International Journal of Contemporary Pediatrics
Laguvaram S et al. Int J Contemp Pediatr. 2025 Feb;12(2):200-203
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20250084

Original Research Article

Evaluating shock index as a prognostic tool in septic shock patients

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Received: 04 January 2025
Revised: 22 January 2025
Accepted: 23 January 2025

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ABSTRACT

Background: Septic shock is a leading cause of morbidity and mortality in children worldwide. The shock index (SI), defined as a quotient obtained by dividing the heart rate (HR) with systolic blood pressure (SBP), is a potential tool that may aid in early prognostication of outcomes in paediatric septic shock, though data on its utility remains limited.
Methods: A hospital-based cross-sectional study was conducted in the paediatric intensive care unit (PICU) at Navodaya Medical College, Raichur, over one year. A total of 100 children aged 1 month to 12 years with septic shock were included. SI values were calculated and analysed for their association with inotrope requirement, multiple organ dysfunction syndrome (MODS), length of PICU stay, and outcomes. Children with cardiogenic, hypovolemic, or obstructive shock and those previously treated at other centres were excluded.
Results: Out of 100 children with septic shock, 76 survived and 24 died, with a mortality rate of 24%. Elevated SI values (>1.2) were seen in 78%, correlating with disease severity. Survivors had a mean SI of 0.9±0.1, while non-survivors had 1.3±0.2 ($p<0.05$). Among elevated SI cases, 64% required inotropes, and 42% developed MODS compared to 8% with normal SI ($p<0.01$). The average PICU stay was longer for elevated SI cases (7±3 days versus 4±1 days). Persistently high SI values predicted poor outcomes and mortality.
Conclusions: Elevated SI can be a valuable non-invasive parameter that aids health care professionals in triaging sick children in a limited resource setting, allowing for timely referral to higher centres. Continuous monitoring of SI trends alongside HR and SBP can aid in early identification of high-risk patients, enabling timely and targeted interventions.

Keywords: Septic shock, Paediatric intensive care units, Triage, Systolic blood pressure

INTRODUCTION

Sepsis is one of the leading causes of morbidity and mortality among infants and children worldwide, particularly in resource-limited settings like India. It accounts for more than 60% of under-five deaths globally, with septic shock contributing significantly to this burden.[1,2] Septic shock arises due to tissue hypoperfusion caused by the release of inflammatory mediators, maldistribution of intravascular volume, and myocardial dysfunction. Despite advances in paediatric intensive care guidelines, the management of septic shock remains a significant challenge, especially in developing countries, due to the scarcity of data and limited resources.[1,2]

Shock index (SI), defined as the ratio of heart rate (HR) to systolic blood pressure (SBP), was first described in 1967 and is considered a simple, non-invasive marker of hemodynamic status. A normal SI in adults typically ranges from 0.5–0.7, with values above 1.0 indicating worsening hemodynamic status.[3,4]

Early identification and intervention in septic shock are critical for improving outcomes. SI has shown potential in predicting morbidity and mortality, particularly in resource-limited settings where advanced diagnostic tools are unavailable. It can also aid in triaging patients in primary and secondary healthcare setups, allowing to identify critically ill patients and refer them promptly to higher centres.[3,5]

Despite its utility, the use of SI in paediatric septic shock remains underexplored. Limited data exist on its application in paediatric intensive care, particularly in India, where the burden of sepsis is high. This study aims to evaluate the association between SI and clinical outcomes in children with septic shock, thereby providing insights for optimizing early management strategies.[1,5]

METHODS

Hospital-based cross-sectional study was conducted in the paediatric intensive care unit (PICU) at Navodaya Medical College, Raichur, over one year from August 2023 to September 2024. A total of 100 children aged 1 month to 12 years with septic shock were included by employing convenient sampling technique. SI values were calculated and analysed for their association with inotrope requirement, multiple organ dysfunction syndrome (MODS), length of PICU stay, and outcomes.

Inclusion criteria

Children of age group 1 month-12 years admitted in the intensive care unit with septic shock or who later develop septic shock during PICU stay were included.

Exclusion criteria

Children less than 1 month and greater than 12 years and children with cardiogenic shock, hypovolemic shock and obstructive shock, and children who had received inpatient treatment at other centers prior to admission were excluded.

Statistical analysis

All statistical analysis was performed according to intention to treat principle by statistical package for the social sciences (SPSS) software version 27 for Windows (SPSS Inc., Chicago, IL, USA). Data was entered into Microsoft excel data sheet and was analysed using SPSS 27 version software. Categorical data was represented in the form of frequencies and percentage. Chi-square test/pooled Chi square was used as test of significance for qualitative data.

