

Original Research Article

Prediction of mortality by pediatric risk of mortality (PRISM III) score in tertiary care rural hospital in India

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ABSTRACT

Background: The mortality in pediatric and neonatal critical care units can be predicted using scores. Prediction of mortality using (PRISM III) score in first 24 hours of admission in pediatric intensive care unit (PICU) and neonatal intensive care unit (NICU).

Methods: Pediatric cases below 14 years with necessary investigations admitted in PICU and neonates in NICU during the period 1st August 2009 to 31 July 2011. Post-operative and patients with malformations or malignancy were excluded. A prospective observational study carried out at tertiary care rural hospital having 10 bedded well equipped PICU and NICU each. In subjects fulfilling inclusion criteria, PRISM III score which includes 17 variables was calculated within 24 hours of admission. The outcome at discharge was determined as non-survival or survival.

Results: With increasing PRISM III score there was increase in mortality. PRISM III score offered a good discriminative power with the areas under the ROC curve > 0.86 (95% CI).

Among different variables minimum systolic blood pressure, pupillary reflex, mental status (GCS), acidic pH, total co2, BUN, platelet count and PTT showed very high significant association with the mortality and Pco2, PaO2, temperature, potassium and creatinine showed significant association with mortality. Variables like Heart rate, Glucose, Alkaline pH and WBC count showed no significant association with the mortality.

Conclusions: PRISM III score can be effectively used as a reflector of severity of illness.

Keywords: NICU, Pediatric mortality, PRISM III, PICU

INTRODUCTION

The intensive care of pediatric and neonatal diseases has improved in recent times in India. With increase in demand of specialized intensive care unit services in rural India many tertiary care hospitals had been established with excellent infrastructure and dedicated manpower. The outcome of intensive care in India has not been widely reported, though the need for sophisticated equipment and aggressive treatment of critically ill infants and children is still well recognized. Evaluation of the results of such therapy requires the use of accurate and easily applied methods for describing the patients as

well as their outcome. The Pediatric Risk of Mortality (PRISM III) Score has been devised to help the physician to predict probable outcome and risk of mortality of the patients being admitted into the PICU and NICU. PRISM III scoring system provides health care administrator an outlook regarding patient's prognosis. It provides medical staff with epidemiological criteria and may help in decision making for Pediatric Intensive Care Unit (PICU) and Neonatal intensive care unit (NICU) admissions and correct identification of patients who might benefit from such care.¹⁻³ The constancy of the relationship between parameters of tests and outcome is the backbone of the use of these predictors for quality assurance purposes. If

the observed number and distribution of outcomes are similar to the predicted number and distribution of outcomes, then the performance of the institution is equivalent to those institutions validating the predictor in other part of world.

The purpose of this study is to see whether PRISM III score can predict mortality in children admitted to a PICU and NICU at tertiary care rural hospital under Indian circumstances.

The objective of this study was to prediction of mortality by application of pediatric risk of mortality (PRISM III) score in first 24 hours in pediatric intensive care unit (PICU) and neonatal intensive care unit (NICU) patients of a tertiary care multi-speciality hospital in rural setup in India.

METHODS

Inclusion criteria

Pediatric cases with necessary investigations admitted directly to the PICU aged between 1 month and 14 years and below 1 month of age in NICU over a period of 2 years enrolled into the study.

Exclusion criteria

- Congenital malformation
- Post-operative cases
- Malignancy.

The information that was collected on each PICU and NICU admission includes name, age in months, ipd no, ventilator required or not, stay in PICU and NICU, diagnosis, nature of outcome (survival / non-survival). All the subjects with necessary investigations required to were enrolled and their PRISM III score was evaluated within 24 hours after arrival to the PICU and NICU. The PRISM III score evaluation was done as per recommendation of Pollack et al.⁴ The outcome at discharge was determined as non-survival or survival.

PRISM III divides cases into 4 age groups as follows,

- Up to 1 month
- >1 to 12 months
- >12 to 144 months (12 years)
- > 144 months (> 12 years).

Each patient has to be examined and investigated to get the four Subscores as below:

Cardiovascular and neurologic vital signs

Cardiovascular and neurologic vital signs has 5 measures i.e.

- Systolic blood pressure

- Heart rate
- Glasgow coma score
- Temperature
- Pupillary response.

Acid-base and blood gas

Acid-base and blood gas has 5 measures i.e.

