

Frequency of Electrolyte Disorders and Its Effect On Mortality Among Children Admitted In Pediatric Intensive Care Unit

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ABSTRACT

Objective: To determine the frequency of electrolyte disorders, i.e., serum sodium and potassium and to evaluate its effect on mortality rate among children admitted at the pediatric intensive care unit.

Study Design and Setting: This was a descriptive cross sectional study conducted at Pediatric Intensive care unit of Civil Hospital Karachi from April to December 2017

Methodology: Informed consent was obtained from 150 parents of the children who fulfill the inclusion criteria. Laboratory data (serum sodium and serum potassium) were recorded during the stay in the pediatric intensive care unit. Data was analyzed using SPSS version 20. Mean \pm S.D was calculated for quantitative variables. Frequency and percentage were calculated for gender, electrolyte disorders and mortality. Effect modifiers were controlled by stratification of age, gender and electrolyte disorders (Hypernatremia, Hyponatremia, Hyperkalemia, and Hypokalemia). Post-stratification, Chi-squared test was applied. P-value = 0.05 was taken as significant.

Results: Out of 150 patients, electrolyte disorders in terms of serum sodium and potassium, were found in 86(57.3%) children. Mortality in children with electrolyte disorders was found to be 46(53.5%) which was significantly higher ($P < 0.001$) than patients without electrolyte disorders 40(46.5%). Hypernatremia was found in 48(32%), hyponatremia 24(16%), hyperkalemia 21(14%) and hypokalemia in 42(28%) patients. In comparison; of electrolyte disorders with mortality; significant association was found in hypernatremia ($P < 0.001$), and hyperkalemia ($P < 0.001$).

Conclusion: The most common electrolyte abnormalities were hypernatremia and hypokalemia. Mortality was significantly higher in subjects with electrolyte disorders, especially hypernatremia and hyperkalemia.

Keywords: Electrolyte Disorders, Intensive care unit (ICU), Mortality, Potassium, Sodium

INTRODUCTION:

Electrolytes such as sodium and potassium play a vital role in maintaining cellular structure and function, generating energy and controlling the potential for action across cell membranes, especially those of muscles and nerve cells, which play an important role in critically ill patient's outcome.^{1,2} Any disruption in the serum level of these

electrolytes may lead to a variety of clinical disorders including neuromuscular dysfunction and life-threatening cardiac arrhythmias, particularly where more than one electrolyte is deficient.^{3,4} The most severe complications of hypokalemia are cardiac arrhythmia and acute respiratory failures due to respiratory muscles paralysis while other adverse effects include muscle weakness, fatigue, rhabdomyolysis, nausea and constipation.^{5, 6} Although hyperkalemia is associated with neuromuscular symptoms such as extreme muscle weakness or ascending muscle paralysis, it can also cause paresthesias, palpitation, and cardiac conduction that can lead to adverse outcome in patients in intensive care unit patients.⁷ Hyponatremia is also a frequent electrolyte abnormality observed in critically ill patients.^{8, 9} Severe acute decline in serum sodium concentration may cause neurologic dysfunction such as seizures and coma. The most severe complication of hyponatremia is cerebral edema that may lead to catastrophic conditions like brain stem herniation and cardiac arrest¹⁰. On the other hand; hypernatremia can cause brain hemorrhage like subdural and subarachnoid hemorrhages due to the rupture of bridging veins because of a decrease in brain volume. The clinical symptoms are progressive that might commence with irritability, agitation, lethargy, and irritability and can progress to twitching, seizures, and coma¹¹. Thus, maintaining the levels of potassium and sodium within acceptable limits is therefore well understood in most

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intensive care units. They are known as prognostic predictors and their disruption can be avoided by considering the appropriate intravenous fluids and nutrition¹².

