Original Article

Validity of pediatric risk of mortality score in prediction of mortality in North Indian pediatric intensive care unit

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Abstract

Background: The pediatric risk of mortality (PRISM) score allows assessment of the severity of illness and mortality risk adjustment in heterogeneous groups of the patients in an objective manner. It has been developed and validated mostly at pediatric intensive care unit (PICUs) of developed countries with very few reports from India. **Objectives:** This study was planned to evaluate the usefulness of the PRISM score and to correlate it with the mortality in patients admitted to PICU of a northern Indian PICU. **Material and Methods:** A prospective, observational study was conducted between January 2012 and June 2013, during which a total of 150 consecutive cases were enrolled for the study. PRISM score was calculated within 24 h of their admission and receiver operating characteristic (ROC) curve was used to establishing the validity of the PRISM score for predicting the mortality. **Results:** Overall mortality was 12.5%, and the PRISM score for survivors versus non-survivors was 7.5878 ± 5.032 versus 20.63 ± 3.41, respectively. No difference was seen between the observed and expected value of mortality calculated from PRISM score (Z = 0.467-1.521, p = 0.291–0.64), thereby establishing the validity of the PRISM score in predicting the mortality in our PICU (ROC curve - area under the curve 0.934). The observed and expected values of the mortality were more comparable for lower PRISM scores (0-15) and a PRISM score of 13.5 has the highest sensitivity and specificity. **Conclusion:** We concluded that PRISM score is a valid parameter to predict the mortality among the ICU patients in Indian set ups.

Key words: *Mortality, Pediatric intensive care unit, Pediatric risk of mortality score, Receiver* operating curve

The pediatric risk of mortality (PRISM) score is a third generation scoring systems that allow assessment of the severity of illness and mortality risk adjustment in heterogeneous groups of patients in an objective manner, enabling conversion of these numbers into a numerical mortality risk based on logistic regression analysis. It may also be used for comparison of quality of care between pediatric intensive care units (PICUs) by using standardized mortality rates and for comparison of severity of illness between different treatment arms in clinical trials. The PRISM has been developed and validated in tertiary PICUs in mostly developed countries [1-3] with very few reports from India [4-6].

ICUs and PICUs are managed by a varying number of residents, fellows, pediatricians, or nurses, with varying degrees of PICU experience and training. There is not only an expected difference in the quality of service provided to the admitted patients, but also an inter-observer difference in severity scoring of PRISM score. This may imply that these scoring systems may not have the same reliability and validity in cases of every PICU unit although available reports from the Indian subcontinent [4-6] favor the usefulness of the PRISM score in the PICU setting. Due to this fact, this study has been planned to evaluate the PRISM score and to correlate it with mortality in patients admitted to the PICU of a northern Indian tertiary referral pediatric hospital.

MATERIALS AND METHODS

This was a prospective, observational study conducted in an eight bedded, Northern Indian, tertiary referral PICU which provides care to approximately 200 children per year from 1 month to 18 years of age with an average mortality of 10%. The study was conducted prospectively over a period of 1½ year, between January 2012 and June 2013, during which a total of 150 consecutive cases were enrolled for the study. This group included all the patients admitted to the PICU from 1 month of age to 18 years. All the patients enrolled for the study had their PRISM score calculated, within 24 h of their admission. Readmissions were considered as separate admissions.

If the deaths occurred in the operation theater, it was included only if the patient was operated upon in the course of the management, during the PICU stay and for the treatment of

an illness which required PICU care. Any terminally ill patients transferred from the PICU for "comfort care" were included as PICU patients, if the patient survived for the 24 h following PICU discharge. Those patients admitted in continuous CPR who did not achieve stable vital signs for ≥2 h were not included in the study. Death occurring within the first 10 h of PICU admission or if the case was discharged from the PICU in <24 h were excluded from the study. Newborn infants <1 month of age or children above 18 years of age were not included in the study.

The study design was approved by the Institution's Ethical Committee, and a written consent was acquired from all the parents of the participants. The treating pediatrician enrolling the patients in the study group and the staff collecting the data were blinded for study design and outcome. All the data were recorded on a standardized data sheet and included demographic variables (such as age and sex), length of stay and outcome (survival or death), operative status of the patient and the 14 physiological dysfunction variables used in the definition of the PRISM score. Blood pressure was recorded using non-invasive blood pressure monitoring and oxygen saturation was recorded with a pulse oximeter. Arterialized capillary heel prick blood was used for determining PaO_2, $PaCO_2$ and bicarbonate. Standard laboratory techniques were utilized to estimate total bilirubin, potassium, calcium, glucose, prothrombin time and partial thromboplastin time. The clinical assessment to record heart rate, respiratory rate and pupillary reaction and the Glasgow coma score were done by the resident doctor.

