Original Article

Study of metabolic disturbances in patients admitted in paediatric intensive care unit (PICU)

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Metabolic & Electrolyte disturbances are common problems encountered in Paediatric intensive care unit (PICU) and are associated with increased morbidity and mortality[1]. Acid base homeostasis is fundamental for maintaining life. Paediatric Risk of Mortality (PRISM) score is used to quantify physiological status and can compute expected mortality & morbidity risk[2]. It was a cross-sectional observational study of duration 1 year. Patients from 2 months to 12 years admitted in PICU were randomly enrolled. Written and informed consent was taken. Patients submitted for investigations included acid and base gas analysis (ABGA) and serum electrolytes. PRISM score was applied. Proforma was filled and conclusion derived. Out of 100 patients enrolled, 75 were discharged and 25 expired. ABGA abnormality was seen in 84%. Electrolyte imbalance was observed in 58%. Metabolic acidosis and hyponatremia was observed in 41% and 38% of total cases respectively. The mean cut off value of the PRISM SCORE in the study observed was 9.3± 3.3. Survivors showed mean PRISM score of 6.04 while non-survivors had mean prism score of 12.72. Majority of patients admitted in PICU had acid base disturbances on presentation and was associated with poor outcome. Metabolic acidosis was the most common acid base abnormality while Hyponatremia was the most common electrolyte disturbance observed. PRISM score is a good indicator for prediction of mortality when the score crossed average mean and is a better indicator for prediction of survival when the score was below the mean[11].

Key words : Intensive care, ABGA, PRISM score.

Metabolic & Electrolyte disturbances are common clinical problem encountered in Paediatric intensive care unit (ICU) and are associated with increased morbidity and mortality[1]. Internal acid base homeostasis is fundamental for maintaining life. Early recognition & prompt correction of Metabolic & Electrolyte abnormalities are necessary to avoid catastrophes & attempts made to maintain normal homeostatic till the organ function is recovered, for better outcome.

Because of instability of homeostatic mechanisms and functional immaturity of vital organs, children are susceptible to develop life threatening emergencies which demand urgent attention to prevent irreversible bio physiological alteration.

Various scoring system are applied for predicting outcome of patients admitted in PICU. For example, Paediatric Risk of Mortality (PRISM).

Paediatric Risk of Mortality (PRISM) : PRISM is a physiologically based score used to quantify physiological status and when combined with other independent variables, it can compute expected morbidity & mortality risk in the paediatric ICU. PRISM was developed from physiologic stability index (PSI) to reduce the number of variables from 34 to 14 numbers of ranges from 75 to 23 without losing the predictive power. It is institution independent and can be used within limits to compare different intensive care units[3,4].

PRISM Parameters : (1) Heart rate, (2) Respiratory rate, (3) Systolic blood pressure and age, (4) Diastolic blood pressure, (5) Glasgow coma score, (6) Pupillary reaction to light, (7) PaO_2 to FIO_2 ratio, (8) $PaCO_2$, (9) Bicarbonate, (10) PT and aPTT, (11) Total serum bilirubin 12) Serum potassium, (13) Serum total calcium, (14) serum glucose[5] (Table 1).

Interpretation :
• Minimum score 0, which has an excellent prognosis
• Maximum score 76, which is almost invariably associated with death

Prediction of Morality in ICU (R)[6]

R = [0.207 * (PRISM score)] – [0.005 *(age in months)] – [0.433 *(operative status)] – 4.782

Where :
• Operative status = 1 if postoperative or 0 if non-operative
• Upper limit for age used in implementation will be 19th birthday

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Table 1 — *Showing PRISM Parameter*		
Parameter	Ranges	Points
Systolic blood pressure in mm Hg :		
Infants	130-160	2
	55-65	2
	> 160	6
	40-54	6
	<40	7
Children	150-200	2
	65-75	2
	> 200	6
	50-64	6
	< 50	7
Diastolic blood pressure in mm Hg :		
All ages	> 110 mm Hg	6
Heart rate in beats per minute :		
Infants	> 160	4
	< 90	4
Children	> 150	4
	< 80	4
Respiratory rate in beats per minute :		
Infants	61-90	1
	> 90	5
	Apnea	5
Children	51-70	1
	> 70	5
	Apnea	5
PaO_2/FIO_2 :		
All ages	200-300	2
	< 200	3
$PaCO_2$ in torr (mm Hg) :		
All ages	51-65	1
	> 65	5
Glasgow coma score :		
All ages	< 8	6
Pupillary reaction :		
All ages	Unequal or dilated	4
	Fixed and dilated	10
PT/PTT :		
All ages	1.5 times control	2
Total bilirubin in mg/dL :		
> 1 month	> 3.5	6
Potassium in mEq/L :		
All ages	3.0-3.5	1
	6.5-7.5	1
	< 3.0	5
	> 7.5	5
Calcium in mg/dL :		
All ages	7.0-8.0	2
	12.0-15.0	2
	< 7.0	6
	> 15.0	6
Glucose in mg/dL :		
All ages	40-60	4
	250-400	4
	< 40	8
	> 400	8
Bicarbonate in mEq/L :		
All ages	< 16	3

