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A predictive indicator for pediatric sepsis and septic shock: The shock index

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Abstract
Introduction: The primary etiology of sepsis in children and young adults is typically attributed to infection by a pathogenic agent such as a virus, bacteria, parasite, fungus, or toxin. It is possible to successfully treat sepsis and septic shock within the crucial initial hours when a patient is brought to the pediatric intensive care unit (PICU).
Methods: A prospective clinical trial was conducted from January 2016 to December 2016 in the paediatric critical care unit of the Department of Paediatrics at Nootan Medical College and Research Centre in Gujarat, India. The hospital's ethical review board granted approval for the trial to begin.
Results: Analyzed were 40 children who were diagnosed with sepsis/septic shock and were admitted to the pediatric intensive care unit. Infants exhibiting an alternative form of shock or falling into a more severe group were excluded from the study. Children were classified based on their shock index at 0, 1, 2, 4, and 6 hours following admission.
Conclusion: Prior to admission Further research is required to investigate the correlation between suicidal ideation (SI) in the ambulance on the way to the emergency room (ER), SI as an indicator of treatment response, and the association between SI and organ dysfunction. The aim is to establish more precise and accurate threshold values that are both sensitive and specific.

Keywords: Shock index, prognostic measure, pediatric sepsis, organ dysfunction

Introduction
The primary etiology of sepsis in children and young adults is typically attributed to viral, bacterial, parasitic, fungal, or toxic agents. It is possible to successfully treat sepsis and septic shock within the critical initial hours when a patient is brought to the pediatric intensive care unit [1]. The following table presents the systolic blood pressure thresholds at which children are classified as having hypotension [2]. These cutoffs are situated slightly above the 5th percentile of systolic blood pressure (SBP) for a specific age group and have a 5% overlap with the range that is considered normal for a healthy young individual. When the patient's blood pressure decreases by 10 mmHg from their initial level, it is recommended to conduct a comprehensive set of diagnostic procedures to assess for symptoms of shock. These threshold values have been determined using children who are developmentally typical and not currently unwell [3, 4]. Children who experience accidents and stress are likely to have elevated blood pressure. Therefore, if a young child appears to be unwell, it is possible that their blood pressure is unusually low. The occurrence of low blood pressure in septic shock is due to the widening of blood vessels, rather than a decrease in the amount of blood within the blood vessels. In the event of hypotension occurring in a kid experiencing shock, it is expected that compensatory mechanisms such as tachycardia (increased heart rate) and vasoconstriction (Narrowing of blood vessels) will not effectively restore normal blood pressure. Hypotension occurs when there is a sudden decrease of 20-25% in the amount of blood circulating in the body. Hypotension is observed as a very late sign of the clinical condition and is a warning sign of an upcoming cardiac arrest [5, 6].
The Shock index, derived by dividing the heart rate by the blood pressure, was formulated by Allgower and Buri during the 1960s. Based on their observations, the optimal SI range for a physically fit adult is often between 0.5 and 0.7. The Shock Index, which is the ratio of heart rate to systolic blood pressure, can serve as a measure of mortality in pediatric sepsis and septic shock. Here are a few pertinent studies [7, 8].

Carcillo *et al*. demonstrated that fluid resuscitation and the administration of vasoactive medicines increased the shock index, facilitating the assessment of treatment effectiveness. Research conducted by Shannor N Acker *et al*. has shown that a pediatric-specific shock index is more effective than an age-unadjusted shock index in identifying children who have suffered life-threatening injuries, especially those affecting the abdomen, and who are at a significant risk of death due to their condition [9, 10].

Shannon N. Acker *et al*. conducted a study that found SIPA to be more dependable than age-adjusted hypotension in requesting emergency medical help for trauma situations. The objective of this study is to ascertain the predictive value of the PICU shock index in relation to mortality in children who are affected by sepsis or septic shock. An investigation into the correlation between shock index and patient outcome within the initial 6 hours following admission to the intensive care unit (ICU) can aid in determining the optimal thresholds for monitoring the patient's status [11, 12].

