Journal of Family Medicine

Open Access

Austin Publishing Group

Research Article

Study of Serum Electrolytes and Blood Sugar Changes in Children with Severe Acute Malnutrition

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Received: September 22, 2022; **Accepted:** November 01, 2022; **Published:** November 08, 2022

Abstract

The purpose of this study was to look at the serum electrolyte status of malnourished children with and without diarrhoea/vomiting in order to manage serum electrolyte abnormalities in cases of severe acute malnutrition.

This prospective observational hospital based study (n=112) carried out at a tertiary care hospital. The enrolled subjects was divided into 2 groups: those who had diarrhoea and/or vomiting (Group A; 42: 37.5%) and those who did not (Group B; 70: 62.5%). 1.5 mL of venous blood in an EDTA vial and 2 mL of venous blood in a plain vial were drawn and sent straight away for further analysis. All patients had the following tests: Blood glucose; CBC; Serum electrolytes (Na^+, K^+, Ca^{++}). Other investigations, like KFT, ESR, LFT, Urine (R/M), and Stool (R/M) were undertaken to corroborate the diagnosis whenever clinical indicated.

Males (65; 58.03%) outnumbered females (47; 41.96%). 73.21% of the patients were between the ages of 6 and 24 months. SAM is more common in lower socioeconomic status 74 (66.07%).SAM was associated with hypokalemia in 7 children, (16.66%), hyponatremia in 6 children (14.28%), hypernatremia in 2 children (4.76%), hypocalcemia in 3 children (7.14%) and hypoglycemia in 3 children (7.14%) in group A (n=42). SAM in Group B (n=70) were associated with hypokalemia in 3 children (4.28%), hyponatremia in 9 children (12.85%), hypernatremia in 5 children (7.14%), and hypocalcemia in 4 children (5.71%). Out of 112 SAM children, 79 children were cured (70.53%). 60 of the 79 cured children (or 75.94%) had achieved their target weight, but just 8 of the 30 defaulter children (or 26.66% of them) had.

Electrolytes changes are prevalent in malnourished children, and they can be subclinical or manifest during diarrhoea/vomiting. Although frequency of hypoglycemia was low, measurement of blood sugar and serum electrolytes are helpful to avoid life threatening situation. Despite recent breakthroughs in medicine and technology, severe acute malnutrition remains a problem. Faulty feeding habits, poor supplementary feeding practises, confusion about children's nutritional needs, frequent illnesses, big family size, and low socioeconomic level are all predictors of severe malnutrition. Aside from literacy, there is an urgent need to educate mothers on nutrition, low-cost diets, and breast-feeding methods in order to prevent and treat childhood malnutrition.

Keywords: Malnutrition; Electrolytes; Serum; Children; Hospital; Diarrhoea

Introduction

Malnutrition is a serious global issue, particularly in developing countries such as India, where the majority of people live below the poverty line. These children need extra care because they are our supreme assets, as children of today are human resource for tomorrow. As per NFHS- 4 (2015-16), 35.7% children below 5 years are underweight, 38.4% are stunted and 21 % are wasted and these children have mortality rate ranging from 20% to 30% [1].

Severe Acute Malnutrition (SAM) is the most dangerous form of malnutrition. If left untreated, causes death. WHO diagnostic criteria for SAM in children aged 6 to 60 months is any of the following [3]: 1) Weight-for-length/height < -3SD (wasted) or 2) Mid-upper arm circumference < 115 mm or 3) Oedema of both feet (kwashiorkor with or without severe wasting). It can manifest as wasting, oedema or with complications of SAM.

It interacts with diarrhoea in a vicious circle leading to high morbidity and mortality in children, and is a complicating factor for other illnesses in developing countries. Malnourished children have more severe diarrhoea, which lasts longer. The prevalence of diarrhoea is 5-7 times more in malnourished as compared to normal children and its severity is 3 to 4 times greater in malnourished children as compared to normal children [2].

Malnutrition causes a variety of electrolyte imbalances in the body. Sodium, potassium, bicarbonate, and water are the most prevalent electrolyte imbalances. In malnutrition with edematous state body water content is increased accompanied by sodium retention that is primarily extra cellular but serum sodium level is reduced in most children with malnutrition masking the sodium

Citation: Singh YB, Sethi AS, Verma M, Sethi RS. Study of Serum Electrolytes and Blood Sugar Changes in Children with Severe Acute Malnutrition. J Fam Med. 2022; 9(8): 1318.

overload. These levels may be low due to associated diarrhoea. Total body potassium is decreased in all malnourished as much as 25% in overt malnutrition, due to decreased intake and poor muscle mass. Potassium is predominantly intracellular ion needed for maintaining homeostasis integral to normal cellular function but only 2% of body content is in extra cellular fluid so plasma potassium is a poor indicator of total amount in the body. However plasma potassium concentration has importance in immediate therapy in case of life threatening hypokalemia. In malnutrition sub clinical deficiency of potassium may be present without any clinical feature but these children are at risk of hypokalaemia during diarrhoeal disease, which makes the clinical picture of deficiency obvious and patient presents with muscle weakness, hypotonia, apathy, abdominal distention, paralytic ileus and serious cardiac arrhythmias [7-10]. Both malnutrition and electrolyte disturbances are considered to be risk factors for death among children with diarrhoea [4-6]. Underlying causes of malnutrition includes poverty, lack of access to food, ignorance, disease, conflicts, climate change, lack of safe drinking water.

