DOI: 103126/JNPS.V4113

Original Article

# Serum Electrolyte Abnormality in Children Admitted to Paediatric Emergency and ward: A Cross-Sectional Study

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## Article History

Received on - 2024 May 01
Accepted on - 2024 Sep 29

## Keywords:

Electrolyte imbalance; Emergency; Hyponatremia; Paediatric

## Online Access

**DOI:** https://doi.org/10.60086/jnps1232

## Abstract

**Introduction:** The electrolyte disturbances resulting from underlying disease can adversely affect outcomes in children. Few previous studies have been conducted in the paediatric intensive care unit regarding electrolytes disturbances. This study aimed at calculating the prevalence of dyselectrolytemia involving sodium and potassium in the paediatric emergency, and ward of a tertiary care center.

**Methods:** This was a prospective cross-sectional study carried out in a tertiary center from 10th November 2023 to 30th December 2023, after obtaining ethical clearance (reference: 216/080/081-IRC). A total of 112 children from one month to 18 years of age were included via the convenience sampling method. The variables included age, sex, diagnosis, serum sodium, and potassium.

**Results:** The serum electrolyte abnormality was observed in 49.1% of patients. The most common admitting diagnosis was pneumonia in 47.3%. The mean age of children was 3.7 years with male preponderance (58%). The most prevalent electrolyte abnormality was hyponatremia (45.5%), followed by hyperkalemia (8%), hypokalemia (0.9%), and no cases of hypernatremia. Approximately, half (49%) of children with pneumonia had hyponatremia.

**Conclusions:** There is a high burden of serum electrolyte abnormality in children admitted to paediatric emergency and ward of which hyponatremia appears to be the commonest.

## Introduction

The identification and management of serum electrolyte abnormalities in children have crucial roles in guiding therapy and determining outcomes.[1] Children are more prone to developing electrolyte imbalance given higher metabolic rate and larger body surface area per unit of body mass in comparison to adults.[2] Sodium and potassium are the major electrolytes involved in maintaining cellular integrity and action potential across the cell membrane. The derangements in serum electrolytes concentrations can lead to various complications including neurological dysfunction and cardiac arrhythmia.[3]

Hyponatremia leading to cerebral edema and intracranial hypertension manifest earlier in children owing to a greater brain-to-skull size ratio giving rise to headache, vomiting, loss of consciousness, and seizures.[4] Its prognostic meaning as a possible marker of more severe disease has not yet been well established. Similarly, hypernatremia generally associated with inadequate breastfeeding, dehydration, and diabetes insipidus causes mortality in 60%, and can manifest as seizure, coma, and death.[5] Likewise, potassium disturbances resulting from renal dysfunction and drugs can lead to cardiac arrhythmia.

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There is a lack of enough data on the prevalence of electrolyte abnormalities in Nepal in paediatric emergency and ward settings. Furthermore, there is a paucity of data on the incidence of serum potassium abnormalities.[6] Therefore, this study was planned to study the prevalence of electrolyte disorders in children admitted to paediatric emergency and ward.

## Methods

A prospective hospital-based cross-sectional study was conducted over two months (10th November 2023 to 30th December2023) after ethical approval by IRC (Institutional Review Committee) reference 216/080/081-IRC at B.P. Koirala Institute of Health Sciences, Dharan, Nepal. Children aged one month to 18 years of age, admitted to a paediatric ward or emergency were included in the study after obtaining written consent from parents. Serum sodium and potassium were collected as a part of routine investigation and were estimated using ISE (Ion Selective Electrode) method.[7] The serum sodium <135 mEq / L was regarded as hyponatremia and > 145 mEq / L hypernatremia. Similarly, serum potassium of < 3.5 mEq / L and > 5.5 mEq / L was considered hypokalemia and hyperkalemia respectively.[8] A convenience sampling technique was used for data collection.The variables used were age, sex, serum sodium, potassiumand admitting diagnosis.The sample size was calculated using the following formula:

$N = (Z^2 \times p \times q) / e^2$

N = (1.96 x 1.96x0.573x0.427) / (0.1x0.1)

N= 94

where,

N = Minimum required sample size

Z= 1.96 at 95% confidence interval

P= Proportion of children with electrolyte disorder taken as 57.3%[3]i.e., serum sodium and potassium and to evaluate its effect on mortality rate among children admitted at the paediatric intensive care unit.

Q=1-p

E= margin of error, 10%

The calculated minimum sample size was 94; however, 112 patients were included in the study. The clinical and demographic parameters were recorded as per the performa. The data was entered in Microsoft Excel 2016 and analyzed using Stata software version 14.2. Descriptive statistics was used to analyze the data like distribution (frequency of events), mean, median, mode, and standard deviation. Additionally, Chi square and t-test were used for inferential statistics. P-value < 0.05 was considered statistically significant.