- Acidic pH
- Alkaline pH
- Pco₂
- Total CO₂
- PaO₂.

Biochemical tests

Biochemical tests have 4 measures i.e.

- Plasma Glucose.
- Serum Potassium
- Serum Creatinine
- Blood urea nitrogen (urea).

Hematology tests

Hematology tests have 3 measures i.e.

- white blood cell count
- platelet count
- PTT.

After assessment of child and details of various investigations we have to give score as per age of patient for various variables and sum up all subscores to get final score for PRISM III of that child within 24 hour of admission. After getting the subscores add all subscores to get final PRISM III as below

Total PRISM III score (24 hours) = (cardiovascular and neurologic subscore)

+ (acid base and blood gas subscore)
+ (chemistry subscore)
+ (hematology subscore)

Interpretation

- Minimum subscore and total score: 0
- Maximum cardiovascular and neurologic subscore: 30
- Maximum acid-base and blood gas subscore: 22
- Maximum chemistry subscore: 10
- Maximum hematology subscore: 12
- Maximum total PRISM III score: 74
- The higher the total score, the worse the prognosis.

The data was processed by SPSS version 13 for statistical analysis.

RESULTS

A total of 723 patients were recruited in this study. 428 patients were males (59.2%) and 295 were females (40.8%). Mortality in males was 64 (14.95%) and in females it was 43 (14.58%). Total mortality in our study was 107 (14.8%). Patients included from NICU below 1 month were 361 out of which 68 died (18.83%). In age from 1 to 12 months, patients were 112 and 9 (8.03%)

was mortality. Out of 473 infants 77 died (16.27%). 126 patients were from age group between 13 -60 months and mortality was 14 (11.11%). In age group of 61-144 months 96 patients were recruited and 13 (13.54%) died. 28 patients from age group 144-168 months were included and 3 (10.71%) died. Overall 723 patients were included and 107 patients died hence the mortality in our study was 14.80%. Mean age was 26.85 months.

Table 1: Mortality in different PRISM III groups.

Prism group	Total	Survival	Death	Observed mortality(%)
0-5	260 (35.96%)	260	0 (0.00%)	0.00
6-10	247 (34.16%)	247	0 (0.00%)	0.00
11-15	90 (12.45%)	87	3 (2.8%)	3.33
16-20	24 (3.32%)	14	10 (9.34%)	41.67
21-25	21 (2.90%)	4	17 (15.88%)	80.95
26-30	28 (3.87%)	3	25 (23.36%)	89.29
31-35	29 (4.01%)	0	29 (27.10%)	100.00
36-40	18 (2.49%)	1	17 (15.88%)	94.44
41 and more	6 (0.83%)	0	6 (5.60%)	100.00
Total	723 (100%)	616	107 (100%)	14.80

In above table we have correlated PRISM III score at the end of 24 hours with the outcome in our patients. We have made few groups of total PRISM III score such as 0-5, 6-10, 11-15, 16-20, 21-25, 26-30, 31-35, 36-40 and 40 above. In first group of PRISM III score "0-5" there were 260 (35.96%) patients and all survive i.e. 0.00 % mortality. In next group with PRISM III score "6-10" there were 247 (34.16%) and 0.00% mortality. In group of "11-15", there were 90 (12.45%) patients with 3 (3.33 %) mortality. In group of "16-20" there were 24 (3.32%) patients and 10 (41.67%) was mortality. In group of "21-25" patients were 21 (2.90%) and mortality was 17 (80.95%). 28 (3.87%) patients were in group of "26-30" score and observed mortality was 25 (89.29%). In group of "31-35" score 29 (4.01%) patients were recruited and mortality was 29 (100%). In next group of "36-40" score 18 (2.49%) patients were recruited and 17 (94.44%) died. In last group with PRISM III score "41" and above, there were 6 (0.83%) patients and mortality was 6 (100%). This table suggests that with increasing PRISM III score there is increase in mortality. One patient in group of 36-40 could be salvaged, this tells us that even with high PRISM III score we should not lose hope and keep treating child.

PRISM III score in our center offers a good discriminative power with the areas under the ROC curve > 0.86 (95% CI). This area under the curve is an expression of the overall accuracy of a model in differentiating outcome groups and is a good measure of its predictive ability. The closer the ROC curve area is to 1.0, the better the prediction model.