Probability of mortality in the ICU = EXP(R) / [1 + EXP(R)]

Probability of survival from ICU = 1 – (probability of mortality)

Assessment :

• Sensitivity: correct prediction of non-survival

• Specificity: correct prediction of survival

MATERIAL AND METHOD

It is observational cross-sectional study conducted during 1 year, IRB (Institutional review board) approval obtained. Patients from 2 months to 12 years admitted in PICU were randomly enrolled. Inclusion criteria for admission in Pediatric intensive care unit (PICU): severe respiratory distress or not breathing or gasping or central cyanosis or cold extremities with capillary refill time >3 second, weak and fast pulse/ shock or diarrhoea with severe dehydration or active convulsion or coma or poisoning[7]. Patients were submitted for routine and specific investigations like acid base gas analysis (ABGA) and serum electrolytes level. Patients were managed according to standard protocol and monitored for Acid Base and Electrolytes disturbances at specific intervals. PRISM score for outcome applied in all enrolled patients. Written and informed consent obtained from their parents/guardians for using the case data for research purpose. Details of the patients collected from the case reporting files. Proforma was filled. Data was analysed statistically by using student T test and conclusion derived.

RESULTS

(1) Total number of patients and outcome (Fig 1) :

Out of 100 patients enrolled, 75 were discharged and 25 expired, with mortality of 25% with average PICU stay of 3.5 days.

(2) Age and mortality (Fig 2):

Out of 100 admissions, 29% were of <1-year age, 31% were of 1-5 years age and 40% were of > 5 years age. Out of 29 patients of age less than 1 year, 11 (37.9%) expired. Out of 31 patients between 1 and 5 years of age, 6 (19.3%) expired and out of 40 patients of age more than 5 years, 8 (20%) expired.

Fig 1

Fig 2

(3) Abnormalities in ABGA (Table 2, Fig 3) :
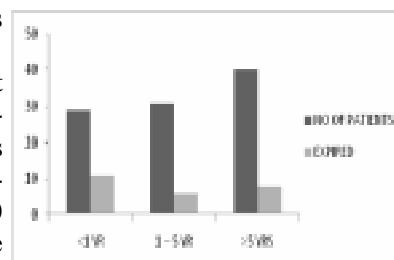
Out of 100 patients, 41% had metabolic acidosis, 29%

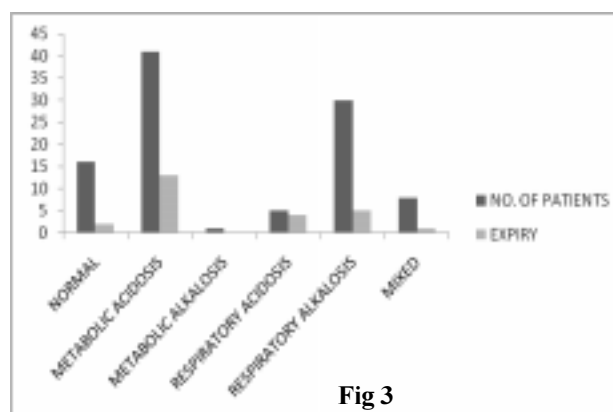| Table 2 — *Abnormalities in ABGA*			
Type	No of Patients (n=100)	Expiry	Mortality (%)
Metabolic Acidosis	41	13	31.7
Respiratory Alkalosis	29	5	17.3
Respiratory Acidosis	5	4	80
Metabolic Alkalosis	1	0	0
Mixed	8	1	12.5
Total	84	23	27.3

Fig 3

showed respiratory alkalosis, 5% presented with respiratory acidosis, 1% showed metabolic alkalosis, mixed dis-

order was observed in 8%, Maximum mortality seen with Respiratory Acidosis. Metabolic acidosis is the most common abnormality observed in critical care.

(4) Serum Electrolytes abnormalities (Table 3) :

Out of 100 admissions, 58% presented with abnormal

Table 3 — *Serum Electrolytes abnormalities*			
Type	No of Patients (n=100)	Expired	Mortality (%)
Hyponatremia	38	15	39.4
Hypernatremia	4	1	25
Hyperkalemia	4	1	25
Hypokalemia	2	1	50
Hypocalcemia	2	0	0
Mixed	8	4	50
Total	58	22	37.9

electrolytes, out of these 38% presented with hyponatremia, 4% presented with hypernatremia, 4% presented with hyperkalemia, 2% presented with hypokalemia, 2% presented with hypocalcemia, Mixed electrolyte imbalance was noted in 8%.

