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Clinical Accuracy of PRISM III Score in determining mortality in severely ill Pediatric patients in Pediatric ICU

Muhammad Sajid, Mir Nousharwan, Sana Sarwar, Javaid Laal, Ameer Ahmad, Nousheen Fatima

Abstract

Objective: To assess the accuracy of PRISM III score in predicating mortality in severely ill pediatric patients.

Study Design and Settings: A cross sectional study was conducted in Pediatric ICU of BVH from 1st March 2021 to 28 Feb 2022.

Methodology: Patients were enrolled after informed consent as per inclusion and exclusion criteria. Clinical details and lab data were collected within 4 hours of admission to ICU and documented on performa. Outcome was followed. Results were analyzed in spss 20.

Results: Out of 34 patients 13 (38.2 %) were male and 21 (61.8 %) were females. Age ranges from 1 month to 14 years. Regarding diagnosis maximum patients were of pneumonia and Pyomeningitis, that were 5 each this makes 14. 7% of study population for each diagnosis. PRISM score ranges from 0 to 14 with mean of 4.3 and median of 3. Out of them 21 (61.8 %) had PRISM score 3 or less and 13 (38.2 %) had 4 or more. PRISM III score has Sensitivity of 71.4 %, specificity of 70.3 %, Positive predictive value of 38.4 %, negative predictive value 90.4% and diagnostic accuracy of 20.5 %.

Conclusion: PRISM III score has clinical accuracy of 20.5 % in determining prognosis in severely ill pediatric patients.

Keyword Index: Mortality, PRISM III score, Pediatric ICU

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INTRODUCTION

Pediatric Intensive care unit (PICU) has a pivotal role in saving lives from life threatening illnesses. But there is a huge burden over the PICU. Selection of the patients who need intensive care unit care is important in resource limited countries. To reduce extra burden, those patients should be selected who have good outcome regarding morbidity and mortality. There is a lot of advancement is going on in the field of medicine and this has increased scope of pediatric intensive care units. First pediatric ICU was established in Switzerland almost six decades' age. Since then a lot of improvement has been done in this and it resulted in improvement in mortality in children.[1] Even so many innovations and progress in treatment options, still early diagnosis and optimization in management is the key step. When a child becomes ill, there are certain changes occur in normal physiological processes. These changes result in abnormalities in vital signs of patients that involve changes in respiratory, renal, cardiovascular and endocrine parameters. These changes can be quantified by using different scoring systems by these parameters. Then these scoring systems can be used as an important tool in assessment of severity of disease, prediction of morbidity, mortality and monitoring of clinical status of patients. These scorings systems usually incorporate vital signs, clinical status and certain lab test that depict the actual disease status and severity. Indicators of scoring that make them a

better tool are; cost effective, easy to use, reliable and ability to predict the mortality.[2,30]

It was noted in previous studies that the first 24 hours of hospitalization are most important and about one third of them lose their lives in golden period[1]. A study that was done in United states showed that mortality in pediatric intensive care unit was ranged from 1. 85 % to 3.38%.[6]

Different scoring systems were being used for prediction of mortality in intensive care units. Two most common of them are Pediatric risk of mortality score (PRIM) and Pediatric index of mortality (PIM). PRIM score was initially validated from 9 pediatric ICU data from USA from 1984 and 1985.[9] This included 1415 patients from these 9 settings. Originally this included 34 variables which were difficult to get data and to calculate score. Now this has been updated and only 17 variables are being used to calculate PRISM III score.[4] This is based on assessment within first 24 hours of admission. In comparison to this PIM score was initially validated in Australia, New Zealand, and UK. It was introduced in 2003.It is based on 10 variable.