The patients were followed up during a hospital stay, and the outcome measures were recorded as died or survived at the end of the hospital stay. Collected data were entered in an online PRISM score calculator and was calculated for every included patient in his/her first 24 h of PICU admission [7]. Studied patients were classified in five groups according to their PRISM scores: 0-5, 6-10, 11-15, 16-20 and 20 or more. To estimate the probability of death in the ICU for this patient (p [ICU death]), the PRISM score, patients age and operative status are combined in a linear logistic regression as follows and was calculated using available software.

p(ICU death)=exp(r)/[l+ exp(r)]

Where r = 0.207 × PRISM - 0.005 × age (in months) - 0.433 × operative status - 4.782, with operative status = 0 if non-operative, 1 if post-operative. The specific model and coefficients were used in the linear logistic regression involving all the 14 coded variables, mirrored the technique used by Pollack et al. [8]. A forward stepwise linear logistic regression was then carried out to investigate which of the 14 coded variables were necessary for predicting mortality outcome for our data. Comparisons of different variables between survivors and non-survivors were done by employing t-test or Mann–Whitney test and Chi-square test. Quantitative variables were assessed by Student's t-test and one-way ANOVA. A receiver operating characteristic (ROC) curve was used to establishing the validity of the PRISM score for predicting the mortality. Results were considered as statistically significant if there was a $p \leq 0.05$. Statistical analysis was performed using SPSS 17.0 (SPSS Inc., IBM, UK).

RESULTS

We enrolled 150 consecutive patients in our study from January 2012 to June 2013. The mean age of survivors was 80.84 ± 61.072 months and for non-survivors was 83.32 ± 79.55. PRISM score for survivors was 7.5878 ± 5.032 and for non-survivors were 20.63 ± 3.41. There was no significant difference in the age, weight and duration of PICU stay between the survivors and non-survivors (Table 1).

There was also no statistical difference (Z = 0.467-1.521, p = 0.291-0.64) between the actual number of observed deaths in the PICU and the expected mortality calculated from the PRISM score of the individual patients. These results establish the validity of the PRISM score as a predictor of mortality in our ICU. The observed and expected values of the mortality were more comparable for lower PRISM scores (0-15), which may be explained by the fraction of the patients in the lower PRISM score categories (Table 2 and Fig. 1).

The above ROC curve has an area under the curve of 0.934 thereby indicating that the PRISM score is a valid parameter to predict the mortality among PICU patients (p = 0.0001). In addition, we observed that the PRISM score of 13.5 had the highest sensitivity and specificity in predicting the ICU mortality in our study patients (Table 3 and Fig. 2).

DISCUSSION

An accurate estimate of the severity of a disease process is affected by the clinical ability of the physician, thereby making the prediction of mortality variable and difficult. Prediction of the patient outcome is relevant for resource allocation as the optimum usage of ICU beds will allow for the maximum utilization of limited resources in countries such as India [9,10].

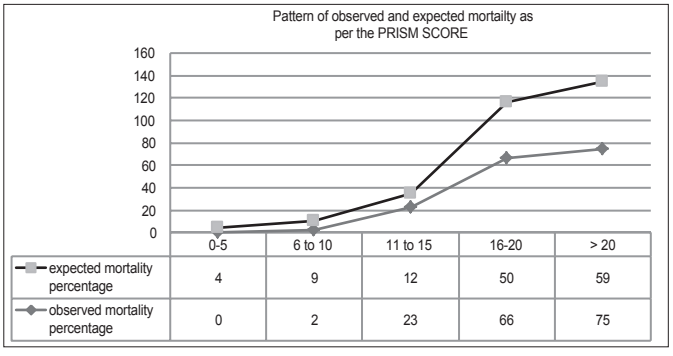

Figure 1: Pattern of observed and expected mortalityas per the pediatric risk of mortalityscore

Table 1: Distribution of demographic values of survivors and non-survivor patients

	n	Weight (kg)	Age (months)	PRISM score	PICU stay (days)
Survivor	131	16.8±11.4	80.8±61.07	7.5±5.0	4.6±3.0
Non-survivors	19	18.2±13.1	83.3±79.5	20.6±3.4	4.2±2.8
Z and p value		Z=21.4, p=0.631	Z=103.4, p=0.874	Z-11.9, p=0.000	Z=6.23, p=0.607

PICU: Pediatric intensive care unit, PRISM: Pediatric risk of mortality

Table 2: Observed and expected values of PRISM scores of survivors and non-survivors in different categories (z=0.467-1.521, p=0.291-0.64)

Prism score	Survivor n (%)		Non-survivors n (%)	
	Observed	Expected	Observed	Expected
0-5	56 (100)	54 (96)	0 (0)	2 (4)
6-10	44 (100)	40 (91)	0 (2)	4 (9)
11-15	24 (77)	23 (88)	2 (23)	3 (12)
16-20	4 (33)	6 (50)	8 (67)	6 (50)
>20	3 (25)	5 (42)	9 (75)	7 (58)