The goal of this study was to investigate the serum electrolyte status in malnourished children with and without diarrhoea/vomiting so that serum electrolyte disturbances could be managed in case of severe acute malnutrition.

Materials and Methods

This prospective observational hospital based study (n=112) was conducted from May 2018 to October 2019 at the Nutritional Rehabilitation Centre, Department of Paediatrics, Maharani Laxmi Bai Medical College, Jhansi (U.P.), a tertiary care hospital, after written informed consent was obtained from parents or guardians of children. This study excluded children under the age of six months and those above the age of five, as well as those with liver or kidney illness and those on diuretic medication. The enrolled subjects were divided into two groups, with diarrhoea and/or vomiting (Group A) and those without diarrhoea or vomiting (Group B). 2 mL of venous blood in a plain vial and 1.5 mL of venous blood in an EDTA vial were drawn and immediately sent to the central pathology lab, Department of Pathology, MLB Medical College, Jhansi, U.P. for analysis.

Due emphasis was taken to access general condition, pulse rate, respiratory rate, temperature, level of hydration, chest auscultation, organomegaly, saturation, blood pressure, level of orientation. Cardiovascular system, respiratory system, central nervous system, abdominal and genitourinary system have done in each and every case. Following investigations were done in all patients-Blood glucose; CBC; Serum electrolytes (Na^+, K^+, Ca^{++}). Other investigations were undertaken to corroborate the diagnosis whenever clinical indicated. KFT, ESR, LFT, Urine (R/M), and Stool (R/M) were among them.

Socioeconomic status was classified according to modified Kuppuswamy scale (Modified in 2014) [11].

Statistical analysis

All the above information was collected & compiled systematically in tabular form. Categorical variables were presented in number and percentage (%) and continues variables were presented as mean ± SD. Qualitative variables were compared using Chi-square test/ Fisher's exact test as appropriate. A p value of < 0.05 was considered statistically significant. The data was entered in MS excel spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

This study included 112 patients (Males: 65; (58.03%); females: (47; 41.96%)] from the Department of Pediatrics at Maharani Laxmi Bai Medical College in Jhansi, Uttar Pradesh, India. There were 42 (37.5%) patients aged 6-12 months, 40 (35.71%) aged 13-24 months, 21 (18-75%) aged 25-36 months, and 9(8.03%) aged 37-60 months among the 112 cases (Table 1).

SAM is more common in lower socioeconomic status 74 (66.07%) which is followed by upper lower 20 (17.86%), lower middle 10 (8.93%), upper middle class 7 (6.25%) and upper class 1 (0.89%) (Table 2).

There were 100 (89.28%) patients with weight for height <3SD, 54 (48.21%) with MUAC <115mm and 76 (6.21%) with B/L pitting oedema (Table 3).

Among 112 SAM children, 42 (37.5%) SAM children with diarrhoea and or vomiting (Group A) and 70 (62.5%) did not (Group B) (Figure 1).

SAM was associated with hypokalemia in 7 children, (16.66%), hyponatremia in 6 children (14.28%), hypernatremia in 2 children (4.76%), hypocalcemia in 3 children (7.14%) and hypoglycemia in 3 children (7.14%) in group A (n=42). SAM in Group B (n=70) were associated with hypokalemia in 3 children (4.28%), hyponatremia in 9 children (12.85%), hypernatremia in 5 children (7.14%), and

Table 1: Gender and age-wise distribution of SAM children.

	N	Percentage
Gender		
Male	65	58.04
Female	47	41.96
Age intervals		
6-12 months	42	37.50
13-24 months	40	35.72
25-36 months	21	18.75
37-60 months	9	8.03

Table 2: Distribution of SAM children according to their Socioeconomic status (SES).

Socioeconomic status	N	Percentage
Upper	1	0.89
Upper middle	7	6.25
Lower middle	10	8.93
Upper lower	20	17.86
Lower	74	66.07

Table 3: Distribution of SAM children.

Criteria	N	Percentage
Weight for height	100	89.28
MUAC	54	48.21
B/L pitting oedema	7	6.21

Table 4: S. Electrolyte and B. Sugar change in both group A and group B.

