

# Metabolic Acidosis: An Important Morbidity in SAM Children

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## ABSTRACT

This observational prospective study was conducted among 100 children between 6 to 60 months of age group of Nutritional Rehabilitation Unit in a tertiary care hospital with the purpose to study arterial blood gas status in severely malnourished children (SAM: Severe Acute Malnutrition). Children were identified, arterial blood sample was taken at admission and results were correlated with nutritional status of the children at discharge. Statistical data was analysed by using graph-pad. Sixty two percent children were male and 38% were female (MF Ratio 1.63:1) with 69% being in the age group 6-18 months. Children with pH 7.35-7.45 were 50%, whereas those with pH <7.35 and pH >7.45 were 34% and 43.6% respectively. About 88% were discharged, 4 % expired and 8% patients left the treatment. Maximum mortality was noted at pH <7.35 group (p value < 0.0149). Duration of hospital stay was more or less similar in all pH groups. There was no observed difference in weight gain in pH groups. The study concludes that metabolic acidosis is associated with poor outcome, while duration of hospital stay and weight gain has no effect.

**KEY WORDS:** arterial blood gas (ABG); metabolic acidosis; pH; severe acute malnutrition (SAM)

## INTRODUCTION:

Severe acute malnutrition affects nearly 20 million preschool-age children, mostly from the World Health Organization (WHO) African Region and South-East Asia Region. Malnutrition is a significant factor in approximately one third of the nearly 8 million deaths in children who are under 5 years of age worldwide.<sup>[1]</sup> Severe acute malnutrition is a major public health issue. Malnutrition is a state of catabolism. The severe malnutrition may lead to persistent increase in acid load in the internal milieu of the body disturbing the internal homeostasis. The normal function of all body cells depends on the regulation of acid base balance. The kidneys, lungs and blood buffers can usually balance acids and bases. Blood is a connective tissue. It flows through all parts of the body. Arterial Blood Gas (ABG) studies are concerned with respiration, the exchange of gases between the lungs and blood and between blood and tissues.<sup>[2, 3]</sup> By analyzing the ABG of malnourished children, it can be ascertained whether any change in

the acid base balance is one of the factors besides many others for the increased morbidity and mortality in the children suffering from PEM.

Metabolic acidosis is the most common disorder encountered in clinical practice.<sup>[4]</sup> A study noted that Metabolic acidosis (56.3%), Hypokalaemia (23.4%), Hyponatraemia (13%), Hypochloreaemia (4.2%) and hypernatraemia (3.1%) was observed in similar patients.<sup>[5]</sup> Another study conducted with purpose of assessing relationship between electrolyte abnormalities and mortality observed electrolyte disturbance in 80% patients while acid base disturbance was observed in all. Majority (70%) of patients were below 2 years of age. There were 37 (65%) males and 20(35%) females. ABG analysis was performed only in 16 patients. Arterial blood gas analysis could be performed only in 16 patients. Metabolic acidosis was present in 15 (94%) while one (6%) had metabolic alkalosis.<sup>[6]</sup>

In a prospective cohort study conducted in India among children between 6 to 60 months of age admitted in the Severe Malnutrition Treatment Unit, the brachial artery sample was analyzed by Automated Blood gas analyzer. Out of 200 children studied 51% were males and 49% were females. 15.5% children has pH <7.35, 41.5% has pH between 7.35 to 7.45 and 43% has pH >7.45. Of 31 children with pH <7.35, 22.58% expired with significant p value of 0.0004.