Different models have been designed in determining the mortality of the patients but among them prism scoring system is widely used worldwide [5,7,8], that's why we have selected this model in our study to predict the mortality of the patients so that we may help to choose those patients for ICU care who may get benefit from it. Different scoring systems haven compared in different studies.[9,11]

To access the good outcome, different criteria's have been designed. Among them, pediatric logistic organ dysfunction (PELOD) , Pediatric index of mortality (PIM) and Pediatric risk of mortality (PRISM) are the three frequently used scoring systems. According to the authors, Newer versions of these scoring systems, PIM 2 & PRISM III score have showed good results. [2,3,4] In 1988, Pollack et al. Initially made Pediatric Risk of Mortality (PRISM) scoring system. [8] It consisted of 14 variables, with the addition of 3 variables, PRISM was later on updated to PRISM III, in 1996.[5,6,7] In developing countries due to limited resources, any tool that can predict mortality can be helpful in prioritizing intensive care and affect outcome in critically sick patients.[10]

The purpose of our study is to determine the clinical accuracy of prism 3 scoring system in determining the mortality in pediatric intensive care unit patients at a tertiary care hospital.

METHODOLOGY

Institutional review board Quaid-e-Azam Medical College/ Bahawal Victoria Hospital Bahawalpur approved this study with letter Number 1346/DME/QAMC, Bahawalpur. This cross sectional observational study was conducted in Pediatric Intensive care unit of Quaid-e-Azam Medical College/ Bahawal Victoria Hospital Bahawalpur from 1 st March 2021 to 28 Feb 2022.

Children of either gender with age from 1 month to 15 years , who are admitted in pediatric Intensive care unit of Bahawal Victoria Hospital/ Quaid-e-Azam Medical College Bahawalpur .Exclusion criteria was; Patient having any underlying malignancy, Patients having obvious anomaly, Received any treatment before admission in any other hospital. Sampling of patients were done in convenient consecutive, non randomized manner as randomization was not required due to lack of two groups. Written informed consent was taken from either of parents before enrolling them in study. All details written in Urdu format were given to parents. All details were explained and all quires answered. All parents who signed written consent were enrolled as per inclusion and exclusion criteria. Parents were told that they can withdraw their consequent any time if they feel.

Clinical details and lab data were documented in 4 hours from admission to ICU and documented on Performa. A standard questionnaire was used. Calculation of The PRISM III score was done by using its different varibales. These variables has few clinical parameters and few laboratory tests. Among clinical indicatiors are temperature, pulse or heart rate, blood pressure (systolic), level of conciousness by GCS, and puplillary reactions to light. Laboratory test include; Aterial blood gas with values of CO2, PaO2, and especially pH. Serum glucose level, blood potassium level, white blood cells, blood urea & creatinine, PT & APTT and platelets. Each of these variable has specific score. With patients result of that variable,that score was labeeled and in the end total PRISM III score was calculated by summing up all variable score. Outcome was calculated as expiry, discharged or LAMA. Results were analyzed in SPSS 20. Descriptive statistics for quantitative data evaluated in terms of maximum & minimum ranges, mean value and importantly standard deviation (SD). Percentages and frequencies were calculated from qualitative data. The evaluation of This PRISM III score was done by its ability to predict specific outcomes by interpreting area under ROC. The parameters used for analysis of ROC curves were negative predictive value calculation and positive predictive value. Specificity and sensitivity was also calculated. Established bench marks were used as area under curve; if this value is 0.9 or more then it shows excellent discrimination, if it is 0.8 then it implies as good and lastly it is acceptable if its value is 0.7.

The PRISM III score calibration was evaluated by comparison of predicted mortality with observed mortality. In this process first step was to get predicted mortality from this, then this value was stratified in categories. Last step is comparing with observed mortality from this study. To quantify calibration, the Hosmer–Lemeshow test is an important tool for quantification of this calibration. This test used predicted mortality and compared it with observed ones and then calculated goodness-of-fit. Calibration was interpreted as acceptable if it has $p = 0.05$. And if result shows while any other results then it shows that there issues

in this scoring system.

