

# RESEARCH ARTICLE

# PROGNOSTIC VALUE OF SHOCK INDEX IN CHILDREN WITH SEPTIC SHOCK

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# Abstract

..... ..... Manuscript History Introduction: Septic shock in pediatric age group is likely due to result Received: 30 January 2023 of sequence of disorders that is due to infection by viruses, bacteria, Final Accepted: 28 February 2023 parasite, fungi or toxins of organisms. The outcome is improved with Published: March 2023 early recognition and resuscitation of sepsis and septic shock in the golden first few hours of PICU admission. Hence, we conducted this retrospective surgery between PICU shock index in ICU mortality and morbidity. Material & Methods: The study was retrospective and performed in 1 paediatric intensive care unit in Department of Paediatrics, A. J Hospital, Mangalore, Karnataka. The following specimen data were collected 0.2.4.6.hours after admission : HR and SBP for SI calculation. Patients were divided into 2 groups according to their outcome(death/survival) Results: A total of 75 children admitted with septic shock between June 2018 and May 2020 were included. Shock index was significantly different between survivors and non survivors at 0,2,4,6 hours of admission (P-0.003,P-0.029,P-0.043,P-0.006 respectively) compared to HR and SBP alone separately. The cutoff point of SI for death in our study at 0 hours is < 1.7 with sensitivity of 63.6% and specificity of 62.3%, at 2 hours cutoff is <1.6 with sensitivity of 68% and specificity of 70%, at 4 hrs cutoff is < 1.55 with sensitivity of 68% and specificity of 66%, at 6 hours cutoff is < 1.5 with sensitivity of 72.7% and specificity of 68%. Conclusions: In our population of children with septic shock, SI was a clinically relevant and easily calculated predictor of mortality.It could

be better measure of hemodynamic status than HR and SBP alone, allowing for early recognition of severe sepsis.

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#### Introduction:-

Sepsis in pediatric age population is perhaps a results of sequence of diseases that's because of infection by contagions, bacteria, virus, parasites, fungi or toxins of organism. In 1960s, Shock index was first introduced by Allgower and Buri<sup>1</sup>. They plant that the traditional value of shock index during a healthy adult ranges from 0.5 to 0.7. In adults, shock index >0.9 was significantly related to hypoxia, myocardial dysfunction, increased mortality and thus with intensive care and rescuscitation. However in pediatrics, the shock index and its normal range has not been studied yet. The wide range of normal vital signs vary in each age population features a confounding effect and thus there is a wide normal range of shock index in various age groups. The outcomes are better with early recognition and rescuscitationof sepsis and septic shock within the golden first few hours of PICU admission.

Repeated studies in children and adults have been demonstrated that early recognition and aggressive resuscitation of shock is associated with better outcome. Thus, we sought to use a simple, non invasive, metric tool that can serve as a predictive marker of high risk children for poor outcome in children with sepsis/septic shock.

While all the scores and prognostic markers are complex as they are composed of multiple parameters, which needs lab analysis, invasive, expensive and time consuming, shock index, is the ratio of heart rate to systolic blood pressure is an inexpensive ,clinical tool that helps us to remain vigilant in ER/PICU by finding the subtle presentations of pediatric sepsis and septic shock. The usual therapeutic goals of initial resuscitation of shock are normalisation of hemodynamic and laboratory values such as heart rate, BP,CVP and lactic acid. However, many studies have shown that normalization of these parameters does not necessarily improve morbidity or mortality in sepsis/septic shock.

## Methodology:-

This study was retrospective and was performed in thepediatric intensive care unit (PICU) at tertiary care hospital. At admission, children were grouped into respective categories according to International Pediatric Sepsis Consensus Conference definition of Sepsis. Children between the ages 1 month and 18 years that were admitted to PICU with sepsis/septic shock (INTERNATIONAL PEDIATRIC SEPSIS CONSENSUS CONFERENCE 2005<sup>15</sup>). Children presenting with other types of shock such as cardiogenic shock,obstructive shock, hypovolemic shock other than septic shock were excluded from the study.

