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ORIGINAL ARTICLE

MORTALITY RISK ASSESSMENT IN PICU USING PRISM-III-24 SCORE

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ABSTRACT: OBJECTIVE: Assessment of risk of mortality using PRISM III-24 score in children admitted to PICU of Basaweshwara Teaching and General Hospital, attached to Mahadevappa Rampure Medical College, Gulbarga. **DESIGN:** Prospective cohort study. Setting: PICU of BTGH, Gulbarga. **METHODS:** 404 patients who had been admitted consecutively to the PICU during a period of 12 months (July 2011 to June 2012) were studied. PRISM III-24 score was calculated. Hospital outcome was recorded as survived/expired. Calibration and discrimination of the model was calculated by Hosmer-Lemeshow goodness-of-fit test and Area under the ROC Curve. The association between r (empirical function) and PRISM III-24 score was assessed by Binary Logistic Regression method. **RESULTS:** Out of 404 patients, 363 (89.85%) survived and 41 (10.15%) expired. Males formed the majority (227/404). CNS cases (n=118, 29.2%) constituted the majority. Mean age, length of hospitalization, and mean PRISM III-24 score were 59.22±51.12 months, 99.84±91.61 hours, and 4.92±7.74 (range 0-36). The test was well designed for the study (goodness-of-fit value P-value 0.186). ROC analysis indicated a strong predictive power for the PRISM III-24 (AUC 0.936). The observed (O) mortality rate was 10.15% and the expected (E) mortality rate was 10.12% with an O/E ratio of 1.003. **CONCLUSION:** PRISM III-24 score is a good predictor of mortality in PICU patients under Indian circumstances. The PRISM III-24 scoring system was highly calibrated in our institute.
KEYWORDS: Mortality risk, PICU, PRISM III-24 score, outcome.

INTRODUCTION: At the heart of optimal clinical medicine is the ability to prognosticate. Understanding a patient's likely outcome, and how that outcome might change depending on alternative interventions, is essential if care is to be optimized. Perhaps, nowhere is this issue both more important and more difficult than in intensive care. The ICU is home to a wide array of expensive technologies that can both help and harm the critically ill patient. ICU patients often have multiple complex conditions that make prognostication difficult and decisions must be made rapidly and courageously, as time is of the essence.

The capacity to estimate patient risk of mortality is extremely important because such estimate would be useful in achieving many different goals such as assessing patient's prognosis, ICU performance, ICU resource utilization, evaluating therapies, and also controlling and matching severity of illness in clinical studies.[1]

The lack of consistency, reliability, and accuracy in physician's subjective opinions concerning patient status necessitates quantitative clinical scores. Clinical scoring systems have become the standard instrument used in ICU benchmarking. Since the early 1980s, various scoring systems have been used in PICUs to evaluate the severity of illness.

The Pediatric Risk of Mortality (PRISM) score was developed from the Physiologic Stability Index (PSI)[2] to reduce the number of physiologic variables required for mortality risk assessment from 34 to 14 and to obtain an objective weighing of the remaining variables.[3]

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PRISM III, an updated third-generation physiology-based scoring system, was developed in 1996 at the Children's National Medical Center in Washington, DC based on the data collected at 32 pediatric intensive care units using 11,165 admissions.[4] PRISM III has 17 physiologic variables subdivided into 26 ranges and 8 other risk factors and is population independent. Mortality predictions can be made by using either the first 12 hours (PRISM III-12) or the first 24 hours (PRISM III-24) of physiologic, demographic, and diagnostic data.[5]

The objective of the study was assessment of risk of mortality using PRISM III-24 score in children admitted to PICU of Basaweshwara Teaching and General Hospital, attached to Mahadevappa Rampure Medical College, Gulbarga.

METHODS: The PICU in BTGH, Gulbarga, is an 11-bedded ICU within an 84-bedded Pediatric Department. Here, we admit patients from 1 month of age to ≤ 18 years of age.

This is a prospective cohort study on 404 patients who had been admitted consecutively to the PICU during a period of 12 months (July 2011 to June 2012). We used PRISM III model to evaluate its accuracy and predictive power for estimation of our PICU mortality rate and concomitantly assess the overall efficacy of our PICU therapeutic activities.

