

## Accuracy of Pediatric Risk of Mortality (PRISM III) score in predicting mortality risk among children admitted in Pediatric Intensive Care Unit

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### Abstract

**Objective:** To assess the accuracy of pediatric risk of mortality score in predicting mortality risk among children admitted in the pediatric intensive care unit.

**Methods:** It is a descriptive cohort study conducted at PICU. It was conducted over six months from December 2022 to June 2023. All patients admitted in PICU with critical illness having age 1 month to 12 years of either gender was consecutively enrolled. Patients were classified in 3 groups according to the PRISM scores 1-10 (low risk), 11-20 (moderate risk), and 21-30 (high risk) was also done. The accuracy of PRISM III score was defined based on the presence of moderate or high risk of mortality at the time of hospitalization in the PICU among patients who died within 14 days. Data was analyzed on SPSS version 24.

**Results:** Of 135 patients, the mean age of the patients was  $2.65 \pm 2.14$  years. There were 90 (66.6%) with  $\leq 3$  years of age while 45 (33.3%) with  $\geq 3$  years of age. Low PRISM risk score was observed in 65 (48.1%), moderate in 64 (47.4%), and high in 6 (4%) patients. Mortality was observed in 28 (20.7%) patients. The sensitivity of the PRISM score is found to be 94.8%, the specificity is 62.8%, and positive predictive value of 33.9%, negative predictive value was 95.9%. The accuracy of the PRISM score is found to be 65.57%.

**Conclusion:** PRISM III is a reliable score in predicting mortality risk among children admitted to the Pediatric intensive care unit.

**Keywords:** PRISM III, Pediatric mortality, PICU

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### Introduction

Pediatric intensive care units (PICU) have now become an integral part of every healthcare system. By intensively monitoring patients with life-threatening diseases, the main aim of PICU is to save lives and reduce morbidity and mortality. Although there has been profound advancement in technology and medical guidelines regarding PICU

management, there is still some loophole in terms of any instrument or tool which could assess the severity of disease at the time of admission. Therefore, it seems prudent to objectify the disease severity at admission in the form of the scoring system, assessing its prognosis and risk of mortality<sup>1,2</sup>.

In the ICU, clinical scoring systems have become a crucial management tool. ICU mortality risk assessment guides regarding the present mortality risk and future predictive outcome of defined management plans<sup>3</sup>. This in turn not only gives an insight to the healthcare professionals regarding treatment options but also about the prognosis also helps from a counseling perspective<sup>4</sup>.

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One of these predictive models is called PRISM III which is used in many ICUs for prediction of mortality. Poor prognostic factors included a very low GCS, a need for ventilation, and inotropic cardiac support<sup>5</sup>. Multiple studies have been conducted so far internationally that have reported PRISM III as an efficacious score for predicting pediatric mortality in PICU<sup>6-8</sup>. Civil Hospital Karachi is one of the largest public healthcare institutes that cater to large masses of patients from all over the country, especially the southern and western provinces. In a limited resources center like ours, a study design like this helps identify a good prognostic model in terms of pediatric ICU management. Thus, there is a dire need for a study that can determine the management algorithm for PICU patients in our population so that management and counseling can be done as planned<sup>9</sup>.

After the introduction of mortality scores in the ICU, they are now applied in day-to-day practice and nowadays the scores are also an essential part of research and quality control<sup>10</sup>. In Pakistan, data on application of PRISM scores in intensive care is scarce and mostly are from private sector hospitals. There is a larger number of critically ill children admitted in pediatric intensive care units of public sector hospitals, but data from these institutes is scarce. Therefore, we designed this study to evaluate the accuracy of using the PRISM III score in deciphering the mortality among children admitted to the PICU of Civil Hospital Karachi. The results will be helpful in deciding application of these scores routinely in the management of critically ill children and predict the need of aggressive monitoring and management in these children.

### Methodology

It is a descriptive cohort study conducted at PICU. It was conducted over six months from December 2022 to June 2023. The sampling technique was nonprobability consecutive sampling and the sample size was estimated via an epi sample size calculator. The confidence interval was kept at 95% with a 7% margin of error and reported frequency of mortality in child with PRISM score >10 as 21.8%.<sup>9</sup> The sample size was calculated came as 134.

Inclusion criteria comprised of patients who were admitted to pediatric ICU with critical illness aged 1 month to 12 years, of both genders. Patients who died were discharged or Left against medical advice within 24 hours. Post-operative patients, children with cardiac problems, or patients received after cardiopulmonary resuscitation or not showing vital stability for at least 2 hours were excluded.

