

Application of pediatric risk of mortality-III score to predict outcome in critically sick children admitted in a tertiary care pediatric unit in a developing country

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ABSTRACT

Objective: The aim of this study is to assess the utilization of the pediatric risk of mortality-(PRISM)-III score to predict mortality in critically sick children and determination of mortality risk factors in a tertiary care pediatric unit. **Materials and Methods:** In this cross-sectional descriptive study, 100 children admitted during an 18-month period were enrolled in the study. PRISM-III score and mortality risk were calculated. Follow-up was noted as death or survival. **Results:** Of 100 patients, 27 died and 73 survived. The 47% of the patients were males. The PRISM-III score was 0-9 in 75%, 10-19 in 15% and 20-29 in 8%, ≥ 30 in 2% of patients. PRISM-III score showed an increase of mortality from 8% in 0-9 score patients to 100% in ≥ 20 score. PRISM-III score was significantly associated with study variables such as duration of hospital stay, mental status (Glasgow Coma scale < 8), and blood pH < 7.28 ($p < 0.001$). **Conclusion:** PRISM-III score showed good predictive value (94.5%) and adequate discriminatory capacity (area under receiver operating characteristics curve 90.8%), and thus constitutes a useful tool for the assessment of prognosis for pediatric patients.

Key words: Mortality, Pediatric intensive care unit, Pediatric risk of mortality, Prognostic score

The pediatric risk of the mortality (PRISM) score is effective in predicting children's mortality. Information about the predictive value of PRISM score is very limited outside the America and Europe, especially in developing countries [1]. PRISM score may help the medical group to decide which patient benefits more from admission to the pediatric intensive care unit (PICU), especially in centers with limited PICU beds [2].

The PRISM score is one of the main indicators used in the pediatric intensive care is validated from physiology stability index (PSI) by Pollack et al. It reduces the number of physiological variables required for pediatric intensive care mortality risk assessment from 34 (in the PSI) to 14 and to obtain an objective weighting of the remaining variables. Its third revision PRISM-III was first presented by Pollack et al., in 1996. This scoring system is based on 17 physiologic variables which are subdivided into 26 ranges [3]. It presents an excellent discriminatory performance and prediction, being used as a prognostic score to assess the gravity of the disease. Some studies show that PRISM has the ability to assess indication while other studies show that PRISM overestimates the mortality [4,5].

Lacroix et al., pointed out that PRISM score may be used in neonates, infants, children and adolescents with severe

disease, but may not be used in preterm neonates and adults [6]. A prospective study in India showed that a simple clinical scoring system will be useful in predicting the severity of illness and outcome at admission in an emergency [7]. The purpose of this study was to evaluate the PRISM-III scoring system to predict mortality in critically sick children and to determine mortality risk factors in a PICU like set up in a tertiary care pediatric unit in a developing country.

MATERIALS AND METHODS

This study was performed at a multi-specialty tertiary care teaching hospital in Delhi, having 150 bedded Pediatric Department with 10 beds dedicated for critically sick children. Total 100 critically sick children (1-12 years of age) of both sexes, admitted in the pediatric ward during 18-month were enrolled in the study. However, patients who had a hospital stay of < 12 h or died within 12 h of admission, those transferred to other departments for further management, a patient of head trauma and surgical cases and children with congenital malformations otherwise incompatible with life, were excluded from the study.

The study was conducted after taking Institutional Ethics Committee approval and patients were enrolled after taking

informed written consent of the parents/legally acceptable representative. Detailed history and clinical examination were recorded in the preset proforma including age, sex, and duration of hospital stay. The Glasgow Coma scale and modified Glasgow Coma scale were applied as per the age specifications for assessing mental status of the patients. Body temperature, blood pressure (non-invasive), and blood glucose (with glucometer) was measured at admission. All cases were subjected to estimation of serum levels of potassium and sodium, blood urea and creatinine, blood glucose, hemograms, prothrombin time, and partial thromboplastin time. PRISM-III scores (Table 1) were applied for every patient at the time of admission and recorded, then their hospital course was followed to determine the outcome of their sickness (as death or survival).

Studied patients were classified in 4 groups according to their PRISM-III scores: 1-9, 10-19, 20-29, 30 or more. The association of age, sex, PRISM-III score, pH, and duration of hospital stay and Glasgow coma score (GCS) with the outcome (nonsurvivors) was tested using the Chi-square or Fisher's exact test whichever was appropriate. The association between PRISM-III scores and the outcome was further assessed using logistic regression analysis and observed and expected deaths were provided for each PRISM-III score group. The appropriateness of the model is assessed by Hosmer-Lemeshow Chi-square test. Receiver operating characteristics (ROC) Curve analysis was also performed to test the appropriateness of predicted probability of death by PRISM-III score. The results were considered significant at 5% percent level of significance. The statistical software MS EXCEL and SPSS 17.0 were used for all the analyses.

