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ORIGINAL ARTICLE

Role of shock index and pediatric age adjusted shock index as a predictor of mortality and morbidity in patients admitted at PICU.

Anum Tanveer[1], Murtaza Ali Gowa[2], Hira Nawaz[3], Bakhtawar Chandio[4], Ghazala Jamal[5], Nadia Bibi[6]

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ABSTRACT… Objective: To determine shock index (SI), and Pediatric age adjusted shock index (SIPA), and their role in predicting mortality and morbidity in patient admitted in Pediatric Intensive Care Unit (PICI) of a tertiary care hospital of Karachi, Pakistan. **Study Design:** Cross-sectional study. **Setting:** PICU of National Institute of Child Health, Karachi, Pakistan. **Period:** May 2024 to November 2024. **Methods:** A total of 155 children of any gender, aged between 1-14 years, and admitted to PICU were analyzed. SI, and SIPA were assessed with respect to indicators like need for mechanical ventilation (MV), and inotropic agents, need of blood transfusion within 24 hours, and duration of PICU stay. In-hospital mortality was also documented. **Results:** In a total of 155 children, the mean age was 7.18±3.71 years, while 78 (50.3%) were boys. The most common presenting complaints included difficulty breathing, and fever, in 49 (31.6%), and 48 (31.0%) children, respectively. Mechanical ventilation was required more frequently in children with abnormal SIPA scores (p=0.004). The need for inotropic support also showed significant association with abnormal SIPA scores (p=0.003). Children with abnormal SIPA scores had significantly longer PICU stays (p=0.013). Mortality rates were significantly higher among children with abnormal SI scores (p=0.026), and abnormal SIPA scores (p=0.003). **Conclusion:** This study underscores the clinical utility of SIPA as a reliable predictor of adverse outcomes in critically ill pediatric patients. Compared to SI, SIPA demonstrated superior predictive strength for key morbidity indicators, including mechanical ventilation, inotropic support, extended PICU stay, and mortality.

Key words: Inotropes, Mechanical Ventilation, Mortality, Sepsis, Shock Index.

INTRODUCTION

A pediatric intensive care unit (PICU) is a specific area of the hospital created to provide care for critically sick children who have serious infections, circulatory compromise, respiratory distress, unintentional poisoning, and other life-threatening diseases.[1] Depending on the different PICU facilities and the health of the referred patients, variable degrees of mortality have been recorded in the literature, ranging from 3% to 37.0%.[2-5]

The field of pediatric critical care medicine has advanced quickly as a result of advancements in medical knowledge of pediatric anesthesia, medicine, and surgery as well as in the understanding of life-threatening pathophysiological processes and the creation of scientific and technology monitoring techniques.[6] There are many tools for identifying risk of mortality and morbidity including in PICU admitted patients such as pediatric risk mortality score (PRISM) and pediatric risk mortality (PIM).[7] However, these tools contain so much details, and require too many laboratory investigation. Recently, clinicians have shown increasing interest in shock index (SI), and pediatric-age adjusted shock index (SIPA) for the prediction of morbidity and mortality in PICU admitted patients.[8]

When a patient presents with trauma or an acute haemorrhage, the SI which is calculated as the ratio of heart rate (HR) to systolic blood pressure (SBP), is frequently employed as a predictor.[9] In non-traumatic critically ill patients, variations in SI values over time can predict mortality.[10]

1. MBBS, Postgraduate Trainee Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
2. MBBS, FCPS (Padiatric Medicine) MRCPCH (UK), PCCM, Associate Professor Section Head Pediatric Intensive Care Unit, National Institute of Child Health, Karachi, Pakistan.
3. MBBS, FCPS (Pediatric Medicine), Consultant Pediatrician and Post-Fellow Critical Care Medicine, Pediatric Intensive Care Unit, National Institute of Child Health, Karachi, Pakistan.
4. MBBS, Women Medical Officer Pediatric Intensive Care Unit, National Institute of Child Health, Karachi, Pakistan.
5. MBBS, MCPS (Pediatric Medicine), Senior Registrar Pediatric Intensive Care Unit, National Institute of Child Health, Karachi, Pakistan.
6. MBBS, Postgraduate Trainee Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.