Data was collected after IRB approval and informed consent from parents. PRISM III score by definition is used to predict mortality using the most abnormal values of the following 17 clinical and laboratory parameters in the first 24 hours of the ICU stay. Patients were classified into 3 groups, according to the PRISM score, 1-10 (low risk), 11-20 (moderate risk), and 21-30 (high risk). Other variables like demographic data, admission criteria, length of stay, the need for ventilation, and mortality and outcome were also documented.

Readmissions to the PICU, within 24 hours, were analyzed as separate patients score because each admission presented a separate opportunity for an outcome. Detailed clinical and laboratory examination was performed. Most abnormal values of systolic blood pressure, temperature, mental status, heart rate, pupil reflex, pH, total CO<sub>2</sub>, PCO<sub>2</sub>, arterial PaO<sub>2</sub>, glucose, potassium, creatinine, urea, white blood cells, PT, APTT, and platelets in the first 24 hours of the ICU stay was used to calculate the PRISM score.

Data was analyzed on SPSS 24. Quantitative variables like age and length of PICU stay was expressed as mean and standard deviation or median (IQR). Normality of data was assessed by using Shapirouilk test, whereas qualitative variables like gender, need of mechanical ventilation, reason of admission in PICU, low/moderate/high PRISM score, mortality, and accuracy was computed as frequency and percentages. Chi-square and Fisher's tests were used and a p-value less than or equal to 0.05 was considered significant.

## Results

Of 135 patients, the mean age of the patients was  $2.85 \pm 2.84$  years. Female gender was predominant. The mean length of hospital stay was  $8.73 \pm 4.06$  days. There were 103 (76.2%) patients with <14 days of hospital stay while 32 (23.7%) with 14>days of hospital stay. The mean PRISM score was  $11.39 \pm 6.05$  (Table 1). Low PRISM risk score was observed in 66 (48.8%), moderate in 65 (48.1%), and high in 4 (2.9%) patients.

The need for mechanical ventilation was observed in 63 (46.6%) patients. Of 63 patients who required mechanical ventilation, 22 patients had a mild score, 35 patients had a moderate score and all 6 patients with a severe score required mechanical ventilation (Table 2).

**Table 1.** Demographic variables of study participants

Variables	Frequency
Mean age (years)	$2.85 \pm 2.84$
Males	47 (34.8%)
Females	88 (65.%)
The mean length of stay (days)	$8.73 \pm 4.06$
Mean PRISM score	$11.39 \pm 6.05$

**Table 2.** Need of mechanical ventilation in relation to Categories of PRISM III score

Categories of PRISM III Score	Mechanical Ventilation needed	Mechanical Ventilation not needed	Total	P value
Low risk	22 (33.3%)	44 (66.6%)	66	0.84
Moderate risk	37 (56.9%)	28 (43.0%)	65	0.09
High risk	4 (100%)	0	4	0.07
<b>TOTAL</b>	63	72	135	

**Table 3.** Mortality ratio of study participants in relation to Categories of PRISM III score

Categories of PRISM III Score	Mortality of patients		Total	P-value
	Yes	No		
Mild risk	2 (3.0%)	64 (97.0%)	66	
Moderate risk	22 (33.8%)	43 (66.2%)	65	
High risk	4 (100%)	0	4	<0.001
<b>Total</b>	28 (20.7%)	107 (79.3%)	135	

## Discussion

PRISM scores are frequently used in the analysis and medical management of sick adolescents, children, infants, and neonates. It warrants the establishment of an initial baseline score that aids in further comparing and predicting the progress. Three versions or modifications have been published till today<sup>11</sup>.

The first version was called Physiologic Stability Index abbreviated as PSI. It was coined by a panel of intensivists and included 34 variables from 7 organ systems of the patient's body<sup>8</sup>.

PSI stemmed from the "Therapeutic Intervention Scoring System that encoded and quantified the illness severity based on therapeutic requirements. All the variables in PSI were scored like 1, 3, or 5 depending on whether the disease was worth concern but not enough to change therapy, whether the therapy needed to be changed, or whether the disease was life-threatening.

Seeing the subjectivity and the vast number of variables used in PSI, Pollack came up with a PRISM score which was an enhanced version of PSI. This score was published in 1988.<sup>9</sup> Based on data collection from nine PICUs in North America, this score decreased the number of variables from 34 to 14 and further also decreased the ranges from 75 to 23. This score, PRISM II, showed doctor-friendly, easier to use, and better predictability in terms of disease severity prediction<sup>12</sup>. This data was collected from 1984 to 1985 but this scoring system is limited by its underestimation of morbidity in cardiac surgery patients.

In 1966, further modifications in PRISM II were done and PRISM III came into existence. 11,165 patients were studied in 32 pediatric units, in Northern America. Three groups were defined based on age and then further sub-scores were described based on organ systems and laboratory tests which were as follows; cardiovascular and neurological vitals along with biochemistry, hematology, acid-base analysis, and coagulation analysis. The variables have been reduced to 17 now with easier scoring and quicker contemplation<sup>13</sup>.

