation (IHME) on the global burden of sepsis estimated 48.9 million incident sepsis cases and 11 million sepsis-related deaths worldwide in 2017.[4]

Septic Shock (SS) is defined as a sepsis (denoted by a Sequential Organ Failure Assessment≥2 points) plus serum lactate ≥2 mmol/L and persistent hypotension despite adequate volume resuscitation, necessitating vasopressors to maintain a mean arterial blood pressure ≥65 mm Hg.[5] Globally, SS is one of the most common causes of admission in both the adult and paediatric populations,[6] and it is associated with a significantly high mortality rate.[7] SS is globally recognized by WHO as a health priority.[8]

The shock index (SI) is a quick and useful indicator that can alert clinicians of potential underlying problems related to occult bleeding, haemorrhage or sepsis that might be overlooked if vital signs such as heart rate (HR) and systolic blood pressure (SBP) were reviewed in isolation.[9] Shock index (SI) is defined as heart rate divided by systolic blood pressure (SI = HR/SBP). Normal range being 0.5 to 0.7 beats per minute per mm Hg in healthy adults. The normal range for this measure is currently accepted as 0.5–0.7, though some evidence suggests that up to 0.9 is acceptable.[10]

Early effective fluid resuscitation is an important step in the stabilisation of sepsis-induced tissue hypoperfusion or septic shock along with the stabilisation of airway and breathing. Sepsis induced hypoperfusion may be manifested by acute organ dysfunction and/ or ± hypotension and increased serum lactate.[11] Giving insufficient fluids and/or administering fluids too slowly to hypotensive patients with hypovolemia can contribute to continued hypoperfusion and increased morbidity and mortality. Similarly, giving excessive fluids to a volume unresponsive patient can contribute to volume overload and can equally increase morbidity and mortality.[12]

Therefore, assessing a patient's volume status and fluid responsiveness, and monitoring patient's response to fluid administration is critical in maintaining the balance between meeting a patient's fluid needs vs. contributing to complications of volume overload.[12] With this background the present study was conducted with the main objectives to assess utility of shock index to predict hemodynamic collapse and fluid responsiveness in septic shock patients.

METHODOLOGY

This is a cross-sectional study conducted with total of 90 patients aged > 15 years with SBP<100mm Hg and with a positive blood culture admitted in ICU department of Bapuji Hospital, Chigateri General Hospital attached to J. J. M Medical College, Davangere, Karnataka. Patients on medications that have significant atrio-ventricular blockage effect, patients with associated upper gastrointestinal bleeding, immunocompromised states, and sepsis patients with low blood pressure who were started on inotropes immediately <2 hours from arrival to the emergency department were excluded from the study.

SI was calculated after initial resuscitation for the patients presenting with septic shock. SI was calculated by using the formula; SI = HR/SBP. The cut off value of SI was taken as 0.87 since it was determined to have the highest sensitivity and specificity for predicting the patient's lack of responsiveness to fluid resuscitation.

Patients were divided into two groups *viz.* Group A (n=45) with SI < 0.87 and Group B (n=45) with SI ≥0.87. Percentage of patients who were fluid responsive was calculated in both groups.

Statistical analysis

Data were entered in Microsoft Excel 2013 and statistical analysis was done using IBM Statistical Software for Social Sciences (SPSS) version 22. Categorical variables were represented in the form of percentages, frequencies and continuous variables were presented as descriptive statistics (Mean and Standard deviation). Association of variable data was done using Chi-square test. $p\leq0.05$ was considered as statistically significant.

RESULTS

Majority of the patients i.e., 48.90% enrolled in the study belonged to age group of 56-70 years followed by 41-55 years of age (32.20%) with female predominance (56.70%) as compared to male (43.30%) patients (Table 1).

Table 1: Demographic characteristics of study subjects

Variables	No. of Cases	Percentage (%)
Age (years)		
26-40	12	13.30

41-55	29	32.20
56-70	44	48.90
>70	5	5.60
Gender		
Male	39	43.30
Female	51	56.70

The results of association of age, gender and fluid responsiveness was represented in Table 2. The results revealed that majority of patients i.e., 39 % of patients belonging to age group of 41-55 years responded to fluid administration. However, there were 64% & 36% of patients belonging to age group of 56-70 & > 70 years respectively who did not respond to fluid administration. There was a statistically significant (p<0.01) association found between age groups and responsiveness to fluid administration based on Chi-square test.

