

Prevalence of Electrolyte Abnormalities in Critically Ill Children Admitted to a Paediatric Intensive Care Unit.

Abstract:

Background: Electrolyte disturbances are frequently encountered in critically ill children admitted to the paediatric intensive care unit (PICU). These abnormalities may result from the underlying disease process, altered physiological responses to critical illness, or therapeutic interventions. A wide range of conditions, including respiratory infections, acute gastroenteritis, central nervous system disorders, sepsis, trauma, burns, cardiac diseases, postoperative states, and congenital disorders, can disrupt fluid and electrolyte homeostasis. Early identification and appropriate correction of electrolyte abnormalities are essential for optimizing clinical management and preventing complications in critically ill children.

Aim

To determine the prevalence and pattern of electrolyte abnormalities among critically ill children admitted to the Paediatric Intensive Care Unit and to assess their association with the primary organ system involved.

Methods

A hospital-based observational study was conducted in the Paediatric Intensive Care Unit (PICU) of a tertiary care teaching hospital over a period of 10 months, from May 2024 to February 2025. Children aged 1 month to 12 years admitted to the PICU during the study period were enrolled after obtaining informed consent from their parents or legal guardians. Demographic and clinical details were recorded using a predesigned proforma. Serum electrolyte levels (sodium and potassium) were measured at the time of admission, and participants were categorized based on the presence or absence of electrolyte abnormalities. The frequency and pattern of electrolyte abnormalities were analysed in relation to the primary organ system involved.

Results

A total of 90 children were included in the study, with infants constituting the largest age group (36.7%). Sodium abnormalities were identified in 35 (38.9%) children, of whom 27 (30.0%) had hyponatremia and 8 (8.9%) had hypernatremia. Potassium abnormalities were observed in 33 (36.7%) children, including 19 (21.1%) with hypokalemia and 14 (15.6%) with hyperkalemia. Hyponatremia was most frequently observed in children with respiratory

disorders and infectious diseases (18.5% each), while hyponatremia was more common among those with respiratory and central nervous system disorders (25.0% each). Hypokalemia was most commonly associated with respiratory system involvement (31.6%), whereas hyperkalemia was most frequently seen in children with infectious diseases (21.4%).

Conclusion

Electrolyte abnormalities are common among critically ill children admitted to the Paediatric Intensive Care Unit, with hyponatremia and hypokalemia being the most frequently encountered disturbances. Significant associations were observed between electrolyte abnormalities and the primary organ system involved. Routine electrolyte assessment at the time of PICU admission, along with early recognition and timely correction of these abnormalities, is essential for optimizing clinical management and preventing complications in critically ill children.

Keywords: Electrolyte abnormalities, Hyponatremia, Hypermnatremia, Hypokalemia, Hyperkalemia, Paediatric Intensive Care Unit, Critically ill children.

Introduction:

Electrolyte disturbances are among the most frequently encountered metabolic abnormalities in critically ill children admitted to the paediatric intensive care unit (PICU). These derangements may occur secondary to the underlying illness or as a consequence of therapeutic interventions and can adversely affect physiological homeostasis if not recognized and managed promptly.¹

Maintenance of fluid and electrolyte balance is fundamental to the management of critically ill children. Electrolyte imbalances may result from disease processes, altered fluid therapy, end-organ dysfunction, iatrogenic factors, or positive pressure ventilation. Early identification and timely correction of these abnormalities are essential to restore homeostasis and support optimal organ function in critically ill patients.²

The primary objective of intensive care is to maintain physiological homeostasis and preserve normal organ function. Among the various electrolytes, sodium and potassium play a pivotal role in maintaining fluid

balance, cellular function, and neuromuscular activity. Disturbances in these electrolytes are commonly encountered in children admitted to the PICU.³

Sodium is the principal extracellular cation and the major determinant of serum osmolality and extracellular fluid volume. Alterations in sodium homeostasis are common in critically ill children and may occur in a wide range of clinical conditions. Previous studies have reported a high prevalence of hyponatremia and hypernatremia among children admitted to intensive care units, highlighting the need for routine electrolyte assessment at admission.^{4,5}

Potassium is the predominant intracellular cation, with an intracellular concentration of approximately 150-160 mEq/L and a normal serum concentration of 3.5-5.0 mEq/L. This concentration gradient is maintained by the Na⁺/K⁺-ATPase pump and is essential for maintaining the resting membrane potential, neuromuscular excitability, and normal cellular function.⁶ Potassium abnormalities are also frequently encountered in critically ill children and require prompt recognition and appropriate management.⁷

Considering the high frequency of sodium and potassium abnormalities in critically ill children and their potential impact on clinical management, the present study was undertaken to determine the prevalence and pattern of electrolyte abnormalities among children admitted to the PICU and to evaluate their association with the primary organ system involved.

