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Original Research Article

Clinical profile and outcome of patients admitted in pediatric intensive care unit of tertiary care teaching hospital of rural North India: an observational study

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ABSTRACT

Background: Aim of the study was to study the clinical profile of the patients admitted in the intensive care unit and their outcomes in the rural area of north India.
Methods: A prospective observational study was conducted in the PICU of rural tertiary care centre over a period of one and half year. The severity of illness and outcome were analyzed using PRISM (Pediatric risk of mortality) and PIM2 (Pediatric index of mortality) scores.
Results: A total of 500 patients with mean age of patients admitted in PICU was 8.08±5.56 years. The most affected system was found to be the CNS (34.80%), followed by GIT (27.40%), respiratory (17%) and various other causes (13.6%) and CVS (7.2%). There was an overall mortality of 13.40% and a survival percentage of 86.60%. Significant association was seen between various variables of PRISM and PIM2 scores. 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. Attributed to the fact, the current scope of study leveraged into a prospective observational study with multitude of variables, multivariate analysis with random sampling was performed by SPSS 21. Significant levels were corroborated at ($p<0.05$) to validate mortality (outcome) based on PIM2 and PRISM scores in first place.
Conclusions: The knowledge of demographic and clinical profile of the patients in a particular area and use of physiological scores can help streamline the use of limited resources in PICUs of developing countries.

Keywords: Clinical profile, PICU, PIM2, PRISM

INTRODUCTION

In the developed countries, pediatric emergencies and intensive care are well established but in the developing countries, intensive care facilities are limited. The history of pediatric intensive care in India dates back to early 90s, when 4 centers were established in north, south, and west India. Caring for critically ill pediatric patients is demanding and outcome is directly dependent on the training level, expertise of treating physician, availability of facilities and the knowledge of the prevalent diseases in the particular area. As per the 2020 WHO data, worldwide approximately 5 million children aged less than 5 years dies in a year, 80% of which occurred in the developing countries.[1] Nigeria and India alone account for almost one third of all the deaths.[2] According to NHFS-5 the under 5 mortality rate for Haryana is 38.7 with the urban and rural under 5 mortality rates of 36 and 39.8 respectively.[3]

Children having respiratory, cardiovascular, central nervous system and others in that order or life-threatening

traumatic injuries constitute the most common reason for admissions in PICU.[4] These patients require a very high level of monitoring of vital signs and other body functions and support to organ functions. The main objective of the pediatric intensive care is not only to lower the mortality but also the restoration of the child's health.[5] As there are a number of associated risk factors which include abnormal neuro-development and other life-threatening disorders increasing the hospital stay in the children, it is therefore important to prioritize and plan intensive care facilities for a given population for optimal use of resources.[6]

Different objectives of scoring systems were established, which were to evaluate the patients at a single point in time (status index), prediction of an outcome (prognostic index) and description of clinical change (clinical index).[7] Both quantitative and qualitative assessment in form of therapeutic intervention scoring system (TISS) and clinical classification system (CCS) respectively were found to be indirectly reflecting the severity of illness by observing therapeutic needs, justifying the need of a more direct method to assess severity of illness.[7,8] The physiologic stability index (PSI) was established, by choosing a total of 34 routinely or frequently measured variables from 7 systems including respiratory, cardiovascular, neurologic or metabolic systems,which are affected by physiological instability.[9]

The PSI score was analyzed and assessment was undertaken to reduce the number of physiologic variables required for severity of illness which led to reducing the number of variables from 75 to 23.[10] Variables used in the PRISM score were re-evaluated and based on data from 32 PICUs, this scoring system was labelled as PRISM III score. A total of seventeen parameters including systolic BP, temperature, percentage of acid-base gas parameters, serum creatinine, blood urea nitrogen (BUN), white blood cell (WBC) count, and the platelet count were used in making the scoring system. PRISM III score is institution independent and can be calculated at twelve hours and twenty four hours labelled as PRISM-12 and PRISM-24, respectively.[11] This score was again updated to PRISM IV prediction algorithm based on the first four hours of PICU care, and was also separated into cardiovascular, neurologic, respiratory, chemical and hematologic components, and the total PRISM was also separated into neurologic and non-neurologic categories.[12] Another score named the PIM 2 score was introduced and updated in 2003 to predict the outcome of the children admitted to PICUs.[13]

Availability of resources, infrastructure and medical manpower differ in different regions especially in urban and rural areas. It is therefore necessary to study the clinical profile of the patients admitted in the intensive care unit and their outcomes in the different geographic areas in order to plan the services and optimizing the resource utilization to improve the outcome of the patients.

