



Original Article



Prevalence and Patterns of Electrolyte Imbalance in Children Diagnosed with Acute Severe Malnutrition at a Nutritional Stabilization Center

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ABSTRACT

Malnutrition accounts for around 35% of all fatalities in Pakistan among children under five, making it the primary cause of childhood mortality in that country. The most severe type of malnutrition, known as severe acute malnutrition (SAM), was frequently linked to electrolyte abnormalities. The purpose of this study was to ascertain how frequently electrolyte imbalance occurred in children with SAM who were admitted to a tertiary care facility. **Objective:** To Determine the Prevalence and Patterns of Electrolyte Imbalance in Children Diagnosed with Acute Severe Malnutrition at a Nutritional Stabilization Center". **Methods:** A cross-sectional study was carried out in Nawabshah at the Department of Pediatrics, Peoples University of Medical and Health Sciences, from May 16 to August 15, 2024. This study comprised 92 patients with severe acute malnutrition, ranging in age from 2 to 60 months. Non purposive sampling technique was used for data collection. Children with secondary causes of wasting were excluded, including those with congenital heart disease, chronic renal or liver illness, TB, cancer, and hemolytic anaemia. Weight-for-height was calculated using measurements of weight, length, and height. When the weight-for-height ratio fell below the -3 standard deviation (SD), children were diagnosed with SAM. The lab received blood samples that were taken for serum electrolytes. The chi-square test was used for stratification, and descriptive statistics were computed. **Results:** Participants' average ages ranged from 23.63± 12.71 months. A total of 85 (93.4%) of the 92 SAM patients had an electrolyte imbalance. The prevalence of hypokalemia (70.08%), hypocalcemia (56.52%), hyponatremia (32.60%), and hypomagnesemia (28.26%), respectively. **Conclusions:** Children with SAM experience dyselectrolytemia both with and without problems. In all cases of SAM, serum electrolyte levels may need to be assessed in order to identify hyponatremia and hypokalemia in the absence of symptoms. This will facilitate the inpatient treatment triage process for patients with asymptomatic hyponatremia and hypokalemia.

INTRODUCTION

A lack of nutrients and energy causes malnutrition since the body needs both in order to grow and develop properly. Malnutrition can show up in a number of ways, including undernutrition, stunting, wasting, micronutrient deficiencies, and being overweight or obese as an adult [1]. Malnutrition plays a significant role in the burden of diseases that affect children and is a global public health concern. Malnutrition affects 50–150 million young children under the age of five globally. It is the primary cause of one-third of mortality among children under five [2]. Between 50 and 38 per cent of the world's wasted and stunted

children reside in Pakistan [3]. In Pakistan, around 35% of deaths involving children under five are related to malnutrition. Malnutrition results in a number of anomalies in the body's electrolyte levels. The electrolyte imbalances involving sodium, potassium, bicarbonate, and water are the most prevalent ones. When a child is malnourished and edematous, their body water content rises along with extracellular sodium retention. However, in most cases, their serum sodium level falls, concealing their salt overload. The accompanying diarrhea may be the reason for these low levels. Because of low muscle mass and



decreased consumption, total body potassium can drop by up to 25% in cases of overt malnutrition [4].

Children who are underweight frequently suffer electrolyte abnormalities. When diarrheal illnesses are present, electrolyte imbalance increases the risk of death in children [5]. Low serum sodium levels cover up the sodium overload in extremely malnourished, edematous children. [6, 7]. Hypokalemia frequently manifests as paralytic ileus, hypotonia, apathy, and cardiac arrhythmias. Clinical signs of hypocalcemia are frequently modest. However, if hypomagnesemia also exists, hypocalcemia can cause deadly convulsions in young infants [8]. Children who are undernourished are more vulnerable to electrolyte balance-related illnesses and deaths. The results of this study will be useful in estimating the degree of electrolyte imbalance in kids with SAM, and more research can be done for a more thorough examination.

The purpose of this study was to determine the Prevalence and Patterns of Electrolyte Imbalance in Children Diagnosed with Acute Severe Malnutrition at a Nutritional Stabilization Center. This will allow treatment strategies to be developed expeditiously and prevent potentially devastating outcomes for these children.