RESULTS

A total of 100 children admitted to the PICU with septic shock were included in the study. Among them, 76 children survived, while 24 succumbed to their illness, resulting in a mortality rate of 24%. Elevated SI was significantly associated with adverse outcomes, including increased inotrope requirement, MODS, prolonged PICU stay, and higher mortality rates.

The study population included children aged 1 month to 12 years, with a slight male preponderance (68% male versus 32% female).

Table 1 summarizes the demographic characteristics of the study population (n=100). The majority of children belonged to the age group of 1 to 6 years (43%), followed by those less than 1 year (30%) and more than 6 years (27%). Males accounted for 68% of the sample, resulting in a male-to-female ratio of 2.1:1.

Table 1: Subject demographics and background information.

S. no.	Parameters	Values (%)
1	Total sample size	100 children
2	Age in years (mean±SD)	5.1±2.5
3	Age distribution (years)	
	Less than 1	30
	1 to 6	43
	More than 6	27
4	Gender ratio (M/F)	2.1: 1
5	Gender distribution	
	Males	68%
	Females	32

Elevated SI values (>1.2) were observed in 78% of the patients at admission, strongly correlating with disease severity. Among survivors, the mean SI at admission was 0.9±0.1, whereas non-survivors had a significantly higher mean SI of 1.3±0.2 ($p<0.05$).

Figure 1 shows the distribution of SI values at admission for survivors and non-survivors in the study.

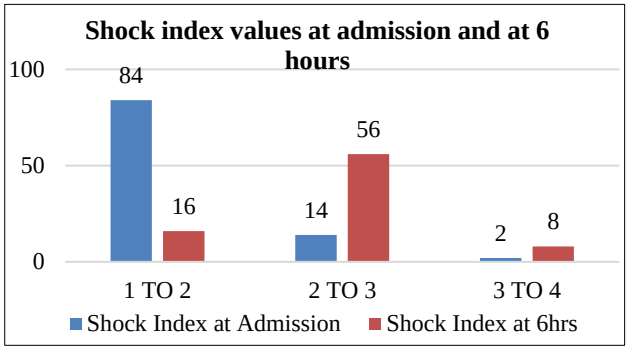

Figure 1: Shock index distribution at admission and at 6 hours among survivors and non-survivors.

Inotrope requirement

A total of 64% of children with elevated SI required inotropes to maintain hemodynamic stability. The most commonly used inotropes were dopamine (58%) and norepinephrine (30%). Children requiring inotropic support had a mean SI of 1.4 compared to 0.8 in those who did not ($p<0.01$) (Table 2).

MODS

MODS was diagnosed in 42% of patients with elevated SI versus only 8% with normal SI ($p<0.01$). Mortality among

children with MODS was significantly higher (65%) compared to those without MODS (8%) (Table 2).

Table 2 highlights the percentage of patients requiring inotropic support and those that presented with MODS based on their SI values at admission.

Table 2: Inotrope requirement and MODS by shock index at admission.

Variables	MODS		Inotrope requirement	
	Yes	No	Yes	No
SI at admission				
1-2	22	62	42	42
2-3	14	0	14	0
3-4	2	0	2	0
SI at 6 hours				
<1	0	16	4	12
1-2	12	44	26	30
2-3	18	2	20	0
3-4	8	0	8	0

Duration of PICU stay

The average PICU stay for children with elevated SI was 7±3 days compared to 4±1 days for those with normal SI ($p<0.05$). Prolonged PICU stays (>7 days) were observed in 52% of the children with SI >1.2 (Figures 2a and b).

Figures 2a and b provides the average length of PICU stay for children with elevated SI and normal SI values at the time of admission and at 6 hours after admission.