Methods:-

After obtaining approval from the Institutional Ethics Committee, a hospital-based observational study was conducted in the Paediatric Intensive Care Unit (PICU) of a tertiary care teaching hospital over a period of 10 months, from May 2024 to February 2025. Children aged 1 month to 12 years admitted to the PICU during the study period were enrolled in the study after obtaining written informed consent from their parents or legal guardians. Children referred from other hospitals after receiving treatment and those whose caregivers did not provide consent were excluded from the study.

Demographic and clinical details, including age, sex, date of admission, provisional diagnosis, duration of PICU stay, and the primary organ system

involved, were recorded using a predesigned case record proforma. Venous blood samples were collected within one hour of admission for estimation of serum electrolyte levels (sodium and potassium). Patients were subsequently categorized based on the presence or absence of electrolyte abnormalities, and the pattern of electrolyte disturbances was analysed in relation to the primary organ system involved

Definition:

Hyponatremia-SerumSodium<135mmol/dL

Hypernatremia-SerumSodium>145mmol/dL

Hypokalemia-SerumPotassium<3.5mmol/dL

Hyperkalemia-SerumPotassium>5.5mmol/dL

Statistical analysis

All data were entered into a Microsoft Excel spreadsheet and analysed using OpenEpi software (version 2.3.1). Categorical variables were expressed as frequencies and percentages. Associations between categorical variables were analysed using the Chi-square test or Fisher's exact test, as appropriate. A p value of <0.05 was considered statistically significant.

Results

A total of 90 children admitted to the Paediatric Intensive Care Unit (PICU) were included in the study. Infants constituted the largest age group, accounting for 36.7% of the study population. The respiratory system was the most commonly involved primary organ system (31.1%), followed by the central nervous system (13.3%).

Sodium abnormalities were observed in 35(38.9%) children, while potassium abnormalities were present in 33 (36.7%) children. Hyponatremia (30.0%) was the most frequently encountered electrolyte abnormality, followed by hypokalemia (21.1%), hyperkalemia (15.6%), and hypernatremia (8.9%).

A statistically significant association was observed between serum sodium abnormalities and the primary organ system involved ($p = 0.01$). Hyponatremia was most frequently seen in children with respiratory disorders and infectious diseases (18.5% each), whereas hypernatremia was more commonly observed

among children with respiratory and central nervous system disorders (25.0% each).

Similarly, a statistically significant association was found between serum potassium abnormalities and the primary organ system involved ($p = 0.01$). Hypokalemia was most commonly associated with respiratory system involvement (31.6%), while hyperkalemia was most frequently observed in children with infectious diseases (21.4%).

Age	N	%
<1year	33	36.6
1-5year	24	26.6
6-10year	18	20.0
>10year	15	16.6

SystemInvolvement	SerumPotassium					
	Hypokalemia		Normal		Hyperkalemia	
	N	%	N	%	N	%
Respiratory	6	31.6	20	35.08%	2	14.28%
CNS	3	15.7%	8	14.03%	1	7.14%
CVS	0	0.00%	2	3.50%	0	0.00%
GIT	2	10.5%	6	10.52%	2	14.28%
Renal	1	5.26%	3	5.26%	2	14.28%
Hepatobiliary	1	5.26%	2	3.50%	0	0.00%

Metabolic	2	10.5%	3	5.26%	2	14.28%
Infections	1	5.26%	6	10.52%	3	21.42%
Sepsis	2	10.5%	3	5.26%	2	14.28%
HematoOncology	0	0.00%	1	1.75%	0	0.00%
Poisoning	1	5.26%	1	1.75%	0	0.00%
RTA	0	0.00%	2	3.50%	0	0.00%
Total	19	100.00%	57	100.00%	14	100.00%

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SystemInvolvement	SerumSodium					
	Hyponatremia		Normal		Hypernatremia	
	N	%	N	%	N	%
Respiratory	5	18.51%	21	38.18%	2	25.00%
CNS	4	14.81%	6	10.90%	2	25.00%
CVS	1	3.70%	1	1.81%	0	0.00%
GIT	4	14.81%	5	9.09%	1	12.5%
Renal	1	3.70%	4	7.27%	1	12.5%
Hepatobiliary	2	7.40%	1	1.81%	0	0.00%
Metabolic	2	7.40%	4	7.27%	1	12.5%