METHODS

A cross-sectional study was carried out in Nawabshah at the Department of Pediatrics, Peoples University of Medical and Health Sciences, from May 16 to August 15, 2024. Peoples University of Medical and Health Sciences ethical board approved the study. The IRB approval number is PUMHSW/SBA/PVC/ERC/25/2024. The parents or guardians of the admitted patients provided written approval. This study comprised 92 patients with severe acute malnutrition, ranging in age from 2 to 60 months. WHO Sample size calculator was used to calculate sample size. A sample size of 92 children was calculated at a prevalence of 93% taken from a similar study [3]. Non purposive sampling technique was used for data collection. Children with secondary causes of wasting were excluded, including those with congenital heart disease, chronic renal or liver illness, TB, cancer, and hemolytic anaemia. Based on the diagnosis provided by the history, physical examination, and relevant test results, the secondary reasons were ruled out. The chief researcher created a self-made questionnaire, which the stabilization center's skilled nursing staff completed. Age, gender, and name were the demographic information gathered. A sample of blood approximately 2 milliliters was taken from patients in the Stabilization Center ward, which was forwarded to the pathology department. Serum calcium and magnesium levels were measured using a fully automated chemistry analyzer Beckman Coulter AU-680, which operates on the principle of spectrophotometry, while sodium and potassium analysis was carried out using the patient's

serum on a fully automated Electrolyte Analyzer Diestro 103 AP, which operates on the principle of ion selective electrode (ISE). The pathology department's lab technicians conducted the biochemical evaluation, and the nurses documented the results on the questionnaire. The Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows (IBM Corp., Armonk, NY, USA) was used to analyze the collected data. For quantitative variables including age, serum concentrations of Na, K, Ca, and Mg, and the length of SAM, mean \pm SD was computed. The frequency of electrolyte imbalance in children with SAM was determined to be a qualitative variable. Additionally, distinct frequencies and percentages were computed for hyponatremia, hypokalemia, hypocalcemia, and hypomagnesemia.

RESULTS

Our analysis showed that 93.5% of children had electrolyte imbalances. A total of 51 (59.3%) males and 35 (40.7%) female children had electrolyte imbalance (p -value 0.004). Most of the children 63 (68.5%) with electrolyte imbalance were below the age of 24 months. The duration of SAM was not significantly related with electrolyte imbalance. Most of the parents were illiterate or had a primary education whose children had electrolyte imbalance (Table 1).

Table 1: Demographic Data (n=92)

Variables	Electrolyte Imbalance N (%)			p-value
	Yes	No	Total	
Gender				
Male	51 (59.3%)	6 (100%)	57 (62%)	0.004
Female	35 (40.7%)	0 (0%)	35 (38%)	
Age (Months)				
≤24 Months	60 (69.8%)	3 (50%)	63 (68.5%)	0.152
>24 Months	26 (30.2%)	3 (50%)	29 (31.5%)	
Duration of SAM (Days)				
≤30	43 (50%)	3 (50%)	46 (50%)	1.000
>30	43 (50%)	3 (50%)	46 (50%)	
Educational Status of Parents				
Illiterate	33 (38.4%)	0 (0%)	33 (35.9%)	0.001
Primary	34 (39.5%)	6 (100%)	40 (43.5%)	
Secondary	15 (17.6%)	0 (0%)	15 (16.8%)	
Intermediate or Above	4 (4.5%)	0 (0)	4 (3.8%)	

Of the 92 children, 38% (n = 35) were female and 62% (n = 57) were male. The children were 23.63 months old on average, and SAM lasted 46.13 days on average. The average serum values of Na, K, Ca and Mg (Table 2).

Table 2: Serum Electrolyte Means and Standard Deviations (n=92)

Variables (mEq/l)	Mean \pm SD	Range
Serum Sodium	134.65 \pm 5.27	127.0-145.0
Serum Potassium	2.75 \pm 0.796	1.6-4.7
Serum Calcium	7.60 \pm 1.02	6.0-9.6
Serum Magnesium	1.91 \pm 0.41	0.8-3.2

According to our data, 93.4% of children exhibited electrolyte abnormalities. The majority of the children (70.08%) had hypokalemia, while 56.52%, 32.60%, and 28.26% had hypocalcemia, hyponatremia, and hypomagnesemia, respectively (Table 3).