Table 1: PRISM-III scores (17 variables and 26 ranges)

Variable	Age restriction				Score appointed
	Neonate	Infant	Child	Adolescent	
SBP (mmHg)	40-55	45-65	55-75	65-85	3
	<40	<45	<55	<65	7
Temperature	All ages		<33°C or >40°C		3
Mental status	All ages		Stupor or coma (GCS<8)		5
	Neonate	Infant	Child	Adolescent	
Heart rate	215-225	215-225	185-205	145-155	3
	>225	>225	>205	>155	4
Pupillary reflex	All ages=one pupil fixed		Pupil>3 mm		7
	All ages=both fixed		pupil>3 mm		11
Acidosis pH	All ages=pH: 7.0-7.28 or total CO ₂ (mEq/L): 5-16.9				2
	All ages=pH: <7.0 or total CO ₂ : <5				6
pH	All ages=7.48-7.55				2
	All ages≥7.55				3
PCO ₂ (mmHg)	All ages=50.0-75.0				1
	All ages≥75.0				3
Total CO ₂ (mmol/L)	All ages≥34.0				4
Arterial PaO ₂ (mmHg)	All ages=42.0-49.9				3
	All ages=42.0				6
Glucose	All ages>11.0 mmol/L (200 mg/dl)				2
Potassium	All ages>6.9 mmol/L				3
	Neonate	Infant	Child	Adolescent	
Creatinine (μmol/L)	>75	>80	>80	>115	2
White blood cells	All ages≤3000 cells/mm ³				4
	Neonate			All other ages	
Prothrombin time (PT)	PT>22.0 s			PT>22.0 s	3
Partial thromboplastin time (PTT)	PTT>85.0 s			PTT>57.0 s	3
Platelets (cells/mm ³)	All ages=100,000-200,000				2
	50,000-99,999				4
	<50,000				5

Total PRISM-III - 24 score. PT: Prothrombin time, PTT: Partial thromboplastin time, PRISM: Pediatric risk of mortality, GCS: Glasgow coma score

RESULTS

A total of 100 children between 1 and 12 years of age admitted in PICU like set up were studied, and out of these, 27 died and 73 survived. The mean age of patients was 6.47±3.24 years and Male: Female ratio was 0.8:1. The overall mean PRISM-III score was 7.64±7.09 with significantly higher scores among non-survivors (16.37±7.87) than in survivor (4.42±2.82) and this difference was statistically significant (p<0.001). Association between study variables and outcomes are shown in Table 2. The outcome was not associated significantly with sex and age groups. The extreme of pH notifying severe acidosis or alkalosis and mental status (GCS) of patients were significantly associated with death.

The mean duration of hospital stay was 9.21±6.26 days and GCS was 12.73±3.60. Both of these variables showed significant association with outcome. Outcomes were poor in patients with duration of stay between 24 h and 3 days and mean PRISM-III score of 18. In patients with a hospital stay of 4-7 days (and mean score 7.98) and 8-15 days (mean score 4), 32.50% and 5.56% death were seen respectively. No death seen in patients with a hospital stay of ≥16 days. The likelihood of death was 47.2% less for patients if the hospital stay increased by 1 day (OR=0.538, p<0.0001). 85.72% of cases die with GCS<8 and also have mean PRISM-III score of 18.10 at admission whereas only 9% cases with GCS>8 died. With each one unit increase in the mental status, the risk of mortality decreased by 42.3% (OR=0.587) (p<0.001). In the present study, cases who had pH<7.28 has mean PRISM-III score of 20.75 with 100% mortality (p<0.0001). A significant association was seen between acidosis with poor outcome as all the patients with acidosis (n=8) died whereas among those who had not acidosis, only 20.65% died.

Table 3 shows the discrepancies between the observed and the expected values across the four score divisions are not significant (p>0.5). The area covered by ROC curve (Fig. 1) was 90.8% which shows that predicted death risk based on PRISM-III score was excellent in predicting the probability of death.

The PRISM-III score significantly predict the death correctly by 94.5%. Its sensitivity was 92% and specificity was 84%. The value of Kappa was 0.74 that showed that agreement was good. Fig. 2 shows prediction of the probability of death according to PRISM-III score.

