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Role of PRISM and PIM2 Scores in assessment of PICU mortality risk - An exploratory study.

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Abstract

Background: In (PICU) the pediatric intensive care unit, quantifying severity of illness, timely identification and appropriate intervention are most crucial. The risk models developed using routinely available PICU data like pediatric risk of mortality III (PRISM-III) and the pediatric index of mortality 2 (PIM-2) help in quantifying the severity and producing the mortality risk score. Caring for critically ill pediatric patients is demanding and outcomes are directly dependent on the training level and the expertise of the treating physician as well as availability of facility and timely access of the patients. Availability of resources, infrastructure and medical manpower differ in different regions and urban and rural areas. It is therefore necessary to study the usefulness of these scoring systems in preventing pediatric mortality. This can help in planning the services and optimizing the resource utilization to improve the outcome of the patients.

Material and Methods: The present prospective observational study was conducted in a tertiary care hospital from rural area during the period April 2021 to December 2022. The total PICU admissions during the study period were screened with inclusion and exclusion criteria and the number of study subjects enrolled were 500.

A predesigned validated questionnaire was used to collect data including detailed history, examination and the laboratory data of the patient. The severity of illness and outcome were analysed using PRISM and PIM2 scores. The course of illness and treatment was observed and the outcome duly noted. Multivariate logistic

regression was used to study the associated risk factors in PICU admissions.

Results: During the study period 500 subjects were admitted in PICU with 86.60% (433) survival. Mean age of patients admitted in PICU was 8.08 ± 5.56 years with a male predominance (59.2% were males and 40.8% were females). The most affected system was found to be the central nervous system (34.80%), Cardiovascular system (7.2%) was the least affected system. The mean length of stay in PICU was 4.3 days ranging between 2-15 days. Statistically significant association was seen between various variables of PRISM and PIM2 scores like heart rate, respiratory rate, blood pressure, Glasgow come scale, serum potassium and arterial oxygen tension. Both PRISM and PIM2 score proved with good predictors of mortality and severity of illness. However, higher value was not a sure indication of mortality.

Conclusion: PRISM and PIM scores help in predicting mortality and survival in PICU admissions. Risk stratification is better with PRISM score, hence helps in decision making and optimizing resources. Predicted mortality is underestimated with both the scores. It could be because of infrastructure, quality of care and patients profile. Overall, both the scores are good predictors of mor tality and PRISM score has better prognostic vali dation for PICU admissions.

Keywords: Paediatric intensive care unit; Paediatric Index of Mortality; Paediatric Risk of Mortality; Paedia tric Mortality.

Introduction

Paediatric critical care represents a convergence of knowledge and techno logies. Early intensive care has led to a better patient care and clinical outcome. Caring for critically ill paediatric patients is demanding and out comes are directly dependent on the training level and the expertise of the treating physician as well as availability of facility and timely access of the patients.

PRISM scoring system is a physiologic stability index that predicts mortality through normal physiologic distur bances during the period of disease. It was first described by Pollack et al[1] in PRISM score is severity scoring system and serves as an objective and efficient method for the physicians to predict the outcome and risk of mortality. Paediatric Index of Mortality (PIM 2) score used for predicting outcome of patients admitted in PICU[2]. PRISM and PIM scores are used to produce a mortality risk score using data that are routinely available at PICU admission.

Availability of resources, infrastructure and medical manpower differ in different regions and urban and rural areas. PRISM and PIM2 score decide which patient benefits more from admission to PICU in lieu of limited PICU beds. The knowledge of scores avoids undue admissions to PICU, decreasing quantum of therapy leading to decrease in suffering and financial burden.

These scores help to prioritize and plan intensive care facilities and optimize the resource utilization to improve the outcome of the patients. These scores can be used to study and evaluate the quality of the medical care in PICU. Most of the western countries have developed these scores and validated extensively in their settings. The present study was conducted to explore the role of PRISM and PIMS score in assessment of PICU mortality risk in rural Indian set up and to know the relevance and usefulness of these models.