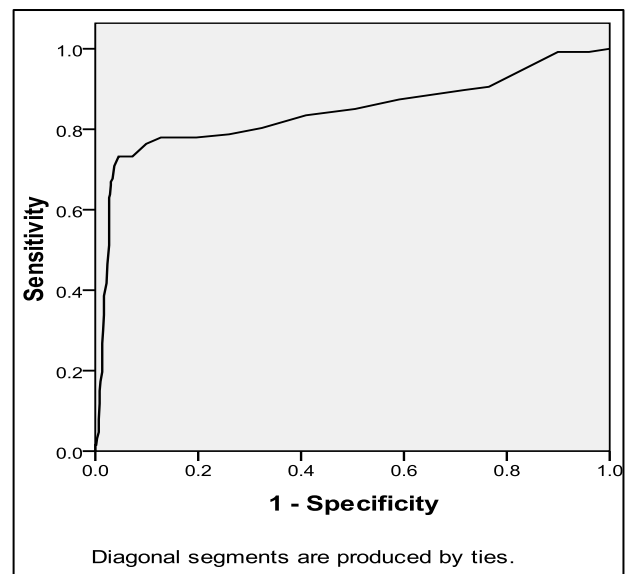


Figure 1: ROC curve for prism score.

Calibration evaluates how well the model classifies subjects into low, medium and high risk categories. PRISM had a significantly good calibration for our PICU asserting that expected and observed mortalities are comparable in the various risk intervals.

The predicted mortality with the PRISM score correlated well with the actual observed mortality. The result on goodness on the prediction model as seen by the Hosmer-Lemeshow goodness of fit Chi-square test showed that

expected death were 105.9 i.e., 14.64% and there is no significant (p value 0.638) difference between the expected mortality (14.64%) and observed mortality i.e.,

14.8%. The Hosmer and Lemeshow goodness-of-fit test showed a good calibration of the PRISM III score (p = 0.638).

Table 2: Goodness of the predictive model. Hosmer Lemeshow test.

Prism score	Total number	Death		Alive	
		Observed	Expected	Observed	Expected
0-5	260	0	0.01	260	259.990
6-10	247	0	0.159	247	246.841
11-15	90	3	2.397	87	87.608
16-20	24	10	10.316	14	13.684
21-25	21	17	16.197	4	3.803
26-30	28	25	25.597	3	2.403
31-35	29	29	27.988	0	1.012
36-40	18	17	17.166	1	0.834
40>	6	6	5.976	0	0.024
Total	723	107	105.9	616	616.2

DISCUSSION

At our centre we found that mortality is 14.8% comparatively less than other studies in region.^{5,9} But it is higher as compared to many studies from developed countries.^{10,11,13} With increase in PRISM III score there is

increase % of mortality and that is comparable to Indian, Asian and other studies too.⁴⁻¹³ Choi et al as compared to other studies found very low mortality of 2.6%, he gave explanation for this as Sepsis was significantly under-represented in his study population (2.3%) compared with other reports (30%-41%).^{7,15,16}

Table 3: Prediction of PRISM III score in other studies.

Study	Age group	Mortality (%)	Area under the ROC curve	Variables with the greatest importance
Present study	New-born to adolescent	14.8	0.86	Minimum systolic blood pressure, Pupillary reflex and mental status (GCS), acidic pH, Total CO ₂ , BUN, platelet count and PTT
Bhatia et al ⁵	New-born to adolescent	24.7	0.89	Systolic blood pressure, abnormal pupillary reflexes and altered mental status (GCS), acidic pH
Khilani et al ⁶	-	6.7	0.9	-
Choi et al ⁷	New-born to adolescent	2.6	0.912	-
Bilan et al ⁸	New-born to adolescent	9.05	0.898	-
Ana Lilia et al ⁹	Above 1 month to adolescent	24.7%		Abnormal pupillary reflex, acidosis, BUN, WBC
Pollack et al ⁴ Multicenter study	New-born to adolescent	2.2-16.4%	0.947±0.007	Minimum systolic blood pressure, abnormal pupillary reflexes and altered mental status (GCS)
Anthony et al ¹⁰ Multicenter study	Infant to adolescent	9.2%	-	-
Gemke et al ¹¹	Infant to adolescent	6.6%	0.78	-
Slater A et al ¹² Multicenter study	Neonate to adolescent	-	0.93	-
Tan GH et al ¹³	Neonate to adolescent	4.5%	-	Abnormal pupils, systolic blood pressure, altered GCS
Pollack et al ¹⁴ Multicenter study	New-born to adolescent	4.9%	0.902	Bilateral fixed pupils, lowest systolic blood pressures, lowest temperature, lowest pH

