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Study of Prism III Scoring System in the Outcome of Patient Admitted in Pediatric Intensive Care Unit in Tertiary Care Centre in Haldwani

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ABSTRACT

Critically ill children admitted to Pediatric Intensive Care Units (PICUs) are at increased risk of mortality. Prognostic scoring systems like the Pediatric Risk of Mortality (PRISM) III score help quantify illness severity and predict outcomes. While validated extensively in developed countries, data on its applicability in resource-limited settings like India remain limited. This study evaluates the utility of PRISM III as a prognostic tool in a tertiary care PICU in Haldwani. This prospective observational study was conducted from September 2022 to February 2024 at the Department of Pediatrics, Government Medical College, Haldwani. A total of 260 pediatric patients admitted to the PICU for various critical conditions were included, with exclusions for neonates, surgical cases, and patients with burns or short PICU stays. PRISM III scores, based on 17 clinical and laboratory parameters within the first 24 hours of admission, were analyzed. Statistical analyses included ROC curve evaluation and chi-square tests to correlate PRISM III scores with outcomes such as mortality, mechanical ventilation and vasoactive drug use. The study reported a mortality rate of 15% among participants, with higher PRISM III scores significantly associated with increased intervention requirements and mortality. Patients requiring mechanical ventilation and vasoactive drugs had mean scores of 15.01 and 16.89, respectively ($p<0.01$). The optimal PRISM III cut-off score for predicting mortality was 12, with a sensitivity of 95%, specificity of 87% and overall accuracy of 91%. ROC analysis yielded an area under the curve (AUC) of 0.905. Higher PRISM III scores were inversely correlated with PICU and hospital stays, reflecting the critical nature of these cases. The PRISM III scoring system is an effective prognostic tool for critically ill pediatric patients in resource-limited settings. It demonstrated strong predictive accuracy for mortality and highlighted its utility in assessing illness severity, guiding interventions and improving outcomes in PICU care. These findings support its broader application for optimizing critical care management in developing healthcare systems.

INTRODUCTION

One pediatric population of special interest comprises critically ill children requiring intensive care services, as these children face an increased risk of mortality. The primary purpose of the Pediatric Intensive Care Unit (PICU) is to mitigate mortality by providing intensive monitoring and treatment to critically ill children at high risk of death[1]. Technological advancements in PICUs have enabled more sophisticated care for children and adolescents, equipping these units to manage highly complex cases, albeit at significant cost. However, these technological advances have not always succeeded in improving patient outcomes. Instead, they often extend life expectancy in ways that may inadvertently increase suffering or prolong the process of dying[2,3]. Given these challenges, it has become essential to characterize the severity of disease at the time of admission and assess its prognosis. This evaluation can be performed using mortality prognostic scores, which objectively quantify the severity of a patient's condition and estimate their probability of death based on clinical status[4]. Such scores are valuable tools for selecting treatments, addressing ethical dilemmas, formulating economic strategies and improving patient care. Furthermore, by correlating mortality with the severity of illness, these scores enable patient classification and facilitate comparisons of clinical studies and technological resources[5]. At admission, establishing clinical and laboratory criteria to estimate the number and intensity of organ dysfunctions and the need for therapeutic interventions can be challenging. Since the introduction of mortality scores in ICUs, they have become increasingly integral to quality control and research methodologies. These scores are now widely used to evaluate the quality of care, estimate the risk of mortality and compare services based on the complexity of underlying diseases[6]. Among the key tools utilized in PICUs is the Pediatric Risk of Mortality (PRISM) score, derived from the Physiologic Stability Index (PSI). The PRISM score was validated with data from 1,415 patients across nine U.S. PICUs between 1984 and 1985. Statistical analyses streamlined the PSI categories, reducing the number of physiological parameters and forming the basis for the PRISM score[7]. PRISM calculates mortality risk using 14 physiological and laboratory parameters recorded within the first 24 hours of PICU admission. A logistic regression equation incorporates the PRISM score, patient age and surgical status at admission to estimate the risk of death[8]. Later, PRISM was updated to PRISM III in 1996, incorporating three additional variables to improve predictive accuracy. Validated among 11,165 patients in 32 PICUs in the USA, PRISM III demonstrated superior predictive performance compared to its predecessor. While extensively validated in tertiary PICUs in developed countries, reports on its use in the Indian subcontinent remain limited[9]. Recognizing the need for localized data, this study is designed to evaluate the PRISM III score as a prognostic indicator for children admitted to the PICU in a tertiary care center in Haldwani.

