Original Article

Pediatric Education and Research
Volume 6 Number 2, May - August 2018
DOI: https://dx.doi.org/10.21088/per.2321.1644.6218.3

Clinical Predictors of Metabolic Acidosis in Hospitalized Children of 6-60 Months with Severe Acute Malnutrition

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Abstract

Context: Malnourished children are at increased risk of many common infections and their complications. In those hospitalized with Severe Acute Malnutrition (SAM), concomitant infections and diarrhoea are frequent complications resulting in adverse outcome. Metabolic acidosis is a consequence of dehydration in diarrhoea, and the diagnosis of dehydration is based on history of fluid loss. Present study carried out to find the predictors of metabolic acidosis among children hospitalized with SAM. *Aims:* To study the predictors of metabolic acidosis among children hospitalized with severe acute malnutrition. *Settings and Design:* Department of Paediatrics Shyam Shah Medical College Rewa, Prospective cross sectional study. *Methods and Material:* Children between 6-60 months fulfilling the WHO criteria of SAM were enrolled. Variables recorded were sociodemograghic, anthropometry, history, clinical sign and laboratory results. Study population was grouped in children with (case) and without metabolic acidosis as (control). WHO guidelines for management of SAM was used to treat the morbidities. *Statistical analysis used:* Data was analyzed by using SPSS 16, variables were initially analyzed in univariate model, and then independently associated factors with metabolic acidosis were identify using logistic regression analysis. A probability of less than 0.05 was considered statistically significant ($p<0.05$). *Results:* Out of total 202 children, 91 (45%) children developed metabolic acidosis, 110 (54%) out of 202 children were presented with either acute watery diarrhoea or vomiting or both; out of which 69 (62%) developed metabolic acidosis and association of fluid loss was significant ($p<0.001$). Septic shock, watery diarrhoea and vomiting were independently associated with metabolic acidosis in SAM children. *Conclusions:* History of fluid loss either in form of loose motion or loose motion with vomiting and septic shock were independently predict metabolic acidosis in SAM children.

Keywords: Metabolic Acidosis; Severe Acute Malnutrition; Dehydration; Shock.

Introduction

Malnourished children are at increased risk of many common infections and their complications. In those hospitalized with SAM, concomitant infections and diarrhoea are frequent complications resulting in adverse outcome. Metabolic acidosis is a consequence of dehydration in childhood diarrhoea [1], it may be because of severe sepsis and/or pneumonia without dehydration [2].

Faecal loss of bicarbonates in dehydrating diarrhoea [3] and anaerobic cellular respiration in sepsis [4] are responsible for development of metabolic acidosis. The clinical diagnosis of dehydration in severe acute malnutrition (SAM) is based on definitive history of diarrhoea or vomiting and history of a recent change in eye status [5] Therefore SAM children with definitive history of fluid loss could have dehydration and severe dehydration is diagnosed as history of fluid loss and sign of poor perfusion (cool extremities, prolonged capillary refill and weak and fast pulse for age cut off). However, there is knowledge gap about the correlation between history of fluid loss and development of metabolic acidosis in SAM. So we did this study to identify predictors of metabolic acidosis among children hospitalized with SAM.

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Received on 03.08.2018, **Accepted on** 31.08.2018

Materials and Methods

This is a prospective cross sectional study on SAM children recruited from august 2012 to July 2013 over one year period at severe malnutrition treatment unit (SMTU) of Medical college located in Central India. The inclusion criteria were children between 6-60months of age fulfilling WHO criteria for SAM [6]. The exclusion criteria were children with congenital malformations, cerebral palsy and inborn error of metabolism. The ethical committee of the college approved the study and informed consent was obtained from the parents of all patients before the study. Detailed history, clinical examination, sociodemographic variables, anthropometry, laboratory results and arterial blood gas results were recorded in predesigned case report forms. Metabolic acidosis was defined as pH<7.35 with HCO3<22mmol/l in blood gas analysis. Laboratory test results such as severe anaemia (Hb<4gm/dl), hypokalemia (serum K<3.5mmol/l), hyperkalemia (serum K>5.5mmol/l),hyponatremia (serum Na<130mmol/l) and hypernatremia (Serum Na> 146mmol/l) were used to diagnosed severe anaemia and electrolyte imbalance respectively. Diarrhoea was defined as the passage of three or more abnormally loose or watery stools in the previous 24 hours [7]. Pneumonia was diagnosed based on radiological evidence of consolidation or patchy opacities [8] and clinical criteria defined by WHO [9]. Severe dehydration was differentiated from septic shock based on clinical features response to administration of 15ml/kg body weight fluid over an hour [10] and respond to fluid. WHO guidelines for the management of SAM [10] was use to treat the morbidities.

All data were entered into excel sheet and analyzed by using SPSS 16. Comparison was made between SAM with (case) and without metabolic acidosis (control). Differences in proportion were compared by the X^2 or Fisher Exact test when applicable and difference of means were compared by Student t test. A probability of less than 0.05 was considered statistically significant ($p<0.05$). Strength of association was determined by a calculating odds ratio and its 95% confidence interval (95%Cl). Variables were initially analyzed in univariate model, and then independently associated factors with metabolic acidosis were identify using logistic regression analysis.

