ORIGINAL RESEARCH PAPER

Paediatrics

PREDICTION OF RISK OF MORTALITY IN PAEDIATRIC INTENSIVE CARE UNIT BY PRISM SCORE

KEY WORDS:

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ABSTRACT

Background: PRISM is the Paediatric risk of mortality score which has been devised by Pollock et.al. to predict the mortality in hospitalized children. PRISM score is a revised form of physiologic stability index of mortality score.

Objectives: The primary objective was to determine the efficacy of Prism Score in critically ill patients, evaluating it as a simple bedside parameter, to study the outcome of critically ill patients using PRISM score and to prognosticate the mortality.

Methods: Study was conducted at a Pediatric Intensive Care Unit (PICU) of a private tertiary care hospital in Navi Mumbai, for a total duration of 2 years (2012 – 2014), wherein 203 inpatients fulfilling the inclusion criteria were admitted. Sample size of the study was 203.

A detailed history was taken, followed by thorough general and systemic examination and the details were entered in a predesigned proforma. All the inpatients were further evaluated by the following study variables which included 14 physiological variables of the score.

Results: Of the 132 males and 71 females in the study, 108 males and 61 females survived. Maximum patients were > 36 months of age. Maximum cases (51) were of Respiratory System, followed by Central Nervous System, Infectious diseases and others. Maximum survivors (142) were with PRISM Scores 1 – 9, and maximum non-survivors (8) were with PRISM Score 20 – 29. The prediction of probability of death according to PRISM score of 5 was 4% and that of above 15 was > 50%.

Conclusion: The goodness prediction by Hosmer – Lemeshow Goodness model showed that prediction of mortality by PRISM score to be highly significant. This study revealed that the prediction of probabilities of death in PICU significantly increased with increasing PRISM Score.

INTRODUCTION

Paediatric critical care represents a convergence of knowledge, technologies and approaches to multi system organ failure from the emergency department, operating room, neonatal intensive care areas, adult ICU's. With the evolution of paediatric intensive care in India, the required special care for the critically ill children is being achieved, playing a major role in the management of critically ill children.

Children who have acute neurological deterioration, respiratory distress, cardiovascular compromise or life-threatening traumatic injuries constitute majority of the admissions to a paediatric intensive care unit (PICU) requiring a very high level of monitoring of vital signs and other body functions and may also need mechanical ventilation invasive intra vascular monitoring, and frequent attention by both the nursing and the medical staff.

A critically ill child is exposed to state-of-the-art equipment and undergoes aggressive treatment in a well-established PICU and evaluation of the outcome of such therapy serves as a guide for prognosis, cost analysis, starting, inter institutional comparison. This enables changes in the management protocols and measures taken to reduce the factors which contribute to poor outcomes.

Various scoring systems are currently used in evaluating PICUs, like Glasgow coma scale, Pediatric trauma Score or Injury severity score, Paediatric index of mortality score, the physiologic stability index or the Paediatric risk of mortality (PRISM). Out of all these scoring systems, PRISM score has shown to be most effective in predicting the risk of mortality and as well as the factors contributing to poor outcomes. Hence, we have evaluated our PICU using PRISM score.

PRISM SCORE:

PRISM is the Paediatric risk of mortality score which has been devised by Pollock et.al. to predict the mortality in hospitalized children. PRISM score is a revised form of physiologic stability index of mortality score. This score uses 14 physiologic variables (34 ranges) based on abnormalities observed at the bedside examination and laboratory assessment. The PRISM score has a consistently strong relationship between the numbers of malfunctioning organ system at 12 and 24 hours and the mortality risk in a given PICU. It serves as an objective and efficient method for the physicians to predict the outcome and risk of mortality a well as help them to provide the medical service with valuable epidemiological criteria. Despite the availability of many severities predicting scoring systems, the outcome of PICU in India have not been widely reported. Hence, with the above theory we have conducted this study in our PICU using PRISM score.

