MORTALITY RISK ASSESSMENT IN PEDIATRIC INTENSIVE CARE UNIT OF A DEVELOPING COUNTRY USING PRISM SCORE

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ABSTRACT

Objective: To assess the application and efficacy of PRISM score in predicting mortality rate in a tertiary care PICU of a developing country.

Study Design: Prospective cohort study.

Place and Duration of Study: This study was carried out at Pediatric Department, Pak Emirates Military Hospital Rawalpindi, from Mar 2017 to Aug 2017.

Material and Methods: In this study 370 consecutive admissions as per the inclusion criteria were enrolled. PRISM score was calculated as recommended by original authors and outcome for each patient was recorded as expired or discharged. Hosmer-Lemeshow goodness-of-fit test and Area under the ROC Curve were used to ascertain the power of calibration and discrimination of the score.

Results: Out of the 370 patients with a mean age of 19 months, 282 (76.2%) survived and 88 cases expired (23.8%). Male to Female ratio was 1.56:1 and the majority of patients were infants (225/370). Infants recorded highest mortality percentage (24%). Infectious diseases were the most common etiology. There was no association of gender with outcome however length of stay had a positive correlation with survival. Mean PRISM score was 14.0 with scores significantly lower in survivors (p<0.001). Pearson Chi-square revealed significant association between PRISM score categories and child outcome. Hosmer & Lemeshow statistic was non-significant (p=0.244) at 10.30, revealing an acceptable goodness of fit of the regression model. Area under ROC curve was .885 indicating good predicting power of the model.

Conclusion: PRISM score showed good discriminatory capacity and was found to be a useful tool for predicting prognosis of pediatric patients admitted to a tertiary pediatric intensive care unit in resource constrained developing countries.

Keywords: Mortality risk, Pediatric intensive care unit, PRISM score, Prognostic score.

INTRODUCTION

Pediatric intensive care units (PICU) are pivotal in effective pediatric emergency and critical care and can significantly reduce mortality in resource-limited countries[1,2]. The first 24 hours of hospitalization are most susceptible and an estimated 33% of patients die in this golden period[1]. A number of critical illness scoring systems have been devised to assess the illness severity related mortality, stratifying patients with poor outcome and remove the subjective physician's bias concerning mortality risk[3-8]. These scoring systems have been widely used in pediatric intensive care units (PICUs) to prioritize specialized care as needed, evaluate different management protocols in relation to the outcomes and compare ones performance with other institutions[1,2,9-13].

In developing countries with resource constraints and limited pediatric intensive care beds these scoring systems help physicians predict the mortality risk and in deciding which patient will benefit more from admission to PICU resultantly improving survival of sick children[9,10,12-14]. PICU scoring systems are mostly studied in developed nations settings and studies from developing nations have shown contradicting results with some authors finding these models to have poor discriminatory ability and

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under predicted the actual mortality[9,12,15]. Pediatric risk of mortality (PRISM) and Pediatric index of mortality (PIM) are the two scoring systems widely in practice worldwide. Newer versions of these scores PIM 2 and PRISM III have shown better performance according to their authors but their high cost has restricted their use especially in resource constraint countries[9,3,16].

PRISM is considered to be the most effective in predicting the risk of mortality[4]. However, there is a limited data for application of PRISM score in Pakistan and there is a need to determine whether it can be effectively utilized in our setup[9]. The purpose of this study is to evaluate the predictive power of mortality of PRISM score in a Tertiary Pediatric Intensive Care Unit in a developing country.

MATERIAL AND METHODS

This prospective cohort study was conducted at PICU, Pak Emirates Military Hospital Rawalpindi over a period of 6 months from March 2017 to August 2017. The unit comprises of a 10 - bedded Pediatric ICU with mechanical ventilation facility on 5 beds. The PICU team includes one pediatric consultant and three pediatric residents. One pediatric resident is available in PICU around the clock. Two nurses are available in each shift. The unit receives pediatric patients from 01 month to 12 years of age.

The study included 370 consecutive admissions to PICU during the study period. Patients' aged less than 1 month, expiring within first 8 hours of admission or discharged within 12 hours of PICU admission were excluded from the study.

PRISM scoring system is a physiologic stability index which is used to predict mortality through normal physiologic disturbances during the period of disease. It uses 14 parameters (physiological and laboratory data) and for each one the highest severity value is recorded in the first 24 hours[4]. Following international PRISM guidelines, each patient was assigned an observation chart, on which demographic data, physiological variables and diagnostic data required to calculate PRISM score, clinical diagnosis, total duration of stay and outcome as either expired or survived was recorded. The most abnormal value of every parameter during the first 24 hours was used to calculate PRISM score.