The mortality of sepsis in a Turkish PICU was reported as higher than 50%.¹⁶ This may be related to age difference, because patients in other reports were significantly younger. It may partly explain the low mortality of his PICU, although it was similar to that of other western centres.¹²

In this study among the different variables minimum Systolic blood pressure, Pupillary reflex and mental status (GCS) Acidic pH, Total CO₂, BUN, PaO₂, potassium, creatinine, platelet count and PTT showed highly significant association with the mortality. Remaining variables like heart rate, glucose, alkaline pH and WBC count showed no significant association with the mortality.

Bhatia et al stated that among different variables, systolic blood pressure, abnormal pupillary reflexes and altered mental status (GCS) and acidic pH were found to be associated with greater risk of mortality.⁸ Pollack et al in his multicenter study found significant association of minimum systolic blood pressure, abnormal pupillary reflexes and altered mental status (GCS) with higher risk of mortality.⁴

Ana Lilia et al found that out of the 17 physiologic variables only four of them were significant: abnormal pupillary reflexes OR 9.9 (95% CI, 3.5-28.4), acidosis OR 3.1 (95% CI, 2.0-4.9), blood urea nitrogen concentration OR 1.03 (95% CI, 1.01-1.04), and white blood cell count OR 1.02 (95% CI, 1.01-1.03).⁹ In this study we found WBC as insignificant. Abnormal pupils, systolic blood pressure, altered GCS, found significant in study by Tan GH et al.¹³ Pollack et al in multicenter study of 16 PICU found that bilateral fixed pupils, lowest systolic blood pressures, lowest temperature, lowest pH were significant.¹⁴

PRISM III score in our center offers a good discriminative power with the areas under the ROC curve 0.86 (95% CI). The predicted mortality with the PRISM score correlated well with the actual observed mortality. The result on goodness on the prediction model as seen by the Hosmer- Lemeshow goodness of fit Chi-square test showed that expected death were 105.9 i.e., 14.64% and there is no significant (p value 0.638) difference between the expected mortality (14.64%) and observed mortality (14.8%). Bhatia found that the risk of mortality was significantly high with higher scores (p <0.05).⁵ The area under the ROC curve was 70%, which validates the PRISM-III score in predicting mortality. Khilani et al concluded that gross mortality was 6.7% (59 patients).⁶ PRISMIII adjusted mortality was directly proportional to PRISMIII scores. Bilan et al found that ROC analysis indicated a strong predictive power for the PRISM-III (area under the curve = 0.898) and the test was well fit to the designed study (goodness-of-fit p-value = 0.161).⁸ The observed short-term mortality rate was 9.05% and the expected mortality rate by the PRISM-III scoring was

9% (O/E ratio =1.005). The PRISM-III scoring system was highly calibrated in their institute.

Choi et al found that the AUC for PRISM III-24 was 0.910 (95% CI, 0.805-1.000), and Chi squared goodness-of-fit test showed no significant misfit between the number of expected deaths and observed deaths by PRISM III-24, P = 0.395.⁷ Gemke et al stated that discriminatory performance assessed by ROC curves showed an area under the curve of 0.78 (95% CI 0.67-0.89) for the PRISM III score. Slater et al.^{11,12} The area (95% confidence interval) for PRISM III were 0.89 (0.92-0.94). The calibration of the models was assessed by comparing the number of observed to predicted deaths in different diagnostic and risk groups. PRISM III over predicted death by 130% of observed deaths. He also concluded that prediction was best while using PIM2 with no difference between observed and expected mortality in Australia. Pollok et al found that the area under the receiver operating curve indicated excellent discrimination and accuracy (area under the receiver operating curve PRISM III-24 development 0.958).⁴

CONCLUSION

The overall performance of the PRISM III score is good with AUC of 0.86 (good discrimination) and reasonable agreement between observed and expected mortality. The Hosmer and Lemeshow goodness-of-fit test showed a good calibration of the PRISM III score (p = 0.638). Among the different variables minimum systolic blood pressure, pupillary reflex and mental status (GCS), acidic pH, total co₂, BUN, platelet count and PTT showed highly significant association with the mortality and Pco₂, PaO₂, potassium and creatinine showed significant association with mortality but remaining variables like heart rate, glucose, alkaline pH and WBC count showed no significant association with the mortality.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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