Table 3: Distribution of Electrolyte Imbalance Frequency (n=92)

Variables	N (%)
Hyponatremia	30 (32.60%)
Hypokalemia	70 (70.08%)
Hypocalcemia	50 (56.52%)
Hypomagnesemia	26 (28.26%)

DISCUSSION

Malnutrition frequently results in electrolyte abnormalities, which continue to be a significant health issue in underdeveloped countries. Serum electrolyte levels in malnutrition reflect the concentration of electrolytes in the blood rather than the total body content. Parents who lack literacy were ignorant of the balance needed for their child to grow normally. Thus, an improper diet deficient in vital nutrients leads to an imbalance in serum electrolytes. In the current study, of the 92 children, 38% (n = 35) were female and 62% (n = 57) were male. According to our data, 93.4% of kids exhibited electrolyte abnormalities. The majority of the children (70.08%) had hypokalemia, while 56.52%, 32.60% and 28.26% had hypocalcemia, hyponatremia and hypomagnesemia, respectively. A total of 93.5% of children with SAM who were hospitalized also had electrolyte imbalances, according to Raza M *et al.*, The most prevalent electrolyte problem was found to be hypokalemia, which affected 79.9% of the patients [3]. According to Laghari GS *et al.*, Group B consisted of 46 malnourished children without diarrhea, while Group A included 54 malnourished children with diarrhea. Out of 79 children, 43 (79%) had hyponatremia (serum sodium <135 meq/l), with 27 of these cases occurring in Group B (p<0.0001). Regarding hypokalemia (serum potassium <3.5 meq/l), 27 malnourished children from Group A were affected, compared to 10 from Group B [5]. In a research conducted in India, hyponatremia was the most often found electrolyte abnormalities among the 60 SAM children who were enrolled (21-35%), followed by hypokalemia (18-30%) and hypocalcemia (15-25%). Thirteen (21.6%) individuals had metabolic acidosis, four (6.7%) had hypoglycemia, and two (3.3%) had metabolic alkalosis [9]. In a different study, by Ashok E *et al.*, Thirteen cases (20.0%) had hypocalcaemia, twenty-one cases (28.0%) had hypokalaemia, and three cases (4.0%) had hypopatrema. Thirty had elevated creatinine (40.0%) and 34 had elevated urea (44.0%). Of the 19, (25.3%) with random blood sugar, hypoglycemia was found [10]. Ali S *et al.*, conducted a study on children having severe acute malnutrition. The cases were 2.4 ± 3.13 years old on average. Male children made up 84 (62.6%) of the total, while girls made up 50 (37.3%). 57 patients (42.5%) had hypokalemia [11]. In a research by