Methodology

The present prospective observational study was con ducted in a tertiary care hospital from rural area during the period April 2021 to December 2022, after an app roval from the Institutional Ethics Committee. The total PICU admissions during the study period were screened

with inclusion and exclusion criteria and the number of study subjects enrolled were 500. All the admissions between the age 1month to 18 years were enrolled and informed written consent in local language was obtained. All the cases with unstable vital signs, with history of cardiopulmonary resuscitation before admission, or had cardiopulmonary resuscitation within 2 hours of admission and discharge or death within 24 hours of PICU admission were excluded.

A detailed proforma history, examination and the labo ratory data required to calculate study scores was recorded for each patient in predesigned validated pro forma. Heart rate, respiratory rate, Glasgow Coma Score, pupillary reactions score was calculated by clinical assessment. Arterial oxygen ratio, arterial carbon dioxide tension, fractional inspired oxygen ratio and bicarbonate were recorded from Arterial Blood Gas (ABG) analysis. Amongst the laboratory investigations, blood sugar was done for all the patients. Other investigations like calcium, potassium, total bilirubin, prothrombin time and partial throm bo plastin etc. were obtained as per the requirement. The severity of illness was evaluated using the PRISM (as per the recommendation of Pollack et al[1]) and PIM2 (as described by Slater A[2]. et al) score within 24 hours of admission. The course of illness and treat ment was observed and Primary outcome of the patient was recorded as 'Survived' or 'Died'.

All the PICU admissions during study period, including the enrolled patients, were managed according to the standard treatment protocol followed by the PICU. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. Categorical variables derived were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Univariate and multivariate logistic regression was used to find out significant risk factors of mortality. A p value of <0.05 was considered statistically significant.

Results

Out of 500 enrolled study subjects 433 subjects survived. Overall mortality of 13.40% and a survival of 86.60% was observed. Mean age of patients admitted in PICU was 8.08 ± 5.56 years with a male predominance (59.2% were males and 40.8% were females). The most affected system was found to be the central nervous system (34.80%), followed by gastrointestinal system (27.40%), respiratory system (17%) and various other causes (13.6%) were like poisoning, renal, endocrinology, multi organ dysfunction etc. Cardiovascular system (7.2%) was the least affected system.

The mean age of the study population was 8.08 ± 5.56 years with a mean ICU stay for 4.25 ± 2.84 days. The mean PRISM was 9.14 ± 6.55 and the mean PIMS score was 4.11 ± 2.02. The means of various parameters assessed and for the biochemical results has been shown in Table 1.

The mean PIMS score of the children who survived was 3.69 ± 1.53 and the children who died was 6.84 ± 2.61. Statistically significant difference was found between the two groups based on PIMS score (p <0.001). It is evident that higher PIMS score had significantly higher chances of mortality (Table 2).

The mean PRISM of the children who survived was 7.45 ± 5.02 and the children who died was 20.06 ± 4.5. Statistically significant difference was found between the two groups based on PRISM (p <0.001). Higher PRISM was significantly correlated with increase in risk of mortality (Table 3)

On doing univariate logistic regression for mortality, it was found that SBP, HR, RR, AOT, GLASGOW scale, PT/PTT, TOTAL SERUM BILIRUBIN, POTASSIUM, CALCIUM, PRISM, PIMS SCORE AND UI in PR were

the significant risk factors for mortality (p-value < 0.05). Rest of the variables i.e age, DPP, ACT, GLUCOSE, BICARBONATE, ICU stay, sex of the baby, and FD in PR showed a p value >.05 and thus the regression analysis didn't show a correlation for them. It was found that with every 1 unit of increase of SBP, mortality reduced by 1.9%, with an increase of 1 unit of HR, mortality decreased by 1%, with an increase of 1 unit of GLASGOW scale, mortality decreased by 2.92%, with an increase of 0.1 unit of Potassium, mortality rate decreased by 3.15%. Few variables showed an increase in the chances of mortality with the increase in value, RR (OR = 1.026), PT/PTT (OR 6.796), Total Serum Bilirubin (OR = 1.339), Calcium (OR = 1.182), PRISM (OR =1.435), PIMS score (OR = 2.139). The chances of mortality with UD was significantly higher as compared to BR with OR = 8.592. It has been shown in Table 4.