METHODS

Study design and period

This prospective observational study was carried out in the pediatric intensive care unit, department of pediatrics at Maharishi Markandeshwar institute of medical sciences and research, Mullana, Ambala from December 2016 to July 2018.

Source and study population

A total of 500 patients admitted in PICU with age 3 months to 18 years were randomly enrolled in the study after taking informed written consent in local language from the patient's parents. The patients under the age of 3 months, who were discharged or expired within 24 hours of admission or whose parents refused to give the written consent were excluded from the study.

A detailed proforma including detailed history, examination and the laboratory data of the patient was recorded for each patient by the primary investigator. The course of illness and treatment was observed and the outcome duly noted.

Study variables

HR (Heart rate), RR (Respiratory rate), Glasgow coma score, PR (Pulse rate) scores were calculated by clinical assessment. The SBP and DBP were measured by non-invasive method using sphygmomanometer with cuff appropriate for the age. AOT (Arterial oxygen tension), ACT (Arterial carbon dioxide tension) 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 thromboplastin etc were obtained as per the decision of the treating practitioner.

Sample size

Based on random sampling strategy and adherence to inclusion criteria, with a population size of 500 patients admitted in PICU over a definite period, at confidence level 95%, sample size was computed by formula.

Outcome measures

Primary outcome of the patients was recorded as survived or died.

The severity of illness was evaluated using PRISM III and PIMS-2 scores.

To estimate the probability of death in the intensive care unit for a patient [p(ICU death)], the PRISM III score together with age and operative status are combined in a linear logistic form as follows:

p(ICU death)=exp r/[1+exp r]

Where, r=0.207×PRISM-0.05×age (in months)-0.433×operative status-4.782

Where operative status: 0 if non operative and 1 if post-operative.

The outcome was also evaluated on the basis of PIM-2 score.[6]

Probability of death=exponential PIM 2 /(1 + exponential PIM 2)

Data was recorded in the predesigned proforma covering all the above variables.

Statistical analyses

Categorical variables derived were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used.

Statistical tests were applied as follows: Quantitative variables were compared using Independent T test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.

Qualitative variables were correlated using chi-square test. Multivariate logistic regression was used to find out significant risk factors of mortality.

A $p<0.05$ was considered statistically significant. The data was entered in MS excel spreadsheet and analysis was done using statistical package for social sciences (SPSS) version 21.0.

RESULTS

Out of total 500 patients enrolled during the period of 20 months (December 2016-July 2018); mean age of the children was 8.08±5.56 years. 29.6% of the children were in the age group 1-5 years followed by 24.2% in 6-10 years and 22.8% in 11-15 years. Rest of the children were either <1 year or >15 years (Table 1). The gender distribution was 59.2% males and 40.8% females (Table 1). Among the diagnosis distribution, 34.8% of the children had CNS disorder followed by GIT disorder in 27.4%, 17% had a respiratory disorder and only 7.2% had a CVS disorder (Table 2). In our study the survivor and the non-survivor distribution was 86.6% as well as the 13.4% respectively (Table 1). On comparing the various age groups based on the mortality of the children, no statistically significant difference was found with the mean age of the children who survived was 7.98±5.52 years and the children who died was the 8.74±5.81 (Table 1).

On assessing the PR, majority of the children (92%) had BR. On comparing the PR based on the mortality of the children, statistically significant association was found ($p<0.001$) between UD (unilateral dilated) and mortality (Table 3).

The mean HR of the children who survived was 109.25±30.45 and the children who died was 99.85±30.87. Statistically significant difference was found and it is evident that patients who died had significantly lower heart rate as compared to patients who survived (Table 3).

