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Prism III Scoring System: A Predictor of Mortality in Pediatric Intensive Care Units at Tertiary Care Center

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Abstract
Intensive care is crucial for managing critically ill children the Pediatric Risk of Mortality (PRISM) III score is a key quantitative tool for predicting mortality risk in Pediatric Intensive Care Units (PICUs). Despite its global use, there is limited data on its applicability in tertiary hospitals in Central India. This study aimed to evaluate the effectiveness of the PRISM III score in predicting mortality outcomes among pediatric patients in a tertiary care hospital. A prospective observational study was conducted over 18 months (February 2021-July 2022) in the PICU of a tertiary care hospital in Central India. The study included 250 children aged 2 to 12 years admitted to the PICU. Detailed demographic information, medical history clinical assessments, including vital signs and Glasgow Coma Scale (GCS) scores, were recorded within 24 hours of admission. The PRISM III score was used to evaluate mortality risk. Statistical analysis was performed using chi-square tests, Hosmer and Lemeshow test logistic regression. A significant correlation was found between higher PRISM III scores and increased mortality (P = 0.0001). In the highest PRISM III score group (>30), the observed mortality rate (48 patients) exceeded the expected mortality (18.4 patients), yielding an O/E ratio of 2.61. There was also a significant association between PRISM III scores and GCS categories (P = 0.0001), with higher PRISM III scores linked to more severe GCS categories. The overall mortality rate was 34%, with 66% of patients discharged. The PRISM III score effectively predicts mortality outcomes in pediatric patients admitted to PICUs in Central India. This study highlights the importance of regional adaptations and integration with clinical assessments to improve the accuracy of outcome predictions. Future research should validate these tools across diverse settings and focus on local health trends and clinical presentations.

INTRODUCTION

Intensive care has become very important in the management of critically ill children[1]. The care of critically ill children remains one of the most demanding and challenging aspects of the field of paediatrics. A paediatric intensive care unit (PICU) is a unit in a hospital where most critical children with life-threatening conditions receive paediatric care[2].

The prevalence of PICU mortality also varied in different regions of the globe. In Brazil, India Nigeria the prevalence of PICU mortality was 10.3%, 2.1% 34.6% respectively, while in Gondar (Northwest Ethiopia), Ayder referral hospital (North Ethiopia) Jimma (Southwest Ethiopia) PICU mortality rate were 30.9%, 8% 40% respectively[3]. Estimating the risk of mortality in ICU allows the physicians to assess the prognosis of the patient, plan therapies aid in evaluating the performance and resource utilization in an ICU[4].

The prediction of mortality risk by paediatricians is highly subjective (qualitative), therefore, there is a need for a scoring system (quantitative) for patients admitted to PICU. Clinical scoring systems have become a vital instrument in ICU. Scoring systems evaluate the patient's mortality risk in the ICU by assigning a score to patient and predicting the outcome[5]. In 1985, Pollack *et al.* designed Paediatric Risk of Mortality (PRISM) score for prediction of mortality in PICU. It consisted of 14 variables. PRISM is a second-generation, physiology-based predictor of mortality risk for paediatric ICU patients[4]. PRISM was later modified to PRISM III with an addition of three variables by Pollack in 1996. PRISM III (17 variables) was tested among 11,165 patients in 32 PICUs across the USA and yielded better results than PRISM in predicting mortality[5].

The PRISM III has been studied with successful results in various PICUs however, an Italian study carried out in 26 PICUs did not support the predictive power of PRISM III[6]. There is only limited data related to the application of PRISM III in tertiary hospitals across Central India. This study aimed to determine the usefulness of the PRISM III score in predicting the mortality outcome of patients admitted in PICU of a tertiary care hospital.

Aim and Objectives: To evaluate the effectiveness of the Pediatric Risk of Mortality (PRISM) III score in predicting mortality outcomes in a tertiary care hospital, focusing on clinical assessments and patient characteristics.

- To determine the role of PRISM III score as a predictor of mortality in pediatric patients admitted to the PICU, using clinical observations and patient demographics.
- To assess the associated factors that may predict mortality in the PICU setting, such as age, gender, clinical signs documented medical history.

MATERIALS AND METHODS

This research was conducted as a single-center, prospective observational study over 18 months, from February 2021 to July 2022, in the Pediatric Intensive Care Unit (PICU) of a tertiary care hospital located in Central India. The study aimed to evaluate the effectiveness of the Pediatric Risk of Mortality (PRISM) III score in predicting mortality among PICU patients. The study population comprised children aged 2-12 years admitted to the PICU during this period. Inclusion criteria were patients within this age range, of any gender, who were willing to participate and comply with the study protocol. Exclusion criteria included patients outside the age range and those who had participated in another study within the last 30 days. Withdrawal criteria encompassed withdrawal of consent, medical necessity, or protocol violations.

Data collection involved recording detailed demographic information, including name, age, address education, on a pre-structured proforma. Data management was meticulous, with information entered from case record forms into an Excel sheet, backed up weekly validated periodically by experts, ensuring accuracy and confidentiality.

