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Original Research Paper

Paediatrics

STUDY OF MORTALITY IN CHILDREN WITH ELECTROLYTE ABNORMALITIES IN PEDIATRIC INTENSIVE CARE UNIT

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ABSTRACT

Background: Electrolyte abnormalities are common in ill children requiring the intensive care. As the electrolytes play an important role to maintain homeostasis and has impact on the final outcome of the patient, the present study was undertaken. The aims of this study was to determine the prevalence of electrolyte abnormalities in children admitted in Pediatric Intensive Care Unit at the time of admission, primary organ involvement seen and the mortality associated with it. **Methods:** The study enrolled all the patients from 1 month to 12 years admitted in PICU of a tertiary care hospital during January 2019 to June 2020 (18 months). The children were divided according to the presence or absence of electrolyte abnormality. The organ system involved was analyzed in each group. **Results:** The prevalence of electrolyte abnormality in terms of sodium and potassium in the present study was 55.56% (100 of 180). The most common electrolyte abnormality was hyponatremia (30.6%) followed by hypokalemia (20.6%). The mortality in children with electrolyte abnormality was significantly higher than mortality in those without electrolyte abnormality and was found to be 51.7% in the present study. Maximum children with hyponatremia had infections (23.6%) and those with hypernatremia had gastrointestinal involvement (17.6%). Hypokalemia was most frequently seen in cases of respiratory involvement (27%) and hyperkalemia seen in renal involvement (25%). **Conclusion:** There is significant association of the electrolyte abnormalities at admission in PICU with mortality and primary system involvement, which was seen in the present study. Close monitoring and correction of electrolyte abnormalities reduces the mortality in ill children.

KEYWORDS : Homeostasis, Intensive care unit, Mortality.

INTRODUCTION

Electrolyte abnormalities are common in critically ill children who need intensive care and occur in a variety of conditions and may remain unrecognized and result in morbidity and mortality irrespective of the primary problem.[1]

Understanding of common electrolyte abnormalities, early recognition, prompt correction and maintaining homeostasis in the body is vital for the final outcome of these children.2 Electrolyte imbalance can occur due to many possibilities like underlying disease itself, fluid and electrolyte intervention, end organ injury, due to use of electrolyte deranging medications and Positive Pressure Ventilation (PPV).

Critical care provision through paediatric intensive care units (PICU) is aimed at maintaining the 'homeostasis' in the body which is vital for the optimal functioning of the organ systems. This involves not only fluids but also electrolyte balance.

Sodium (Na+) is the most abundant cation in the extracellular fluid, ranging from 135-145 mEq/l. Amongst all the electrolytes, sodium is unique in the sense that it is closely regulated by water balance. The serum osmolality is determined by sodium and is therefore responsible for the maintenance of intravascular volume.1,3 The incidence of either hypernatremia or hyponatremia in the intensive care unit is around 30% and are an independent risk factor for poor prognosis.[4]

Potassium (K+) is the predominant cation in the ICF. Its concentration within intracellular compartment is from 150-160 mEq/l while serum ranges from 3.5-5 mEq/l.1,6 The Na+,K+ ATPase maintains this concentration which is much higher than the plasma. For maintenance of the resting membrane potential and neuromuscular functions, the normal ratio between extracellular and intracellular compartment is necessary.[7]

Thorough understanding of common electrolyte abnormalities helps in early recognition and prompt correction of these imbalances which is essential to avoid poor outcome.[1,4,8]

The present study was undertaken keeping in mind the importance of electrolyte homeostasis and its significant impact on the final outcome of the patient, to study the association of electrolyte abnormalities at admission with mortality in children admitted in pediatric intensive care unit. Since sodium and potassium are the electrolytes most frequently deranged in critically ill patients, we are studying these electrolytes in present study. We will also study the association of primary organ system involvement with electrolyte abnormalities present at admission and their association with the mortality.

METHODS

The study was conducted in the Pediatric Intensive Care Unit at a tertiary care hospital after obtaining approval of the Institutional Ethics Committee. We enrolled all the patients admitted in PICU of age 1 month to 12 years during January 2019 to June 2020 excluding those children who were referred from other hospitals after any form of treatment. At the time of admission, the patient's clinical picture was recorded in a prefixed case proforma consisting of age, sex, date of admission, provisional clinical diagnosis, duration of PICU stay, organ system primarily involved and final outcome in terms of discharge or death. Information of blood investigations like serum electrolytes (sodium, potassium) at admission (within 1 hr of admission) was collected.