	Group A		Group B		p-value	Total	
Criteria	N	%	N	%		N	%
Hypokalemia <3.5meq/l	7	16.66	3	4.28	0.026	10	8.92
Hyponatremia <135 meq/l	6	14.28	9	12.85	0.829	15	13.39
Hypernatremia >150meq/l	2	4.76	5	7.14	0.614	7	6.25
Hypocalcemia Ionic Ca++2<1mmol	3	7.14	4	5.71	0.762	7	6.25
Hypoglycemia <54mg/dl	3	7.14	0	0	NA	3	2.67

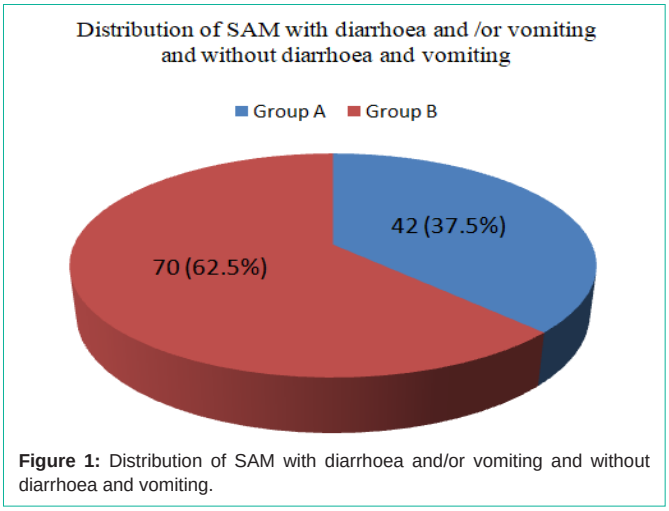

Figure 1: Distribution of SAM with diarrhoea and/or vomiting and without diarrhoea and vomiting.

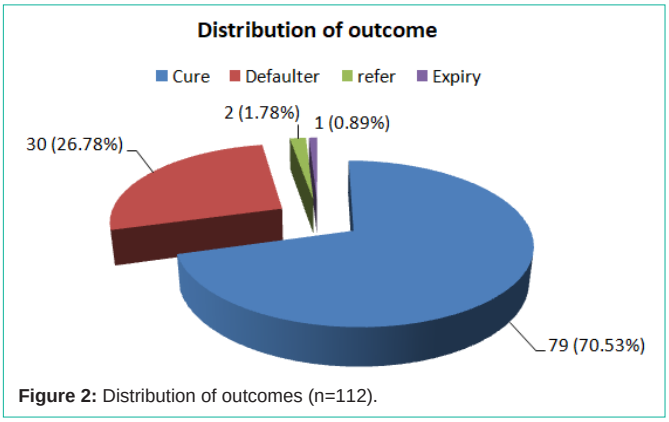

Figure 2: Distribution of outcomes (n=112).

hypocalcemia in 4 children (5.71%) (Table 4).

Out of 112 SAM children, 79 children were cured (70.53%) and 30 children were defaulter (26.78%). Out of 30 defaulter children, 9 children were absconded (8.03%) and 21 children were left against medical advice LAMA (18.75%). Out of 112 SAM children, 2 children were referred (1.78%) and 1 child expired (0.89%) (Figure 2).

Out of 79 cured children, 60 children had achieved target weight (75.94%) and out of 30 defaulter children, 8 children had achieved target weight (26.66%) (Table 5).

Discussion

Severe malnutrition is not only an important cause of morbidity and mortality, but also leads to permanent impairment of physical and possibly mental growth of those who survive. In addition to

Table 5: Distribution of SAM children who achieved target weight.

Outcome	No. of cases	Target weight achieved	Percentage
Cure	79	60	75.94
Defaulter	30	8	26.66
Abscond	9	4	44.44
LAMA	21	4	19.05

critical care, nutritional therapy followed by nutritional rehabilitation is very important aspect of these children. Despite concerned efforts and social organizations morbidity and mortality of malnutrition remains a challenge [12].

This prospective study done over a period of 11⁄2 year i.e. May 2018 to Oct 2019 and 112 SAM children were included, 73.21% of whom were between the ages of 6 and 24 months. Similar to this study, Alasad et al., (2019) [13] did a retrospective descriptive cross sectional study conducted in 215 SAM patients, from Jan to Dec 2015, reporting that 94% of children 94% of children were between the ages of 6 and 24 months. Gangaraj et al., (2013) also reported that 61.06% of children were in between 6-24 month of age [14].These studies thus have similar findings as our study, with majority of severely malnourished children being less than 24 months of age. In initial 2-3 year of life rapid growth occurs and requirement of substrates for energy and building of tissue also increases which explains high incidence of severe acute malnutrition in this age group.

