Clinico-biochemical profile of sick children with severe acute malnutrition

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ABSTRACT

Objective: Severe acute malnutrition (SAM) classified as edematous and marasmus, however, Kwashiorker represents the most severe phenotype of edematous malnutrition. The aim of this study was to describe the clinico-biochemical profile in sick children with severe acute malnutrition. **Materials and Methods:** This is a descriptive cross-sectional study, which included children aged 6 to 60 months, fulfilling the World Health Organization (WHO) criteria of severe acute malnutrition. We collected data on demography, anthropometry, history, and clinical examination. Investigations included arterial blood gas analysis, serum electrolytes, calcium, serum albumin, and blood sugar. *P* value < 0.05 was considered significant. **Results:** One hundred twenty-two children with SAM were recruited, out of which 65 (53.27%) had edematous malnutrition and 57 (46.7%) had nonedematous malnutrition. Out of total children, 90 (73.77%) were discharged from hospital, 18 (14.7%) died, and 14 (11.4%) were left against medical advice. Out of 122 children with SAM, edematous children were younger (25.7 vs. 34.5 months, *P* = 0.002). Children with edematous malnutrition were more likely to have pneumonia (*P* = 0.04), acute gastroenteritis (*P* < 0.001), hyponatremia (*P* = 0.04), metabolic acidosis (*P* = 0.005), and hypocalcemia (*P* = 0.006) when compared with nonedematous children. Edematous malnutrition has 1.3 and 1.4 times more risk of death and leave against medical advice (LAMA) respectively as compared to nonedematous malnutrition. Mortality was higher in edematous malnutrition (12, 66.6%) than nonedematous malnutrition (6, 33.3%). **Conclusion:** Edematous malnutrition was commonly prevalent in 1 to 3 years of children and clinical and biochemical abnormalities frequently co-exist with edematous malnutrition.

Keywords: Edematous malnutrition, morbidity, severe acute malnutrition

Introduction

Childhood undernutrition is still a major global health problem, contributing to morbidity, mortality, and increased risk of diseases.[1,2] Severe acute malnutrition (SAM) among childhood is at risk category, which predisposes the children at a greater risk of dying from common infections, increases the frequency and severity of such infections, and contributes to delayed recovery despite nutritional rehabilitation.[3,4] The case fatality rate of SAM in under-five children ranges from 30-50% and 35% of death among under-five children is directly or indirectly contributed by malnutrition.[5] SAM

clinically manifests as edema and marasmus, however, kwashiorkor represents the most severe phenotype of edematous malnutrition.[6,7] Pathophysiology of edema in malnutrition was not established, although current evidence in literature correlates developmental origin and prenatal factors influence the clinical phenotype of malnutrition.[8,9] How children with edematous malnutrition differ from children with nonedematous malnutrition in terms of socio-demographic background, clinical characteristics, and household diet, may help to understand the cause of edema. However, few investigators studied this, with variable results and diagnostic criteria used that were different from today.[10,11] Coexisting clinico-biochemical morbidities may be a consequence of malnutrition *per se* or predisposed the children to develop nutritional edema yet to establish. With this background, we conducted a study to describe the clinico-biochemical profile in sick children with severe acute malnutrition.

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Materials and Methods

Study was approved by ethical committee on 09.11.2016, Dean/2015-2016/EC/454. This is a descriptive cross-sectional study, conducted from September 2016 to May 2018 in a tertiary care teaching hospital situated in northern India. Inclusion criteria were children fulfilling the World Health Organization (WHO) criteria of SAM, i.e. weight-for-height/length (SD score below -3SD of the median for WHO Child Growth Standards), and/or mid-upper arm circumference < 11.5 cm, and/or by the presence of noninflammatory bilateral pitting edema.[12] The cohort was sub-classified into edematous and nonedematous. Informed consent was obtained from the parents before the study. Detailed history, clinical examination, sociodemographic variables, anthropometry, laboratory results were recorded in predesigned case report forms. We used following definitions to characterize various co-morbidities: Metabolic acidosis (pH < 7.35 with HCO3 <22 mmol/l), severe anemia (Hb <4 gm/dl), hypoglycemia (blood sugar <54 mg/dl), hypoalbuminemia(albumin<2.5g/dl),hypocalcemia(calcium<8mg/dl), hypokalemia (serum K <3.5 mmol/l), hyperkalemia (serum K >5.5 mmol/l), hyponatremia (serum Na <130 mmol/l), and hypernatremia (serum Na >145 mmol/l). Diarrhea was defined as the passage of three or more abnormally loose or watery stools in the previous 24 hours.[13] Pneumonia was diagnosed based on radiological evidence of consolidation or patchy opacities[14] and clinical criteria defined by WHO.[15] Severe dehydration was diagnosed as a definite history of diarrhea with the sign of poor perfusion [cold extremities, tachycardia, capillary refill time < 3 sec]. Septic shock was diagnosed as a clinical sign of poor perfusion without diarrhea.[12] The data of clinical features, biochemical, and hematological parameters were recorded in standard pretested proforma. All data were entered into an excel sheet and analyzed by using statistical package for the social sciences (SPSS) version 16, and appropriate table and diagrams were generated. Morbidities were presented as numbers and percentages. Chi-square or Fishers exact test was used to compare the categorical variables. A *P* value < 0.05 was considered significant.