Meena *et al.*, dyselectrolytemia was found in 94.0% of the 100 children with complex SAM. The SAM children with the majority of co-morbidities had subnormal sodium levels (128-135 mEq/L) and normal potassium levels (368-4.34 mEq/L) at the time of admission. The mean potassium level was 4.17 ± 1.03 mEq/L and the mean sodium level was 131.82 ± 6.66 mEq/L in children with complex SAM. The average potassium level and sodium level of the children in the control group were 4.14 ± 1.11 mEq/L and 135.90 ± 4.26 mEq/L, respectively [12]. To determine how frequently hypokalemia occurs in children with severe acute malnutrition, ur Rehman M *et al.*, did a study. A total of 44 (45.8%) of the 96 patients were male and 52 (54.2%) were female. It was 20.65 ± 11.961 months on average. Overall 50 (52.1%) children had no electrolyte imbalance while 46 (47.9%) children had hypokalemia. Children's gender and age groups were taken into consideration while analyzing the prevalence of hypokalemia, and the p-values were 0.973 and 0.176, respectively [13]. According to a study by Khan S *et al.*, in total, 100 children suffering from severe acute malnutrition were a part of this study. There were 40 (40%) females and 60 (60%) males; the mean age was 23.65 months. Diarrhea was seen in 66% of the patients. 23 children (23%) and 28 children (28%) had hypokalemia and hyponatremia, respectively. The relative means for potassium and sodium were 3.06 (+1.7517) and 138.96 (8.692). Magnesium and calcium had respective means ± SD of 2.23 (2.38) and 8.51 (1.58) [14]. A local study reported that Group B consisted of 36 malnourished patients without diarrhea, while Group A included 64 malnourished patients, also without diarrhea. Serum electrolyte levels were tested in both groups, and the results were statistically analyzed. Hypokalemia was observed in 40 patients (62.5%) from Group A and 8 patients (22.22%) from Group B (p<0.001). Similarly, hyponatremia was present in 17 patients (26.56%) from Group A and 5 patients (13.88%) from Group B (p<0.001). Additionally, low serum bicarbonate levels were found in 41 patients (64%) from Group A and 15 patients (41.66%) from Group B (p<0.001) [15]. According to a study by Zulqarnain A *et al.*, patients who had severe acute malnutrition and diarrhea had hyponatremia in 28 (31.1%), hypokalemia in 55 (61.1%), and hypocalcemia in 12. (13.3%) of the patients [16]. Of the 113 SAM children involved in an international study, 42 did not have any issues, and 71 had. Serum potassium was measured at 4.29 ± 0.75 meq/L, sodium at 134.58 ± 5.45 meq/L, and chloride at 103.31 ± 7.16 meq/L on average. Of the children, 7.1% had hypokalemia and 43.4% had hyponatremia. The mean serum electrolyte values and the frequency of hyponatremia and hypokalemia did not differ statistically significantly across the groups [17]. An Indian study revealed that on day one, 72% of children had hyponatremia, while 6% exhibited hypernatremia. By day three, the hyponatremia rate dropped to 60%, and by day eight, hypernatremia decreased to 4%. Approximately 68% of the children maintained normal sodium levels. Between day 1 and day 8, there was a significant improvement in mean sodium

levels, reaching an average of 135.8 ± 9.9 on day eight. Hypokalemia was most prevalent on day one, affecting 38% of patients. On day three, 28% had hyperkalemia, and by day eight, 80% of the children had normal potassium levels. The mean potassium levels also significantly improved, reaching 5.5 ± 1.24 by day eight [18]. Overall 53 patients (66%) in a local study reported having diarrhea for 1-3 days, with a mean duration of 3.2 ± 1.7 days. Ten patients (12.5%) showed no electrolyte imbalance, while 26 patients (32.5%) and 44 patients (55%), respectively, had hyponatremia and hypokalaemia. Hyperkalaemia and hypernatremia were absent in every subject [19]. In comparison to children who were not malnourished, children with edematous malnutrition had higher rates of pneumonia ($P = 0.04$), acute gastroenteritis ($P < 0.001$), hyponatremia ($P = 0.04$), metabolic acidosis ($P = 0.005$) and hypocalcemia ($P = 0.006$) [20]. An Indian study, they looked at children between the ages of six and 59 months. The average age of admitted patients was 24.18 months, or almost 24 months. At the time of admission, the most common median age was almost one year (13 months). The relationship between serum potassium and sodium and the survival of SAM was shown to be statistically significant in their investigation [21]. In a different Indian study, 77 (64.17%) SAM children who had diarrhea also had dysnatremia, with 76 of them having hyponatremia (63.33%) and 2 cases having hypernatremia. For both diarrheal and non-diarrheal SAM patients, there was no statistically significant difference associated with hyponatremia (P value of 0.09) [22]. The mean age of all cases in a local study was 35.84 ± 14.36 months, with a minimum and maximum age ranging from 6 to 60 months. There were 60 (41.7%) female cases and 84 (58.3%) male cases. Serum potassium levels were 3.20 ± 1.33 mmol/L and sodium levels were 134.82 ± 8.63 mmol/L on average. The incidence and percentage of hyponatremia and hypokalemia, respectively, were 47 (32.6%) and 86 (59.7%), based on the operational criteria [23].

CONCLUSIONS

Children with SAM experience dyselectrolytemia both with and without problems. In all cases of SAM, serum electrolyte levels may need to be assessed in order to identify hyponatremia and hypokalemia in the absence of symptoms. This will facilitate the inpatient treatment triage process for patients with asymptomatic hyponatremia and hypokalemia.

Authors Contribution

Conceptualization: MNC

Methodology: A

Formal analysis: HNB

Writing, review and editing: A, MAS, AHR, N, SC

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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