Aims and Objectives:

- To Study PRISM III score as a prognostic indicator in children admitted at the Pediatric Intensive Care Unit.
- To study the clinical and etiological profile of children needing admission in PICU in a tertiary care centre

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Pediatrics at Government Medical College, Haldwani and Susheela Tiwari Government Hospital, Haldwani, Uttarakhand, from September 2022 to February 2024. The study included pediatric patients admitted to the PICU for various critical conditions, including those requiring mechanical ventilation, those with impending respiratory failure, upper or lower airway obstruction, alveolar disease, unstable airways, or after successful resuscitation. Other inclusion criteria encompassed comatose patients and those with neurological conditions like meningitis, encephalitis, hepatic encephalopathy, cerebral malaria, poisoning and status epileptic us. Additionally, patients presenting with any type of shock-septic, hypovolemic, neuro genic, carcinogenic (e.g., myocarditis, cardiomyopathy, congenital heart diseases)-or bleeding emergencies, including gastrointestinal bleeding, co agulopathies and disseminated intra vascular coagulation (DIC), were included. Exclusion criteria comprised neonates under one month old, patients staying in the PICU for <one hour, those with burns, surgical cases, multiple congenital anomalies and patients who declined consent or opted out of the study. The study utilized the PRISM III scoring system to assess the severity of illness in pediatric patients admitted to the PICU, collecting data on 17 key variables within the first 24 hours of admission. The worst possible values for each parameter were recorded to ensure an accurate depiction of illness severity. These variables included vital signs such as systolic blood pressure, heart rate, and temperature, neurological assessments like the Glasgow Coma Scale and pupillary reaction and critical laboratory parameters such as blood gas analysis (pH, bicarbonate, PaO2, PaCO2), glucose levels, potassium, blood urea nitrogen, creatinine and hematological values like WBC and platelet counts. Coagulopathy was assessed using prothrombin and activated partial

thromboplastin time. Each parameter was scored based on ranges specified in the PRISM III system, reflecting the degree of deviation from normal values and their impact on mortality risk. Additional details were noted, including the age of the patients (categorized into four groups), the primary system affected and the diagnosis. For children requiring mechanical ventilation, settings such as positive inspiratory pressure and oxygenation parameters were recorded. Non-ventilated children on oxygen therapy had their mode of oxygen delivery documented. The use of vaso active agents during resuscitation and the presence of multi-organ dysfunction syndrome (MODS) were also significant variables. Furthermore, the need for renal replacement therapy (RRT) in cases of acute kidney injury and metabolic complications, as well as prior requirements for cardiopulmonary resuscitation (CPR), were considered critical indicators. The structured scoring of these parameters provided a comprehensive tool to evaluate the severity of illness and predict outcomes in critically ill children.

Statistical Analysis: Descriptive statistics were employed to summarize patient characteristics. Quantitative variables, such as age, weight, length of stay and PRISM score, were expressed as mean (SD), while categorical variables like gender and outcome were presented as frequencies (%). The PRISM score's performance was evaluated through discrimination and calibration analysis. Discrimination was assessed using the area under the ROC curve and calibration was tested with the Hosmer-Lemeshow goodness-of-fit chi-squared test. A significance level of $p<0.05$ was used. SPSS Version 26.0 facilitated most statistical analyses, while Microsoft Excel 2021 was utilized for graphical representation where applicable.

RESULTS AND DISCUSSIONS

The study revealed a mean age of 2.14 years among the subjects, with 41.5% of participants falling within the 1-5 years age group. A male predominance was noted, as 60.4% of the participants were male, compared to 39.6% female, resulting in a male-to -female ratio of 1.52:1. Neurological comorbidities were the most prevalent, affecting 28.1% of the subjects, followed by respiratory (13.1%), renal (12.7%), hematological (12.3%) and gastrointestinal comorbidities (11.9%). Mechanical ventilation was utilized in 28.1% of the cases, while vasoactive drugs were administered in 19.2% of the patients. The study reported a mortality rate of 15%, with a re-admission rate of 21.5%, underscoring notable clinical challenges in the management of pediatric patients in the intensive care unit. Analysis of the PRISM III (Pediatric Risk of Mortality) scores revealed significant associations with critical interventions. The mean PRISM III score was markedly higher among patients requiring mechanical ventilation (15.01 vs. 4.97., $p<0.01$), indicating the increased severity of illness in this subgroup. Similarly, patients who required vasoactive drugs also exhibited significantly higher mean PRISM III scores (16.89 vs. 4.89., $p<0.01$), reflecting a correlation between higher PRISM scores and the necessity for advanced therapeutic support. Interestingly, a significant inverse correlation was observed between PRISM III scores and the length of stay in both the PICU and the hospital overall. Higher PRISM III scores were associated with shorter durations of stay ($p<0.01$), which may reflect the critical nature and potential for adverse outcomes in patients with the highest severity of illness. These findings highlight the utility of PRISM III scores in predicting the intensity of care and clinical outcomes in this population.