51% of female patients responded to fluid administration as compared to male patients (49%). Whereas, 64% & 36% of female & male patients respectively were non-responsive to fluid administration. However, there was a non-significant (p = 0.288) association found between gender and responsiveness to fluid administration based on Chi-square test.

Table 2: Association of age, gender and fluid responsiveness

Variables	Fluid Responder (%)	
	Yes	No
Age (years)		
26-40	24.00	0.00
41-55	39.00	0.00
56-70	37.00	64.00
>70	0.00	36.00
p<0.001		
Gender		
Male	49.00	36.00
Female	51.00	64.00
P = 0.288		

There was a statistically significant (p<0.001) association found between SI and responsiveness to fluid administration between the groups based on Chi-square test (Table 3). Results depicted that 80% of patients in Group A (i.e., SI<0.87) responded to administration of fluid whereas only 33% of patients in Group B (i.e., SI≥0.87) responded to administration of fluid.

Table 3: Association of SI and fluid responsiveness between groups

Shock Index (SI)	Fluid Responder (%)	
	Yes	No
Group A	80.00	20.00
Group B	33.00	67.00
p<0.001		

DISCUSSION

Sustained elevation of the SI after fluid resuscitation has been demonstrated to sensitively predict hemodynamic collapse in patients presenting at the emergency department with severe sepsis as well as organ dysfunction.[13] Hence, the SI has been used as a risk stratification tool for detecting changes in hemodynamic parameters before the onset of systemic hypotension and cardiorespiratory collapse.[14] Therefore, in the current study we aimed to determine utility of shock index to predict hemodynamic collapse and fluid responsiveness in septic shock patients.

The results of our study revealed that majority of the patients i.e., 48.90% belonged to age group of 56-70 years with female predominance (56.70%) as compared to male (43.30%) patients. Furthermore, results of association of age, gender and fluid responsiveness delineated that there was a statistically significant (p<0.01) association found between age groups and responsiveness to fluid administration. However, there was a non-significant (p = 0.288) association found between gender and responsiveness to fluid administration. These findings were comparable with the various other research investigations reported in the literature. Aseri et al., reported in their research investigation that the mean age of patients was found to be 57.4 years, and it was found to be significantly (t = 3.4, P =0.001) responsive to fluid administration, i.e., patients who were responsive to fluid administration being younger with mean age of 53.2 years than those who were non responsive to fluid therapy with mean age of 65.6 years.[15] In another study by Althunayyan et al., the mean age of the study subjects was reported to be 48 years.[16] Study of Prashanth et al., revealed that the mean age of the study population was found to be 48.8 years and maximum number of patients were between 35–60 years of age.[17] Similar to our study findings, Aseri et al., also reported female predominance (51%) as compared to male patients without any significant association between gender and responsiveness to fluid administration.[15]

In our study, there was a statistically significant (p<0.001) association found between SI and responsiveness to fluid administration between the groups i.e., 80% of patients in Group A (SI<0.87) responded to administration of fluid. Whereas, 33% of patients in Group B (SI≥0.87) were fluid responders & 67% of patients in Group B were non-responsive to administration of fluid. In concurrence to our study findings, Aseri et al., demonstrated that patients with SI≥0.87 and responsiveness to fluid administration was significantly (P = 0.007) associated.[15] Furthermore, in a study reported by Nathan et al., on patients with postpartum hemorrhage revealed that with a blood loss of ≥1500 mL, a SI <0.9 was reassuring by predicting ICU admission.[18] Keller et al., delineated that with regard to post-intubation hypotension, a pre-intubation SI score ≥0.9 was found to be predictive of post-intubation hypotension in apparently hemodynamically stable patients.[19]

Moreover, an increasing trend in SI scores was shown to be more reliable at predicting outcomes in geriatric trauma patients than a single reading.[20,21] In addition, as per various investigators, it was evident that SI scores for trauma patients correlated with hospital resource usage and mortality rates. An SI score ≥1 after a 1L of crystalloid resuscitation is predictive of the need for oxygen carrier resuscitation.[22,23] According to Nakasone et al., the preembolization SI score was found to be associated with extravasation on angiography in patients with episodes of gastrointestinal bleeding.[24]

CONCLUSION

In conclusion, this preliminary cross-sectional study demonstrated the use of SI to predict hemodynamic collapse and fluid responsiveness in septic shock patients. The SI appears to be an accurate screening modality for assessing hemodynamic collapse in septic shock patients when used with a cut-off value of 0.87, especially in patients between 41-55 years old. However, owing to the limitations of this study like minimum sample size, sepsis screening, appropriate fluid resuscitation, further studies are recommended in a large cohort to affirm this study findings.

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