In the current study, the majority of patients (83.92%) had a lower socioeconomic status (modified Kuppuswami scale).Kumar et al., (2014) [15] and Choudhary et al., (2015) [16] in their study reported that majority of malnourished children belonged to lower socio economic status. Likewise, Tariq et al., (2015) [17] observed that malnutrition was higher in lower socioeconomic class (61.6%).The increased incidence of SAM in lower socioeconomic status was also corroborated by other studies. As found in the preceding research, children in underprivileged communities were prone to malnutrition due to a lack of food, poor purchasing, ineffective distribution, and insufficient use.

Males were more common than females with ratio of 1.38:1.Similar to this study, Menon et al., (2007) [2] reported that malnutrition was relatively more common in males compared to females (57% vs 43%). Likewise, Maguy et al., (2018) [18], also reported that 53.3% of child were male as compared to female (46.7%).Present study were hospital based where male patients were more than female which might be due to the fact male children are brought to hospital early and are given more importance. Moreover male child gets more medical attention than female and in rural area parents usually does not seek medical

advice for female child. Ritual and social norms are also responsible.

Analysis of different WHO criteria used for diagnosis of SAM revealed that 100 (89.28%) children had weight /length (or height) < -3SD, 54 (48.21%) children had MUAC <115mm, whereas bilateral pitting oedema was seen in 6.21% (in 7 children). 41 children (36.6%) had weight/length <-3SD as well as MUAC <115mm. Similar to our study, Suman et al., (2012) [19] reported that majority i.e. 48% of children satisfied weight/length (or height) criteria in their study. Ganesh et al., (2014) [20] in their study on malnutrition observed that weight/length (or height) criteria was satisfied in 85 children (77.3%) whereas only 3 children (2.7%) satisfied MUAC criteria. Both criteria present in 22 children (20%). There was no child observed to have nutritional oedema in their study.

In the present study, 42 SAM children (37.5%) presented with diarrhoea and or vomiting, while 70 SAM children (62.5%) were not having diarrhoea or vomiting. Menon et al., (2007) [2] showed that 64 SAM children (64%) were having diarrhoea and 36 children (36%) were not having diarrhoea. Fatima et al., (2017) [21] showed that 67 SAM children (67%) were having diarrhoea and 33 SAM were not having diarrhoea.

In the current study, hyponatremia was observed in 14.28% of patients in group A, whereas Fatmia et al., (2017) [21] and Bilal et al., (2016) [22] reported hyponatremia in 10.4% and 32.5% of cases in group A, respectively. Hyponatremia was found in 26.55% of patients by Zulqarnain et al., (2015) [23]. In the current study, 12.85% of the patients in group B had hyponatremia, whereas Fatima et al., (2017) [21] reported hyponatremia in 9.1% of the patients in group B, and Memon et al., (2007) [2] reported hyponatremia in 13.88% of the patients. Gangaraj et al. (2013) [14] found hyponatremia in 14.8% of the patients.

There were 4.76% cases of hypernatremia in group A and 4.28% cases of hypernatremia in group B in this study. Memon et al (2007) [2] found hypernatremia in 1.56% of cases with diarrhoea group A and 5.55% of those without diarrhoea group B. Gangaraj et al., (2013) [14] found hypernatremia in 14.25% of group A cases and 18.5% of group B cases.

Conclusion

Malnutrition is a global health problem with significant morbidity and a major cause of death in children. 'It often starts in the womb and end in the tomb'.112 patients were enrolled in our study who fulfilled the inclusion criteria. The majority of patients were between the ages of 6 and 24 months and were from lower socioeconomic status. In group A, there were 42 children; 7 (16.66%) had hypokalemia, and 6 (14.28%) had hyponatremia. In terms of sodium alteration, we found hypernatremia in 2 children (4.76%), hypocalcemia in 3 children (7.14%), and hypoglycemia in 3 children (7.14%) in group A. There were 70 children in group B, 3 children (4.28%) had hypokalemia, 9 children (12.85%) had hyponatremia. Similarly as regards to change in sodium is concerned we observed hypernatremia in 5 children (7.14%), and 4 children (5.71%) had hypocalcemia. Majority of the children got cured and achieved their target weight. Electrolytes changes are commonly present in malnourished children which may be sub-clinical and become obvious during diarrhoea/vomiting. Although frequency of hypoglycemia was low, measurement of blood sugar and serum electrolytes are helpful to avoid life threatening situation. Severe acute malnutrition still remains prevalent despite recent advances in medicine and technology. The determinants of severe malnutrition include faulty feeding practices, poor complementary feeding practices, and ignorance about nutritional needs of children, repeated infections, large family size, and low socioeconomic status. Apart from literacy, there is a strong need to provide education regarding nutrition, low cost diets and breast feeding practices to mother to prevent as well as manage malnutrition in children. Weight/ Height ratio is one of the best among the criteria for identifying SAM and hence every child should be screened adequately on presentation.

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