Results

Demographic characteristics as shown in Table 1, there were 122 children with SAM, out of these 65 (50.4%) had edema and 57 (49.54%) had nonedematous malnutrition. The common affected age group of children are 1 to 3 years in edematous malnutrition (*P* = 0.04). Male to female ratio in edematous children were 1.9:1 and in nonedematous malnutrition were 1.4:1. SAM is more prevalent in the lower middle class as compared to the upper lower class. The mean age of presentation of edematous children was 25.73 (13.37) vs 34.35 (16.81) (*P* = 0.002) months as compare to nonedematous children. As shown in Table 2, common co-morbidities associated with edematous malnutrition were acute diarrhea (86.15%), pneumonia (72.30%), B-complex deficiency (43.07%), and meningitis (26.15%),

respectively. Edematous malnutrition was 3 times more likely to have acute diarrhea (*P* < 0.001) and 1.4 times more likely to have pneumonia (*P* = 0.04). Edematous malnutrition has 1.3 and 1.4 times more risk of death and LAMA, respectively as compared to nonedematous malnutrition. Table 3 reveals that morbidities like dehydration, cardiac failure, hypernatremia, hypokalemia, and severe anemia were near equally distributed in edematous and nonedematous malnutrition. However, hypoalbuminemia (80%), hypocalcemia (36.92%), metabolic acidosis (24.61%), hypoglycemia (21.53%), and shock (20%) were more prevalent in edematous as compared to nonedematous malnutrition. Edematous malnutrition was 1.6 times more likely to have hypocalcemia (*P* = 0.006), and 1.16 times more likely to have metabolic acidosis (*P* = 0.04), whereas nonedematous malnutrition has 1.4 times more likely to have hyponatremia (*P* = 0.04).

Discussion

The main observations of this study were that edematous children were more likely to have pneumonia, acute gastroenteritis, metabolic acidosis, and hypocalcemia. The common co-morbidities were diarrhea, pneumonia, and b-complex deficiency in this study, similar results were reported by Chakroborty *et al.*[16] and Irena *et al.*[17] The proportion of edematous SAM was more than 50% in this study, this is similar to previous hospital-based study by Munthali *et al.*[18], Girma *et al.*[10], and Rytter *et al.*[9] There is a lack of evidence in literature studying the detailed distribution of clinico-biochemical morbidity in edematous and nonedematous malnutrition. However, a retrospective hospital-based study reports that anemia, diarrhea, pneumonia, tuberculosis, and sepsis were more prevalent in edematous malnutrition (*P* = 0.009).[18] Similar results were reported in this study and it also further adds that hypocalcemia (*P* = 0.006) and metabolic acidosis (*P* = 0.005) were associated with edematous children whereas hyponatremia (*P* = 0.04) was associated with nonedematous children. Children aged 1 to 3 years were more vulnerable for the development of nutritional edema as reported in this study and this observation was similar with the previous study by Rytter *et al.*[9] and Girma *et al.*[10] However, both these two authors and Talbert *et al.*[11] reported that infections (acute diarrhea, pneumonia) were negatively correlated

Table 1: Baseline characteristics of the study population

Variables		Edematous (*n*=65)	Nonedematous (*n*=57)	*P*
Age (month)	6-12	12 (18.46%)	19 (33.33%)	0.04
	13-36	37 (56.92%)	20 (35.08%	
	37-60	16 (24.61%)	18 (31.57%)	
Age of presentation (month, SD)		25.73 (13.37)	34.35 (16.81)	0.002
Gender	Male	43 (66.15%)	34 (59.64%)	0.57
	Female	22 (33.84%)	23 (40.35%)	
SES*	IV	16 (24.61%)	17 (29.82%)	0.93
	V	29 (44.61%)	32 (56.14%)	
MUAC# mean (SD)		9.7 (1.2)	8.7 (1.6)	0.02§

* SES: socioeconomic status, # MUAC: Mid upper arm circumference. § *p* value was calculated by unpaired *t* test and rest *p* value were calculated by Chi-square test