AIMS AND OBJECTIVES

1. To determine the efficacy of Prism Score in critically ill patients.
2. To evaluate the PRISM score as a simple bedside parameter.
3. To study the outcome of critically ill patients using PRISM score.
4. To prognosticate the mortality.

MATERIAL AND METHODS

A Cross-Sectional, Prospective, Randomized, Non-

Interventional, Descriptive Study was conducted at a Pediatric Intensive Care Unit (PICU) of a private tertiary care hospital in Navi Mumbai, which was well equipped with all the monitors and mechanical ventilators and also backed by 24 hours hospital laboratory facility, portable x-ray, bedside echocardiography and ultrasonography facilities and an ABG machine, wherein inpatients fulfilling the inclusion criteria for a total duration of 2 years (2012 – 2014) were admitted. Sample size of the study was 203. Institutional ethics committee approval was taken, and an informed consent was obtained before enrolling patients into the study.

A detailed history was taken, followed by thorough general and systemic examination. The details of the same were entered in a predesigned proforma. PRISM score, being a measure of illness severity based on the abnormality observed in the bedside examination and laboratory assessment, all the inpatients were further evaluated by the following study variables which included 14 physiological variables of the score.

STUDY VARIABLES:

A. Age
B. Sex
C. Length of Hospital stay
D. Number of organ failures on admission
E. Primary affected system
F. PRISM variables

Indications for PICU admission

1) All patients requiring mechanical ventilation
2) Patients with impending respiratory failure
§ Upper airway obstruction
§ Lower airway obstruction
§ Alveolar disease
§ Unstable airway
3) All paediatric patients after successful resuscitation
4) Comatose patients
§ Meningitis, Encephalitis
§ Hepatic encephalopathy
§ Cerebral malaria
§ Head injury
§ Poisoning
§ Status epilepticus

5) All types of shock/hemodynamic instability
§ Septic shock
§ Hypovolemic shock
§ Bleeding emergencies
§ Bleeding diathesis, DIC
§ Cardiogenic shock: Myocarditis, cardiomyopathy, CHDs
§ Neurogenic shock
§ Multiple trauma
6) Cardiac arrhythmias
7) Hypertensive emergencies
8) Severe acid base disorders
9) Severe electrolyte abnormalities
10) Acute Renal Failure: patients requiring hemodialysis, hemofiltration and peritoneal dialysis
11) Post-operative patients: requiring ventilation, unstable patients
12) Acute hepatic failure

Inclusion Criteria:

1) All the patients admitted to the PICU

Exclusion Criteria:

1) All the patients less than one month old.
2) Patients staying in PICU less than one hour.

The association of study variables and diagnosed cause of illness with the ICU mortality was statistically analyzed using Chi-square test, in terms of Odds Ratio, it was assessed by logistic regression analysis. The Goodness of Prediction was assessed by Hosmer-Lemeshow test and Receiver Operating Characteristic curve analysis.

OBSERVATIONS AND RESULTS

Out of the 203 cases included in the study, 169 (83.2%) patients survived and 34 (16.7%) expired.

Table 1: Association of demographic profile with outcome

Demographic Profile		Total Number	Survivors	Non-Survivors	P value
Sex	Males	132	108 (81.8%)	24 (18.1%)	0.254
	Females	71	61 (85.9%)	10 (14%)	
Age	< 12 months	71	58 (81.6%)	13 (18.3%)	0.794
	12 - 36 months	57	48 (84.2%)	09 (15.7%)	
	> 36 months	75	63(84%)	12 (16%)	

Male children formed the majority 132 (65%) with a survival rate of 81.8% whereas female patients were 71 (35%) with a survival rate of 85.9%. There was no significant association between the sex and the outcome (p = 0.254).

There were 71 (34.9%) patients aged <12 months, 57 (28%) between 12 - 36 month and 75 (36.9%) patient aged >36 months with survival rates being 81.6%, 84.2% and 84% respectively. There a no significant correlation of age with the outcome (p = 0.794).