Ample literature on electrolyte imbalance have concentrated on the occurrence and prevalence of such electrolyte disorders in patients in the intensive care unit but there is scarce literature on the impact of such disorders on mortality rate. Pakistan has a greater number of children with electrolyte disorders admitted every day to pediatric intensive care unit. Despite of this, the research on the prevalence of electrolyte disorders and its effect on mortality rates are lacking within our population. In fact, due to a lack of resources and clinical expertise about the treatment of electrolyte disorders, mortality in our population is estimated to be higher than in the western world.^{13,14} Therefore, the aim of this study was not only to assess the frequency of serum sodium and potassium disorders but also to assess their effects on mortality rate in children admitted to the pediatric intensive care unit in Civil Hospital Karachi. The outcome of this study would be beneficial to take aggressive measures against electrolyte imbalances to reduce the mortality.

METHODOLOGY:

All children between the ages of 2 months to 12 years who were admitted in Pediatric Intensive Care Unit, Civil Hospital Karachi from April to December 2017 with duration of at least 48 hours of PICU stay, were included in the study. Patients undergoing emergency or elective surgical procedures, patients on diuretic therapy and patients with documented chronic or co-morbid illness were excluded such as endocrinopathy, cerebral palsy, chronic liver disease, congenital heart disease. Patients were enrolled through non-probability consecutive sampling. The demographic data of all the participants regarding age, sex and admitting diagnosis was noted on a predesigned proforma. Blood samples were drawn on admission to find out the initial serum levels of sodium, potassium. Then, the levels were repeated 24 hourly or earlier (if needed). Determination of electrolytes was the standard examination in all patients admitted to the pediatric intensive care unit at Civil Hospital, Karachi. No personal identity revelation was made on the questionnaires and confidentiality of all data was maintained during the study phases. There is no conflict of interest or funding source to declare. The normal serum levels of sodium and potassium are given below¹⁵.

Normal serum sodium level 135mEq/L-145 mEq/L.

Normal serum potassium level 3.4mEq/L-5.3 mEq/L.

Any value below or above the following cut-off values was considered to be anomalous suggesting an electrolyte imbalance.

For this study, Mortality was recorded for those patients, who died after at least 48 hours of admission in Pediatric Intensive care unit. Sample size of the study (n=142) was

calculated by taking prevalence of hypernatremia i.e. 6.3%.¹⁶ Confidence Interval of 95% and margin of error 4%. For convenience, a total of 150 patients were enrolled. Data was analyzed using SPSS version 20. Mean \pm S.D was calculated for quantitative variables. Frequency and percentage were calculated for gender, diagnosis at admission, electrolyte disorders and mortality. Effect modifiers were controlled by stratification of age, gender and electrolyte disorders (Hypernatremia, Hyponatremia, Hyperkalemia, and Hypokalemia). Post-stratification, Chi-squared test was applied. P-value = 0.05 was taken as significant.

RESULTS:

A total number of 150 patients were included in this analysis with a mean age of 50.33 months \pm 46.46 (Table.1) with Confidence Interval (42.84-57.83). Out of these 150 patients, 93 (62%) were male and 57 (38%) were female. Regarding the admitting diagnosis, majority i.e. 52 (34.66%) had respiratory illness, 36(24%) had neurological illness, 28 (18.66%) had sepsis/infection, 12 (8%) had cardiovascular problem, 10 (6.66%) had gastrointestinal ailment and 12(8%) were categorized in miscellaneous group including endocrine diseases.

Mixed electrolyte disorders (serum sodium and potassium abnormality) were found in 86(57.33%) children. Hypernatremia was found in 48(32%), Hyponatremia 24(16%), Hyperkalemia 21(14%) and Hypokalemia was found in 42(28%) children. Hypernatremia and Hyperkalemia were significantly more common in patients who expired (62.5%) (P=0.0001), and (28.8%) (P=0.0001) respectively (Figure2 & 3).

Overall, mortality was found to be 34.66% (52 out of 150 patients). Mortality in children with electrolyte disorders was found to be 46(53.5%) which was significantly higher (P=0.0001) than children without electrolyte disorders 40(46.5%)(Figure1).

DISCUSSION:

This comprehensive case study was carried out at Civil Hospital Karachi to assess the prevalence of electrolyte disorders and their impact on mortality in children admitted in pediatric intensive care unit.