Oxygen saturation was monitored by pulse oximeter. Liver Function Tests, bilirubin, Prothrombin Time, PTTK, glucose, blood urea, creatinine, sodium, potassium and calcium were measured by standard laboratory tests. Arterial blood gas analysis was performed in each patient. Vital signs including Blood Pressure, heart rate, respiratory rate, pupillary reaction and the Glasgow Coma score were recorded at regular intervals by on duty residents. The patients were followed up during hospital stay and the outcome as death or survival was recorded at the end of hospital stay. PRISM score was calculated by using individual charts assigned to each patient. The studied patients were classified in 3 groups according to the PRISM scores 1-10, 11-20, and 21-30. The mortality predicted by the PRISM score (P) is calculated by the following equation: Predicted Death Rate = elogit/ (1+elogit) "e" is a constant value and "logit" stands for function of PRISM score.

All data were analyzed in SPSS (v.20). Descriptive statistics were run for characteristics of patients. Quantitative variables (age, weight, length of stay and PRISM score) were presented as mean (SD) and categorical variables (gender and outcome) as frequencies (%). Primary outcome of this study was child mortality. Performance of PRISM score was evaluated by assessing discrimination and calibration. Discrimination is the strength of a model to predict the outcome (survival or expired) and calibration measures the association between the predicted and observed outcome. Mortality discrimination was assessed by calculating area under the receiver operating characteristic (ROC) curve and Hosmer and Lemeshow goodness-of-fit chi squared test was applied to test the calibration

power. A *p*-values <0.05 were considered significant.

RESULTS

During the study period 419 patients were admitted in PICU. 49 did not meet inclusion criteria (39 babies less than one month of age, 7 were discharged before 12 hours and 3 patients died within eight hours of admission), thus 370 were included in the study. Of these 370 patients, 144 (39%) were admitted from emergency and 226 (61%) were shifted from indoor pediatric wards. Mean age of the children was 19 months (25.87) with a higher proportion (n=226, 61.10%) of girls. Mean weight of children was 7 kilograms (4.92) and length of stay at hospital was 3.00 (1.00) days. After treatment, most of the children were stepped down to ward (n=282, 76.2%) and 88 cases (23.80%) expired.

Majority of patients were less than one year of age 225 (60.80%), 117 (31.60%) patients between 1 to 5 year of age and 28 patients were aged more than 5 years of age. The mortality rate was highest among infants 54 (24%), among 1-5 years the number was 23 (19.7%), and in >5 years 11 (39.3%) children expired. The common underlying diseases with the observed mortality percentage are depicted in table-I.

Of the 168 patients with PRISM score 1-10, 7 patients died (4.2%). PRISM score of 11-20 and 21-30 was observed in 131 and 70 patients, of

Table-I: Outcome of patients based on underlying disease.

Underlying Disease	Number of patients	Mortality (%)
Pneumonia	126	34 (27%)
Infectious	32	10 (31.2%)
Congenital Heart Disease with Respiratory Problems	42	14 (33.3%)
Meningitis	28	4 (14.2%)
Renal Failure	16	2 (12.5%)

Table-III: Calibration of PRISM score.

PRISM score cut-off value	Frequency (n)	Outcome		Total	Chi-square value
		Survival	Expired		
≤10	Observed	161	7	168	111.61 (p<0.001)
	Expected	128.0	40.0	168.0	
	Total	95.8%	4.2%	100.0%	
11-20	Observed	98	33	131	
	Expected	99.8	31.2	131.0	
	Total	74.8%	25.2%	100.0%	
21-30	Observed	23	47	70	
	Expected	53.4	16.6	70.0	
	Total	32.9%	67.1%	100.0%	
31+	Observed	0	1	1	
	Expected	.8	.2	1.0	
	Total	0.0%	100.0%	100.0%	
Total	Observed	282	88	370	
	Expected	282.0	88.0	370.0	
	Total	76.2%	23.8%	100.0%	

Table-II: Mean (SD) PRISM scores according to outcome of the cases.

	Outcome	N	Mean	SD	r
Prism Score	Survived	282	11.49	5.747	0.60*
	Expired	88	21.81	6.091	
	Overall	370	14	7.30	

*p< 0.001

which 33 (25.2%) and 47 patients (67.1%) did not survive, respectively (table-II). Mean PRISM score overall was 14.0 with mean PRISM scores significantly lower in survivors. Pearson Chi-square revealed significant association between PRISM score categories and child outcome (survival/expiry). According to it, observed frequencies for child mortality increased with increasing cut off scores. Children falling between PRISM score of 2-9 reported a mortality

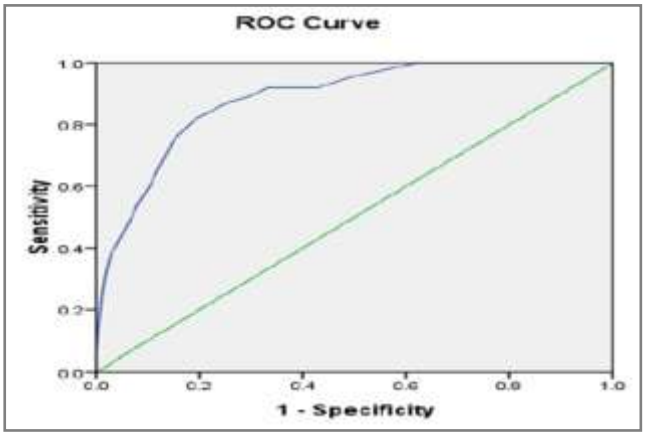

Figure: ROC for PRISM score (area under curve 0.885).

of 0% while those scoring >25 reported a mortality of 77.80% (table-III).

