A study of serum electrolytes in severe acute malnourished children with and without complications

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Received - 26 November 2017 Initial Review - 22 December 2017 Published Online - 14 March 2018

ABSTRACT

Objective: Children with severe acute malnutrition (SAM) are categorized into "complicated and uncomplicated cases" based on clinical criteria alone. Electrolyte imbalance is one of the prognostic factors in severe malnutrition. We aimed to study serum electrolytes in complicated and uncomplicated SAM children. **Methods:** This was a cross-sectional observational study conducted at the nutritional rehabilitation center of a tertiary care hospital attached to a medical college from May 2016 to April 2017. Children between the ages of 1 month and 5 years who met the World Health Organization criteria for SAM were included in the study. Serum electrolytes were estimated with an automated analyzer by ion selective electrode method. **Results:** Among 113 SAM children included, 71 had complications and 42 were without complications. The mean value of serum sodium was 134.58±5.45 meq/L, potassium was 4.29±0.75 meq/L, and chloride was 103.31±7.16 meq/L. Hyponatremia was seen in 43.4% and hypokalemia in 7.1% of children. There was no statistically significant difference in the mean values of serum electrolytes and frequency of hyponatremia and hypokalemia between groups. **Conclusion:** Dyselectrolytemia occurs in SAM children with and without complications. Serum electrolyte levels may need to be measured in all SAM cases to detect asymptomatic hyponatremia and hypokalemia. This will help in triaging those with asymptomatic hyponatremia and hypokalemia to inpatient care.

Key words: *Complications, Hypokalemia, Hyponatremia, Serum electrolytes, Severe acute malnutrition*

As per National Family Health Survey (NFHS)-4, the prevalence of severe acute malnutrition (SAM) has increased from 6.45 to 7.5% in children under 5 years of age in India [1]. Malnutrition is believed to contribute 61% of diarrheal deaths and 53% of pneumonia deaths in India [2]. Electrolyte imbalance is one of the prognostic factors in severe malnutrition [3]. In malnourished children, excess body sodium and chloride exists (although plasma sodium and chloride may be low) and deficiency of potassium and magnesium exists which require supplementation over weeks [3,4].

Children with SAM are categorized into "complicated and uncomplicated cases" based on clinical criteria. SAM children with complications require inpatient management and those without complications can be treated on a community basis. World Health Organization (WHO) states this as a strong recommendation with low-quality evidence [5] As per the WHO, serum electrolytes are measured and supplemented (potassium and magnesium) only in SAM children with complications. SAM children without complications are managed in community with Ready to Use Therapeutic Food (RUTF) which is enriched with minerals and micronutrients [6]. In our country, as RUTF is not available, children are advised home-based energy dense food along with micronutrient supplements. Hence, their diet may still be deficient in minerals. Hence, we wanted to know the serum electrolytes in SAM children without complications so that those with electrolyte disturbance can be referred for inpatient care or supplemented with suitable electrolytes when treated on a community basis.

MATERIALS AND METHODS

This was a cross-sectional observational study conducted at the nutritional rehabilitation center of a tertiary care hospital attached to a medical college from May 2016 to April 2017. After obtaining Institutional Ethical Clearance and informed parental consent, children between the ages of 1 month and 5 years who met the WHO criteria for SAM were included in the study. The WHO criteria for SAM include any one of the following: Weight for height <−3 standard deviation, visible severe wasting, bilateral pitting pedal edema, and mid-upper arm circumference <11.5 cm (in children >6 months age). Children with SAM were categorized into:

Group 1 – SAM children with any of these complications [5,6]

Presence of any emergency signs, edema, persistent vomiting, very weak, apathetic, fever (axillary temperature >38.5°C), fast breathing, chest in drawing, cyanosis, extensive skin lesions, eye lesions, post-measles states, diarrhea with dehydration based on history and clinical signs, severe anemia, purpura or bleeding tendency, hypothermia (axillary temperature <35°C), and poor appetite.

Group 2 – SAM children without any of the above complications

Children suffering from any known systemic illness that would affect serum electrolyte levels (except gastroenteritis) were excluded from the study.