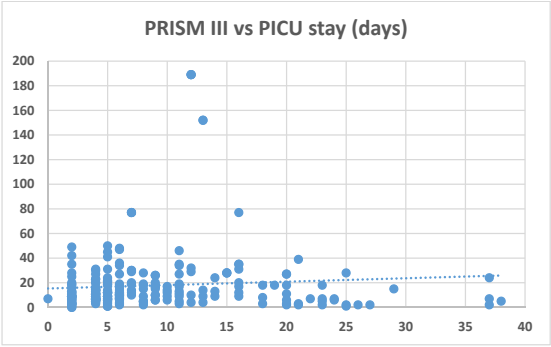

Fig. 1. Correlation Between PRISM III Score with PICU

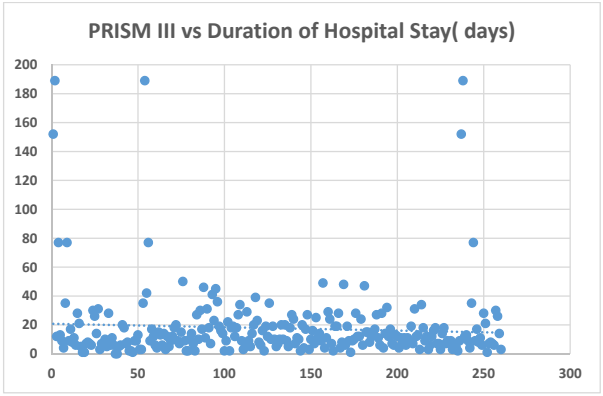

Fig. 2: Correlation Between PRISM III Score with Hospital Stay

Mean PRISM III score was significantly higher among expired cases as compared to survived ones (18.99 vs 4.98., $p<0.01$). Mean PRISM III score was significantly higher among cases requiring re-admission (8.81 vs 6.68., $p<0.01$).

Table 1. ROC Analysis of PRISM III Score for Prediction of Mortality

Test Result Variable(s)	Area Under the Curve (Outcome - Died -1., survived-0)			Asymptotic 95% CI	
	Area	SE	p- value	Lower Bound	Upper Bound
PRISM III	0.905	0.031	<0.01	0.844	0.967
Ideal Cut-off	Sensitivity	Specificity	Accuracy		
PRISM III Score >12	95.0%	87.0%	91.0%		

Receiver operator characteristic curve analysis was done for evaluating the efficacy of PRISM III score to predict mortality. Area under ROC curve was 0.905 (CI: 0.844-0.967) with optimal cut-off of 12, PRISM score >12 had sensitivity and specificity of 95% and 87% with an accuracy of 91%.

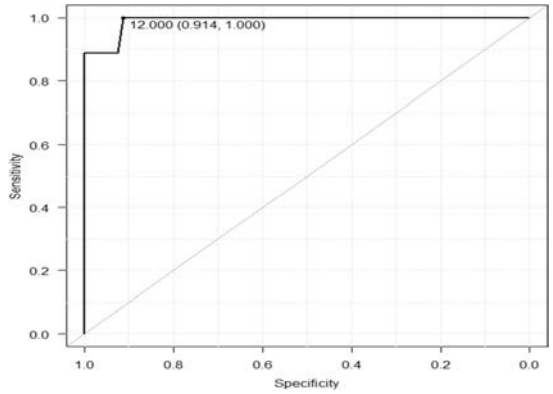

Fig 3 : ROC Curve

Table 2 . Association of PRISM III Score with Outcome

PRISM III	Survived	Expired	%Expired
<10	192	8	4.0%
10-15	29	3	9.4%
16-19	19	12	38.7%
>=20	20	16	44.4%

Chi-square-71.03., p-value <0.01

Mortality rate of PRISM III <10 was 4%, 10-15 was 9.4%, 16-19 was 38.7% and >=20 was 38.7% (p<0.01).