Patients less than 1 month of age, patients in ICU for less than 2 hours, patients with multiple congenital anomalies, and patients who were discharged against medical advice were excluded from the study.

Readmissions to the PICU during the same hospitalization were analyzed as separate patients as there was a possibility of different outcome at each admission. Exact time of admission and discharge were recorded to the nearest minute and length of stay in hospital calculated to the nearest hour. All patients' demographic data, physiologic, and diagnostic data as per PRISM III score and clinical diagnosis were recorded. Patients were classified on admission according to their Primary System Affected as CNS, Respiratory, Sepsis, Gastrointestinal, and Others. Outcome was recorded as survived or expired.

We used only PRISM III-24 model in our study. PRISM III-24 score was calculated using the methodology as recommended. We used the most abnormal value of each parameter within the first 24 hours of ICU stay to obtain the PRISM III-24 score.

The studied patients were classified in 4 groups according to the PRISM III-24 scores 0-9, 10-19, 20-29, and ≥ 30. The overall mortality predicted by the PRISM III score (P) is calculated by the following equation:

$$P=e^{r}/1+e^{r}$$

Where, "e" is a constant value and "r" stands for empirical function of PRISM-III scores, that is calculated by non-linear method of curve-fitting using the observed results.

SPSS version 21™ and Microsoft Excel 2007® were used for statistical analysis. Categorical (qualitative) variables were scored in Contingency Tables and compared by Chi-square test or Fisher's exact test. Quantitative variables were assessed by Flora's z-statistic and One-way ANOVA. Results were considered to be statistically significant if there was $p \leq 0.05$.

The suitability of PRISM III model for this study in our PICU was evaluated by Hosmer-Lemeshow goodness-of-fit test. The capacity of PRISM III-24 score for discrimination between survived and expired patients was calculated by Receiver Operator Characteristics (ROC) Curve. The

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association between r (empirical function) and PRISM III-24 score was assessed by Binary Logistic Regression method.

RESULTS: A total of 436 patients were admitted in PICU during the study period, of which, 6 patients stayed less than 2 hours and 26 patients were discharged against medical advice; a total of 32 patients were excluded from the study.

Of the 404 studied subjects, 363 (89.85%) survived and 41(10.15%) expired. Males formed the majority (n=227, 56.19%) over females (n=177, 43.81%).

Among the studied subjects, children (n=259, 64.11%) formed the majority, followed by infants (n=98, 24.26%) and adolescents (n=47, 11.63%).

As per the primary system affected, CNS group (n=118, 29.2%) constituted the majority followed by others (n=103, 27.3%), respiratory (n=91, 22.5%), sepsis (n=55, 13.6%), and gastrointestinal/hepatobiliary (n=37, 9.2%).

Mean age was 59.22±51.12 months (range 2-184 months). Mean length of hospitalization was 99.84±91.61 hours (range 3-640 hours). Mean PRISM III-24 score was 4.92±7.74 (range 0-36)

The results of the PRISM III-24 scoring in different age groups for prediction of overall mortality rate and comparing it with the observed mortality rate are mentioned in Table 1. There was no statistically meaningful difference between predicted and observed mortality rates neither in age or score groups nor in our total studied patients.

The results of Hosmer-Lemeshow goodness-of-fit test showed that the model of PRISM III-24 score designed in this study was well fit for prediction of mortality rate in our PICU as P (goodness-of-fit value was 0.876 for infants, 0.367 for children, 0.216 for adults, and 0.186 for total studied patients.

The capacity of PRISM III-24 scoring system for discrimination between survived and expired patients in our PICU as analyzed by Area under the ROC curve (AUC) was 0.936 ($p<0.001$, 95% CI=0.887-0.990) for total studied subjects, 0.956 ($p<0.001$, 95% CI=0.892-0.996) for infants, 0.892 ($p<0.001$, 95% CI=0.808-0.980) for children, and 0.964 ($p<0.001$, 95% CI=0.894-0.998) for adolescents.