Patient enrollment was contingent upon obtaining written informed consent from each patient's guardian after explaining the study's nature. Eligible patients were screened by clinicians, given an information sheet their consent obtained. A thorough medical history and physical examination. Vital signs such as heart rate, respiratory rate, temperature, blood pressure and Glasgow Coma Scale (GCS), were also recorded. These measurements were crucial for evaluating risk factors and outcomes based on the PRISM III criteria within 24 hours of admission.

The sample size was calculated considering a standard normal variate at 1% type 1 error (P<0.01) of

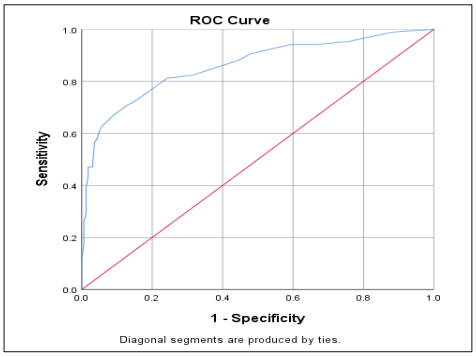

Fig. 1: PRISM III 2: In ROC curve, area under curve

Table 1: Association between Age and Sex. (N=250)

		Age Group * SEX Cross tabulation		
		Sex		
		Female	Male	Total
Age Group	2-5 Years	58 (48.7%)	68 (51.9%)	126 (50.4%)
	6-12 Years	61 (51.3%)	63 (48.1%)	124 (49.6%)
	Total	119 (100.0%)	131 (100.0%)	250 (100.0%)

Table 2: Frequency Distribution of Patients according to Chief Complaints (N=250)

		YES	No
Chief complaints	FEVER	161 (64.4%)	89 (35.6%)
	Cough	64 (25.6%)	186 (74.4%)
	Rash	1 (0.4%)	249 (99.6%)
	Convulsions	41 (16.4%)	209 (83.6%)
	Headache	36 (14.4%)	241 (85.6%)
	Vomiting	45 (18%)	205 (82%)
	Pain in Abdomen	17 (6.8%)	233 (93.2%)
	Pallor	238 (95.2%)	12 (4.8%)
General Examination	Cyanosis	17 (6.8%)	233 (93.2%)
	Icterus	6 (2.4%)	244 (97.6%)
	Clubbing	7 (2.8%)	243 (97.2%)
	Oedema	18 (7.2%)	232 (92.8%)
	Lymphadenopathy	4 (1.6%)	246 (98.4%)
Total			

Table 3: Association between PRISM III Score and Outcomes. (N=250)

	PRISM III Score * OUTCOME Cross tabulation Count			
		Outcome		
		Expired	Discharge	p-value
Prism iii score group	0-5	4	40	
	6-10	4	46	
	11-15	7	27	
	16-20	8	26	
	21-25	5	11	
	26-30	9	9	
	>30	48	6	0.0001**
	Total	85	165	250

Table 4: PRISM III Scoring difference in age group and expected and observed mortality.

Age Group	Mean PRISM III Score	Scoring Group	No. of Patients	Expected Mortality (E)	Observed Mortality (O)	O/E ratio	Logit r	P-value
Total	3.792 ±							
	2.18	0-5	44	15	4	0.27	3.46 ±	0 . 0 0 1
		6-10	50	17	4	0.24	0.54	0.001
		11-15	34	11.6	7	0.60		0.07
		16-20	34	11.6	8	0.69		0.078
		21-25	16	5.4	5	0.93		1
		26-30	18	6.4	9	1.41		0.85
		>30	54	18.4	48	2.61		0.001
		Total	250	85	85	1.00		1

Table 5: Association between PRISM III Score and GCS.

		Association between PRISM III Score and * GCS Cross tabulation GCS			
		Mild	Moderate	Severe	P value
PRISM III	0-5	1 (14.3%)	40 (25.3%)	3 (3.5%)	0.0001**
Score Group.	6-10	3 (42.9%)	39 (24.7%)	8 (9.4%)	
	11-15	2 (28.6%)	26 (16.5%)	6 (7.1%)	
	16-20	1 (14.3%)	24 (15.2%)	9 (10.6%)	
	21-25	0 (0.0%)	11 (7.0%)	5 (5.9%)	
	26-30	0 (0.0%)	12 (7.6%)	6 (7.1%)	
	>30	0 (0.0%)	6 (3.8%)	48 (56.5%)	250
Total		7 (100.0%)	158 (100.0%)	85 (100.0%)	(100.0%)

2.57, an expected population proportion of 0.10 based on previous studies an absolute error of 5% (0.05), resulting in a sample size of 238 we took 250 as sample. For statistical analysis, data were expressed as percentages and mean±standard deviation. The linearity of the data was checked using Kolmogorov-Smirnov analysis. Microsoft Excel™ 2021, Microsoft® Inc USA, were employed for analysis. Chi-square tests analyzed the significance of frequency distribution differences and the Hosmer and Lemeshow Test evaluated prediction binary logistic regression. A $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSIONS

(Table 1) examines the association between age and sex among the study cohort. The age group was divided into two categories: 2-5 years and 6-12 years.