Definitions

Hyponatremia and hypernatremia were defined as serum sodium concentration below 135 mEq/L and above 145 mEq/L respectively. Hypokalemia and hyperkalemia were defined as potassium level below 3.5 mEq/L and above 5.5 mEq/L respectively.[6]

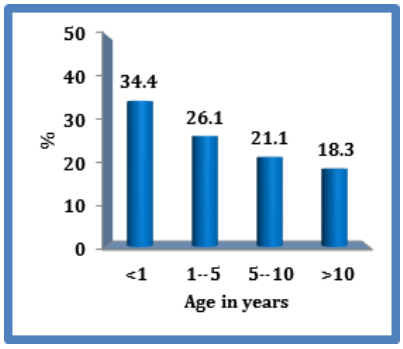
Statistical methods

All data was entered in a master chart in Microsoft Excel sheet and was analysed using open Epi software version 2.3.1. Qualitative data was represented in form of frequency and percentage and analyzed using Chi Square test or Fischer's F test as per the normality test. P value less than 0.05 was considered to be statistically significant.

RESULTS

We studied 180 children admitted in the PICU of a tertiary care hospital, of which infants constituted the maximum number of admissions (34.4%). Maximum number of admissions had central nervous system involvement (25.6%) followed by respiratory system (20.6%).

Graph 1: age wise distribution of study population.

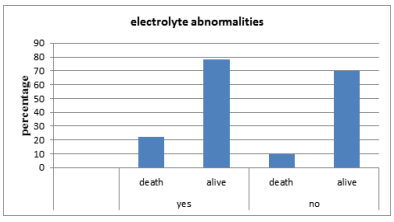


The prevalence of electrolyte abnormalities in our study was 55.56% (100 out of 180) in terms of sodium and potassium abnormality. The most common electrolyte abnormality was hyponatremia (30.6%) followed by hypokalemia (20.6%). Hypernatremia was observed in 9.4% and hyperkalemia in 15.6% cases.

The mortality in patients with hyponatremia and hypernatremia was 21.9% and 25% respectively, which was significantly higher than the mortality in normonatremic patients which was 15.7%. The association of hyponatremia and hypernatremmia at admission with mortality was found to be statistically significant. (p value=0.02)

The mortality in the group with hypokalemia and hyperkalemia was found to be 31.3% and 15.6% which was higher than the mortality in the group with normokalemia which was 14.7%. However, the association was not statistically significant. (p value=0.14)

Graph 2: Outcome of study population in presence and absence of electrolyte abnormality.



The association of primary organ syatem involvement with the presence of electrolyte abnormality was found statistically significant (p=0.01). Maximum number of study participants with hyponatremia had repiratory (20%) followed by central nervous system involvement (14.5%) and those with hypernatremia had maximum of gastrointestinal system involvement (17.6%)

Hypokalemia was most frequently observed in patients with repiratory involvement (27%) and hyperkalemia with renal involvement (25%).

Table 1: Association of sodium values with the primary organ system involved in the study.

System Involvement	S Sodium					
	Hyponatremia		Normal		Hypernatremia	
	Count	%	Count	%	Count	%
Respiratory	11	20.0%	23	21.3%	3	17.6%
CNS	11	20.0%	35	32.4%	3	17.6%
CVS	3	5.5%	2	1.9%	2	11.8%
GIT	6	10.9%	7	6.5%	3	17.6%
Renal	5	9.1%	7	6.5%	1	5.9%
Hepatobiliary	3	5.5%	3	2.8%	1	5.9%
Metabolic	0	0.0%	4	3.7%	2	11.8%
Infections	10	18.2%	11	10.2%	1	5.9%
Sepsis	5	9.1%	5	4.6%	1	5.9%
Hemato Oncology	1	1.8%	2	1.9%	0	0.0%
Poisoning	0	0.0%	7	6.5%	0	0.0%
RTA	0	0.0%	2	1.9%	0	0.0%
Total	55	100.0%	108	100.0%	17	100.0%

Table 2: Association of potassium values with the primary organ system involved in the study.

System Involvement	S Potassium					
	Hypokalemia		Normal		Hyperkalemia	
	Count	%	Count	%	Count	%
Respiratory	10	27.0%	24	20.9%	3	10.7%
CNS	3	8.1%	39	33.9%	4	14.3%
CVS	1	2.7%	5	4.3%	1	3.6%
GIT	1	2.7%	12	10.4%	3	10.7%
Renal	2	5.4%	4	3.5%	7	25.0%
Hepatobiliary	3	8.1%	4	3.5%	0	0.0%
Metabolic	4	10.8%	1	0.9%	1	3.6%
Infections	4	10.8%	15	13.0%	6	21.4%
Sepsis	5	13.5%	3	2.6%	3	10.7%
Hemato Oncology	0	0.0%	3	2.6%	0	0.0%
Poisoning	2	5.4%	5	4.3%	0	0.0%
RTA	2	5.4%	0	0.0%	0	0.0%
Total	37	100.0%	115	100.0%	28	100.0%