Table No. 2 shows the association of study variables like sex, age groups, primary system affected, mean age, mean length of hospital stay, and mean PRISM III-24 score with risk of mortality, but there was no statistically meaningful difference in sex, age groups, primary system affected, and mean age with the risk of mortality. However, mean length of hospital stay was significantly longer in survived patients and mean PRISM III-24 score was significantly higher in expired patients. The observed (O) mortality rate was 10.15% and the expected (E) mortality rate by the PRISM III-24 scoring was 10.12% with an O/E ratio of 1.003.

DISCUSSION: The prediction of mortality in PICU is always uncertain. No two numbers of patients with the same clinical manifestations will respond to the same insult in a similar way. This is certainly true with the diverse spectrum of patient characteristics, lack of uniformity in the clinical judgment by the physicians, and most importantly with the quality of PICU care. Prediction of patient outcome is important for the patients and family and is relevant for policy formulation and resource allocation; the optimum usage of ICU beds will obviously allow maximum utilization of limited resources.[6]

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In this study, we evaluated the functioning of PICU of BTGH using PRISM III-24 scoring system. The study population consisted of 404 patients. The distribution with regards to age, sex, and age groups were comparable with other studies.[3,4,7,8]

Though in most of the studies[7-11], respiratory diseases formed the majority, in our study CNS group (29.2%) topped the majority followed by others (27.3%), respiratory (22.5%), sepsis (13.6%) and gastrointestinal/hepatobiliary (15.8%). Being a tertiary care hospital, many of the cases are referred to us from the other hospitals in and around Gulbarga. This can explain the different mode of distribution of patients in this study with respect to their primary system affected.

The results of Hosmer-Lemeshow goodness-of-fit test showed that the PRISM III-24 model designed in this study has been well fit for prediction of mortality rate as P (goodness-of-fit value) was 0.186 for total studied subjects. This value measures calibration (correlation between the predicted and actual outcome over the entire range of risk prediction)[5]. Goodness-of-fit value (P) of >0.05 is considered as good suitability of test.

The capacity of PRISM III-24 score for discrimination between survived and expired subjects as analyzed by ROC curve showed a strong predictive power for the PRISM III-24 (AUC = 0.936). The capacity of discrimination is considered to be high whenever the area under the curve (AUC) is close to 1. This area under the curve is an expression of the overall discrimination across the range of risks and is a good summary measure of reliability of the study.[5]

The short-term observed mortality rate was 10.15% which is correlating with the studies of Leuterteet al[6] and Bilan et al[8], where the observed mortality rate was 8.33% and 9% respectively.

Some researchers have emphasized the role of patients' age in prediction of mortality rate by different models of assessment[3]. Therefore, we studied the results of PRISM III-24 scoring system separately in 3 different age groups in addition to the study of total patients as a single group. The results have been well fit for all age groups. Short-term observed and expected mortality rates were almost equal (O/E ≈ 1) in all age groups, which means that the health care quality is on optimal level for all categories of age like infants, children, and adolescents.

PRISM III scoring system has greatly enhanced the paediatric intensivists' ability to measure outcomes in the PICU objectively. It permits the quantification of severity of illness through the development of probability models predicting mortality risks[12]. The PRISM III score utilizes appropriate age-adjusted physiologic variables unlike the original PRISM score where age was included as an explicit variable[3,13]. The logic of this approach was confirmed by our study, which showed that although mortality risk was higher in the adolescent compared to the other age groups, this difference was not statistically significant.

Mortality prediction models need to be validated before they can be applied in an environment that is substantially different to the environment in which they were developed. The ideal probability model would be institution independent and population independent.[1] Though, there are several scoring systems to assess the risk of severity and the risk of mortality, PRISM III score is widely accepted.[1,14] However, a lot of information is needed to calculate it. It takes 24 hours, during which time period, lots of deaths can occur, so the score may be diagnosing death rather than predicting it. It is also affected by the quality of initial PICU management, which could in turn affect predicted mortality. However, there is no evidence that ICU data collection over 24 hours affects the score's validity.[5]

Although the utility of scoring systems in outcomes research is well established, their use in the development and implantation of practice guidelines and critical pathways has yet to be determined. This model cannot be used to predict outcome in a single patient.