Methods

The study included children who were hospitalized to the paediatric intensive care unit at the Department of Paediatrics, Nootan Medical College and Research Centre, Gujarat, India, for the period of six months from January 2016 to December 2016. The study was authorized to proceed following approval from the hospital's ethical review board.

Children were provided with definitions for sepsis, severe sepsis, and septic shock. There were a total of 50 children who were divided into three age categories: under 1 year old, between 2 and 6 years old, and 6 years old and older. Upon admission, the children were categorized based on the criteria established by the International Pediatric Sepsis Consensus Conference.

Inclusion Criteria

Definition of sepsis and septic shock for children admitted

Exclusion Criteria

Other forms of shock in children who attend for treatment.

Analyzed were children who were hospitalized and met the specified inclusion criteria. For this particular situation, we obtained explicit consent in writing from the parents or legal guardians. Blood pressures were measured at 0, 1, 2, 4, and 6 hours after treatment to determine both the systolic and diastolic values. Auscultation was employed to determine heart rates, while blood pressure was monitored using a mercury sphygmomanometer with a cuff size suitable for the individual. The patients were divided into two groups, each representing a distinct probable outcome.

Results

This study analyzed a group of forty children who had been diagnosed with sepsis or septic shock and were admitted to the paediatric critical care unit for treatment. The study excluded babies who displayed an alternative type of shock or who experienced a higher level of severity than what was deemed acceptable. The shock index was utilized to categorize the children at 0 hours, 1 hour, 2 hours, 4 hours, and 6 hours after their arrival.

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

Sr. No.	Parameter with value	
1	Age in years (Mean ± SD)	5.4±4.6
2	Sex ratio (M/F)	2
3	**Severity on admission:**	
	Sepsis (17)	42.5%
	Severe sepsis (13)	32.5%
	Septic shock (10)	25%

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

Table 2: Comparison of Mortality Rates by Age

Sr. No	Age in years	Outcome	Mortality
1	All age (40)	Survived (38)	100%
		Died (02)	
2	≤1 year (18)	Survived (18)	45%
		Died (0)	
3	>1 to ≤6 years (12)	Survived (11)	30%
		Died (1)	
4	>6 to ≤12 years (10)	Survived (10)	25%
		Died (0)	

In our study, we observed that the severity of infection was positively correlated with age in our sample. Specifically, the distribution of infection severity across all age groups followed the pattern of SEPSIS > SEVERE SEPSIS > SEPTIC SHOCK. Nevertheless, the severity distribution exhibited some variation both across and within the distinct age cohorts. The data is represented using a horizontal bar chart, where the length of each bar corresponds to the percentage of participants in that category. Each header clearly indicated that the N values of the individual groups differed. Our research revealed that there was a rise in self-injury (SI) among 1% of the individuals who survived and 1% of those who died. 23 individuals successfully endured the ordeal with a decreased shock index, whereas 9 individuals did not. Therefore, we can infer that there is a 1.56-fold higher relative risk of death for each incremental increase in SI between admission and 6 hours. Similarly, there is a higher probability of survival for each incremental decrease in SI between admission and 6 hours.

Discussion

This study examines the hourly threshold values of shock index, ranging from 0 to 6 hours after admission, in children admitted to the Pediatric Intensive Care Unit (PICU) with a diagnosis of sepsis or septic shock. Shock index levels falling within this range are deemed to be standard, as per the research conducted by Yuki Yasaka *et al*. Yuki Yasaka *et al*. conducted study which found that the typical range for children under the age of one is 0.8 to 2.3. Our research findings indicate that the threshold value is 2.16 at 0 hours and 1.77 at 6 hours. To clarify, if the SI in the age group of 1 year at 0 hours is 2.16, it would result in a sensitivity of

57.14 percent and a specificity of 75 percent. This would correspond to a relative risk of mortality that is 2.01 times greater. Similarly, among children aged 1 year, a Social Interaction (SI) score more than 1.77 is linked to a 2.85 times higher relative risk of mortality (95% CI: 0.78, 10.37). The sensitivity of this association is 71.43%, and the specificity is 75% [11-13].