(5) PRISM score in the study (Fig 4) :

The maximum score observed in the study was 22. Out of 100 patients, survivors showed mean PRISM score of 6.04 while non-survivors had mean PRISM score of 12.72. Increased prediction of mortality was observed with increase in the score[8].
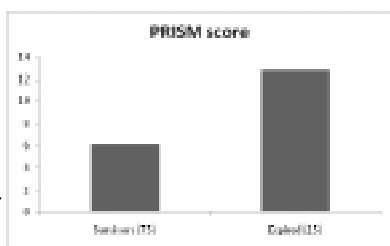

Fig 4 — PRISM score in the study

(6) PRISM score with its mean value of the study (Table 4) :

The mean cut off value of PRISM score in the study observed was 9.3±3.3. Considering 9.0 as the cut off value for the present study, 60% had

Table 4 — *PRISM score with its mean value of the study*		
Mean PRISM Score	No of Patients (N=100)	Expiry
<9	60	6
9-22	40	19

score less than 9 with 10% mortality. 40% had score more than 9 with 47.5% mortality. Increased score had more prediction of mortality after crossing the average mean score[9,10].

(7) Statistical analysis of PRISM score with the relation to mean score (9.0) (Table 5) :

Statistical analysis of the study showed sensitivity of 76% (54.87-90.64), specific-

Table 5 — *Statistical analysis of PRISM score*		
Statistics	Value (%)	Range (%)
Sensitivity	76	54.87- 90.64
Specificity	72	60.44- 81.76
Positive predictive value	47.5	37.18- 58.04
Negative predictive value	90	81.54- 94.83

ity of 72% (60.44-81.76), positive predictive value of 47.5% (37.18-58.04) and negative predictive value of 90% (81.54-94.83). This showed that patients with low prism score definitely have better outcome for survival[11].

DISCUSSION

Electrolyte and acid base abnormalities are common in children who need intensive care. They occur in variety of conditions and result in morbidity and mortality irrespective of the primary problem. Timely recognition, a high index of suspicion and a thorough understanding of common electrolyte and acid base abnormalities is necessary to ensure their correction. This study was conducted during 1 year in 2 months to 12 years pediatric patients admitted in intensive care units. In study, total 100 patients were enrolled, out of which 75 were discharged and 25 expired. Infancy are associated with poor outcome in this study. Taori *et al* Study where mortality in infants was higher (37.8 %) as compared to older children (16.2 %)[12].

In present study, mortality in infants was 37.9%. In our study, 41% had metabolic acidosis, 29% showed respiratory alkalosis, 5% presented with respiratory acidosis, 1% showed metabolic alkalosis, mixed disorder was observed in 8%. Metabolic acidosis is the most common abnormality observed in PICU patients. In Kinia *et al* study also had 32.4% of cases with metabolic acidosis[13].

Hyponatremia was the most common electrolyte disturbance observed in PICU admissions and was also the most fatal electrolyte abnormality[14]. In present study, 58% presented with abnormal electrolytes, out of these 38% presented with hyponatremia, 4% presented with hypernatremia, 4% presented with hyperkalemia, 2% presented with hypokalemia, 2% presented with hypocalcemia, Mixed electrolyte imbalance was noted in 8%. In Murthy *et al* study, hyponatremia seen in 15-20% cases[15].

PRISM (Pediatric Risk of Mortality) score is physiologically based score that predicts morbidity and mortality risk according to the changes of normal values during disease period. This was a score designed by Pollack *et al* in 1988[16]. The purpose of study was to evaluate the PRISM scoring system in predicting the morbidity and mortality rate in PICU patients. PRISM score was calculated according to guidelines and the score was used for individual patient to predict the outcome. The mean cut off value of PRISM score in the study observed was 9.3±3.3. Considering 9.0 as the cut off value for the present study, 60% had score less than 9 with 10% mortality, 40% had score more than 9 with 47.5% mortality. Increased score had more prediction of mortality after crossing the average mean score[9, 10]. In R Bellad *et al* study, mean PRISM score for survivors was 6.5± 3.6 and 15.5±7 for non-survivors[11]. In our study survivors showed mean PRISM score of 6.04 while non-survivors had mean PRISM score of 12.72. This study showed that increased prediction of mortality was

observed with increase in the score and with lower PRISM score definitely have better outcome for survival.

Conclusion

Patients admitted in PICU with emergency signs required immediate intervention as accurate diagnosis of metabolic disturbances was lifesaving. Majority of patients admitted in PICU had abnormal acid base disorder on presentation and poor outcome is seen in such patients. Metabolic acidosis is the most common acid base abnormality observed followed by respiratory alkalosis. Mortality is highest in patients presenting with a Respiratory acidosis. Hyponatremia is the most common observed electrolyte disturbance with maximum mortality. Major risk factor for mortality were hyponatremia, hypokalemia, respiratory acidosis and metabolic acidosis. Metabolic disturbances and electrolytes disturbances in infancy are associated with fatal outcome. PRISM score was used in the present study because less number of parameters are required without losing its predictive value. PRISM Score was useful in predicting the survival and mortality. It would be advisable to individualise and interpret the PRISM score according to the hospital setting.

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