In a pre-tested prestructured proforma detail of history, examination, anthropometry of the enrolled patients was recorded. In all included children, 3 ml of venous blood sample was collected under aseptic precautions at the time of admission or in the outpatient department. The serum was then separated immediately, and estimation of serum electrolytes (by ion selective electrode method) was carried out as soon as possible by an automotive analyzer. The normal reference range of serum sodium was 135–145 meq/L, serum potassium was 3.5–5 meq/lt, chloride was 97–111meq/lt as per the laboratory standards, and Nelson textbook of pediatrics [7]. Hyponatremia was defined as serum sodium < 135 meq/lt and hypokalemia as serum potassium <3.5 meq/lt [7]. The data were analyzed by descriptive statistics. Student's t-test and ANOVA were applied to analyze the data obtained from the study. For all tests, the difference was considered significant if the probability $p<0.05$. Statistical analysis was done using SPSS version 20.

RESULTS

A total of 292 patients were screened for eligibility, out of which 17 refused to give consent, 162 children had secondary SAM (renal disease, congenital heart disease on diuretics, and other chronic illness). Remaining 113 SAM children were enrolled into the study. There were 61 males (53%) and 52 (46%) females. 38 children (33.6%) were <6 months and 75 (66.3%) were between 6 months and 5 years of age. 48 SAM children were without complications 71 SAM children had complications (acute diarrhea with some dehydration - 18, Acute diarrhea with shock - 6, persistent diarrhea - 2, pneumonia - 13, severe pneumonia - 7, anemia - 8, edema - 4, sepsis - 5, seizures 5, skin lesions - 2, and late hemorrhagic disease of newborn - 1). The mean value of sodium was below normal range whereas that of potassium and chloride was in normal range. We found that 43.4% of patients had hyponatremia and 7.1% had hypokalemia (Table 1).

There was no significant difference in the mean values of sodium, potassium, and chloride between SAM children with and without complications. About 43% children in both groups had hyponatremia. There was no difference in the frequency of hyponatremia and hypokalemia between SAM children with and without complications.

Among the entire group, 26 of them had diarrhea/acute GE. There was no difference in mean values of the serum electrolytes and frequency of hyponatremia in SAM children with diarrhea and those without diarrhea (Table 2). Although the frequency of hypokalemia was more in SAM children with diarrhea, this was not statistically significant.

DISCUSSION

The main finding of our study is that frequency of hyponatremia and hypokalemia is similar in complicated and uncomplicated SAM patients. As per current WHO guidelines [5], triaging SAM children into inpatient/outpatient care is based on clinical criteria alone. A significant number of SAM patients without complications are presenting with electrolyte derangements indicating that serum electrolyte levels may have to be measured at the point of the first contact to detect asymptomatic hyponatremia or hypokalemia and triaging them to inpatient care. As the estimation of serum electrolytes is not available at the primary health-care level, newer technology to detect electrolyte levels can be developed to detect uncomplicated SAM children with dyselectrolytemia and such children can be referred for inpatient care. This is important as dyselectrolytemia has a bad prognosis in SAM children [3]. Other option would be to refer all

Table 1: Serum electrolytes in SAM children with and without complications

Variable	Entire group	SAM with complications (n=71)	SAM without complications (n=42)	p value
Mean sodium (mEq/L)	134.58±5.45	134.62±5.23	134.50±5.81	0.911
Mean potassium (mEq/L)	4.29±0.75	4.24±0.78	4.38±0.69	0.336
Mean chloride (mEq/L)	103.31±7.16	103.3±7.95	103.33±5.64	0.979
Hyponatremia (%)	49 (43.4)	31 (43.7)	18 (42.9)	0.934
Hypokalemia (%)	8 (7.1)	5 (7)	3 (7.1)	0.984

SAM: Severe acute malnutrition

Table 2: Serum electrolytes in SAM children with and without diarrhea

Variable	SAM without diarrhea (n=87)	SAM with diarrhea (n=26)	p value
Mean sodium (mEq/L)	134.89±5.07	133.54±6.57	0.271
Mean potassium (mEq/L)	4.34±0.68	4.12±0.95	0.173
Mean chloride (mEq/L)	103.57±5.77	102.42±10.67	0.602
Hyponatremia (%)	38 (43.7)	11 (42.3)	0.902
Hypokalemia (%)	4 (4.6)	4 (15.4)	0.080

SAM: Severe acute malnutrition

children with SAM to nutritional rehabilitation center, screen for dyselectrolytemia and refer back the SAM children with normal electrolytes for community management.