The following data were extracted from the patient day sheets with the additional information obtained from the medical record: demographic data (age, sex, weight) and status at PICU discharge (death vs survivors). The following specific data were collected at 0, 2, 4, and 6 hours after admission: HR and SBP for SI calculation, diastolic blood pressure. Shock index was stratified by age.<sup>5</sup>

Shock index was calculated as HR/SBP<sup>5</sup>. For unrecordableBP, a systolic BP of 30mmHg was considered(as per PIM score).HR of 0 was used for unrecordable BP. Hence, during a cardiac arrest, SI was 0.Values of 0 were not included for multivariate analysis or trend. An improvement in shock index was defined as decrease in SI at 0 hours and 6 hours. And the trend of shock index(increasing/decreasing/static) during the first 6 hours was also noted.

Different age adjusted and hourly cut off values, their distribution, sensitivity, specificity as prognostic marker of sepsis/septic shock, confidence interval and the area under ROC was calculated for absolute values of shock index and changes in shock index at admission and hourly intervals and the relative risk of mortality obtained.

Statistical analysis was conducted using SPSS version 23. Vital status (survival vs death) was compared for SI at 0, 2, 4, and 6 hours after admission and changes in SI during the first 6 hours. The demographic characteristics were summarised using descriptive statistics. The characteristics were described using frequency and percentage. The comparison of categorical data was done by chi-square test and/or Fishers exact test. P value of <0.05 was considered statistically significant.

# **Results:-**

75 children admitted with septic shock between June 2018 and May 2020 were included. Majority of the patients admitted were between the ages of 4-11 years, with a mean age of  $6.42 \pm 0.91$  years. The male to female ratio was 0.91:1. There was no significant difference in the 2 groups regarding age, weight, and sex.

Identified pathogens were MRSA (4%), Streptococcus pneumoniae (4%), Acinetobacter(1.3%), Candida albicans (1.3%), Staphylococcus aureus(1.3%), Klebsiella(1.3%) and no pathogen (86.7%). Treatment of shock consisted of fluid resuscitation and at least one catecholamine (noradrenaline, adrenaline dopamine, dobutamine,) plus steroids in case of shock refractory to adrenaline.

Mortality rate was 29.3%, and remaining were discharged after treatment.

SHOCK INDEX		Count	Column N %				
SI At 0	Abnormal	51	68.0%				
	Normal	24	32.0%				
	Total	75	100.0%				
SI At 2	Abnormal	37	49.3%				
	Normal	38	50.7%				
	Total	75	100.0%				
SI At 4	Abnormal	36	48.0%				
	Normal	39	52.0%				
	Total	75	100.0%				
SI At 6	Abnormal	41	54.7%				
	Normal	34	45.3%				
	Total	75	100.0%				

Table 1:- Shock Index.

Age-adjusted SIs were different between survivors and non-survivors at 0,2,4 and 6 hours, with a relative risk (RR) predictive of death at the same time points, however it was statistically insignificant.

			PROGNOSIS									
			Death			Discharged			Total			
				Column N	Row N		Column N	Row N		Column N	Row N	
			Count	%	%	Count	%	%	Count	%	%	
SI A 0	At	Abnormal	15	68.2%	29.4%	36	67.9%	70.6%	51	68.0%	100.0%	
		Normal	7	31.8%	29.2%	17	32.1%	70.8%	24	32.0%	100.0%	
		Total	22	100.0%	29.3%	53	100.0%	70.7%	75	100.0%	100.0%	
SI A 2	At	Abnormal	12	54.5%	32.4%	25	47.2%	67.6%	37	49.3%	100.0%	
		Normal	10	45.5%	26.3%	28	52.8%	73.7%	38	50.7%	100.0%	
		Total	22	100.0%	29.3%	53	100.0%	70.7%	75	100.0%	100.0%	
SI A 4	At	Abnormal	14	63.6%	38.9%	22	41.5%	61.1%	36	48.0%	100.0%	
		Normal	8	36.4%	20.5%	31	58.5%	79.5%	39	52.0%	100.0%	
		Total	22	100.0%	29.3%	53	100.0%	70.7%	75	100.0%	100.0%	
SI A 6	At	Abnormal	14	63.6%	34.1%	27	50.9%	65.9%	41	54.7%	100.0%	
		Normal	8	36.4%	23.5%	26	49.1%	76.5%	34	45.3%	100.0%	
		Total	22	100.0%	29.3%	53	100.0%	70.7%	75	100.0%	100.0%	

## **Table 6:-** Correlation Of Si With Outcomes.

For the population as a whole, mean SI at 0 and 6 hours ranged from 1.40 to 2.17. Shock index was significantly higher when compared between survivors and non-survivors at 0,2, 4, and 6 hours compared to HR and SBP alone separately.(P = 0.003, P=0.029, P=0.047, P=0.006 respectively.)