## Results

Over two months of study period, 112 patients, 65 males, and 47 females, fulfilling the inclusion criteria were enrolled. The mean age of children included was 3.7 years (Table 1). The mean serum sodium and potassium were 135.2 ± 3.9 mEq / L and 4.5 ± 0.7mEq / L respectively. Hyponatremia was the most common serum electrolyte abnormality observed in 45.5% of the patients. Similarly, hyperkalemia was found in 8% and hypokalemia in 0.9% (Table 2).

**Table 1:** Baseline characteristics (N=112)

| Variable | Mean / Range |
|---|---|
| Age (Years) | 3.7 ± 3.8 (0.1-14) |
| Serum Sodium | 135.2 ± 3.9 |
| Serum Potassium | 4.5 ± 0.7 |

**Table 2:** The proportion of serum electrolyte abnormality (N = 112)

| Variables | N (%) |
|---|---|
| Serum electrolyte abnormality | 55 (49.1) |
| Hyponatremia | 51 (45.5) |
| Hypokalemia | 1 (0.9) |
| Hyperkalemia | 9 (8) |
| Hypernatremia | 0 (0) |

Among the enrolled patients, most of them had diagnosis of pneumonia (47.3%), followed by episodic viral wheeze in 9.8% (Table 3). Around half of the children (49%) with pneumonia had hyponatremia. There was a significant difference in serum sodium level between the groups with abnormal serum electrolytes andnormal serum electrolytes. However, there was no significant difference in serum potassium levels between the groups with normal serum electrolytes and abnormal serum electrolytes (Table 4). Similarly, there was a significant difference in serum sodium between groups with normal sodium and abnormal serum sodium levels. There was significant difference in serum potassium between groups with normal serum potassium and abnormal serum potassium concentrations (Table 5).

**Table 3:** Diagnosis of children on admission to ward and emergency (N = 112)

| Variables | N (%) |
|---|---|
| Autoimmune encephalitis | 1 (0.9) |
| Acute gastroenteritis | 3 (2.7) |
| Acute myeloid leukemia | 1 (0.9) |
| Appendicitis | 1 (0.9) |
| Biliary atresia | 4 (3.6) |
| Burn | 1 (0.9) |

| | |
|---|---|
| Cleft lip | 1 (0.9) |
| Dilated cardiomyopathy | 1 (0.9) |
| Diabetic ketoacidosis | 1 (0.9) |
| Episodic viral wheeze | 11 (9.8) |
| Empyema | 2 (1.8) |
| Febrile seizure | 5 (4.5) |
| Gastroesophageal reflux disease | 1 (0.9) |
| Hypothyroidism | 1 (0.9) |
| Immune thrombocytopenic purpura | 2 (1.8) |
| IgA nephropathy | 1 (0.9) |
| Intussusception | 1 (0.9) |
| Landau Kleffnersyndrome | 1 (0.9) |
| Meningitis | 2 (1.8) |
| Mastoiditis | 1 (0.9) |
| Nephrotic syndrome | 2 (1.8) |
| Pneumonia | 53 (47.3) |
| Post infective glomerulonephritis | 3 (2.7) |
| Pelvic-ureteric junction obstruction | 1 (0.9) |
| Reactive cervical lymphadenitis | 1 (0.9) |
| Systemic lupus erythematosus | 2 (1.8) |
| Seizure disorder | 1 (0.9) |
| Synovitis | 1 (0.9) |
| Acute tonsillitis | 1 (0.9) |
| Cervical tubercular lymphadenitis | 1 (0.9) |
| Acute pharyngitis | 1 (0.9) |
| Urinary tract infection | 1 (0.9) |
| Viral hepatitis | 1 (0.9) |
| Olanzapine poisoning | 1 (0.9) |

**Table 4:** Comparison of serum electrolytes between groups with and without serum electrolyte abnormality (N = 112)

| Variables | Serum Electrolyte Abnormality (Mean ± SD) | Normal Serum Electrolyte (Mean ± SD) | P value |
|---|---|---|---|
| Serum Sodium | 132.4 ± 3.1 | 138 ± 2.3 | < 0.001 |
| Serum Potassium | 4.6 ± 0.7 | 4.4 ± 0.6 | 0.232 |