The mean SBP of the children who survived was 97.95±20.73 mm of Hg and the children who died was 87.64±36.38 mmHg. Statistically significant correlation was found between lower SBP and mortality (Table 3). The mean DBP of the children who survived was 74.45±18.23 mmHg and the children who died was 69.31±28.78 mmHg. It is evident that patients with lower DBP have statistically significant correlation with mortality (Table 3).

The mean AOT of the children who survived was 318.18±54.78 and the children who died was 278.85±64.79. There were high chances of survival in patients with higher AOT as compared to patients with low AOT and the difference was statistically significant (Table 3). The mean ACD of the children who survived was 41.22±11.88 and the children who died was 39.09±12.02. No significant difference was found between the two groups based on ACD (Table 3).

The mean RR of the children who survived was 45.43±19.35 and the children who died was 57.7±27.52 with statistically significant difference. Similarly, the difference in mean total of the children between survivors (1.91±1.02 mg/dl) and non survivors (2.25±1.03 mg/dl) was also significant. Patients with high RR and S. bilirubin has the significantly higher mortality rate (Table 3).

The mean potassium of the children who survived was 4.54±1.33 meq/l and the children who died was 3.92±1.45 meq/l. Lower potassium values were associated with the significantly higher mortality rate (Table 3).

No difference was found in the mean glucose levels, mean bicarbonate, mean PT/PTT, mean calcium levels and mean ICU stay of the children between survivor and non- survivor groups (Table 3).

The mean PIMS score of the children who survived was 3.69±1.53 as compared to 6.84±2.61 which showed statistically significant correlation of mortality with higher PIMS score (Table 4 and 6). Mean PRISM of children who survived was 7.45±5.02 and children who died 20.06±4.5. Higher PRISM significantly correlated with increase in risk of mortality (Table 4 and 5).

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 PIM-2 score were significantly associated with mortality ($p<0.05$). Rest of the variable showed no significant association with mortality. It has been shown in (Table 7).

Table 1: Demographic profile.

Variables	N (%)	Survivor, N (%)	Non survivor, N (%)
Age (in years)			
<1	51 (10.20)	45 (10.39)	6 (8.96)
1-10	269 (53.8)	236 (54.50)	33 (49.25)
11-15	114 (22.80)	98 (22.63)	16 (23.88)
>15	66 (13.20)	54 (12.47)	12 (17.91)
Total	500 (100)	433 (86.6)	67 (13.4)
Gender			
Male	296 (59.20)	258 (59.58)	38 (56.72)
Female	204 (40.8)	175 (40.42)	29 (43.28)
Total	500 (100)	433 (86.6)	67 (13.4)

Table 2: Diagnosis distribution.

Diagnosis	Frequency	Percentage (%)
Cardiovascular	36	7.20
Central nervous system	174	34.80
Gastrointestinal	137	27.40
Respiratory	85	17.00
Others	68	13.60
Total	500	100.00

Table 3: Individual physiologic parameters mortality correlation.

Factors	Survivor (Mean)	Non-survivor (Mean)	P value
Heart rate	109.25±30.45	99.85±30.87	0.006
RR	45.43±19.35	57.7±27.52	0.005
PR			
BR 460 (92%)	409 (94.46%)	51 (76.12%)	<0.0001
FD 11 (2.2%)	10 (2.31%)	1 (1.49%)	
UD 29 (5.80%)	14 (3.23%)	15 (22.39%)	
Total 500 (100%)	433 (86.6%)	67 (13.4%)	
SBP	97.95±20.73	87.64±36.38	0.001
DBP	74.45±18.23	69.31±28.78	0.006
Glassgow	10.34±2.33	8.51±2	<0.0001
ICU stay	4.23±2.88	4.42±2.52	0.171
AOT	278.85±64.79	318.18±54.78	<0.0001
ACD	41.22±11.88	39.09±12.02	0.363
Total S. bil	2.25±1.03	1.91±1.02	0.006
Glucose	134.62±48.89	131.76±67.52	0.81
Potassium	4.54±1.33	3.92±1.45	0.0005
HCO_3	23.77±6.44	23.91±8.97	0.764
PT/PTT	0.95±0.19	1.05±0.27	0.154
Calcium	9.35±1.69	9.99±2.72	0.11

ACD: Arterial carbon dioxide tension; AOT: Arterial oxygen tension; BR: Bilateral reacted; DBP: Diastolic blood pressure; FD: Fixed dilated; HR: Heart rate; PR: Pupillary reactions; PT/PTT: Prothrombin time/ partial thromboplastin ratio; RR: Respiratory rate; SBP: Systolic blood pressure; UD: Unilateral dilated.