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Although rate of weight gain was less in extremes of pH but difference is not significant when compared with group of pH 7.35 to 7.45. It was concluded that the catabolic state of severe malnutrition alters the internal homeostasis. This alteration is found to be much less when measured in terms of rate of weight gain/kg/day. The pH < 7.35 is associated with poor outcome.<sup>[7]</sup>

## MATERIALS AND METHODS:

This prospective study was conducted among 100 children selected as per inclusion criteria at Nutritional rehabilitation unit, MLB Medical College, Jhansi during September 2014 to October 2015 after seeking due approval from the Institutional Ethics Committee. The inclusion criteria were (a) age group range 6months-60months, (b) weight-for-height below -3 z-scores (WHO standards), (c) mid-upper arm circumference (MUAC) below 115 mm, and (d) bilateral edema. The exclusion criteria were Children under 6 months, children above 60 months of age, Weight-for-height above -3 z-scores (WHO standards), Mid-upper arm circumference (MUAC) above 115 mm.<sup>[8,9]</sup> The children admitted to the malnutrition treatment unit were screened for the study criteria. Arterial sample was taken for blood gas analysis after performing Modified Allen's Test on the day of admission.<sup>[10]</sup> Rate of weight gain of all the patients in grams/kg/day was recorded using formula - weight at the outcome - weight on admission / admission weight × duration of stay. Thereafter, all data were tabulated and analyzed statistically to detect Acid base Status of SAM children.

## RESULTS:

Out of 100 children observed over 14 months, 62% were male and 38% were female with male to female ratio being 1.63:1. Maximum children 69 (69%) are in the age group of 6 months to 18 months followed by 23 (23%) children in the age group of 18 months to 36 months with majority of children belonging to low socioeconomic status families. The findings of arterial blood gas analysis show that pH < 7.35, pH > 7.45 and normal pH was observed in 34%, 16% and 50% of children respectively. Metabolic Acidosis, Respiratory Alkalosis, Metabolic Alkalosis and Respiratory Acidosis was found in 28%, 13%, 5% and 4% children respectively. Mean value of pH, HCO<sub>3</sub> and PCO<sub>2</sub> were 7.36, 15.3mmol/l and 27 mmHg respectively.

Rate of weight gain in patients with normal pH was 1.73 gm/kg/day, whereas it was 1.57 gm/kg/day and 1.65 gm/kg/day with pH < 7.35 and > 7.45

respectively. The duration of the hospital stay was calculated from amongst those completing the course of treatment. LAMA (Left Against Medical Advice), absconded and expired cases were not included for statistical calculation. Mean duration of all patients was nearly 103/4 (10.78) days. The duration of the stay in patients with no pH abnormality was 11 days (11.06). It was 103/4 days (10.71) in pH < 7.35 and 10days (10.06) in pH > 7.35 group.

The mortality rate of all the SAM patients was 4% (4/100). It was highest (14.28%; n = 4/28) among those with pH < 7.35 and there was no mortality in the groups with normal pH and pH > 7.45.

In our study, 25% (n=1/4) deaths occurred within 24 hours of admission.

## DISCUSSION:

Sixty two percent children were male and 38% were female (MF Ratio 1.63:1) with 69% being in the age group 6-18 months followed by 11/2 year-3 year 23 (23%). Saxena et al., 1997 reported a higher prevalence SAM patient in the age group 0-1year.<sup>[11]</sup> The majority of study group belong to low socioeconomic status. On the systemic interpretation of arterial blood gas analysis, it was found that 34% of children had pH < 7.35, 16% had pH > 7.45 and 50% of children had a pH in the normal range. Twenty eight percent, 13%, 5% and 4% children had metabolic acidosis, respiratory alkalosis, metabolic alkalosis and respiratory acidosis respectively.

Among 34 children with pH < 7.35, the mean value of HCO<sub>3</sub> was 13.35 mmol/l and PCO<sub>2</sub> was 32.67 mm Hg to compensate for the change in HCO<sub>3</sub>-. Robertson SA in 1989 observed that metabolic acidosis is the most common disorder encountered in clinical practice.<sup>[4]</sup>

In our study 47 cases (47%) had diarrhoea as a chief complaint. Out of which, 34.04% (n = 16/47) had pH < 7.35, 55.31 % (n = 26/47) had pH in the normal range and 12.76% (n = 6/47) had pH > 7.45. Odey FA et al and Chisti et al found metabolic acidosis to be the commonest abnormality in severe malnutrition with diarrhoea.<sup>[5,12]</sup> Shah G S, et al studied patients with diarrhoea and observed that acid base disturbance was observed in all cases where the estimations were done.<sup>[6]</sup>

Mean value of pH, HCO<sub>3</sub> and PCO<sub>2</sub> were 7.36, 15.3mmol/l and 27 mmHg respectively. Thus, in severe malnutrition, underlying metabolic acidosis was present while showing compensated, uncompensated or mixed acid base disorders.