Of the 126 children aged 2-5 years, 58 (48.7%) were female and 68 (51.9%) were male. In the 6-12 years age group, there were 61 females (51.3%) and 63 males (48.1%), making the total number of participants fairly evenly distributed between the two sexes with 119 females and 131 males overall.

Table 2 presents the frequency distribution of chief complaints among the 250 pediatric patients admitted to the PICU. The most common complaint was fever, reported in 161 patients (64.4%), followed by cough in 64 patients (25.6%). Other complaints included convulsions (16.4%), headache (14.4%), vomiting (18%) pain in the abdomen (6.8%). Rare complaints were rash (0.4%), pallor (95.2%), cyanosis (6.8%), icterus (2.4%), clubbing (2.8%), oedema (7.2%) lymphadenopathy (1.6%).

(Table 3) focuses on the association between PRISM III scores and patient outcomes. The scores are categorized into groups ranging from 0-5 to over 30. The table shows a significant correlation (P=0.0001) between higher PRISM III scores and increased mortality. For instance, in the highest score group (>30), 48 out of 54 patients expired, whereas, in the lowest score group (0-5), only 4 out of 44 patients expired.

(Table 4) compares the mean PRISM III scoring difference across age groups with expected and observed mortality rates. The table reveals that with increasing PRISM III scores, the observed mortality rate surpasses the expected mortality, particularly in higher score groups. For example, in the >30 score group, the observed mortality (48 patients) was significantly higher than the expected mortality (18.4 patients), yielding a high O/E ratio of 2.61. This indicates the PRISM III score's effectiveness in predicting mortality, with a significant correlation observed across all score groups (P = 0.001).

Lastly, (Table 5) examines the association between PRISM III score groups and the Glasgow Coma Scale (GCS) categories (mild, moderate, severe). A significant correlation (P=0.0001) was observed, where higher PRISM III scores were associated with more severe GCS categories. For instance, in the highest PRISM III score group (>30), all patients (48 out of 48) fell into the severe GCS category, highlighting the potential utility of PRISM III scores in predicting the severity of patient conditions in the PICU.

In our study evaluating age and gender distribution in pediatric intensive care units (PICUs), we observed a demographic pattern consistent with previous research by Mirza[5] and Kaur[7]. with a notable proportion of patients aged between 2-12 years and a slight male predominance, similar to findings by Chauhan[8] and Alkhalifah[9] The chief complaints in our cohort, predominantly fever and cough, differed from the respiratory issues and eating disorders noted in studies by Chegini[10] and Ongun[10] contrasted with the respiratory symptoms reported by González[11] possibly reflecting regional variances in disease presentations. Our study also highlighted a high incidence of pallor (95.2%), which was in contrast to the respiratory signs observed by Straliotto[12] and Phakhounthong[13] indicating potential differences in primary health concerns across regions.

Regarding patient outcomes, our study revealed that 66% were discharged while 34% succumbed, aligning with mortality rates seen in studies by Singhal[14] and Chauhan[8] This underscores the significance of reliable mortality prediction tools in PICUs. In examining the PRISM III score's effectiveness, we found a notable difference in mortality prediction accuracy, particularly in the score groups of 0-5, 6-10 >30 ($p = 0.001$), corroborating findings from Singhal[14] but contrasting with an Italian study[6] that questioned its predictive power, suggesting regional adaptations might be necessary for these scoring systems.

Furthermore, our research showed a significant correlation between PRISM III scores and Glasgow Coma Scale (GCS) outcomes. Patients with lower GCS scores, indicative of more severe conditions, had higher mortality risks ($p<0.005$). This association aligns with findings from Mirza[5] Bhatia[15] and Pollack[16] reinforcing the importance of GCS in assessing mortality risk in PICU settings. Overall, our study highlights the necessity of considering regional differences and the value of integrating clinical assessments for accurate outcome prediction in pediatric intensive care.

CONCLUSION

In conclusion, our study contributes to the growing body of evidence on the utility and applicability of the PRISM III score in different global contexts, highlighting its relevance in the Indian pediatric population. It also underscores the necessity of considering local health trends and clinical presentations in the management and outcome prediction of critically ill pediatric patients. Future research should focus on contextual adaptations of predictive tools and their integration with clinical assessments to enhance the care and management of patients in PICUs globally.

Recommendations: It is recommended to adapt predictive tools like PRISM III to local contexts, considering regional epidemiological data. Integrating scoring systems with clinical assessments, such as the Glasgow Coma Scale, can enhance outcome predictions. Further research is needed to validate

these tools in diverse settings and promote healthcare professionals' training and awareness. Developing hospital-specific protocols based on these scores can standardize care.

Limitations: This single-center study's findings may not apply universally. Exclusion of laboratory parameters limits score comprehensiveness. Sample size and demographic constraints affect generalizability. The retrospective nature introduces potential biases the lack of long-term follow-up hinders assessing

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