**Table 5:** Comparison of serum sodium and potassium between the groups of normal and abnormal serum sodium and potassium (N = 112)

| Parameter | Mean ± SD | P-value |
|---|---|---|
| Dysnatremia | 132 ± 2.8 | < 0.001 |
| Normonatremia | 137.9 ± 2.3 | |
| Dyskalemia | 5.6 ± 1.1 | < 0.001 |
| Normokalemia | 4.4 ± 0.5 | |

## Discussion

Electrolyte disturbances are a crucial aspect to be taken care of in the management of patients in paediatric emergencies to decrease morbidity as well as mortality.[2] They can help in determining the severity of the disease and also act as a marker of recovery.[9] The present study was undertaken were the objective of determining the prevalence of electrolyte abnormalities in children admitted in Paediatric Intensive Care Unit at the time of admission and its association with mortality and primary organ system involvement. Among various electrolyte disorders, hyponatremia is encountered more often in emergency settings.[10] Therefore, this study was done to identify the prevalence and pattern of serum electrolyte abnormalities in children.

The current study showed half (49.1%) of the children had electrolyte disorders which is comparable to a study by Haider et al, which included 150 patients of Paediatric Intensive Care Unit, where serum electrolyte abnormalities was observed in 57.3% of children.[3] The most common illness was pneumonia (47.3%) in our study which was comparable to above study where 34.7% had a respiratory illness. In addition, Haider et al found hyponatremia in 16%, hypernatremia in 32%, including hyperkalemia in 14%, and hypokalemia in 28%. Our study revealed hyponatremia, hyperkalemia, and hypokalemia in 45.5%, 8% and 0.9% respectively. The differences could be attributed to the population cohort having less number of gastrointestinal diseases and sick children in our group as compared to their study population. Additionally, the cut-off for hyperkalemia was different in their study, which was 5.3 mEq / L in contrast to our study, where 5.5 mEq / L was the cut off.

Sil et al found electrolyte abnormalities in 58.5% of children in a study of 200 patients with male predominance (53%) in which 38% had respiratory disease.[11] The sex distribution was consistent with ours (58% male) with the majority being pneumonia cases (47.3%). Hyponatremia and hypernatremia occurred in 27% and 5.5% respectively. Hyponatremia in our study was greater which could be because of a greater proportion of children with pneumonia in our study cohort causing SIADH (Syndrome of Inappropriate Secretion of Anti-Diuretic Hormone) leading to hyponatremia.[12] hyperkalemia in17% and hypokalemia in 9% was concluded in their study which was also higher in comparison to our study which could be due to their study group comprising of children with metabolic (3.5%) and renal disease (1%), contributing to dyskalemia. In a retrospective study by Obiagwu et al in 1909 children, with the majority being males (60.3%), electrolyte derangement was noted in 78.6% with hyponatremia in 41.1% and hypokalemia in 18.9%.[1] The differences in the frequency as compared to our study could be due to patients with altered renal function (17.8%) in their study.

Naseem et al conducted an observational study involving 101

children admitted to Paediatric Intensive Care Unit, electrolyte imbalance was noted in 84.1%.[13] The higher frequency noted was due to consideration of other additional electrolytes (Calcium, magnesium, and phosphorous) in addition to sodium and potassium. The frequency of hypernatremia was higher (37.6%) and hyponatremia was lower (23.5%) as compared to our study. This may have been resulted because of the use of normal saline in infants above one month of age in their study in contrast to our institution protocol where half normal saline is used children above one month. The use of hypotonic fluids can lead to hyponatremia.[14] Hyperkalemia was noted in 18.8% which is explained by MODS (Multi-organ dysfunction syndrome) and AKI (Acute kidney injury) patients in their study group. The prevalence of hypokalemia was higher (30.5%) in comparison to the current study, which could be attributed tothe use of potassium (20 mEq / L) in maintenance fluid according to our institution protocol.

Ali et al conducted a study in 150 critically ill children found hyponatremia in 36% and hypokalemia in 64%.[2] The frequency of hypokalemia was higher in comparison to the current study. The deviation of results could be due to greater proportion of children with features of gastrointestinal illness with vomiting in 74.6% and diarrhea in 71.3%. These gastrointestinal disturbances may have led to increasing frequency of hypokalemia.[15] The study had limitations in terms of descriptive nature, single-center, and with a limited pool of participants which may not be reflective of the true population. There is a scope for a larger study that attempts to find the prevalence and risk factors associated with dyselectrolytemia in which other additional electrolytes can also be considered.

## Conclusions

The study depicts the burden of serum electrolyte derangements in sick children. Hyponatremia appears to be the most common electrolyte disorder in the setting of a paediatric emergency, highlighting its importance in early detection and management. Most of the admitted children had respiratory diseases like pneumonia followed by viral-induced wheeze.

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