Yuki Yasaka *et al*. found that the average age range for children between 1 and 6 years old is typically between 0.7 and 1.22. Our research indicated that the threshold value was 1.43 at the start of the observation period and decreased to 1.16 after 6 hours. If the SI in the 1 to 6 year old age group at 0 hours was 1.43, indicating a relative risk of mortality that was 2.14 times as high, then a sensitivity of 84.71 percent and a specificity of 60 percent would be achieved. In children aged 1 to 6, if the Shock Index (SI) is more than 1.16 at 6 hours, there is a higher risk of mortality with an odds ratio (OR) of 87, a confidence interval (CI) ranging from 2.95 to 2534, a sensitivity of 100%, and a specificity of 80% [14-16].

Based on a mean-average of two age groups, Yuki Yasaka *et al*. state that the typical range for children aged six to twelve is between 0.5 and 1.2. However, our investigation revealed at 0 hours, a threshold of 2.03 was determined, which decreased to 1.56 after 6 hours. Put simply, if a child aged 6-12 has a SI (severity index) greater than 2.03 at 0 hours, they have a 7-fold higher chance of mortality. The confidence interval for this risk is 0.67-72. Additionally, the test has a sensitivity of 50% and a specificity of 98%. Moreover, in individuals aged 6-12, if the SI is greater than 1.56, the likelihood of mortality is amplified by a factor of 15. This conclusion is based on a sensitivity of 50%, specificity of 85.71%, and a confidence interval ranging from 2.25 to 99.7 [17, 18].

The age-specific threshold values for SI at 0 and 6 hours in our investigation align with the upper boundary of the standard normal range of SI reported by Yuki Yasaka for the age groups of 1-year-olds and 1-to-6-year-olds, respectively. However, for the older age group, our cutoff value exceeded the top limit of the conventional normal range of SI. The higher cut off value seen in the age group of children older than 6 to 12 years in our study may be due to more effective shock compensation in older children or to a different distribution of severity and outcome [19].

The study mentioned above found that higher values of systemic inflammation (SI) were linked to an increased risk of mortality in children with sepsis/septic shock. However, the researchers were unable to find a specific threshold value of SI that would definitively indicate mortality risk in any age group. Through the use of Two-Way Repeated-Measures ANOVA, we conducted a thorough investigation to ascertain any statistical indication of a relationship between the SI at various time points and age cohorts. Regrettably, our analysis yielded no such evidence. Furthermore, the lack of a sufficiently large sample size prevented the determination of statistical significance. Nevertheless, there seems to be a connection between a higher likelihood of mortality and elevated average SI values in the deceased groups as opposed to the survived groups, indicating that these disparities hold clinical significance [20].

Research conducted on adults has demonstrated that higher levels of social isolation (SI) tend to have an adverse effect on the predicted outcome or course of a disease or condition. The study conducted by Yuki Yasaka *et al*. indicated that neither a drop in SI over a period of 6 hours nor a sustained increase in SI can be considered as a predictor of death in the Pediatric Intensive Care Unit (PICU). Conversely, when examining the children with a higher Social Interaction (SI) score upon admission, a decrease in SI was associated with a more favorable outcome for the age groups 0–3 and 12+. The findings of our study indicate that there was a 1.56-fold higher risk of death associated with a 6-fold increase in the trend of SI within the first 6 hours of admission. The 95% confidence interval for this association ranged from 0.7 to 3.49 [21].

Conclusion

Systolic index (SI) can serve as an indicator of the likelihood of death in children with sepsis or septic shock. In order to monitor children who are at a heightened risk, we can utilize SI, a straightforward, non-intrusive, cost-effective, and expeditious bedside clinical method. Children who have a greater SI (Severity of Illness) may benefit from more vigorous resuscitation and intensive care. This is because the risk of mortality increases as the SI values become higher and the SI trend continues to rise. Further research is required to discover more precise and accurate cut off values for pre-admission suicidal ideation (SI) in the ambulance to the emergency room (ER), SI as an indicator of treatment response, and the correlation between SI and organ malfunction.

Conflict of Interest

None

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