CONCLUSION: The results show that the PRISM III-24 score is a good predictor of mortality in PICU patients under Indian circumstances.

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Age groups	Mean PRISM scoring	Scoring groups	No. of Patients	Mean predictive mortality rate	Expected mortality (E)	Observed mortality (O)	O/E ratio	Logit r	P
Total	4.92±7.74 (0-36)	0-9	339 (83.91%)	0.007	2.52	3	1.19	Mean±SD - 4.56±1.78 (-8.78-1.94)	0.9
		10-19	33 (8.17%)	0.25	8.40	10	1.19		1
		20-29	20 (4.95%)	0.72	14.30	17	1.18		0.26
		≥30	12 (2.97%)	1.31	15.68	11	0.70		0.46
		Total	404 (100.0%)	0.10	40.90	41	1.003		1
Infant	5.24±8.16 (0-33)	0-9	77 (78.58%)	0.007	0.56	0	0	Mean±SD - 3.68±2.12 (-5.86-1.42)	0.68
		10-19	12 (12.24%)	0.19	2.28	4	1.75		0.82
		20-29	6 (6.12%)	0.60	3.60	5	1.39		1
		≥30	3 (3.06%)	1.50	4.50	2	0.45		0.92
		Total	98 (24.26%)	0.11	10.94	11	1.01		1
Children	4.60±7.58 (0-36)	0-9	225 (86.87%)	0.007	1.48	2	1.35	Mean±SD - 4.52±1.62 (-8.72-1.96)	0.89
		10-19	16 (6.18%)	0.26	4.21	4	0.95		0.65
		20-29	12 (4.63%)	0.67	8.05	11	1.37		0.71
		≥ 30	6 (2.32%)	1.52	9.10	6	0.65		1
		Total	259 (64.11%)	0.08	22.84	23	1.007		1
Adolescent	6.12±7.74 (0-33)	0-9	37 (78.72%)	0.01	0.45	1	2.22	Mean±SD - 5.28±1.36 (-9.72-2.38)	1
		10-19	5 (10.64%)	0.27	1.36	2	1.47		0.71
		20-29	2 (4.26%)	1.05	2.11	1	0.47		0.86
		≥30	3 (6.38%)	1.08	3.19	3	0.94		1
		Total	11.63 (100.0%)	0.14	7.11	7	0.98		1

Table 1: PRISM III-24 scoring difference in age groups and expected and observed mortality

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Variable	Total	Survived	Expired	p-value
Sex				
Male	227 (56.19%)	204 (56.20%)	23 (56.1%)	p>0.05
Female	177 (43.81%)	159 (43.80%)	18 (43.9%)	
Age groups				
Infant	98 (24.26%)	87 (23.97%)	11 (26.83%)	p>0.05
Children	259 (64.11%)	236 (65.01%)	23 (56.10%)	
Adolescents	47 (11.63%)	40 (11.03%)	7 (17.07%)	
Primary system affected				
CNS	118 (29.2%)	103 (28.4%)	15 (36.6%)	p>0.05
Respiratory	91 (22.5%)	83 (22.9%)	8 (19.5%)	
Sepsis	55 (13.6%)	48 (13.2%)	7 (17.1%)	
GIT/Hepatobiliary	37 (9.2%)	37 (10.2%)	0 (0%)	
Others	103 (27.3%)	92 (25.34%)	11 (26.8%)	
Total	404 (100.0%)	363 (89.85%)	41 (10.15%)	
Mean age (in months)	Mean±S.D 59.22±51.12	Mean±S.D 58.54±50.12	Mean±S.D 62.67±52.31	p>0.05
Mean of length of hospitalization (in hours)	Mean±S.D 98.84±91.61	Mean±S.D 106.71±93.5	Mean±S.D 38.92±41.7	p<0.001
Mean of PRISM III-24 score	Mean±S.D 4.92±7.74	Mean±S.D 4.52±7.62	Mean±S.D 23.41±8.29	p<0.001

Table 2: Characteristics of survived and expired patients

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