RESULTS:

Total 34 patients were enrolled as per inclusion criteria/exclusion criteria and informed consent. Out of 34 patients 13 (38.2 %) were male and 21 (61.8 %) were females. Age ranges from 1 month to 14 years. Age groups include 1 month to 1 year 14 patients (41%), 1 year to 5 years 8 patients (23 %) and 6 years to 15 years 12 patients (35 %)

Regarding diagnosis maximum patients were of pneumonia and Pyomeningitis, that were 5 each this makes 14. 7% of study population for each diagnosis. Second most common diagnosis was diabetic ketoacidosis that had 4 patients and this makes 11.8% of total patients. 3rd common diagnosis was organophosphate poisoning that had 3 patients and this makes 8.8% of total patients. Similarly, we had 3 patients of sepsis/ acute kidney injury and this also makes 8.8 % of total patients. There were 2 patients of Dilated cardiomyopathy which makes 5.9 % of total patients similarly there were 2 patients of PPD poisoning which also makes 5.9 % of total patients. . Remaining one patients of each of following diagnosis with frequency of 2.9 % ; Xeroderma Pigmentosa, Febrile fits, Ventricular septal defect with congestive cardiac failure, Gullian Barre Syndrome, Rheumatic Fever, Acute Hepatitis

PRISM score ranges from 0 to 14 with mean of 4.3 and median of 3. Out of total patients 21 (61.8 %) had PRISM score 3 or less and 13 (38.2 %) had 4 or more. As far as outcome is concerned majority of patients that were 27(77.4 %) patients discharged which makes 77.4 % of total patients out of 34 patients seven patients were died despite all treatment and this makes 20.6 %.

When we compared prism score range with outcome. This showed that out of 21 patients who had PRISM score with equal or less than three, 19 discharged (90.5 %) and 2 of them died (9.5%). Out of 13 patients with PRISM score of four or more, 8 patients discharged (61.5 %) and 5 died (38.5%). This makes w p value 0.043 which is less than 0.05 and significant (Table 1).

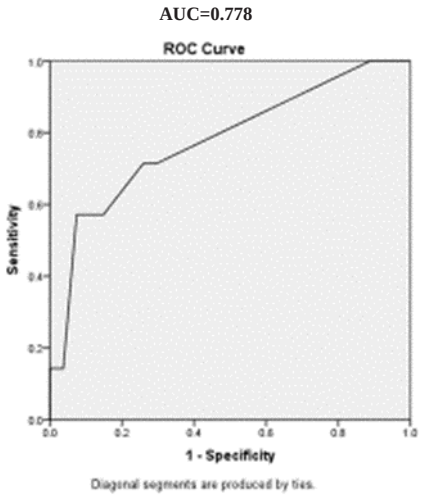
PRISM III score has Sensitivity of 71.4 %, specificity of 70.3 %, Positive predictive value of 38.4 %, negative predictive value 90.4% and diagnostic accuracy of 20.5 %. . The present study concluded that prism scoring system have area under the curve is 0.779.

Table 1: PRISM III score groups in comparison with outcome

Prism III Score Group	Discharge	Death	Total	Mortality
1-3	19	2	21	10%
4-14	8	5	13	38%
Total	27	07	34	

P Value = 0.043

Figure 1: Showing area under curve



DISCUSSION:

Over past few decades, one of the major achievement in global health is decline in childhood mortality. Although recent data and researches only focus on reducing mortality rates and not measure long term morbidity parameters. Pediatric intensive care units are main pillars for management of sick patients and ultimately improvement of child mortality rates and contributing to this global health cause. There is no accepted universal tool for assessment of sick patients admitting to pediatric ICU. Adaptation of a standardized tool in early identification of critically sick children may help in prioritizing their admission in ICU and improvement in outcome. About one fourth that is 25 percent of patients admitted in ICU with clinical or lab evidence of organ failure, and out of them mortality occur in 50 % of cases.[23]