On doing multivariate logistic regression for mortality, after adjusting for confounding factors it was found that AOT, PT/ PTT, TOTAL SERUM BILIRUBIN, CALCIUM, PRISM and PIMS score were significantly associated with mortality (p-value < 0.05). Rest of the variable showed no significant association with mortality. It has been shown in Table 5.

Good association was seen between various variables of PRISM and PIM2 scores like heart rate, respiratory rate, blood pressure, Glasgow come scale, serum potassium and arterial oxygen tension. Both PRISM and PIM2 score proved with good predictors of mortality and severity of illness. However, higher value was not a sure indication of mortality. The mean length of stay in PICU was 4.3 days ranging between 2- 15 days.

Discussion

The clinical profile and outcomes of the patients admitted in PICU vary in different centres either because of difference in disease pattern, severity of illness, variation in availability of resources, facilities or level of training of PICU staff. Outcomes of the intensive care, in the Indian PICU setup especially, have not been extensively studied, scoring systems have been devised to predict mortality of patients admitted to such units. However, in this mortality scoring system ‘Risk management' needs to be considered. Factors like socio demo graphic profile, financial status, co-morbid conditions and baseline health status are strongly associated with the outcome measu red.

Intensive care needs a high level of investment in money, skills and manpower. Therefore, it is desirable to monitor the quality of care provided. Observed mortality figures are a 'hard' end point which could be used for this purpose, when compared with the predicted intensive care unit mortalities at corresponding levels of severity of disease. Therefore, severity of disease in patients could be measured by using the scoring systems. These scoring systems quantify the degree of physiological derange ment of any patient and provide an overall score, which reflects the severity of illness and prognosis.

This study attempts to evaluate the role of PRISM and PIM2 score in PICU mortality in a tertiary care hospital of rural Maharashtra. The age group studied was 1month to 18 years similar age group was studied by Shukla V V[3] et al where the study was conducted in western Maharashtra and by Madan G[4], et al for validity of PRISM score in north Indian set up. Similarly, no significant association was found between age and mortality (p=0.295) in our study.

No statistically significant difference was found in the correlation of gender with mortality (p = 0.657). Males were found to be dominant in both groups of survivors (59. 58%) and mortality (56. 72%). In our study, involvement of central nervous system (34. 80%) was the most common among PICU admissions. Similar finding

was reported in studies conducted by Balakrishnan et al5 (24%) Haque et al 6(31%) Madaan G et al4 () while Lanetzki et al7and Earan S K et al8 (40.2%), Khilnani P et al 9, had reported respiratory system, Abhulimhen Iyoha et al10(41.1%) and Roshani N et al11showed cardiovascular system and Shukla VV et al3, Ozer E A et al12 showed sepsis as the most common system involved.

Associations of PRISM score with PICU mortality:

The mean PRISM of the children who survived was 7.45 ± 5.02 and the children who died was 20.06 ± 4.5. Statistically significant difference was found between mortality and PRISM score.

Singhal et al[13] found that proportion of fatality was only 8.2% with a score of 1-9, and showed a gradual increase with higher scores reaching 66.7% among those >30 which was also statistically significant similar to our study. Majority of authors like Balakrishnan G et al[5], Radovan et al[14], Pollack et al[15]have reported similar observations. But there are authors which reported different results. Balakrishan et al[5] reported that in a Sample of 270 patients were estimated to have 30.8 deaths which was the close to observed death of 29 patients. Well Met al[16] studied the discriminatory performance of the paediatric Risk of Mortality score in a South African intensive care unit. Compared with Euro pean and American ICU populations, patients in above mentioned study were younger, mostly surgical emergency admissions, stayed longer in the ICU and were severely ill with a higher admission PRISM score and overall mortality rate. PRISM showed equally poor discriminatory function at all age groups and diagnostic categories. In the present study, nine variables were found to be independently responsible for the changes in the probability of the mortality of studied cases. Most of the studies Singhal et al[13], Balakrishnan et al[5], Radovan et al[14], Pollack et al[15]have not specifically explored this issue.