PRISM score has been used all over the world for patients in PICU. Other scores that are used are PELOD-2 and PIM-3. All these scoring systems have different parameters in determining the mortality risk. These scores have been compared and analyzed in detail. Data in Pakistan is limited but also supports the PRISM score as a better assessment tool<sup>14</sup>. Some studies do suggest other scoring systems as having better outcomes but still, the majority of literature supports PRISM III.

A meta-analysis by Shen Y et al analyzed 29 studies comprehensively and concluded that all 3 scores mentioned above have comparable efficacy in terms of diagnosing and predicting mortality risks in PICU patients. PRISM III was deemed highly sensitive and specific in determining the mortality risk stratification<sup>15</sup>.

A study done in Nepal studied 480 patients and concluded that PRISM III is very conclusive in predicting the mortality of PICU patients. The greater the score, the higher mortality was seen. The score was recorded within 24 hours of admission. Scores more than 25 or more were associated with a near 100% mortality rate. The study was conducted by Bora R et al<sup>16</sup>.

Although limited data is available in our country, a study done in Karachi by Mirza S et al concluded the same findings in favor of PRISM III. A total of 407 patients were included over one year in a tertiary care PICU in Karachi. The mortality rate in this study was 37%<sup>17</sup>.

A Chinese study by Zhang et al compared PELOD, PRISM, and P-MODS and concluded in favor of PRISM as a good diagnostic tool in differentiating between survivors and nonsurvivors and also in predicting mortality. The study was not in favor of P-MODS as a good predictive tool in terms of calibration in predicted and observed mortality<sup>18</sup>.

PRISM was also evaluated by Siddiqui et al at Rawalpindi, Pakistan. Total 370 patients were evaluated on consecutive admissions and PRISM was applied to their admission criteria and was found to be remarkably effective as a predictive tool<sup>10</sup>. A larger scale study evaluated 2446 patients with a

median age of 4.2 months up to the age of 18 years and compared PIM-3 and PRISM-3 and found PRISM-3 as a superior method of diagnostic prediction. The study was conducted in Iran<sup>19</sup>. Another study at Ziauddin Hospital, Karachi evaluated a total of 263 children up to the age of 12 years and came to the same results in favor of PRISM-3 with higher scores predicting non-survival in PICU patients<sup>20</sup>. 524 patients were evaluated in another study by Kaur A. et al in terms of length of stay. Higher PR-ISM III scores were associated with a longer length of stay and higher mortality in patients admitted to PICU<sup>8</sup>.

Another study in retrospect analyzed a total of 398 patients under 18 years of age with sepsis and provided the results against PRISM III, and in favor of PELOD-2 which yielded a very good predictive value in predicting mortality<sup>21</sup>. Another study compared APACHE II and PRISM III in the cardiac surgery unit for children, and even in those settings, PRISM III proved its efficacy in terms of a predictive tool for mortality. The study evaluated 124 patients in retrospect. It was conducted in Turkey<sup>22</sup>.

A study in India provided similar stats in comparison with the PIM score. PRISM III proved superior to the PIM score in assessing risk stratification although both scores were underestimating the predicted mortality in comparison with observed mortality<sup>23</sup>. Total 207 patients were assessed in India by Shah AA et al and the observation was that the actual death was almost exactly as expected death by PRISM score. The only exception was the patients on vasopressor support and patients requiring mechanical ventilation. There was no mortality in children with scores from 0 to 5<sup>24</sup>.

A study done in Srinagar by Islam t et al studied, 315 patients and came to the conclusion that patients who died had significantly higher PRISM scores on admission than those who were discharged. They excluded children who expired within 6 hours of admission and also children with known metabolic disorders and children who had undergone trauma and were admitted because of it while the study included all patients more than 1 year

and less than 14 years of age<sup>25</sup>. Rsovac et al, in their study concluded that PRISM III score was a fair outcome predictor during the 28 day follow up in patients on mechanical ventilator<sup>26</sup>. Anjali et al reported high sensitivity of 100% and specificity of 95% PRISM III score in predicting severe illness<sup>14</sup>. Similar sensitivity of 95% was found in our study.

Limitations of the study: This is a single centre study in a public sector hospital. Multicentre studies including both public and private sectors with larger sample size are needed to overcome further confounding variables.

### Conclusion

PRISM III score was found to be accurate and highly sensitive for prediction of mortality in critically ill patients admitted in pediatric intensive care unit of a public sector, tertiary care hospital. High PRISM III score was most indicative of mortality. We recommend to apply these scores in all critically ill children so that outcome can be anticipated and aggressive management is done.

### Conflict of Interest

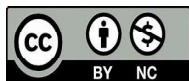
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