In a study that was conducted Intensive care unit of a University Hospital of Tirsova 10 , 11000 Belgrade, Serbia by Snezana Rsovac et all; showed that when patients of pediatric age group with respiratory distress syndrome were followed for 28 days. In this follow up. The PRISM III score predicted fair outcome.[25]

In a study that was done in pediatric intensive care unit by Graziela de Araujo Costa et ; showed concluded that PIM score has discriminatory ability in adequate category. The pediatric risk of mortality score showed adequate discriminatory capacity. This inference can be interpreted in a way that pediatric ICU patient's prognosis can be assessed by this tool.[26]

Different studies showed comparison of different scoring systems for critically sick patients. In a study by Kalvit KR et all; conducted on critical patients , pediatric risk of mortality (PRISM) and pediatric index of mortality (PIM) scoring system were compared in oncology patients of pediatric age group. When compared in groups who survived with those who didn't survived in term of discriminating power, both score has this value in acceptable range.[24]

A recent study was conducted in this regard was by Srinivas, Nidhi et all in a tertiary care hospital in South India. Total 214 cases were enrolled. Age of these cases was minimum 1 month and maximum 18 years. This study lasted for 20 months. In ICU unit Pediatric Risk of Mortality PRISM III score was compared with Pediatric Index of Mortality PIM III score. Estimated mortality using PRISM III was 4 and With PIM III it was 2. In conclusion both these scoring system showed good discriminatory performance, however PRISM III had good better calibration as compared with PIM III score. Majority in this study patients suffered from some neurological disease, followed by respiratory and then cardiovascular problems. Calibration refers to the level of agreement between the actual outcome and the individual probable outcome. Hosmer–Lemeshow goodness-of-fit test was applied for this assessment. Discrimination of a test is defined as its utility in calculation of probability of mortality in both groups that are survived as compared to who didn't survived. Limitation of study was that it was a single centered small cohort with urban population and low rates of mortality.[27]

In a study that was conducted in children hospital Lahore, to different scoring systems like Pediatric Risk of Mortality (PRISM), Pediatric Logistic Organ Dysfunction (PELOD) and the Pediatric Index of Mortality 2 (PIM 2). Study population was from children. As a conclusion of this study two scoring (PRISM & PIM) were validated in Pakistani Pediatric intensive care unit settings. Poor discrimination score were showed for PELOD score in this study. Moreover some advantages were shown for PIM 2 score for patient's stratification as compared with PRISM score.[28] In a study conducted in Pakistan, PRISM score was used a predictor of mortality. This study showed that patients who were not survived had higher PRISM. There was a considerable difference in PRSIM score of patients who died as compared to patients who had good survival. In conclusion in order to prioritize care of ICU and for better outcome in term of mortality, PRISM score can be used effectively.[29]

The findings from our study showed that prism scoring have great association with the mortality. Mortality increases as the prism score increases. In this study, we observed that mortality rate was 20.58%. which is higher than the researches carried out in other countries [(9)]. Mortality rate in a study conducted in children hospital Lahore was 28.7%, which is higher than our study.[28] It was also observed that those patients who have score < 3 their mortality rate was 10% as compared to those who have score > 3 was 38 %.so we may say that those patients who have score > 3 usually benefit from PICU and they have good prognosis. This finding was similar to researches carried out in other countries.[9,10,11]

It was also observed in our study that 41.2% cases of Pyomeningitis, Pneumonia and DKA, as compared to other researches carried out in other parts of the world where more frequent admission in PICU were due to trauma and malignancies and hereditary diseases, [12] so greater emphasis should be given in the management of infectious diseases and the management of diabetes mellitus. Primary prevention of infectious diseases is more helpful in preventing these diseases and good awareness for diabetes control is more helpful in controlling this disease and prevent the undue burden over the ICU.