Table 2: Distribution of Co-morbidity and outcome in study population

Variables	Edematous (*n*=65)	Nonedematous (*n*=57)	P	Relative risk, (95% CI)
I- Co-Morbidity				
(i) Pneumonia	47 (72.30%)	31 (54.38%)	**0.04**	**1.47, 1.01-2.21**
(ii) Acute diarrhea	56 (86.15%)	26 (45.61%)	**<0.001**	**3.03, 1.80-5.50**
(iii) Meningitis	17 (26.15%)	9 (15.78%)	0.163	1.31, 0.89-1.73
(iv) B-Complex deficiency	28 (43.07%)	22 (38.59%)	0.616	1.09, 0.774-1.45
(v) Vitamin A deficiency	11 (16.92%)	7 (12.28%)	0.49	1.16, 0.712-1.60
(vi) Zinc deficiency	3 (4.61%)	7 (12.28%)	0.124	0.54, 0.192-1.123
II-Outcome				
(i) Discharge	43 (66.15%)	47 (82.45%)	0.041	0.69, 0.53-0.98
(ii) Death	12 (18.46%)	6 (10.52%)	0.21	1.30, 0.83-1.72
(iii) LAMA	10 (15.38%)	4 (7.01%)	0.14	1.40, 0.86-1.80

Table 3: Distribution of Morbidity in Study Population

Variables	Edematous (*n*=65)	Nonedematous (*n*=57)	P	Relative risk, (95% CI)
Clinico-Biochemical Morbidity				
(i) Severe dehydration	16 (24.61%)	19 (33.33%)	0.28	0.812, 0.52-1.17
(ii) Septic shock	13 (20%)	7 (12.28%)	0.25	1.27, 0.82-1.69
(iii) Cardiac failure	4 (6.15%	2 (3.50%)	0.83	1.07, 0.46-1.63
(iv) Acute kidney injury	2 (3.07%)	3 (5.26%)	0.08	1.52, 0.95-1.880.
(v) Metabolic acidosis	16 (24.61%)	6 (10.52%)	**0.005**	**1.16, 1.17-2.04**
(vi) Hypoglycemia	14 (21.53%)	9 (15.78%)	0.22	1.26, 0.84-1.68
(vii) Hypocalcemia	24 (36.92%)	19 (33.33)	**0.006**	**1.60, 1.15-2.20**
(viii) Hyponatremia	8 (12.30%)	19 (33.33%)	**0.04**	**1.41, 1.03-1.85**
(ix) Hypernatremia	10 (15.38%)	7 (12.28%)	0.23	1.29, 0.85-1.71
(x) Hypokalemia	26 (40%)	20 (35.08%)	0.186	1.25, 0.89-1.72
(xi) Hyperkalemia	0 (0%)	3 (5.26%)	0.48	0.02, 0.11-1.52
(xii) Hypoalbunemia	52 (80%)	25 (43.85%)	0.57	1.1, 0.79-1.59
(xiii) Severe anemia	31 (47.69%)	25 (43.85%)	0.80	1.16, 0.57-2.38

with edematous malnutrition. This is not in accordance with this study as different sociodemographic, dietary factors, cultural practices, and feeding practices in our country and our center is a tertiary care and received referral from adjoining states. Serum electrolytes levels in SAM children are not a surrogate marker of sufficiency or deficiency, however, identification of dyselectrolytemia has importance in immediate therapy in life-threatening situation. This study showed that the frequency of dyselectrolytemia is equally distributed in edematous and nonedematous children except hyponatremia. Similar results were shown by Menna *et al.*[19] and Dakshayani *et al.*[20] A Study in Hyderabad by the National Institute of Nutrition from 1995 to 2015 showed that edematous malnutrition constitutes only 16.5% of malnourished children and led to mortality in 27.3% of malnourished children.[21] Whereas this study did not aim to identify risk factors of mortality, but we observed that edematous children were more likely to discontinue treatment and are at increase risk of death as compare to nonedematous children. This observation is might be because of geographical, dietary habits, small sample size, and being referral center. A study by Rytter *et al.*[22] showed that hypophosphatemia at day 2 of admission was associated with death, however, Wagnew *et al.*[23] and Barungi *et al.*[24] reported thatage <24 months, diarrhea, and pneumonia were independently associated with death in SAM children. A study by Kumar *et al.*[25] showed that the presence of shock, dehydration oliguria, and hyponatremia independently increases the risk of mortality in children with SAM. This study further adds that edematous children were significantly associated with diarrhea and pneumonia, which led to the occurrence of dyselectrolytemia, dehydration, shock, and metabolic acidosis, which subsequently increases the risk of mortality in edematous children. The results of this study could not be generalized at the community level. The strength of our study was the detailed description of biochemical morbidities in edematous and nonedematous malnutrition. Future research may confirm whether a causal relationship exists between coexisting morbidities and nutritional edema.

Conclusion

This study emphasizes the fact that edematous malnutrition was commonly prevalent in 1 to 3 years of children and clinical and biochemical abnormalities frequently co-exist with them.

Conflicts of interest

There are no conflicts of interest.

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