Pearson Chi Square did not reveal any significant association between gender of children and outcome (Chi-square = 0.58, p=0.90). According to point-biserial correlation (rpb), length of stay had a positive correlation with survival of children (rpb = -0.12, p=0.02). Point-biserial correlation (rpb) revealed that expired patients were significantly correlated with PRISM scores. Binary logistic regression model predicted 83% of the child mortality correctly. It revealed that those scoring high on PRISM scale were 1.27 times more likely to be expired as compared to their counterparts Hosmer & Leme show statistic was non-significant (p=0.244) at 10.30, revealing an acceptable goodness of fit of the regression model. Goodness-of-fit value (p) of >0.05 is considered as good suitability of test. The capacity of PRISM score discrimination between survived and expired subjects was analyzed by ROC curve, yielding a significant area under curve of 0.885 (Std error = 0.02, p<0.001; 95% CI = 0.848-0.921) (fig-1). A PRISM score of 16.5 yielded a sensitivity of 82% and a specificity of 81%.

DISCUSSION

Pakistan has one of the highest under five mortality rate in the world with the majority of deaths ensuing from preventable and reversible causes and there is a dire need for improvement in management of critically ill patients[9,17].

The use of a critical illness scoring system like PRISM score in predicting patient outcome is important for the patients, family and the treating physicians. If properly implemented they can significantly improve outcome and help in optimizing employment of resources in developing world[13]. In this study we assessed the mortality risk in our PICU by using PRISM score. Our observed mortality rate was 23.8% which was comparable to other studies in the developing world[9,10,12-14,18]. Infectious diseases were the most common presenting illness in contrast to trauma, malignancies and genetic disorders in countries where the score was developed[2,4,11,15]. The distribution of sex, and underlying diseases were similar to other studies in the region, but the mean age was quite less at 19 months with 60% of patients less than one year of age[9,12,13].

We found PRISM score to perform better than previous studies from developing world with area under ROC curve of 0.885. This area under the curve is an expression of the overall accuracy of a model and is a good measure of its predictive ability and the closer the value is to 1 better is its predictive ability. The only previous study in Pakistan by Qureshi *et al*[9] observed PRISM and PIM score to have good predictive performance with PRISM score having AUC of 0.78 which is in accordance with our study. Khajeh *et al*[14] also reported good discrimination power of PRISM score with an AUC of 80.3% from a PICU in Iran. Singhal *et al*[10] and Taori *et al*[13] also found PRISM score to have good discriminatory performance in Intensive Care settings in India with area under ROC curve 72% and 80% respectively; however their duration of

stay was inversely related to survival of child in contrast to our results.

Some authors have observed PRISM score outperforming PIM score in terms of calibration and discrimination power. Taori *et al*[13] found PRISM score to have better calibration than PIM score (p=0.627 vs. p=0.028) and Martha *et al*[2] found PRISM to offer a good capacity for discriminating between survivors and moribund patients and performed better than PIM score. Contrary to our findings Anu *et al*[12] found PRISM, PIM and PIM2 to under predict the observed mortality despite having area under ROC curve >0.8 for all models. The characteristics of study population in this study was similar to ours with the majority of cases under one-year, median age of 18 months and a longer duration of stay was associated with better outcome.

A few other studies have also shown that PRISM score has poor discriminatory function in certain demographic settings[12,15,19,5]. The likely reason suggested was differences in patient clinical profile, paucity of resources, and differences in the quality of care as compared to the center where the score was developed[12,5]. Our study, however, showed satisfactory discriminatory performance of PRISM score in differentiating survivors from non-survivors and patients with higher PRISM scores were found to have increased risk of death. Some authors have suggested severe malnutrition to have significant association with mortality irrespective of the PRISM score[20]. This aspect was not studied in our study and further studies in the region are required to modify the mortality scores in developing countries where malnutrition is still a prevalent menace.

CONCLUSION

Our study found PRISM score showed good discriminatory capacity and hence is a useful tool for the prediction of mortality for pediatric patients admitted to a Pediatric Intensive Care Unit in Pakistan. It can be used for effective resource allocation and better management of Patients in intensive and critical care.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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