In our study infants were mostly admitted and affected 41.17%.as compared to other age group children. This is the most vulnerable age group for the diseases. As regard to the gender 61.76% affected were male and others were female. This result may predict that either females have more ability in combating with the stressful situation. Or males are more preferred for the hospital treatment in our setup Aragao et al. also showed that risk of mortality is more in males as compared to females.[13]

As far Median age of admitted is concerned, in our study median age of sample population is nine months which less than a study on the topic of PRISM score conducted by Pollak et al; which showed median age of children as 33 months.[5] In our study few risk factors that increased risk of mortality were identified. Out of them tow factors were mechanical ventilation(p=0.005) and Ionotropic drugs use (p=0.009). This findings was similar as found in other studies conducted on pediatric patients also showed that these are high risk procedures.[14,15]

As far as discriminatory efficacy of different scoring system are concerned, if a score has discrimination of 0.9 or more than this, this is said to be an excellent score. If it has value of 0.8 to 0.9 then it is a good scoring. If this value is 0.79 to 0.7 then is is fairly suitable.[16,17] Moreover A scoring mode's ability to predict is assessed by area under ROC curve. This can be from a value of o to 1.0. The present study concluded that prism scoring system have area under the curve is .779 which shows that it is fair scoring system in predicting the mortality. While similar results showed by results of previous researches from Pakistan. Sidique et al. and Qureshi et al. Study showed that PRISM socre has good (0.885) value of discrimination & Area under curve of ROC curve is 0.78 while an other study by showed PRISM has area under curve as 0.91. An Iranian study showed that PRISM score has discriminatory value of 0.8 while a study from India showed that this score has a good discriminatory score of 0.86.[21,22.] In a study conducted by Akhter H et all showed that area under curve was 0.63. This was lower than observed in our study.[29] So our study showed area under curve which is in fairly suitable category and some studies have higher than this and some has lower area under curve.

In our study PRISM III score has Sensitivity of 71.4 % which comparable to a study conducted in India by Srinivas, et al. that showed a sensitivity of 72.7 %. In our study

specificity of 70.3 % which is less than a similar study conducted in India by Srinivas et al; that showed specificity of PRISM III score as 83.3%. Positive predictive value of PRISM III score in our study is 38.4 % as compared Indian study by Srinivas, et al. that has positive predictive value of 19% (almost half than our study). Negative predictive value of PRISM III score in our study is 90.4% as compared to a similar study by Srinivas, et al. in India has Negative predictive value of 98.3%.[27]

Contingency table for Hosmer and Lameshow test shows comparison of expected mortality and observed mortality in different groups. In group of PRISM score less than or equal to three, we had 21 patients. Out of 21 patients of this group 19 discharged and 2 died. when we calculated expected mortality in this group for discharged and died patients, this was exactly same as expected. So observed mortality and expected mortality was same. In second group of PRIM score of 4 or more, we had total 13 patients. out of them 8 patients discharged and 5 died. Calculated mortality by this test in this group was 5 which is exactly same as observed mortality in this group. In a study by by Srinivas, et al expected mortality by Hosmer and Lameshow test was 4 and observed mortality in that study was 11 which was significantly higher than expected.[27]

Limitation: Our study has limitations of being single centre study and small population size as sample in this study. To generalize the results of it for the population it should be conducted in other centers as well and some other variables should also be added. Other similar studies had a larger sample size. This score was not compared with other scoring used to predict outcome in children. So a multi center study with different demographic profile data, using different scoring models and a larger sample size may be conducted.

Conclusion: PRISM III score has clinical accuracy of 20.5 % in determining prognosis in severely ill pediatric patients.

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Muhammad Sajid, Conception and design, or acquisition of data, or analysis and interpretation of data, drafting the article, and final approval of the version to be published**.**
Mir Nousharwan, Acquisition of data.
Sana Sarwar, Conception and design, Reference Writing, Final approval of the version to be published**.**
Javaid Laal, Acquisition of data, Final approval of the version to be published**.**
Ameer Ahmad, Intlect and critical analysis of article, Manuscript writing, Final approval of the version to be published.
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