Infections	5	18.51%	5	9.09%	0	0.00%
Sepsis	1	3.70%	5	9.09%	1	12.5%
HematoOncology	1	3.70%	0	0.00%	0	0.00%
Poisoning	0	0.00%	2	3.63%	0	0.00%
RTA	1	3.70%	1	1.81%	0	0.00%
Total	27	100.00%	55	100.00%	8	100.00%

Discussion

Electrolyte disturbances are frequently encountered in critically ill children and represent an important challenge in the management of patients admitted to the Paediatric Intensive Care Unit (PICU). Alterations in sodium and potassium homeostasis may occur due to the underlying disease process, altered physiological responses to critical illness, or therapeutic interventions. Early recognition and correction of these abnormalities are essential for maintaining normal cellular and organ function.^{1,3}

In the present study, sodium abnormalities were observed in 38.9% of the study population, while potassium abnormalities were identified in 36.7% of children admitted to the PICU. These findings indicate that electrolyte disturbances are common among critically ill children. The prevalence observed in our study is comparable with previous studies conducted by Panda et al., Elala et al., and Rao and Thomas, although variations in prevalence have been reported across different centres.^{1,5,10} Differences in patient characteristics, disease spectrum, severity of illness, and timing of electrolyte estimation may account for these variations.

Hyponatremia was the most common electrolyte abnormality in our study, occurring in 30.0% of the children, whereas hypernatremia was observed in 8.9%. Similar findings have been reported by Ebrahim et al., who documented hyponatremia in 23.3% and hypernatremia in 11.7% of critically ill children.¹¹ Panda et al. and Singhi et al. also identified hyponatremia as the predominant sodium abnormality among children admitted to the PICU.^{1,2} The relatively higher frequency of hyponatremia may be attributed to disorders such as respiratory infections, central nervous system diseases, sepsis, and gastrointestinal illnesses, all of which are commonly associated with disturbances in water and sodium balance.

The present study demonstrated a statistically significant association between sodium abnormalities and the primary organ system involved. Hyponatremia was most frequently observed in children with respiratory disorders and infectious diseases, whereas hypernatremia was more commonly encountered in children with respiratory and central nervous system disorders. Similar observations have been reported by Agarwal et al., who found a higher incidence of sodium disturbances among children with neurological and respiratory illnesses admitted to the PICU.⁸ These findings emphasize the importance of routine electrolyte assessment in children presenting with these conditions.

Potassium abnormalities were also commonly encountered in our study. Hypokalemia was observed in 21.1% of children and hyperkalemia in 15.6%. The frequency of hyperkalemia in our study was comparable to that reported by Agarwal et al. and Rao and Thomas, whereas the proportion of hypokalemia was higher than that observed in some earlier Indian studies.^{8,10} This difference may be explained by variations in disease profile, inclusion criteria, nutritional status, and the proportion of children presenting with gastrointestinal and respiratory illnesses. Cummings et al. reported an even higher frequency of potassium abnormalities, which may be related to serial electrolyte monitoring throughout PICU stay, whereas our study evaluated electrolyte levels only at admission.¹²

A significant association was observed between potassium abnormalities and the primary organ system involved. Hypokalemia was most frequently associated with respiratory disorders, while hyperkalemia was more common among children with infectious diseases in the present study. Potassium imbalance in critically ill children may result from altered renal handling, gastrointestinal losses, acid-base disturbances, cellular shifts, or the effects of

medications.^{9,13} Recognition of these abnormalities is essential because potassium plays a crucial role in maintaining normal neuromuscular and cardiac function.⁶

The findings of the present study highlight the importance of routine electrolyte evaluation at the time of PICU admission. Early identification of sodium and potassium abnormalities allows timely correction and may help prevent complications related to electrolyte imbalance. Regular monitoring of electrolyte status should therefore be considered an integral component of the management of critically ill children admitted to intensive care units.¹³

The present study has certain limitations. It was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. In addition, serum electrolyte levels were assessed only at the time of admission, and serial measurements during the PICU stay were not evaluated. Future multicentre studies with larger sample sizes and serial electrolyte monitoring may provide a better understanding of the pattern and clinical significance of electrolyte abnormalities in critically ill children.

Conclusion

Electrolyte disturbances are frequently encountered in critically ill children and constitute an important aspect of intensive care management. Hyponatremia and hypokalemia were the most prevalent electrolyte abnormalities in the present study, with significant associations observed between electrolyte abnormalities and the primary organ system involved. Early identification, regular monitoring, and appropriate management of electrolyte disturbances are essential to maintain physiological homeostasis and improve the quality of care in children admitted to the PICU.

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