Fluids and electrolyte disturbances are one of the most common clinical problems encountered in the intensive care unit. Disturbances in fluid and electrolyte homeostasis can occur in critical conditions such as severe burns, sepsis, trauma, heart failure and brain damage. In most cases, electrolyte disturbances may remain subtle and may lead to higher mortality and morbidity.¹⁷

In our study, mixed electrolyte disorders were found in 86(57.33%) children. Since the four electrolyte disorders (Hypo/Hypernatremia, Hypo/Hyperkalemia) were considered together and imbalance among any of them was noted, this might be the reason for the high incidence. Cummings BM

Table 1. Demographic characteristics and main clinical variables (n=150)

Parameter	Frequency	Percentage%
Mean Age(in months)	55.33±46.46	
Gender		
Boy	93	62
Girls	57	38
Admitting diagnosis		
Respiratory	52	34.66
CNS	36	24
Sepsis/infection	28	18.66
CVS	12	8
GIT	10	6.66
Miscellaneous	12	8
Electrolyte Disorders		
Yes	86	57.33
No	64	42.77
Hypernatremia		
Yes	48	32
No	102	68
Hyponatremia		
Yes	24	16
No	126	84
Hyperkalemia		
Yes	21	14
No	129	86
Hypokalemia		
Yes	42	28
No	108	72
Patients Survived		
Yes	98	65.34
No	52	34.66

Figure 1. Comparison Of Overall Mortality With Mixed Electrolyte Disorders (N=150)

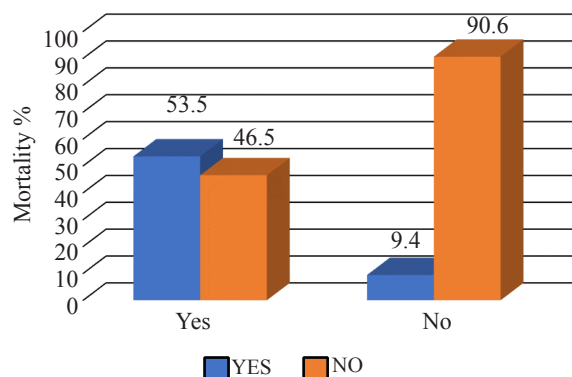


Figure 2. Comparison of mortality with serum sodium levels (n= 150)

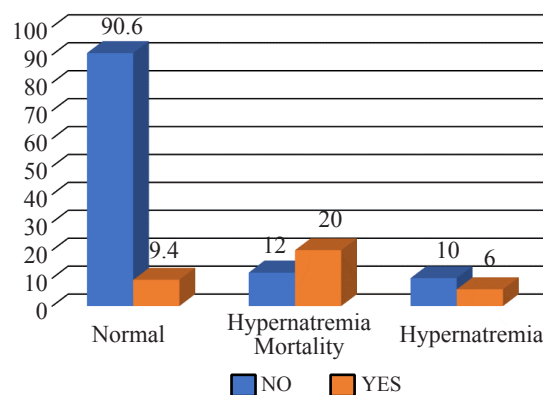
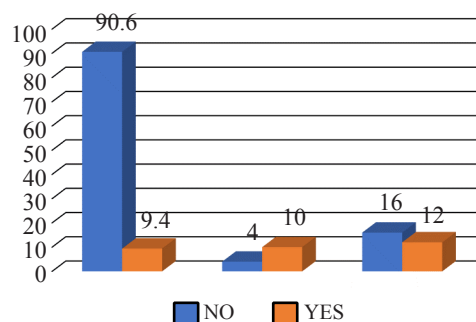


Figure 3. Comparison of mortality with serum potassium levels (n= 150)



found potassium abnormalities alone to be around 40%.¹⁸ Another study focused at all five electrolytes showed 60% incidence.² This proves the statement that electrolyte abnormalities are very common in critically ill children.

Majority had respiratory (34.66%), neurological (24%) and infective/sepsis (18.66%) etiology as noted in previous studies.^{2, 19, 20} The reason for less number of gastrointestinal cases (3.96%) could be the initial stabilization in ER and later shifting to ward upon improvement thus bypassing the PICU stay. This is important because gastroenteritis in children is the major source of electrolyte imbalance, but prompt and proper treatment may avoid PICU admission.