DISCUSSION

PICUs were developed to decrease children’s mortality. Prediction of patient outcome is important for the patients and family and is relevant for policy formulation and resource allocation, the optimum usage of PICU beds will obviously allow maximum utilization of limited resources [2,8]. The

PRISM scoring system was first presented by Pollack et al., in 1988 from PSI. Its third revision PRISM-III has been used to compare the function of different PICUs and assess the manner of resources consumption. This scoring system is based on 17 physiologic variables and out of these minimum systolic

Table 2: Association between study variables and outcome

Variables	Outcome n (%)		p value
	Alive	Dead	
Sex			
Male	34 (72.34)	13 (27.66)	0.889
Female	39 (73.58)	14 (26.42)	
Age group (years)			
1-4	29 (80.56)	7 (19.44)	0.270
5-8	23 (63.89)	13 (36.11)	
9-12	21 (75.00)	7 (25.00)	
Acidosis			
No	73 (79.35)	19 (20.65)	<0.0001
Yes	0 (0.00)	8 (100.00)	
PRISM score			
1-9	69 (92.0)	6 (8.0)	<0.0001
10-19	4 (26.67)	11 (73.33)	
20-29	0	8 (100.0)	
30 and above	0	2 (100.0)	
Duration of hospital stay			
24 h-3 days	0 (0.0)	12 (100.0)	<0.0001
4-7 days	27 (67.50)	13 (32.50)	
8-15 days	34 (94.44)	2 (5.56)	
≥16 days	12 (100.0)	0 (100.0)	
pH groups			
7.0-7.28	0 (0.0)	8 (100.0)	<0.0001
7.29-7.34	24 (72.73)	9 (27.27)	
7.35-7.47	45 (84.91)	8 (15.09)	
7.48 and more	4 (66.67)	2 (33.33)	
GCS			
<8	3 (14.28)	18 (85.72)	<0.001
≥8	70 (88.61)	9 (11.39)	

GCS: Glasgow coma score, PRISM: Pediatric risk of mortality

Table 3: Observed and expected outcome according to PRISM-III score groups

Outcome	Survivors		Non-survivors		Total
	Observed	Expected	Observed	Expected	
1-9	69	69.00	6	2.00	75
10-19	4	4.00	11	4.00	15
20-29	0	0.00	8	8.00	8
30 and above	0	0.00	2	2.00	2

p>0.5. PRISM: Pediatric risk of mortality

blood pressure, abnormal pupillary reflexes, and stupor or coma are the variables most predictive of the mortality [3].

In this study, the mean PRISM-III score was 7.64 ± 7.09 and 75% had a score of 1-9. In a study by Singhal et al., mean PRISM score was 10.9 ± 0.66 , which is comparable to present study [2]. However in a study by Bilan et al., the mean value of the PRISM-III score was 14.22 ± 9.57 [9]. The higher score could be because all the patients admitted in first 24 h were included, whereas we excluded the cases who died in first 12 h. In this study, the mean PRISM score for survivor was 4.42 ± 2.82 and for non-survivors was 16.37 ± 7.87 . Karambelkar et al. showed mean score of 14.83 ± 7.29 in non-survivors and

7.71 ± 4.72 in survivors [10]. Similarly, Bellad et al. showed that mean PRISM score was 6.5 ± 3.6 in survivors and 15.5 ± 7 in non-survivors, which was comparable to our study [11].

In this study, age and sex of cases showed no significant association with outcomes (survivor/non-survivor). Similar results have been reported by Singhal et al., Karambelkar et al., and Ali et al. [2,10,12]. In this study, duration of hospital stay was significantly associated with PRISM score and outcome ($p < 0.0001$). Hospital stay up to 3 days was associated with a mean score of 18 and 100% mortality, whereas stay of ≥ 16 days showed mean score of 5.08 with no mortality. Khajeh et al., showed the similar results [12]. Singhal et al., found mean hospital stay of 7.22 days [2], which was comparable to our study result of 9.21 days.

In the present study, mean mental status (GCS) was 12.73 ± 3.60 and a significant association was seen between mental status and outcome (death). Each one unit increase in GCS decreased 42.3% (OR=0.587) chances of death in these patients. On extensive literature search, no study could be located which compared the outcome and PRISM-III score about duration of stay, mental status, and blood pH respectively.

In our study, increasing PRISM-III score was associated with a proportional increase in mortality. 75 cases had PRISM-III score of 1-9 with expected and observed the death of 2.6% and 8%, respectively. Among the 15 cases with the score of 10-19, the expected death was 26.67% and observed death was 73.33%. In 10 cases with a score of ≥ 20 , both observed and expected death was 100%. Comparable results were shown by the previous study of by Khajeh et al., Bellad et al., and Taori et al. [11-13].

