

**Original research article****Prognostic value of shock index in children with sepsis/septic shock****<sup>1</sup>Dr. Khaja Amer Khan, <sup>2</sup>Dr. Mohammed Zainulabedeem**<sup>1</sup>Pediatric Intensivist, Department of Pediatrics, Hope Children Hospital, Hyderabad, Telangana, India<sup>2</sup>Postgraduate, Department of Pediatrics, Shadan Institute of Medical Sciences, Hyderabad, Telangana, India**Corresponding Author:**

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**Abstract**

**Introduction:** Infection by a virus, bacteria, parasite, fungus, or toxin is the most common cause of sepsis in children and young adults. Successful treatment of sepsis and septic shock in the critical first hours after a patient is admitted to the paediatric intensive care unit (PICU) is possible.

**Methods:** From November 2021 to October 2022, a prospective clinical trial was carried out in the paediatric intensive care unit within the Department of Paediatrics, Hope Children Hospital, Hyderabad, Telangana, India. The hospital's ethical review board gave their blessing for the trial to proceed.

**Results:** 40 children with a diagnosis of sepsis/septic shock who were hospitalised to the paediatric intensive care unit were analysed. Babies that presented with a different kind of shock or who fell into a higher severity category were not included. Children were categorised by their shock index at 0, 1, 2, 4, and 6 hours after admission.

**Conclusion:** Pre-admission SI in the ambulance to ER, SI as a marker of response to treatment, and the relationship of SI with organ dysfunction are all areas in need of further study to determine more sensitive and specific cut off values.

**Keywords:** shock index, prognostic measure, pediatric sepsis, septic shock

**Introduction**

Infection by a virus, bacteria, parasite, fungus, or toxin is the most common cause of sepsis in children and young adults. Successful treatment of sepsis and septic shock in the critical first hours after a patient is admitted to the paediatric intensive care unit is possible <sup>[1]</sup>. The table below provides systolic blood pressure cutoffs at which children are considered to have hypotension <sup>[2]</sup>. These cutoffs lie just over the 5th percentile of SBP for age and overlap by 5% with what is considered typical for a healthy youngster. If the patient's blood pressure drops by 10 mmHg from their baseline, a full battery of diagnostic tests for shock symptoms should be performed. Kids who are developmentally typical and are not actively ill have been used to determine these threshold values <sup>[3, 4]</sup>. Given that children with injuries and stress will have higher than normal blood pressure, a youngster who appears to be sick may have blood pressure that is abnormally low. Hypotension in septic shock results from vasodilatation rather than intravascular volume loss. When hypotension occurs in a child in shock, compensatory mechanisms like tachycardia and vasoconstriction should not work. In the event of an acute loss of 20–25% of the blood volume in circulation, hypotension develops. As a result, hypotension appears to be an extremely late indicator of clinical state and a foreboding portent of impending cardiac arrest <sup>[5, 6]</sup>.

The Shock index, which is calculated by dividing the heart rate by the blood pressure, was developed by Allgower and Buri in the 1960s. From what they've seen, a healthy adult's SI should be between 0.5 and 0.7. An indication of mortality in paediatric sepsis and septic shock may be the Shock Index, the ratio of heart rate to systolic blood pressure. Here are a few examples of studies that are relevant <sup>[7, 8]</sup>.

Rousseaux, Jérémie, *et al.* found that SI was a clinically significant and simple-to-determine predictor of death. An aberrant SI at admission and 6 hours was a predictor of death, and there were differences in age-adjusted SI between survivors and non-survivors. Shock index cutoff values for ICU mortality and the relationship between shock index change and outcome in the first 6 hours after ICU admission were investigated by Yukri yasaka *et al.* Shock index was shown to be improved by fluid resuscitation and the use of vasoactive medications by Carcillo *et al.*, making it easier to evaluate the efficacy of treatment. According to research by Shannor N Acker *et al.*, a pediatric-specific shock index is superior to a shock index that is not adjusted for age in identifying children who have sustained life-threatening injuries, particularly those involving the abdomen, and who are at a high risk of dying as a result of their condition <sup>[9, 10]</sup>.

According to a separate study conducted by Shannon N. Acker *et al.*, SIPA is more reliable than age-adjusted hypotension for calling for emergency medical assistance in cases of trauma. The goal of this study is to determine whether or not the PICU shock index is predictive of death in children experiencing sepsis or septic shock. Examining the relationship between shock index and outcome in the first 6 hours

after ICU admission can help establish appropriate thresholds for monitoring the patient's condition [11, 12].