A study conducted in Kathmandu identified hyponatremia to be 56%, followed by hypokalemia 46%. Almost 37% of patients had mixed electrolyte imbalances²¹. However, our study showed hyponatremia (16%), hypokalemia (28%) and mixed electrolyte disorders (57.33%)

In another study, published in India, mixed electrolyte imbalances were observed in 33% of children. The most frequent electrolyte imbalance was Hyperkalemia which was found in 14.4% similar to our study in which hyperkalemia was found in 14% patients. Hyponatremia was found to be 6.9% compared to 16% of hyponatremia in our study²².

Another prospective study showed that severe hyponatremia was associated with three fold increase risk of morbidity and mortality²³.

Most of the literature has reported hyponatremia to be more prevalent than hypernatremia i.e. 23.2% vs. 16.7%¹⁵, 27.43% vs. 3.5%⁶, 50.5% vs. 9.4%². Sachdev A noted hyponatremia to be 19.3%²⁰. However, hypernatremia was found in 48% of cases and hyponatremia in 16% cases. This might be due to the institutional policy of using 0.9% dextrose saline as maintenance intravenous fluid rather than half strength or other hypotonic solutions in children above one month of age.

One research concluded that potassium imbalance is frequent among children admitted in PICU. Hyperkalemia was observed in 5.4% of 727 children enrolled in this study, while in our study hyperkalemia was reported in 14%. This variation in prevalence could be due to the fact that in this study hyperkalemia was defined as a serum potassium value > 6 mEq / L. However, in this study serum potassium levels > 5.3 mEq / L are considered to be hyperkalemia.²⁴

In a study conducted by Kathryn Maitland, it was found that extreme hyperkalemia was associated with falciparum malaria in 9 children (16%), of whom 7 (78%) died shortly after admission²⁵.

Overall mortality in this study was 34.66% (52/150). However, mortality documented by Panda I was 23.73%⁶ and by Jan M et al as 22.8%²⁶.

In one local study, results showed that out of 101 children enrolled, electrolyte imbalances were present in 85 (84.15%) children. Among these patients, the most frequent abnormality noted was hypocalcemia which was seen in 49 (57.64%) patients, followed by hypernatremia in 32 (37.64%) cases and hypophosphatemia in 30 (35.29%) patients. Hypokalemia was observed in 26 (30.58%) and hypermagnesemia in 18 (21.17%) children. The study found that electrolyte imbalances in critically ill children are associated with a higher risk of mortality. Early mortality, i.e. within 48 hours of admission, was reported in 14 cases of which 12 had electrolyte disturbances.²⁷

In another study carried out at a hospital in India in PICU, results revealed that out of 132 children enrolled in the study, 71 (53.79%) had an electrolyte abnormalities. Among these patients, 29 (40.85%) had hyponatremia, 9 (12.68%) had hypernatremia, 13 (18.31%) had hyperkalemia, 8 (11.27%) had hypokalemia. They also found that patients with electrolyte abnormalities had relatively longer hospital stays.²⁸ The limitation of this study was the smaller sample size; a study with large sample size with multiple centers in Pakistan to validate the results of should be conducted in future. Electrolyte disturbances in children become obvious during illness and early detection and management of these derangements is essential to avoid serious life-threatening situation. They are considered as significant and reliable

indicator of mortality as shown by this study. Another limitation as this study was that the mortality might be primarily due to underlying clinical disorder and not the electrolyte disturbances. For this purpose, children with documented chronic or co-morbid illnesses should have been excluded and mortality was recorded only in those patients with duration of PICU stay of at least 48 hours. Serial serum electrolytes tests are helpful in preventing severe life-threatening circumstances. Thus, the need for early interventions to correct these imbalances is imperative in reducing the mortality.

CONCLUSION:

The results of this study showed higher mortality in children with electrolyte disorders especially hypernatremia and hyperkalemia, thus, concluding that electrolyte imbalance was a significant predictor of prognosis in seriously ill patients.

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