Table 4: Prism III and PIM-2 score correlation.

Score	Survivor	Non survivor	P value
PRISM III	7.45±5.02	20.06±4.5	<0.0001
PIM-2	3.69±1.53	6.84±2.61	<0.0001

PRISM: Pediatric risk of mortality; PIM: Pediatric index of mortality.

Table 5: Correlation of mean PRISM with mortality rate.

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

Table 6: Correlation of mean PIMS score with mortality rate.

PIMS score	Death, (n=67)	Survivor, (n=433)	P 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 7: Multivariate logistic regression for mortality.

Variables	B	S.E.	P value	Odds ratio	95% CI for odds ratio	
					Lower	Upper
SBP	0.033	0.025	0.199	1.033	0.983	1.086
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	1.058
Glassgow	-0.643	0.432	0.137	0.526	0.225	1.227
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						
BR				1.000		
FD	-2.764	1.659	0.096	0.063	0.002	1.627
UD	2.048	22.283	0.927	7.749	0.000	7.19E+19

AOT: Arterial oxygen tension; BR: Bilateral reacted; CI: Confidence interval; DBP: Diastolic blood pressure; FD: Fixed dilated; HR: Heart rate; OR: Odd's ratio; PIM: Pediatric index of mortality; PR: Pupillary reactions; PRISM: Pediatric risk of mortality; PSI: Physiology stability index; PT/PTT: Prothrombin time/partial thromboplastin ratio; RR: Respiratory rate; SBP: Systolic blood pressure; UD: Unilateral dilatation.

DISCUSSION

In critical care medicine, intensive care unit (ICU) results can be assessed on the basis of outcomes such as "death" or "survival" by means of indicators such as mortality rates.[15] Our study was conducted in the PICU of MMU, which was established in early 2000s, serving most of the patients from Haryana and Uttar Pradesh.

Detailed note was made of the clinical as well laboratory details of the patient. The PRISM III and PIM-2 score was calculated within twenty-four hours of admission.

Our study included children between the age group of 3 months to 18 years which was similar to the studies conducted by Iyoha et al (40.01±45.79 months), Shukla et al (36 months), however, Balakrishnan et al included even the neonatal age groups.[15-17] Out of 500 patients enrolled, majority of the patients belonged to the age group of 1-5 years of age (29.60%) which was comparable to as found by Madaan et al (80.84±61.072 months) and Mukhija et al (96.50 months).[15-19]

Most patients who survived belonged to 1-10 years of age (54.50%) and maximum mortality was also seen in this age group (49.25%), both can be justified as they had the maximum number of admissions in the PICU and is comparable to Madaan et al.[18]

In present study, there was male predominance with 59.2% were males and 40.8% were females, similar to that found in most of the studies Iyoha et al (59.8% males and 40.2% females), Roshani et al (54.5% males and 45.5% females), Shukla et al (60.2% males and 39.8% females) and Earan et al (63.6% males and 36.4% females).[15,16,20,21]

In our study, majority of admissions were due to primary central nervous system involvement (34.80%), followed by gastrointestinal disorders (27.40%), respiratory system

(17%) and cardiovascular system (7.20%). Miscellaneous cases (13.60%) included the remaining cases like poisoning, renal, endocrinology, multi organ dysfunction etc. This observation was similar to study carried out by Jyothi et al in which the cause of admission was attributed to central nervous system disorders 195 (32.5%) cases, followed by respiratory system in 122 (20.33%) cases, infections in 97 (16.16%) and cardiovascular system in 65 (10.83%) cases.[22] This was also comparable to a study carried out by Haque et al, however, a study analysing the epidemiological pattern of patients admitted to PICU in South India found that respiratory system was the most common system affected (40.2%).[21,23]

In our study, the PRISM score and PIM2 score was calculated based on the data obtained on admission from each of the cases admitted in PICU.