Correspondence Address:
Dr. Anum Tanveer
Department of Pediatric Medicine
National Institute of Child Health, Karachi, Pakistan.
anumtanveer123@yahoo.com

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In pediatric patients, the normal range of vital signs has an age-specific upper limit, so varied age groups may have varied SI values within the typical range. As a result, SIPA was created which seems more accurate at foreseeing outcomes, including the requirement for urgent surgery, endotracheal intubation, early blood transfusion, ICU, lengthy hospital length of stay, and mortality.[11,12]

Some of the popular tools for triaging and treating children referred to PICU in resource-limited settings include SI, and SIPA. As SI and SIPA are introduced as mortality predictor in PICU admitted patients, data is scarce on their evaluation, no such study has been conducted yet in Pakistan. This is why we planned this study to determine these parameters as morbidity and mortality predictor. This study was aimed to determine SI and SIPA, and their role in predicting mortality and morbidity in patient admitted in PICU of a tertiary care hospital of Karachi, Pakistan.

METHODS

This analytical, observational, cross-sectional study was performed in PICU of National Institute of Child Health, Karachi, Pakistan during May 2024 to November 2024. Approval from Institutional Ethics Committee was obtained for this study (IERB-02/2024, dated: 24-04-2024). Informed and written consents were sought from parents/guardians of all study participants. Considering the anticipated proportion of mortality as 23.5%[13], with 95% confidence level and 7% margin of error, the sample size was calculated to be 141 using WHO sample size calculator. Addition of 10% sample was made to compensate expected leaving against medical advice proportion. So, the final sample size turned out to be 155. Non-probability consecutive sampling technique was adopted. Inclusion criteria were children of any gender, aged between 1-14 years, and admitted to PICU. Parents/guardians unwilling to allow their children to be part of this research were also excluded.

Demographic and clinical characteristics of children were documented at the time of admission. Children admitted in PICU were monitored and assessed by on duty doctor as per hospital protocols. SI, and SIPA were assessed again at 24 hours, to document need for blood transfusion, need for MV, and inotropic agents. Duration of PICU stay, and in-hospital mortality was documented, with respect to normal and abnormal SI, and SIPA scores.SI is calculated as the heart rate (HR) divided by systolic blood pressure (SBP). Normal SI scores are <1.6 for 1-3 years, <1.2 for 3-6 years, and <1.0 for 6-18 years.[14] SIPA is calculated as maximum normal HR divided by minimum normal SBP by age. Normal values for SIPA scores are ≤ 1.2 for age up to 6 years, 1.0 for age between 7 and 12 years, and ≤ 0.9 for age above 12 years.[15] A special proforma was designed to record study data.

IBM-SPSS version 26 was used for entering and analyzing the data. Descriptive statistics such as frequencies with percentages were used to summarize categorical variables. Numerical variables were presented as mean ± standard deviation. Chi-square or Fisher exact test were applied to compare categorical variables. Numerical variables were compared using independent or paired sample t-test. P-value less than or equal to 0.05 were taken as statistically significant.

RESULTS

In a total of 155 children, the mean age was 7.18 ± 3.71 years, ranging between 1-14 years. The study population comprised 78 (50.3%) boys and 77 (49.7%) girls. The most common presenting complaints included difficulty breathing in 49 children (31.6%), fever in 48 (31.0%), diarrhea in 45 (29.0%), and abdominal pain in 39 (25.2%). Among disease categories, respiratory 45 (29.0%), neuromuscular 19 (12.3%), and sepsis 18 (11.6%) were most commonly documented. The mean baseline Shock Index (SI) and pediatric age-adjusted Shock Index (SIPA) scores were 1.18 ± 0.44 and 1.11 ± 0.36, respectively, and these were statistically comparable ($p=0.081$). Abnormal SI scores were observed in 92 children (59.3%), while abnormal SIPA scores were calculated in 82 children (52.9%). Table-I is showing details about the baseline characteristics of children admitted in PICU.