As per the WHO, uncomplicated SAM patients should be treated on a community basis with RUTF enriched with minerals (potassium, magnesium, etc.) and micronutrients. But as RUTF is not freely available in our country, they are given home-based energy-dense food and micronutrient supplementation [5,6]. As a result, their diet is deficient in minerals. It is evident from our study that uncomplicated SAM children too have hypokalemia. We suggest that potassium may be supplemented to uncomplicated SAM children treated on a community basis with home-based diet.

Another finding of our study is that the mean serum electrolytes and frequency of hyponatremia and hypokalemia are similar in SAM children with or without diarrhea indicating that the electrolyte imbalances are not necessarily due to diarrhea. On the contrary, many studies have reported increased frequency of hyponatremia, hypokalemia in malnourished children with diarrhea when compared to SAM children without diarrhea [8-11]. However Fatima *et al*. have reported that mean serum electrolytes and frequency of hyponatremia and hypokalemia are similar in SAM with or without diarrhea [12]. This discrepancy may be due to varying degree of dehydration of included patients in above studies (assuming that severe dehydration is associated with dyselectrolytemia). The number of children with diarrhea was least in our study when compared to all these studies [8-12] and also majority had only some dehydration. We did not correlate dyselectrolytemia with degree of dehydration as the numbers would be too small. Hence, further large studies comparing degree of dehydration with dyselectrolytemia are needed.

The mean value of serum sodium was below normal range in our study. This finding was similar to the results of various studies done in the past by Shaheen *et al*. [13], Meena *et al*. [14], and Nagle *et al*. [15]. On the contrary Fatima *et al*. [12] have reported normal mean sodium levels in 100 children with SAM. The mean serum potassium and chloride was within normal limits in our study concordant with the previous authors such as Meena *et al*. [14] and Fatima *et al*. [12]. On the contrary, Nagale *et al*. have reported decreased mean serum potassium in 50 malnourished children [15]. The normal serum potassium levels in our study were not due to hemolysis as we had rejected all samples with hemolysis.

The mean values of serum electrolytes in complicated SAM patients and uncomplicated SAM patients were similar, and this finding was in contrast to Meena *et al*. [14] who reported a significantly lower mean serum electrolyte in complicated SAM when compared to uncomplicated SAM.

In malnutrition serum, electrolytes do not reflect the body content but only the circulating concentration. Thus, high/normal serum potassium masks intracellular potassium deficiency while low serum sodium masks sodium overload, but they have importance in immediate therapy in cases of the life-threatening situation [16]. In our study, hyponatremia was seen in 43.4% of children. Previous studies have reported the frequency of hyponatremia in SAM children as 11–56% [8,17-22]. Extracellular sodium concentration is reduced in children with protein-energy malnutrition, despite a significant increase in total body and cellular sodium content. The fall of serum sodium is caused by the expansion of the extracellular fluid volume, diarrheal losses, and failure of the energy supply for the sodium pump resulting in sodium accumulation in the cell [3,4].

Hypokalemia was seen in 7.1% children in our study. Previous studies have reported the frequency of hypokalemia in SAM children as 9.5 %–64.5% [8,17-22]. The reason why hypokalemia is less in our study is not clear. Decreased potassium is associated with decreased muscle mass, poor intake, digestive losses, vomiting, and diarrhea [3,4].

There are various limitations in our study. First of all, our sample size was small. Second, we could not correlate the serum electrolytes with degree of dehydration. Third, we were not able to study the outcome of dyselectrolytemia at first contact in SAM children as the outcome is influenced by many other confounding factors such as infections, anemia, and underlying chronic illness. Fourth, we were not able to measure serum electrolytes during and at the end of facility/community-based management of SAM children. Hence, to overcome these limitations, further studies are required in this field.

CONCLUSION

Hyponatremia and hypokalemia occur in SAM children with and without complications. Serum electrolyte levels need to be measured in all SAM cases to detect asymptomatic hyponatremia and hypokalemia. This will help in triaging those with asymptomatic hyponatremia and hypokalemia to inpatient care.

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Funding: None; Conflict of Interest: None Stated.

How to cite this article: Dakshayani B, Monisha, Premalatha. A study of serum electrolytes in severe acute malnourished children with and without complications. Indian J Child Health. 2018; 5(2):120-123.