Association 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. Statistical significant difference was found between mortality and PRISM score. Hence, the observation was a definite increase in the proportion of deaths as the PRISM score got higher. Khilnani et al in 2000 found a general trend towards direct proportionality of PRISMIII scores with respect to increasing mortality in patient population with children with PRISMIII greater than 35 had mortality greater than 40%.[24] Singhal et al 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.[25]

Balakrishan et al reported that in a sample of 270 patients were estimated to have 30.8 deaths which was close to the observed death of 29 patients.[17]

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, Balakrishnan et al, Pollack et al and Radovan et al) have not specifically explored this issue.[11,17,25,26] Balakrishnan et al have reported similar observations though the variables in question were not same.[17] 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.

Benefits of the score

The utility of the PRISM III score in its ability to be a prognostic indicator of condition of patient and severity of illness was well established through this study. As there was an excellent co-relation between the admission scores and the clinical assessment of physiological instability, with relatively easy to measure and simple variables of PRISM, a reasonable idea of the magnitude of organ system derangement can be attained.

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. 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 issue

Association of PIM2 score with mortality

It was concluded that higher the PIM2 score, higher the probability of mortality of the patient. 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 $p<0.005$.[27] This result was similar to that found by Fraser et al and Roshani et al.[20] Fraser et al stated that PIM is a good in performing as a risk adjustment method in children who are entirely managed in the ICUs.[27] They expected a total mortality of 33.2 patients and had an actual mortality of 31 patients. According to the study done by Roshani et al, it was found that on the basis of ease of data collection, availability of laboratory facilities and number of variables required for the study, PIM score performs better than the PRISM score and allows early identification of high-risk patients, thus is useful in risk stratification.[20] 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 et al 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.[16]

We conclude that PIM score 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.

Benefits of PIM2 score

Discriminated well between survivors and non-survivors. It helps in early identification of the severity and deciding of the required interventions in management of patient.

Early interventions have a good impact on outcome despite of high score. As the scoring is done at the earliest possible, it helps in proper counselling of the patients.

Quality of care assessment and economic benefits: The high score served as guideline for further critical care

management and helped to improve the level of care, we as a PICU team, could provide.

Length of stay in the ICU

In our study, the mean length of stay in PICU was 4.3 days ranging between 2-15 days. Patients were grouped on the basis of survivors and non-survivors. It was seen that maximum patients who survived stayed for 4.23±2.88 days and the ones who expired stayed for 4.42±2.52 days. No correlation was found between mortality and period of stay in PICU. This was almost similar to that found in the studies conducted by Haque et al (3.2 days), Begum et al (9.71 days) and Iyoha et al (3.2± 4.5 days).[15,23,28]

Associated factors

It was found that there was a good correlation between the following variables with mortality: HR, SBP, Diastolic blood pressure, RR, AOT, potassium levels and Glasgow coma scale. There was no statistical significance seen between mortality and calcium, glucose levels, PT/PTT and arterial carbon dioxide tension. This was similar to that concluded by Balakrishnan et al who stated that systolic blood pressure, diastolic pressure, heart rate, serum bilirubin and serum potassium as important predictors of mortality.[17] They also found relation with PT/PTT which was different from result of index study.

Strengths of the study

Our study center being the tertiary care center, located in a rural area of Haryana also catering to population of state of Uttar Pradesh, provides insight into diverse demographic profile which can impact the disease profile at presentation.

Limitations

Since our facility is located at remote rural location, the patients are expected to have multiple visits to peripheral medical centres before admission to PICU. This might be responsible for higher physiological scores at admission.

CONCLUSION

At the end we conclude that a well-equipped PICU and a good trained group of physicians facilitate the care of critically ill children. In order to lower the mortality and restoration of the child's health the physiology-based parameters and the knowledge of epidemiological profile, prevalence of various clinical disorders play a grave role.

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