Characteristics		Frequency (%)
Gender	Boys	78 (50.3%)
	Girls	77 (49.7%)
Age	1-5	51 (32.9%)
	6-14	104 (67.1%)
`Presenting features / complaints	Abdominal pain	39 (25.2%)
	Diarrhea	45 (29.0%)
	Difficulty breathing	49 (31.6%)
	Fever	48 (31.0%)
	Vomiting	36 (23.2%)
	Seizures	36 (23.2%)
Disease category	Respiratory	45 (29.0%)
	Neuromuscular	19 (12.3%)
	Sepsis	18 (11.6%)
	Renal	17 (11.0%)
	Hematologic/oncology	17 (11.0%)
	Cardiovascular	17 (11.0%)
	Metabolic/endocrinology	14 (9.0%)
	Allergic	8 (5.2%)
Shock index	Normal	63 (40.7%)
	Abnormal	92 (59.3%)
Pediatric age adjusted shock index	Normal	73 (47.1%)
	Abnormal	82 (52.9%)

Table-I. Characteristics of children (n=155)

In terms of outcomes, the need for blood transfusion within 24 hours of PICU admission was comparable between children with normal and abnormal SI scores (23 of 63 [36.5%] vs. 29 of 92 [31.5%], p=0.518), and SIPA scores (19 of 73 [26.0%] vs. 33 of 82 [40.2%], p=0.061). Mechanical ventilation was required more frequently in children with abnormal SIPA scores compared to those with normal scores (46 of 82 [56.1%] vs. 24 of 73 [32.9%], p=0.004), although no significant difference was observed based on SI scores (40 of 92 [43.5%] vs. 30 of 63 [47.6%], p=0.611). The need for inotropic support also showed significant association with abnormal SIPA scores (49 of 82 [59.8%] vs. 26 of 73 [35.6%], p=0.003) but not with SI scores (46 of 92 [50.0%] vs. 29 of 63 [46.0%], p=0.627). Children with abnormal SIPA scores had significantly longer PICU stays compared to those with normal SIPA scores (11.12±6.19 days vs. 9.04±3.58 days, p=0.013). Mortality rates were significantly higher among children with abnormal SI scores (25 of 92 [27.2%] vs. 5 of 63 [7.9%], p=0.026), and abnormal SIPA scores (25 of 82 [30.5%] vs. 5 of 73 [6.8%], p=0.003). Association of SI, and SIPA with respect to various outcomes are shown in Table-II.

DISCUSSION

Our analysis revealed that SIPA scores were statistically comparable to SI scores at baseline (p=0.081), but SIPA demonstrated a greater ability to predict clinically significant outcomes. Abnormal SIPA scores were associated with higher rates of mechanical ventilation (56.1% vs. 32.9%, p=0.004), and inotropic support (59.8% vs. 35.6%, p=0.003) compared to normal SIPA scores. These findings underscore the importance of SIPA in stratifying patients who may require advanced interventions, as it integrates age-appropriate physiological parameters, which SI does not. Relatively prolonged PICU stay was significantly associated with abnormal SIPA scores (p=0.013). In contrast, SI scores did not show a significant association with extended PICU stay (p=0.597).

Outcomes	Shock Index		P-Value	pediatric-age Adjusted Shock Index		P-Value
	Normal (n=63)	Abnormal (n=92)		Normal (n=73)	Abnormal (n=82)	
Need for blood transfusion within 24 hours	23 (36.5%)	29 (31.5%)	0.518	19 (26.0%)	33 (40.2%)	0.061
Mechanical ventilation required	30 (47.6%)	40 (43.5%)	0.611	24 (32.9%)	46 (56.1%)	0.004
Inotropic support needed	29 (46.0%)	46 (50.0%)	0627	26 (35.6%)	49 (59.8%)	0.003
Duration PICU stay (days)	9.87±4.89	10.33±5.45	0.597	9.04±3,58	11.12±6.19	0.013
Mortality	5 (7.9%)	25 (27.2%)	0.026	5 (6.8%)	25 (30.5%)	0.003