Results

Out of total 202children, 91 (45%) children developed metabolic acidosis. SAM children with metabolic acidosis more often presented with dehydration, septic shock, acute watery diarrhoea and vomiting and its association was significant ($p<0.05$) (Table 1). The distribution of sex, age, sever stunting, severe wasting, oedema, dyselectrolymia and MUAC<11.5cm were not different between the

Table 1: Characteristic of SAM children between 6-60 months of age with(case) and without metabolic acidosis (control)

Variables	Metabolic Acidosis(n=91)	Non Metabolic Acidosis(n=111)	OR	95% CI	P value
Age(months) Median IQR	10(8,18)	10(8,16)			0.335
Male Sex	45	59	1.160	0.67-2.020	0.6
Severe Stunting < 85%	89	109	1.011	0.424-2.410	0.98
Severe wasting <3 SD	84	95	2.380	0.89-6.366	0.084
MUAC <115mm	81	98	0.98	0.48-1.98	0.95
Fever	66	86	1.303	0.68-2.47	0.42
Cough	12	32	2.66	1.28-5.551	0.009
Rapid Breathing	8	25	3.051	1.30-7.151	0.01
Lethargic	5	16	2.93	1.03-8.33	0.04
Watery diarrhoea	26	16	5.170	2.35-11.344	<0.001
Vomiting	5	6	2.652	0.737-9.535	0.135
Diarrhoea &Vomiting	38	19	6.364	3.067-13.204	<0.001
Some Dehydration	29	25	2.96	1.491-5.877	0.002
Severe Dehydration	33	12	7.017	3.191-15.43	<0.001
Hypothermia	3	12	3.56	0.972-13.12	0.05
Oedema	21	32	1.350	0.714-2.554	0.36
Septic shock	23	8	4.355	1.84-10.29	0.001
Pneumonia	16	31	1.816	0.086-3.588	0.08
Severe Anaemia	6	14	0.379	0.125-1.149	0.08
Moderate Anaemia	59	74	0.705	0.36-1.36	0.298
Hypokalemia	42	44	1.37	0.0778-2.25	0.99
Hyponatremia	12	15	0.995	0.439-2.2588	0.08

Table 2: Clinical predictors for metabolic acidosis in children with SAM

Variables	OR	95%CI	P Value
Rapid Breathing	0.473	0.153-1.457	0.192
Lethargic	0.765	0.226-2.594	0.76
Cough	1.180	0.439-3.172	0.74
Acute Watery diarrhoea	6.114	1.324-27.85	0.019
Vomiting	3.852	0.788-18.835	0.09
Diarrhoea & Vomiting	6.924	1.398-34.303	0.018
Some Dehydration	0.639	0.162-2.510	0.52
Severe Dehydration	1.599	0.375-6.814	0.526
Septic shock	7.139	2.691-18.934	<0.001

Table 3: Predictors for metabolic acidosis in SAM children with diarrhea and vomiting

Variables	OR	95%CI	P value
Age 6-12 months	2.954	1.134-7.69	0.02
Hypothermia	6.867	1.232-38.262	0.02

groups (Table 1). In logistic regression analysis, SAM children with metabolic acidosis were independently associated with septic shock (severe sepsis), acute watery diarrhoea and vomiting (Table 2). Out of 202 children, 110 (54%) children were presented with either acute watery diarrhoea or vomiting or both; out of which 69 (62%) developed metabolic acidosis, which was significant ($p<0.001$) with odd ratio 5.355 and 95%CI (2.894-9.910). In children with diarrhoea or vomiting or both, age group of 6-12 months ($p<0.03$) and hypothermia ($p<0.02$) had significant independent association with development of metabolic acidosis (Table 3).

Discussion

Diarrhoea still plays key role in both morbidity and death among under-5 children and accounts for 9% of global under-5 deaths in 2015 [11]. The observation of this study was independent association of septic shock and history of fluid loss with metabolic acidosis. Either acute watery diarrhoea or vomiting or both were risk factors for metabolic acidosis in SAM. Age between 6 to 12 months and hypothermia were two independent risk factors for development of acidosis in children with SAM who had presented with history of fluid loss. Children with diarrhoea developed metabolic acidosis due to loss of bicarbonates in faces [3] similar observation was found by Chisti MJ et al. [12]. Vasodilatation and capillary leakage in septic shock leads to microcirculation derangement as results by product of anaerobic cellular respiration produces lactate which is responsible for acidosis [13,14], similar observation was found by Sharifuzzaman et al [15]. Our observation of younger age (6-12 months) among diarrheal children with SAM and metabolic acidosis compared to those without metabolic acidosis can be explained as dehydration at younger age has severe presentation. Hypothermia is one of the clinical sign of sepsis in SAM , therefore its association with acidosis is self explanatory. WHO guideline recommends definite history of fluid loss as evidence of dehydration, but in this present study we found that definite history of fluid loss is also a predictor of metabolic acidosis in SAM and this is the strength of our study. The limitation of present study was that we only analyzed the children at time of admission and not after their stabilization. So could not find weather reductive adaptation in SAM is contributing to the acid base imbalance. Also Clinical features of metabolic acidosis and pneumonia frequently overlap in young diarrheal children, resulting in differentiation from each other very difficult.

Conclusion

Severe acute malnutrition increases 9 fold chance of mortality, so it necessary to indentified complications in SAM. This present work emphasises that recent history of fluid loss and clinical sign of shock independently predict metabolic acidosis in SAM.

Acknowledgement

Nil

Conflict of Interest: Nil

Key Messages

History of fluid loss either in form of loose motion or loose motion with vomiting and septic shock were independently predict metabolic acidosis in SAM children.

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