Table 2: Association of cause of Illness with Outcome

Cause of Illness	Total Number of Cases	Survivors	Non-Survivors	P value
Respiratory System	51	45 (88.2%)	06 (11.7%)	0.005
Central Nervous System	41	34 (82.9%)	07 (17%)	
Infections	36	23 (63.8%)	13 (36.1%)	
Gastrointestinal Diseases	32	30 (93.7%)	02 (6.2%)	
Cardiovascular System	12	10 (83.3%)	02 (20%)	
Hepatobiliary System	10	08 (80%)	02 (20%)	
Renal Diseases	07	05 (71.4%)	02 (28.5%)	
Hematological Diseases	02	02 (100%)	00	
Miscellaneous	12	12 (100%)	00	

According to the primary system involved at the time admission, Respiratory conditions (n = 51) constituted the major cause of illness followed by Central Nervous System (n = *41),* Infections (n = 36) and Gastrointestinal Diseases (n = 32). The other included Cardiovascular System (n = *12),* Hepatobiliary System (n = I 0), Renal Diseases (n = 7), Hematological Diseases (n = 2) and Miscellaneous (n = 12). The survival rate of patients with Respiratory disorders was 88.2%, CNS was 82.9%, GIT was 93.7% and that of Infectious diseases was 63.8%. The mortality due to Infectious diseases was 36.1 % which very high, contributing to 38.2% of the overall mortality. The cause of illness did not how any significant correlation with the outcome (p = 0.005).

Table 3: Association of PRISM score with outcome

PRISM score	Total Number	Survivors	Non-survivors	P -Value
1-9	150	142(94.6%)	08 (5.3%)	0.000
10- 19	45	1-9 (60%)	18 (40%)	
20-29	08	0	08 (100%)	

t=7.39

The subjects were distributed into three groups based on the observed PRISM scores. 150 patients had PRISM scores

ranging from 1-9, 45 patients had scores between 10-19 and 8 patients had scores between 20-29. The survival rate was 94.6% in the first group (scores 1-9), 60% in the second group (10-19) but there was 100% mortality in the third group (scores 20-29). The proportion of deaths which was only 5.3% among children with the PRISM scores of 1-9, showed a gradual increase with higher scores, reaching 100% among the children with PRISM scores of 20-29. The mean PRISM score among the survivors was 6.50 ± 3.64 and among non-survivors was 15.53 ± 7. Thus, with an increase in PRISM scores, there is a significant increase in mortality (p = 0.000).

Table 4: Association of number of organ failures with outcome

PRISM score	Total Number of Organ Failures	Survivors	Non-survivors	P - Value
0	138	133 (96.4%)	05(3 .6%)	0.000
1	42	30 (7 1 .4%)	12(28.6%)	
2	17	04 (23. 5 %)	13 (76.5%)	
> 3	06	02 (33.3%)	04 (66.7%)	

Out of 203 patients, 138 (67.9%) patients did not have any organ failure; whereas 65 (32%) patients had at least one organ failure at the time of admission. Out of 65 patients, 42 patients had one, 17 had two and 6 had three or more organ failures. Out of 139 patients without any organ failure, 96.4% patients survived, while patients with one organ failure had 71.4%, with two organ failures had 23.5% and those with three organ failure had 33.3% survival rates. The mean number of organ failures in survival group of children was 0.22 ± 0.49 and that of non-survival group of children was 1.47 ± 0.89. Thus, a significant correlation was observed between the number of organ failures at the time of admission and the outcome i.e. Mortality (p = 0.000). The mean duration of hospital stay among survivors was 6.53 ± 3.41days and 3.29 ± 3.10 days among non-survivors. The length of hospital stays showed a statistically significant correlation with the outcome (t=5.463; p = 0.000) (Table - 4).

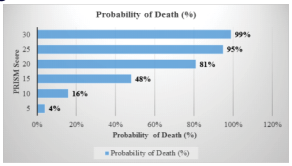
It was observed that Age, Sex and Cause of illness were not significantly associated with the mortality, while the number of organ failures (P=0.000), length of hospital stays (P=0.000) and PRISM scores (P = 0.000) were significantly associated with the mortality.