Bala krishnan et al[5] have reported similar observations through the variables in question were not same. In our study we found that beside PRISM score, Glasgow coma scale, serum bilirubin, potassium, arterial oxygen tension, heart rate and blood pressure were found to have relationship with probability of mortality. We did not find the same observations in case of PT/PTT as seen in the study of Madaan G et al[4]and Balakrishnan et al [5]. This difference may be attributed to different distribution of clinical conditions, socio economic status, demo graphic profile of patients admitted in our institution.

The PRISM score performance in various clinical situ ations:

Although a high PRISM score on admission was definitely treated with a lot of consideration, some of the important observation we made from the series of cases were;

High PRISM score, poor outcome

PRISM score in such presentations were high due to late referral to our Centre or delay in the recognition of seriousness of the symptoms by parents or the treating physician which caused disease progress further to the point where target organ damage may also have occurred.

High PRISM score, good outcome

PRISM score was reflecting very severe physiological instability, had treatable factors which once recognized were easy to treat and revert similar to the observations made by Radovan et al[14] and Madaan G et al[4]. However, larger studies would be required to analyse definitively the above findings.

Low PRISM score, poor outcome

The prediction of mortality by the PRISM score depends to a great extent on the data collected at admission and the level of physiological instability at presentation.

Hence, cases that presented with lower scores in the range less than 15 but probably had 'hard to treat' physiological derangements died in the ICU. Nature of destabilization that occurs in a particular disease process may not always be reflected by the PRISM score.

Length of stay in ICU may contribute to an increase in mortality risk due to other co-morbid factors like nosocomial infections, iatrogenic factors or unforeseen com plications. Radovan et al[14]observed that mortality was significantly higher than predicted among lower risk group patients by application of PRISM score. The sensitivity, specificity and efficiency in general were 1.0, 0.98 and 0.98 respectively. Factors like tracheal intuba tion, central catheters, pneumonia and sepsis were associated with poor outcome for even low risk groups. Madan G et al[4] reported no statistically significant association with length of stay.

The present study revealed the following benefits of the score:

The utility of the PRISM score in its ability to be a prognostic indicator of condition of patient and severity of illness was well established through this study. There was an excellent co-relation between the admission scores and the clinical assessment of physiological instability observed by us. Hence, we felt that with the relatively easy to measure and simple variables with which PRISM score could be computed, we were able to obtain a reasonable idea of the magnitude of organ system derangement we were dealing with.

Pollack et al[15] felt that the PRISM score could have important applications in PICU. It could serve as an accurate, unbiased and easy to use score to assess severity of illness.

Balakrishnan G et al[5] found that the PRISM score to be helpful in terms of prognostication of patient cohorts. They found that it also helped them to compare their performance as an ICU unit and quality of care provided to their patients. They concluded that the PRISM score was institution independent and especially short stay patients.

Decision making and resource allotment: Our study of the PRISM score at admission also revealed an important utility of this system in the above aspect. In a tertiary referral Centre like ours, the major concern that we share in the PICU is the need to make certain vital decisions with regards to correct timing and indication of therapeutic intervention, and the need for rapid mobilization of resources at our disposal. The allocation of man-power, ICU staffing and other technical resources was also facilitated by the PRISM score which, on admission, helped us to gauge the requirements of the admission in terms of the above issues.

Radovan et al [14]expressed the concern of 'overcrowding' of PICUs adversely affecting the environment of the critical care areas and hence the need for a single physiological scoring system to identify critically ill patients in the emergency department and to aid in 'rapid and systematic' triage and stabilization of patients. In this respect, PRISM score was found to be an important tool in not only assessing severity of illness on admission, but also had an important impact on utilization and optimization of hospital resources and added further to the decision-making process by its predictive scoring potential.