**Methods**

Study participants were children admitted to the paediatric intensive care unit at Department of Paediatrics, Hope Children Hospital, Hyderabad, Telangana, India, in the six months between November 2021 to October 2022. The study was allowed to proceed after approval from the hospital's ethical review board.

Sepsis, severe sepsis, and septic shock were all defined for children. A total of 50 kids were split into three age brackets (under 1, between 2 and 6, and 6 and up). The children were classified at admission according to the International Pediatric Sepsis Consensus Conference criteria.

**Inclusion Criteria:** Definition of sepsis and septic shock for children admitted

**Exclusion Criteria:** Other forms of shock in children who attend for treatment.

Hospitalized kids who meet the inclusion criteria were analysed. In this case, we were able to secure written permission from the parents or guardians. Systolic and diastolic blood pressures were taken at 0, 1, 2, 4, and 6 hours post-treatment. Auscultation was used to count heart rates and a mercury sphygmomanometer with the appropriate cuff size was used to monitor blood pressure. The patients were split into two groups, one for each possible outcome.

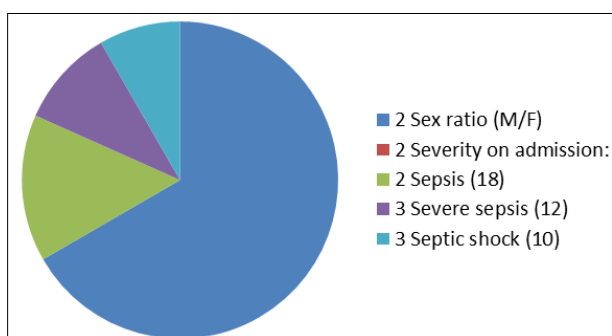
**Results**

Forty children who had been diagnosed with sepsis or septic shock and were admitted to the paediatric critical care unit for treatment were evaluated for this study. Babies that exhibited a different form of shock or who fell into a severity level that was higher than those considered were omitted from the study. The shock index was used to classify the children at 0 hours, 1 hours, 2 hours, 4 hours, and 6 hours following arrival.

**Table 1:** Subject demographics and background info (n=40)

Sr. No.	Parameter with value	
1	Age in years (Mean ± SD)	5.1 ± 2.5
2	Sex ratio (M/F)	2
3	<b>Severity on admission:</b>	
	Sepsis (18)	45%
	Severe sepsis (12)	30%
	Septic shock (10)	25%

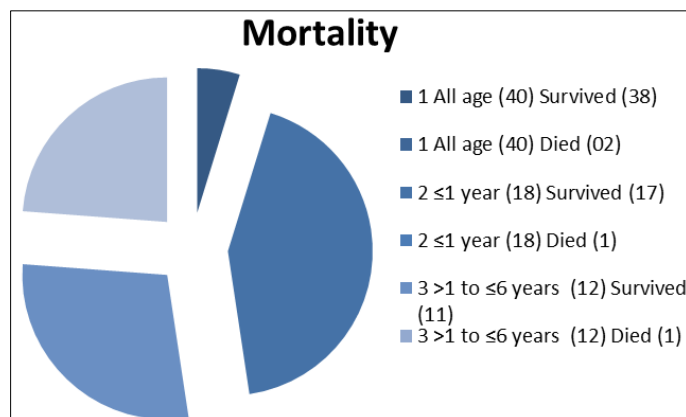
The study's population had an average age of, and the average male to female ratio was 1 to 1.



**Fig 1:** Subject demographics and background info

**Table 2:** Comparison of Mortality Rates by Age

Sr. No	Age in years	Outcome	Mortality
1	All age (40)	Survived (38)	05%
		Died (02)	
2	≤1 year (18)	Survived (17)	45%
		Died (1)	
3	>1 to ≤6 years (12)	Survived (11)	30%
		Died (1)	
4	>6 to ≤12 years (10)	Survived (10)	25%
		Died (0)	



**Fig 2:** Comparison of Mortality Rates by Age

The severity of infection was found to increase with age in our study population, with SEPSIS > SEVERE SEPSIS > SEPTIC SHOCK being the overall distribution across all age groups. However, the distribution of severity varied somewhat between and even within the different age groups. Data are depicted as a horizontal bar chart, with the length of the bar corresponding to the percentage of total participants falling into that category. It was specified under each heading that the respective groups' N values varied. Our research found that an increase in SI occurred in 1% of the survivors and 1% of the fatalities. 23 of those who made it through the ordeal with a reduced shock index, while 9 did not. Consequently, we can deduce that there is a 1.56-fold increased relative risk of mortality for every unit increase in SI between admission and 6 hours, and a correspondingly increased likelihood of surviving for every unit drop in SI between admission and 6 hours.