DISCUSSION

In the present study which was done in a tertiary care center including 180 study participants, the overall mortality of patients was 21.1%. Similar mortality rate was observed in the studies done by Jain M et al and Panda I et al which were 22.8% and 23.73% respectively and these studies were also conducted in tertiary care hospitals.[1,7]

Present study showed electrolyte abnormality (sodium, potassium) in 55.56% patients (n= 100). The prevalence of electrolyte abnormality in the present study was found to be higher compared to study done by Panda I et al which had 44.31% patients with electrolyte abnormality and by Rao SSD et al which had 32.45% patients.1,10 This difference in the prevalence of electrolyte abnormalities may be attributed to the different subset of the study population. The mortality in patients with electrolyte abnormality was found to be 22.0% in the present study, similar to studies done by Rao SSD et al which showed 24.2% and Panda I et al which showed 28.8% mortality in patients with electrolyte abnormalities.[1,10]

We found hyponatremia in 30.6% of patients, it was the most common electrolyte abnormality in patients, admitted to PICU at the time of admission and hypernatremia in 9.4% of patients. Similar results were found in a study conducted by Ebrahim SAE et al which showed 23.33% patients with hyponatremia and 11.66% patients with hypernatremia on admission to PICU. In the study by Jain M et al, hyponatremia and hypernatremia were seen in 12.85% and 5.71% patients respectively.7,11 Lesser patients with hyponatremia in their study can be explained by the exclusion of acute diarrhoeal diseases in their study population. A higher frequency of hyponatremia of 29.8% and 27.4% were observed in the studies done by Singhi S et al and Panda I et al respectively which was similar to the present study.[1,2]

We observed high incidence of hyponatremia in children with central nervous system disorders (20%) and respiratory disorders (20%). This observation of hyponatremia of high incidence in children with CNS disorder was found consistent with the findings of Reddy et al and Agarwal N et al.8 Hyponatremia in acutely ill children was associated with higher mortality (21.9%) which is statistically significant and is in agreement with the findings of Rao and Thomas (20.7%), Agarwal N et al (14.2%) and Singhi et al (13.2%).2,8,12 Present study found a significant association of mortality with the presence of hyponatremia (21.9%) and hypernatremia (25%) at admission. The mortality with hyponatremia and hypernatremia was observed to be 20.7% and 33.3% respectively in the study done by Rao SSD et al.10 Jain M et al in his study on patient population found the mortality associated with hyponatremia and hypernatremia to be 55.5% and 50% respectively.[7]

In the present study, hypokalemia was found in 20.6% cases, being the second most common electrolyte abnormality and hyperkalemia in 15.6% cases. Rao SSD et al and Jain M et al however, found hypokalemia as least common abnormality in their study seen in 3.6% and 5.7% cases respectively.7,10 This difference could be explained as these studies have excluded the diarrheal diseases. Hyperkalemia in their studies was seen in 14.4% and 11.4% cases repectively. In the study by Agarwal N et al results were similar to the present study with hypokalemia observed in 34.4% cases and hyperkalemia in 16.1% cases respectively.8 Much higher potassium abnormality was observed in the study conducted by Cummings BM et al with hypokalemia in 40% and hyperkalemia in 29% cases.13 This could be explained by the serial electrolyte measurements considered in their study. In the present study, only electrolyte values at admission were considered. Of the total 38 deaths in the present study, 22 patients (57.89%) had electrolyte abnormality. Mortality in the hypokalemia and hyperkalemic group was 31.3% and 15.6% repectively, the association being not statistically significant. In the study by Singhi S et al, the mortality among hypokalemia was 15% and hyperkalemia was 10.3%.2 Presence of concomitant electrolyte abnormality further aggravated the risk of mortality.

Significant association was found of potassium abnormalities with the primary organ system involved in the present study. Hypokalemia was most commonly associated with repiratory disorders. Among patients with hyperkalemia, 25% had renal involvement in form of acute or chronic renal failure.

Our study emphasizes the significant mortality in children admitted in PICU with sodium abnormality. The association of mortality with potassium abnormality at admission was not statistically significant in the present study, but mortality was higher as compared to normal population. So, electrolyte abnormality at admission should be appropriately measured and treated aggressively to maintain the homeostasis. The early recognition of electrolyte disturbances at admission and the its treatment helps to improve the outcome in the patients.
There are certain limitations of the present study. Our sample size was small and cannot be applied to general population as the study was conducted in a tertiary care centre. We have not recorded the serial electrolyte values after admission. So we might have missed subsequent electrolyte abnormalities during the hospital stay.

CONCLUSION

Electrolyte abnormalities are common in children admitted to intensive care unit all over the world. They occur in a wide range of conditions and may remain unrecognized which results in morbidity and mortality. They develop or are frequently exacerbated during hospitalization and are associated with increased length of stay and mortality. Hence, regular monitoring of electrolytes play a significant role in prevention of morbidity and mortality in critically ill children.

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