Table 3: Association of PRISM III Score with Biochemical and Clinical Parameters

Mean Values	Prism Score>12	Prism Score<12	Overall Mean Value
Systolic BP	72	94	83
Heart rate	119	98	108.5
Temperature	38ºC	37 ºC	37.5ºC
GCS	9	13	11
PH	7.1	7.36	7.23
Pco2	52	34	43
Po2	44	78	61
Bicarbonate	17	32	24.5
Serum Glucose	74	90	82
Serum Potassium	2.4	4.2	3.3
Serum Creatinine	1.5	0.7	1.2
Serum Bun	52	22	37
WBC	13000	10500	11750
Platelet	1.3 LAKH	1.8 LAKH	1.55 LAKH
PT and APTT	18,40	12,22	15,31

The association of PRISM III scores with biochemical and clinical parameters indicates that patients with PRISM scores >12 exhibited more severe derangements compared to those with scores <12. These patients had lower systolic BP (72 vs. 94 mmHg), GCS (9 vs. 13) and bicarbonate (17 vs. 32mmol/L), alongside higher heart rate (119 vs. 98bpm), temperature (38°C vs. 37°C) and markers of metabolic acidosis such as reduced pH (7.1 vs. 7.36) and elevated Pco2 (52 vs. 34mmHg). Oxygenation (Po2) was poorer (44 vs. 78mmHg) and markers of renal function (serum creatinine and BUN) were elevated (1.5 vs. 0.7mg/dL, 52 vs. 22mg/dL). Electrolyte imbalances (potassium 2.4 vs. 4.2mmol/L) and lower platelet counts (1.3 vs. 1.8 lakh) were noted. Coagulation times (PT/APTT) were prolonged (18/40 vs. 12/22 seconds), indicating higher severity in patients with PRISM >12. These findings align with the critical condition and poorer prognosis of patients with higher PRISM III scores.

The study aimed to assess the PRISM III score as a prognostic indicator in pediatric intensive care unit (PICU) admissions. It builds on earlier scoring systems like TISS and the Physiologic Stability Index (PSI), which were developed to assess illness severity and predict outcomes. The PRISM score, originally derived from PSI, was later modified to PRISM III with 17 variables. It has been validated primarily in developed countries but with limited data from India. The present study evaluated 260 pediatric patients in the PICU to determine the utility of PRISM III in predicting mortality and guiding resource allocation in resource-limited settings. The present study reported a mean age of 2.14 years, with 39.2% of subjects aged 1-5 years and a male predominance (60.4%). Comparable findings were noted by Singhal[10] (mean age 1.7 years, 72% males) and Dey[11]. (Mean age 5.9 years, 65% males). The mean age aligns with Pollack[12] study (2.75 years). Neurological (28.1%), respiratory (13.1%), renal (12.7%), hematological (12.3%) and gastrointestinal (11.9%) conditions were the most common co-morbidities, consistent with findings by Dey[11] and Singhal[10] The mean PRISM III score was significantly higher in cases requiring mechanical ventilation, vasoactive drugs, or re-admission (p<0.01), consistent with Pollock[12]. An inverse but non-significant correlation was observed between PRISM III scores and hospital stay, attributed to higher mortality in severe cases. This aligns with Bellad[13] who reported shorter ICU stays for non-survivors, highlighting variability due to differences in PICU care quality and primary disease conditions, as suggested by Brindha[14]. In the present study, 85% of participants recovered,

while 15% died, aligning with mortality rates reported by Dey[11] (19.6%), Singhal[10] (18%) The PRISM III score, measured within 24 hours of admission, was significantly higher among non-survivors ($p<0.01$). ROC analysis demonstrated strong predictive accuracy with an AUC of 0.905 (95% CI: 0.844-0.967), sensitivity of 95%, specificity of 87% and overall accuracy of 91% at a cut-off score of 12. These findings corroborate prior studies (AUC range: 0.845-0.937) validating PRISM III as a sensitive tool for mortality prediction. This study underscores the utility of PRISM III in ranking critically ill pediatric patients in resource-limited settings, enabling timely referrals to specialized care when necessary.

CONCLUSIONS

This study highlights the PRISM III score as an effective prognostic tool for critically ill children admitted to the Pediatric Intensive Care Unit. The score demonstrated significant associations with key outcome parameters, including the need for mechanical ventilation and vasoactive drugs, hospital stay, mortality and re-admissions. Higher PRISM III scores were strongly correlated with increased mortality rates and greater intervention requirements, emphasizing its utility in assessing illness severity.

Conflict of Interest: No.

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