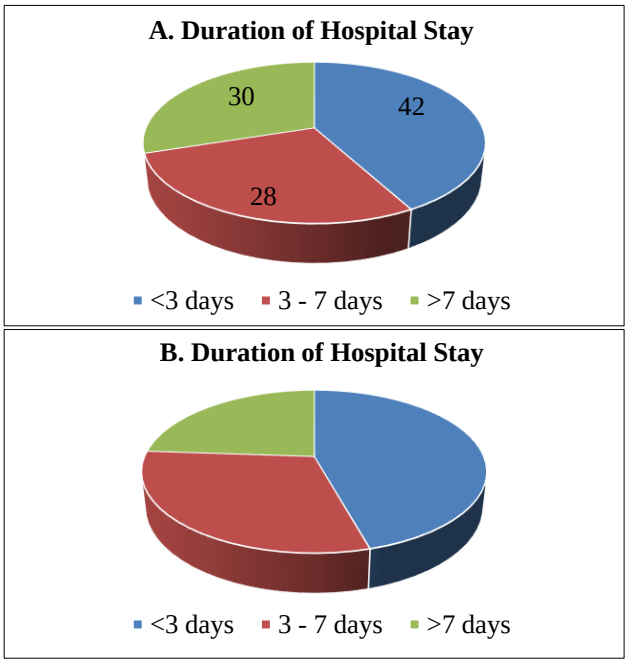

Figure 2: (A) Duration of PICU stay in patients based on SI values at admission, and (B) duration of PICU stay in patients based on SI values at 6 hours after admission.

DISCUSSION

This study emphasizes the utility of the SI as a simple yet effective prognostic tool in paediatric septic shock. Elevated SI values (>1.2) were significantly associated with adverse outcomes, including higher inotrope requirements, MODS, prolonged PICU stays, and increased mortality rates, as demonstrated by studies conducted by Rousseaux et al and Koch et al.[2,3]

In our study, 64% of children with elevated SI required inotropic support, a result comparable to the findings of Rousseaux et al, who demonstrated that SI at admission strongly predicted the need for intensive interventions, including inotropic support and mechanical ventilation.[2] Similarly, Bagali et al highlighted the prognostic significance of elevated SI values in guiding timely interventions in critically ill children.[12]

The strong association between elevated SI and MODS observed in our study mirrors findings by López-Reyes et al, where SI was highlighted as a reliable predictor of MODS and mortality in paediatric septic shock. In our cohort, 42% of children with elevated SI developed MODS compared to only 8% of those with normal SI, reaffirming the predictive accuracy of SI in identifying high-risk patients.[14]

The relationship between SI and length of PICU stay has been widely studied. Prolonged PICU stays (>7 days) were more common among patients with elevated SI in our study. These results align with the work of Ray et al, who observed similar trends in paediatric sepsis and emphasized SI's utility in predicting the severity of illness and resource needs.[16] Furthermore, Radhakrishnan and Nagaraja suggested that socioeconomic stratification, like the Kuppuswamy scale, could play a complementary role in understanding the disparities in healthcare outcomes.[15]

Our findings also support the conclusions of Huang et al, who demonstrated that paediatric age-adjusted SI (SIPA) could reliably predict morbidity and mortality in intensive care settings.[10] Additionally, the clinical utility of age-adjusted shock indices has been underscored by Vandewalle et al, further highlighting its applicability in paediatric care.[4]

This study builds upon the observations of Yasaka et al, who noted that integrating SI into triage protocols could significantly enhance early risk stratification, particularly in resource-limited settings.[6] Moreover, Maheshwari et al emphasized that persistent abnormal SI exposure is associated with higher morbidity and mortality among critically ill patients, which aligns with our observations of consistently high SI values in non-survivors.[11]

In conclusion, SI is a valuable, non-invasive tool that helps healthcare providers in identifying critically ill children at an early stage. Its simplicity, cost-effectiveness, and predictive ability make it particularly useful in resource-

limited settings, where timely interventions can significantly improve outcomes, as noted by Larsen et al and Prasad et al.[5,8]

Limitations

It is a single-centre design with a modest sample size. Future multi-centre studies with larger populations are essential to validate these findings. Integrating SI into routine monitoring and developing age-specific thresholds could further enhance its prognostic accuracy in paediatric septic shock.

CONCLUSION

Elevated SI is a valuable prognostic tool in paediatric septic shock, strongly associated with increased severity, inotrope use, MODS, and prolonged PICU stays. Its simplicity and non-invasive nature make it particularly useful in resource-limited settings, allowing for early identification of high-risk patients. Integrating SI into routine clinical practice can improve outcomes by enabling timely interventions and optimizing critical care management strategies.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Navodaya Medical College, paediatrics department staff and students and all study participants for their willingness to participate in this study, and Dr. Surendra Gunda for his assistance with statistical analysis which was integrated in this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Laguvaram S, Pranam GM, Hirevenkanagoudar U, Chetty S. Evaluating shock index as a prognostic tool in septic shock patients. Int J Contemp Pediatr 2025;12:200-3.