Association of PIM2 scores with mortality

The mean PIMS score of the children who survived was 3.69 ± 1.53 and the children who died as 6.84 ± 2.61. Statistical significance was found between the score and mortality with a $p < 0.005$. This result was similar to that found by Fraser J et al[17]and Roshani N et al [14]. Fraser J et al [17] stated that PIM2 score performs better than the PRISM score and allows early identification of high-risk

patients, thus is useful in risk stratification, but it was not found to be a good representative of possible organ dysfunction and stated PRISM to be a better predictor of mortality. Our result differed from the result of Shukla VV et al[3] who stated that PIM score is not valid without proper recalibration in the Indian settings where the pattern and frequency of the disease are evidently different and standard care is not provided appropriately as compared to the developed countries where the score was formulated.

Most common problems faced during the calculation of the PIM2 score were as follows:

1. It should be calculated using the first value instead of using the worst value within first hour after starting the treatment or any intervention. It also cannot be assessed if the child has received treatment of any sort before getting admitted.

2.Underlying conditions may be misinterpreted like sepsis causing cardiac failure can be labelled as cardiomyopathy or muscular dystrophia could be counted as a case of neurodegenerative disorder which affected the score calculation.

3.Fi02 value obtained at a different time as Pa02.

4.There is no proper definition of the booked admission like admission after an elective surgery is a pre-arranged admission.

5.Effect on pupillary size due to any drug administration or a peripheral cause is not considered. Pupillary reaction may also be absent or abnormal due to any external injury.

Benefits of PIM2 score observed in this study:

1.Discriminated well between the survivors and the non-survivors.

2.It helps in early identification of the severity and quick interventions in the management

3. Early diagnosis helps in proper counselling of the patients.

4. Assessment of Quality of care and cost.

In our study, both the scores proved to be good predictors of mortality and showed strong associations with various factors on multivariate logistic regression analysis. These results were comparable with the original validation data published in the index study on PRISM and PIM score by Pollack et al and Ozer EA et al respectively. We found that age, sex and primary systemic diagnosis had no statistically significant association with mortality risk as predicted by the PRISM and the PIM score. A low PRISM score and PIM score on admission does not necessarily exclude the need for intensive care but only indicates aggressive treatment which may improve the eventual outcome.

Conclusion

At the end we conclude that both the scores showed an excellent correlation between the observed mortality and the predicted mortality by the scoring system and proved to be good indicators of PICU mortality. The scores usage aids in assessment of severity of illness at admission and additionally helps in prognostication of condition of the PICU admission. A well-equipped PICU and a good trained group of physicians facilitate the care of critically ill children and help not only in preventing mortality but also restoring good health of child.

This enables decision making regarding the need for early intervention, resource management and PICU staffing. Cost containment measures and funding could also be planned accordingly.

Limitations

This is a single Centre study representing rural Maha rashtra so result cannot be generalised. Assessment of variable was not related to specific organ involvement.

PIM2 score assessment within 1st hour can get affected by pre hospital management measures.

Table 1: Mean Distribution of various study parameters

Variables	Mean ± SD	Median (Range)	Inter quartile Range
AGE	8.08 ± 5.56	7(0.07-18)	3 - 13
SBP	96.57 ± 23.65	96(52-160)	78 - 114
DBP	73.76 ± 20.01	72(40-120)	57 - 88
HR	107.99 ± 30.64	100(60-166)	84 - 140
RR	47.07 ± 21.02	44(5-100)	32 -56
AOT	312.91 ± 57.73	320(210-402)	275 - 361
ACD	40.93 ± 11.91	40(17-70)	30 - 47
GLASGOW	10.09 ± 2.37	10(4-15)	9 - 12
PT/PTT	0.97 ± 0.21	1 (0.5-1.6)	0.900 - 1
TOTAL S.BIL	1.95 ± 1.03	1.8(0.5-5.5)	1.200 - 2.500
POTASSIUM	4.45 ± 1.36	3.9(2-8)	3.400 - 5.500
CALCIUM	9.44 ± 1.87	9.2(6.2-16)	8.200 - 10.400
GLUCOSE	134.24 ± 51.71	134(32-313)	99 - 175
HC03	23.79 ± 6.82	2402-48)	18-28
PRISM	9.14 ± 6.55	70-26)	4 - 13
PIMS SCORE	4.11 ±2.02	3.86(0.7612.02)	2.696 - 5.027
ICU STAY	4.25 ± 2.84	3(2-17)	3 -5

Table 2: Correlation of mean PIMS score with mortality rate.