Age (r = - 0.121; p = 0.84), length of the hospital stays (r = 0.041; p = 0.559) and number of organ failures were correlated with the PRISM score and there was a moderate correlation between the PRISM score and the number of organ failures (r = 0.586; p = 0.0000).

Therefore, both PRISM score and number of organ failures can be considered as predictors of outcome using logistic regression model on discharge status. (r = > 0.75 is significant).

Since PRISM score was presumed to be good predictor of outcome, a logistic regression analysis was done on the discharge status (survived/non-survived), taking PRISM score as the predictor of mor1tality. The logistic regression equation was log (P/1 -P) = - 4.736 + 0.309 X, where X is PRISM score and - 4.736 is constant. This means that log-odds of child ren dying increases by 0.309 unit increase in PRISM score. The Odds Ratio of this logistic model was 1 .36 with 95% confidence interval (1.24-1.5). ln other words, for an increase of 1 in PRISM score, a child's Odds of death increases by 36%.

Figure 1: Prediction of Probability of death ICU according to PRISM Score



Prediction of probabilities of death in ICU according to PRISM score showed that a child with a score 5 had 4% chance of dying in the ICU and a child with a PRISM score of 15 had 50% probability of death. The probability of death increases with increase in PRISM score (Fig 1).

The results on goodness of the prediction model as seen by Hosmer - Lemeshow Goodness showed that there was not much significant difference between the observed and expected outcome (improved/expired) for the three PRISM score groups (p=0.634). This shows that the prediction of mortality by using PRISM score is highly significant.

Table 5: Goodness of the Predictive Model

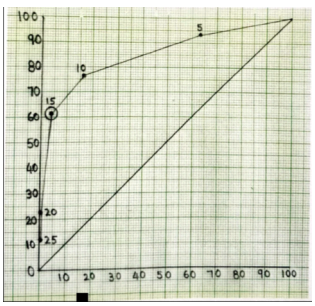
Observed group	Predicted by logistic model		Total
	Non-Survivors	Survivors	
Non-Survivors	18	16	34
Survivors	6	163	169
Total	24	179	203

The Goodness of the Predictive Model was used for the given data and a child was predicted to belong to the "survivor group" if p < 0.05 and to the "non-survivors grow up" if p > 0.05. It was found that a total of 181 (89.2%) out of 203 subjects were correctly classified by the logistic model (Table - 5). The cut-off PRISM score was 15 because for PRISM score of 16, p is > 0.05. Based on these observations "Receiver Operating Characteristic (ROC) curve" was plotted. So, by predicted model for cut-off point of 15, area under curve is 79.7%. (Fig 2, Table - 6).

Table 6: Sensitivity, Specificity and Predictive Values of PRISM Score

PRISM Score	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	% False Positive	% False Negative
> 5	94	36	22.9	96.8	63.9	5.9
> 10	76	83	40.6	94.6	16.6	23.5
> 15	6	95	75	92.6	4.2	38.1
> 20	23	10	100	86.7	0	76.5
> 25	11.8	100	100	84.9	0	88.2

Figure 2: Graph depicting the ROC Curve



DISCUSSION

The outcome of patients in pediatric intensive care units is dependent on multiple factors. The pre-ICU factors like severity of illness, treatment received by the patient before seeking intensive care, time required to transfer the patient from the referring doctor, mode of transport used to shift the patient etc., and PICU factors like the utilization of ICU resources, use of sophisticated equipment, staffing and the effectiveness of this aggressive therapy have a direct impact on the intensive care therapy and the outcome of the patient.

Although many scoring systems exist for different illnesses for assessing severity, a foolproof, qualitative and unbiased assessment of severity of illness is difficult and controversy continues regarding the accuracy of prediction of the mortality due to significantly different mortality rates reported in different studies, ranging from 13-50% [5,6,7]. PRISM

score is scoring system with a basis to predict the outcome of the patient admitted to the PICU. Developed from the physiology stability index, a paediatric severity of illness measure PRISM score is used to predict mortality.