PRISM: Pediatric risk of mortality

Table 3: The sensitivity, specificity and the positive predictive values of various PRISM score cut-off points for predicting the ICU mortality

Positive if≥[a]	Sensitivity	Specificity	Positive predictive value
10.5000	0.931	0.81	1.23
11.5000	0.931	0.851	1.17
12.5000	0.931	0.893	1.11
13.5000	0.931	0.909	1.099
14.5000	0.862	0.942	1.066
15.5000	0.759	0.975	1.031

ICU: Intensive care unit, PRISM: Pediatric risk of mortality, [a]Prism score cutoff taken to predict mortality in PICU

We did not observe any difference in the mean duration of ICU stay among the survivor and non-survivors. Bellad et al. [6] reported that the mean ICU stay among non-survivor was shorter when compared to those survivors. As the inverse of the correlation between PRISM and mean ICU stay is considered to be an indicator of the quality of PICU services [11], a difference in the quality of care available at various centers may explain the observed variability in the ICU stay being reported in different studies. Brindha et al. [12] attribute the median length of PICU stay with the type of primary disease condition affecting the patients and not to the PRISM score of the mortality probability of the patients.

Overall age shows no significant relation to outcome in the present study as has been reported by Tibby et al. [13], De Leon et al. [14] and El-Nawawy [7]. There is significant variability in overall mortality among different studies; however, the overall

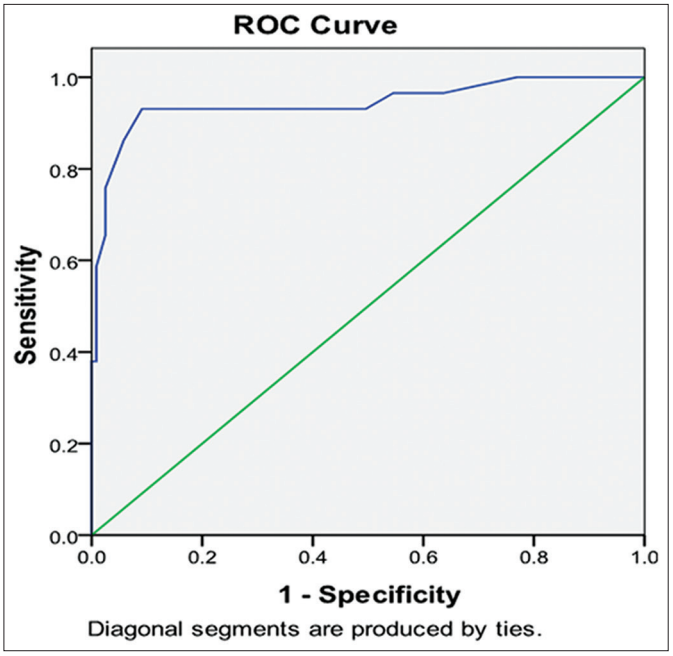

Figure 2: Coordinates of the receiver operating characteristic curve for different cut-off value of pediatric risk of mortality score

mortality of 12.5% in the present study was lower than reported by others.

In this study, PRISM score was found to be a sensitive predictor of outcome (area under the curve - 0.934). PRISM score was found to predict mortality with 90.9% accuracy at a cut-off point of 13.5. These observations are comparable to other studies [4,7]. Bellad et al. reported an overall mortality of 16.7% with 89.2% accuracy at cut-off score of 15 [6]. However, Thukral et al. [15] reported that PRISM under-predicted death in an Indian PICU. Another study from South Africa reported discrepancy between observed and the predicted mortality rates (area under the curve 0.73) [10]. There was under-prediction of mortality at lower PRISM scores and over-prediction at higher scores. We did not observe any discrepancy in our study, which may be related to late presentation to the hospital, delay in admission to the PICU, the quality initial treatment, or higher incidence of younger patients [10,15].

As PRISM score accurately reflect the severity of illness, the initial PRISM score at presentation may be used to determine patients' admission to the ICU, a valuable tool for resource-poor regions. Also, PRISM score may be used for comparison

of the experience of other ICUs/hospitals and for clinical audit of ICUs over a period. Regular use of scoring systems in PICU provides an opportunity not only to predict the outcome, but also helps in the improvement of the quality of care within the limited resources available.

The present study had only 19 events (deaths) in total. Smaller fraction of patients with higher PRISM score contributing to the majority of mortalities is a major limitation of this study. A larger study with more events is warranted to have better understanding of PRISM scores and as it relates to PICU mortality. This study had limitations of a small sample size compared with the original validation studies, which may have affects the validity of the ROC curve used in statistical analysis.

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