ROC curve describes the capacity of PRISM-III scoring system for discrimination between survived and death patients (capacity of discrimination). Whenever its under-curve surface area is close to 1, the capacity of discrimination is considered to be high. It was seen that the area under ROC curve was 90.8% in present study, i.e., 90.8% of the subject could be predicted correctly. Singhal et al., Karambedkar et al., Bellad et al., Bhatia et al., and Bilan et al., had shown the area under ROC curve was 72%, 70%, 82.6%, 89.2%, and 89.8%, respectively, which was similar to the present study [2,9-11,14]. The prediction of probabilities of death using PRISM-III score in the present study showed the probability of death increases significantly with increase in PRISM-III score, and there was no significant difference between the observed and the predicted outcomes, suggesting PRISM-III score to be a sensitive predictor of outcome. This was comparable to other studies [2,9,15].

Regular use of scoring system provides an opportunity not only to predict the outcome but also helps in improvement of the quality of life care within the limited resource. According to Wells et al., there was a discrepancy between observed and

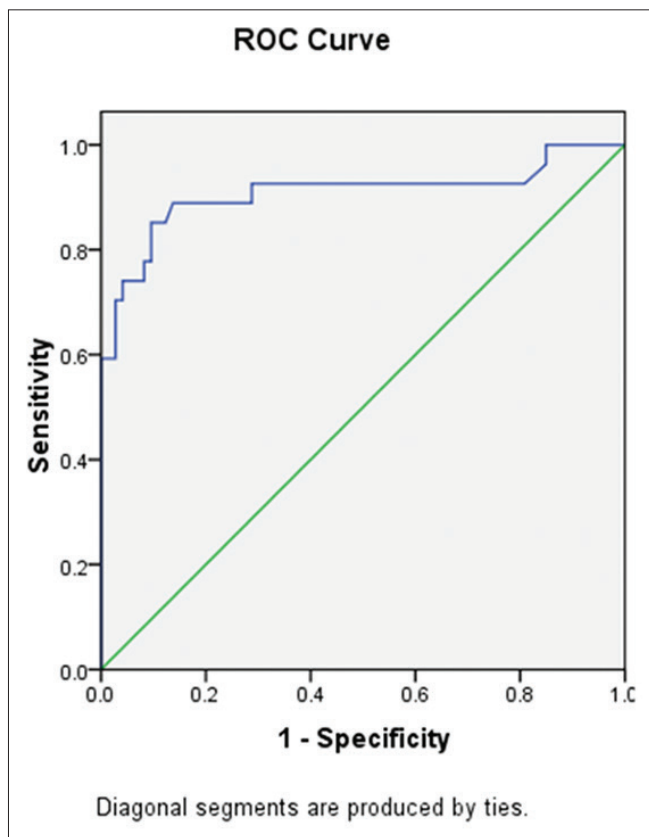


Figure 1: Receiver operating characteristics curve analysis shows that area under curve is 90.8%

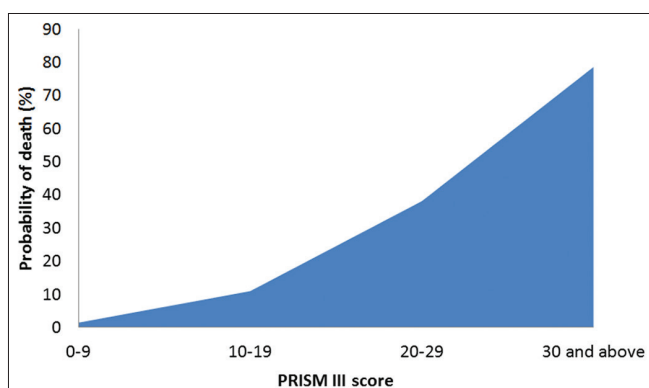


Figure 2: Prediction of probability of death according to pediatric risk of mortality-III score

the predicted mortality rates. There was under prediction of mortality at lower PRISM scores and over prediction at higher scores. Late presentation to the hospital and delay in admission to the PICU might be the responsible factors [8]. The PRISM score at admission to the PICU may have been masked by their initial treatment causing a falsely low PRISM score and underestimation of mortality. Part of the inaccuracy may derive from different demographic characteristics of PICU population and a different pattern of diseases.

In this study, higher PRISM-III score at the time of admission was associated increased chances of mortality; hence, PRISM-III score can be used as an indicator of the initial severity of illness. The strength of this study is large cohort and prospective in nature. Limitation of this study is that it was done in PICU like set up. Further studies can be carried out in PICU like set up so that PRISM-III score can be validated for high dependency unit.

CONCLUSION

PRISM-III score has a good predictive value for predicting the probability of death in sick children admitted in tertiary PICUs.

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