In the present study, demographic profile like age (p = 0.919) and sex (p = 0.245) of the patient did not show any significant correlation with the outcome. A similar observation was also found in another Indian study (age p = 0.90 and sex p = 0.79)[1] but in contrast there was a significant correlation of age and sex with the outcome in a western study (p<0.05)[2].

The major causes of illness in our study were Respiratory disorders, Central Nervous System disorders and Infectious Diseases but no significant correlation between the cause of illness and the outcome was observed (p=0.005). A similar observation was shown in another study but with a significant positive correlation of illness with the outcome (p<0.05)[2].

In the present study, the mean PRISM score among survivors was 6.05 + 3.64 and among non-survivors was 15.53 + 7 and the cutoff point of survival was PRISM sore of 15 with 82.2% accuracy. Our observation that increase in PRISM score is associated with an increase in the mortality, showing a significantly positive correlation with the outcome similar to previous studies[1,2].

The number of organ failures at admission and the length of hospital stay showed a significant correlation with the mortality in our studies. Our observation was as the number of organ failures increases the mortality increases. This association of MODS with poor outcome was also shown in other western countries[4].

In our study, PRISM score showed a moderate correlation with the number of organ failures (p=0.000) while age (p=0.084) and length of hospital stay (p=0.555) did not show any significant correlation with PRISM score. This significant association of the PRISM score with organ failures (p=0.001) was also found in another study[2], however the poor predators in our study were PRISM score, length of hospital stays and number of organ failures.

Our findings of correlation of study variables with the mortality were contrasting to another similar Indian study[1]. In their study, except PRISM score, the remaining variables showed no significant association with the mortality (p>=0.11). The proportion of deaths gradually increased with increase in PRISM score with a cut off PRISM score of mortality in their study (p>0.5) and the "ROC curve" analysis showed area under the curve of 72%[1]. In our study, both the observed and predicted death were low at lower scores (p=0.634) with a cut off PRISM score of 15 and the "ROC curve" analysis showed area under the curve of 79.7%. These findings were almost similar to another study done under Indian circumstances[1]. This clearly states that PRISM score is highly sensitive in predicting the outcome. In a study from South Africa it was observed that there was under prediction of mortality at lower PRISM scores and over prediction at higher rates which was attributed to their "lead time bias". The PRISM score at admission to the PICU may have been masked by the initial treatment causing a falsely low PRISM score and under estimation of mortality[3].

In our study, when a logistic regression analysis was done on discharge status, considering PRISM as the predictor of mortality, it was observed that for an increase of 1 in PRISM score, the child's odds of death increases by 36%. This was in contrast to other study, where the odds of death increased by only 12%[1].

In this study, the PRISM score and the number of organ failures at the time admission also showed a significant correlation with the outcome, also playing a major role in the sensitivity of PRISM score in outcome prediction. In our study the mortality due to infectious diseases was 36.1%, contributing significantly to the overall mortality of 38.2%. Though the cause of illness did not show any significant correlation with the outcome, it may have impact on the sensitivity of the PRISM score in predicting the mortality in our setting, but at the same time, it may depend on the presenting disease of the local population and the severity of the disease. Considering these points, the discrepancy between the odds of death in our study and other studies can be probably explained.

Finally, there was no significant difference between the observed outcome and the predicted outcome using PRISM score and it turned out to be highly sensitive in predicting the outcome of the patients in PICU.

CONCLUSION

The prediction of probabilities of death in our PICU using PRISM score, revealed that, the probability of deaths increases significantly with increase in PRISM score and there was no significant difference between the observed and the predicted outcomes. Therefore, PRISM score is considered to be a good predictor of outcome in our PICU. In our country, the financial constraints of the patients play a major role in seeking intensive care therapy. At the same time, limited resources of PICU can interfere with effective patient care. Therefore, if PRISM score is adopted routinely in paediatric intensive care units, selective patient care can be achieved and the limited resources of the ICU can be used effectively and the financial strain on the patient can be minimized, there by the mortality rate can be reduced.

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