Table-II. Association of shock index and pediatric-age adjusted shock index without respect to outcomes

This distinction highlights the limitations of using a one-size-fits-all approach like SI in pediatric populations, where physiological norms vary significantly with age. Persistent abnormal SIPA scores, as shown in previous studies by Huang et al.[16], have been linked to prolonged hospital stays, supporting our findings and emphasizing SIPA's relevance as a continuous monitoring tool.

Mortality rates in this study were markedly higher in children with abnormal SIPA scores, compared to normal SIPA scores (30.5% vs. 6.8%, p=0.003). Abnormal SI scores were associated with increased mortality (27.2% vs. 7.9%, p=0.026), but the predictive strength was more pronounced with SIPA. This trend has been corroborated by Nazar et al.[17], and Huang et al.[16], which demonstrated SIPA's strong association with mortality in both traumatic and non-traumatic pediatric cases. Contemporary literature highlighted that SIPA's predictive utility makes it a versatile tool for broader applications in critical care.[18]

Blood transfusion within the first 24 hours of PICU admission was not significantly associated with abnormal SIPA scores (p=0.061), or SI scores (p=0.518). This finding marginally contrasts with Kinjalk et al.[19], who identified a significant relationship between elevated SIPA scores and the need for transfusion in pediatric trauma patients. This could be attributable to differences in the patient population and the underlying pathophysiology driving the need for transfusion. Mechanical ventilation, a critical morbidity indicator, was significantly more frequent in children with abnormal SIPA scores (p=0.004), whereas SI scores failed to show a significant relationship (p=0.611). This result reinforces SIPA utility in predicting respiratory compromise and guiding early interventions. Similar observations were drawn in studies by Reppucci et al.[20], and Elkarn et al.[21], which highlighted predictive accuracy of SIPA for ventilation needs in pediatric trauma and emergency settings. The significant association of SIPA with inotropic support needs (p=0.003) further validates its role in identifying hemodynamically unstable patients.

The strengths of this study lie in its robust methodology, including a well-defined patient cohort and the use of validated scoring systems. Several limitations warrant consideration. First, the study's single-center design may limit the generalizability of the findings. Multicenter studies with larger cohorts may provide broader insights into SIPA utility across diverse settings. Second, we did not evaluate serial changes in SIPA scores, which could provide additional prognostic information. Despite these limitations, our findings contribute to the growing evidence base supporting SIPA as a superior tool for risk stratification in pediatric critical care. SIPA predictive advantage stems from its incorporation of age-adjusted physiological norms, making it particularly well-suited for pediatric populations. In contrast, SI relies on unadjusted parameters limits its applicability across varying age groups. The ability to identify high-risk patients early using SIPA could enable targeted resource allocation and improve clinical outcomes in resource-constrained settings. The development of dynamic scoring models that incorporate serial SIPA measurements could further optimize its prognostic value.

CONLUSION

This study underscores the clinical utility of SIPA as a reliable predictor of adverse outcomes in critically ill pediatric patients. Compared to SI, SIPA demonstrated superior predictive strength for key morbidity indicators, including mechanical ventilation, inotropic support, extended PICU stay, and mortality. These findings support the integration of SIPA into routine PICU practice as a non-invasive, easily calculable tool for early risk stratification and decision-making.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Anum Tanveer:** Data collection, drafting, responsible for data's integrity, proof reading.
2	**Murtaza Ali Gowa:** Study concept and design, proof reading, critical revisions.
3	**Hira Nawaz:** Study concept and design, proof reading, critical revisions.
4	**Bakhtawar Chandio:** Data collection, data analysis, proof reading.
5	**Ghazala Jamal:** Study concept and design, proof reading, critical revisions.
6	**Nadia Bibi:** Data collection, data analysis, proof reading.