PlMS SCORE	Death (67)	Survivor (433)	value
Mean ± SD	6.84 ± 2.61	3.69 ± 1.53	< 0.0001
Median (Range)	5.86(3.47-12.02)	3.58(0.76-9.18)	
Inter quartile Range	5.036 - 8.406	2.519 - 4.461	

Table 3: Correlation of mean PRISM with mortality rate

PRISM	Death (67)	Survivor (433)	value
Mean ± SD	20.06 ± 4.5	7.45 ± 5.02	< 0.0001
Median (Range)	20(4-26)	6(1-26)	
Inter quartile Range	20-22	4 - 10	

Table 4: Univariate logistic regression for mortality.

	B	S. E	P value	Odds ratio	95% C. I. for Odds ratio	
					Lower	Upper
AGE	0.025	0.024	0.295	1.025	0.979	1.073

SBP	-0.019	0.006	0.001	0.981	0.969	0.992
DBP	-0.013	0.007	0.052	0.987	0.974	1.000
HR	-0.010	0.005	0.021	0.990	0.981	0.998
RR	0.025	0.006	<.0001	1.026	1.014	1.037
AOT	-0.011	0.002	<.0001	0.989	0.984	0.993
ACD	-0.016	0.011	0.174	0.985	0.963	1.007
GLASSGOW	-0.346	0.062	<.0001	0.708	0.627	0.799
PT/PTT	1.916	0.557	0.001	6.796	2.282	20.240
TOTAL S.BIL	0.292	0.115	0.011	1.339	1.068	1.678
POTASSIUM	-0.378	0.113	0.001	0.685	0.550	0.855
CALCIUM	0.167	0.065	0.010	1.182	1.040	1.343
GLUCOSE	-0.001	0.003	0.673	0.999	0.994	1.004
HC03	0.003	0.019	0.879	1.003	0.966	1.041
PRISM	0.361	0.038	<0. 0001	1.435	1.332	1.544
PIMS SCORE	0.760	0.089	<0.0001	2.139	1.797	2.547
ICU STAY	0.023	0.044	0.607	1.023	0.938	1.115
Male				1.000		
Female	0.118	0.265	0.657	1.125	0.669	1.892
PR – FD	-0.221	1.059	0.835	0.802	0.101	6.394
PR-UD	2.151	0.400	<.0001	8.592	3.922	18.826

Table 5: Multivariate logistic regression for mortality

Variable	B	S.E.	P value	Odds ratio	95% C. i. for Odds ratio	
					Lower	Upper
SBP	0.033	0.025	0.199	1.033	0.983	.086
HR	0.030	0.022	0.165	1.031	0.988	1.076
RR	0.053	0.030	0.075	1.054	0.995	1.117
AOT	0.031	0.013	0.016	1.031	1.006	
GLASSGOW	-0.643	0.432	0.137	0.526	0.225	I .227
PT/PTT	10.803	2.977	0.000	49159.632	143.792	1.68E+07
TOTAL S.BIL	2.005	0.912	0.028	7.427	1.243	44.366
POTASSIUM	-0.237	0.367	0.518	0.789	0.384	1.621
CALCIUM	0.969	0.409	0.018	2.635	1.183	5.871
PRISM	0.389	0.109	0.000	1.476	1.193	1.826
PIMS SCORE	3.038	0.791	0.000	20.864	4.425	98.364
PR-FD	-2.764	1.659	0.096	0.063	0.002	I .627

PR-UD	2.048	22.283	0.927	7.749	0.000	7.19

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