The cutoff point for death for SI in our study at 0 hours is < 1.7 with sensitivity of 63.6% and specificity of 62.3%, at 2 hours cutoff is < 1.6 with sensitivity of 68% and specificity of 70%, at 4 hrscutoff is < 1.55 with sensitivity of 68% and specificity of 72.7% and specificity of 68%.

# **Discussion:-**

Septic shock is the second most cause of mortality in PICU, with a death rate up to 30%.<sup>6</sup>

The prognosis of severe sepsis or septic shock relies on early recognition and rapid implementation of appropriate treatment. However, a minority of children receive optimal treatment.<sup>7</sup> Several barriers to the implementation of guidelines may explain this.<sup>8</sup>

In the 1960s, Allgower and Buri<sup>1</sup>had first introduced the Shock index and is defined as the HR to SBP. They noted that a normalvalue of SI ranges from 0.5 to 0.7 in a healthy individuals.Rousseaux ,Jeremie et al<sup>9</sup> said that SI was clinically important& easily calculated predictor of mortality. AgeadjustedSI were different between survivors and non survivors at 0 and 6 hours and an abnormal SI both at admission and at 6 hours waspredictor of death.

Yukriyasaka et al<sup>10</sup> tried to evaluate the cutoffvalues of shock index for ICU mortality and how change in shock index in the first 6 hours of ICU admission is related with outcome. They have noted that there was higher risk of mortality asshock index increased and demonstrated that children with elevated shockindex may benefit from more aggressive resuscitation and higher levelof care.Samiran Rey et a<sup>11</sup> had done retrospective observationstudy on shock index values and trends in paediatric sepsis as predictors and therapeutic targets. In their study, it was noted that the absolute orchange in SI does not predict early death any more than heart rate and systolic blood pressure alone in children with sepsis.

Lara D Rappoport et al<sup>12</sup> did the first report of age and sexspecific normal values for SI and concluded that age specific vital sign range are recommended in screening for shock then a single valuethreshold.Carcillo et al<sup>13</sup>showed that IVFresuscitation and use of inotropesdrugs improves shock index and thus helps in assessing the interventions.Shannor N Acker et al<sup>14</sup> noted that pediatricspecific shock index(SIPA) more accurately identifies severely injured children, intrabdominal injury requiring transfusion, and are higher riskof death when compared to shock index unadjusted for age.

In our study including 75 patients in septic shock, we showed that SI was predictive of death at 0,2, 4, and 6 hours and children with an abnormal age-adjusted SI at 0 and 6 hours had a higher RR of death than children with a normal age-adjusted SI at 0 and 6 hours.

We would want to evaluate the additional information provided by lactate, a recognized early marker of severe sepsis. Unfortunately, this information was often missing, not allowing thorough analyses of this parameter.

Our study suggests that inclusion of automatically calculated SI with automatic alert in such protocols could be helpful. Shock index may be a better measure of the degree of hemodynamic stability than HR or SBP alone. In our study, HR was significantly different between survivors and nonsurvivors only at 6 hours and SBP was not significant at any time, whereas SI was significantly different between survivors and nonsurvivors at 0,2, 4, and 6 hours.

# **Conclusions:-**

In the present study, children with septic shock, SI was clinically relevant, applicable, easily and rapidly calculated predictor of mortality. It should be added to HR and SBP and integrated in a computer tool and electronic tools, allowing for the early recognition of septic shock and prediction of the need for aggressive treatment. Shock index could be used either in the ER department or in the PICU, ward for activation of a medical emergency and rapid response team. The use of SI should be tested in larger prospective cohorts of children with shock of different cause.

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