### Discussion

In patients hospitalised to the PICU with a diagnosis of sepsis/septic shock, this study demonstrates the hourly cut off values of shock index from 0 hours to 6 hours of admission. Shock index values within this range are considered typical, based on the work of Yuki Yasaka *et al.* According to research conducted by Yuki Yasaka *et al.*, the average range for children younger than one year old is between 0.8 and 2.3. Our research showed that the cut off value is 2.16 at 0 hours and 1.77 at 6 hours. In other words, a sensitivity of 57.14 percent and a specificity of 75 percent would be achieved if the SI in the age group 1 year at 0 hours is 2.16, resulting in a relative risk of death 2.01 times higher. Similarly, in the 1-year-old age group, a SI >1.77 is associated with a 2.85-fold increased relative risk of mortality (95% CI: 0.78, 10.37), sensitivity of 71.43, and specificity of 75<sup>[11-13]</sup>.

Taking the mean of 2 age groups, Yuki Yasaka *et al.* report a typical range of 0.7 to 1.22 for children aged 1 to 6 years old. Our research showed that the threshold value was 1.43 at 0 hours and 1.16 at 6 hours. This means that a sensitivity of 84.71 percent and a specificity of 60 percent would be attained if the SI in the 1 to 6 year old age group at 0 hours was 1.43, indicating a relative risk of death that was 2.14 times as high. Also, in children aged 1 to 6, if the SI is greater than 1.16 at 6 hours, there is an elevated risk of mortality with an odds ratio (OR) of 87, a confidence interval (CI) of 2.95 to 2534, a sensitivity of 100%, and a specificity of 80%<sup>[14-16]</sup>.

According to a mean-average of two age groups, the normal range cited by Yuki Yasaka *et al.* is between 0.5 and 1.2 for children older than six and less than twelve. Nonetheless, we found in our research A cutoff value of 2.03 was found at 0 hours, and a value of 1.56 was found after 6 hours. In other words, a SI of >2.03 at 0 hours for children aged 6-12 is associated with a 7-fold increased risk of death (CI = 0.67-72), 50% sensitivity, and a 98% specificity. Similarly, if the SI is >1.56 in those aged 6-12, the relative risk of death increases by 15 times, with a sensitivity of 50%, specificity of 85.71%, and a CI of 2.25 to 99.7<sup>[17, 18]</sup>.

Our age-stratified cutoff values for SI at 0 and 6 hours are similar to the upper limit of standard normal range of SI given by Yuki Yasaka's study for the 1-year-old and 1-to-6-year-old age groups, respectively. However, for the older age group, our cutoff value was significantly higher than the upper limit of standard normal range of SI. Our study's substantially higher cut off value in the older-than-6-to-12-year-old age group could be attributable to stronger shock compensation in older children or to a different distribution of severity and outcome<sup>[19-21]</sup>.

Higher values of SI were associated with greater risk of mortality in children with sepsis/septic shock, according to the same study cited above, but the researchers were unable to determine what value of SI would be considered a "clear cut off" for mortality in any age group. Using Two-Way Repeated-Measures ANOVA, we looked for statistical evidence of a correlation between the SI at different times and age groups; we found none. Moreover, due to the limited size of the sample, statistical significance

could not be determined. However, there appears to be a correlation between increased risk of death and higher mean SI values in the died groups compared to the survived groups, suggesting that these differences have clinical importance<sup>[22-24]</sup>.

Adult studies have shown that elevated levels of SI tend to have a negative impact on prognosis. Neither a decrease in SI over 6 hours nor a prolonged increase in SI was found to be a predictor of mortality in the PICU in a study by Yuki Yasaka *et al.* On the other hand, when looking at the kids who had a higher SI upon admission, the decline in SI was linked to a better outcome for the age groups 0–3 and 12+. Our results showed that a 1.56-fold increased relative risk of death was related with a 6-fold rise in the trend of SI from the time of admission (0-6 hours), with a 95% confidence interval of 0.7-3.49<sup>[23-25]</sup>.

### Conclusion

In children with sepsis/septic shock, SI can be a potential measure of risk of fatality. To assist us keep an eye out for kids who are at high risk, we can use SI, which is a simple, non-invasive, cheap, and quick bedside clinical technique. Children with an elevated SI may benefit from more aggressive resuscitating and intensive care, as the risk of mortality increases with higher SI values and as the SI trend grows. Pre-admission SI in the ambulance to ER, SI as a marker of response to treatment, and the relationship of SI with organ dysfunction are all areas in need of further study to determine more sensitive and specific cut off values.

**Conflict of Interest:** None

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