Weight gain was almost similar irrespective of

different pH (Table 1). p values as per unpaired 't' test show that the difference is statistically not significant (p1, 0.2865, p2 0.46550, p3 0.6453) (Table 2). Duration of hospital stay was calculated amongst who completed the course of treatment. LAMA, absconded and expired cases were excluded. Overall mean duration of all patients was nearly 103/4 (10.78) days. Duration of hospital stay is not found statistically significant (p>0.05) (p1, 0.6689, p2 0.4785, p3 0.2645) (Table 1).

**Table 1:** Duration of hospital stay and weight gain among pH groups.

| pH        |      | Hospital stay (days) | Weight gain (gm/kg/day) |
|-----------|------|----------------------|-------------------------|
| <7.35     | Mean | 10.71                | 1.57                    |
|           | SD   | 3.03                 | 0.537                   |
|           | N    | 28                   | 28                      |
| 7.35-7.45 | Mean | 11.02                | 1.73                    |
|           | SD   | 2.98                 | 0.665                   |
|           | N    | 45                   | 45                      |
| >7.45     | Mean | 10.06                | 1.65                    |
|           | SD   | 2.43                 | 0.463                   |
|           | N    | 15                   | 15                      |

Eighty eight percent patients had successfully completed the treatment and were discharged from the hospital, whereas 7% of the patient absconded from the hospital, 1% went LAMA and 4% expired (Table 2).

**Table 2:** Outcome among pH groups.

| pH        | Total     | Outcome    |       |           |         |
|-----------|-----------|------------|-------|-----------|---------|
|           |           | Discharged | LAMA  | Absconded | Expired |
| <7.35     | 34        | 28         | 0     | 2         | 4       |
| 7.35-7.45 | 50        | 45         | 1     | 4         | 0       |
| >7.45     | 16        | 15         | 0     | 1         | 0       |
| Total     | 100(100%) | 88(88%)    | 1(1%) | 7(7%)     | 4(4%)   |

The overall mortality rate among SAM patients was 4%. It was highest (14.28%; n =4/28) among those with pH <7.35, whereas there was no mortality among those with normal pH and pH >7.45. The difference was statistically significant (p=0.0149). Saurabh Kumar Patel et al in 2014 observed that mortality rate of all the SAM patients was 5.4%. It was least (1.1%; n = 1/88) in children with normal pH, followed by 3.8% (n = 3/80) in those with pH > 7.45 and highest (20.6%; n = 7/34) in those with pH < 7.35. This difference was statistically significant (p <.00001).<sup>[7]</sup> Chisti et al also observed that children with metabolic acidosis more often had higher case-fatality (16% vs. 5%, p = 0.039) compared to those without metabolic acidosis on

admission.<sup>[12]</sup> Most of the deaths in children visiting hospitals occurred within first 24 hours of admission.<sup>[13,14]</sup> In our study, 25% (n=1/4) deaths occurred within 24 hours of admission. In patients of SAM, metabolic acidosis is an important morbidity leading to statistically significant mortality.

The present study shows that majority of SAM children belong to 6 month to 1 year age group. Most of the patients belong to low socioeconomic status. Metabolic acidosis is the most common pH disorder. Metabolic acidosis is an important morbidity associated with SAM. Rate of weight gain was similar irrespective of different pH. Further studies are needed to confirm the weight gain in different pH disorders.

## CONCLUSION:

Severe Acute Malnutrition (SAM) is common among 6 month to 1.5 year age group. Majority of study group belong to low socioeconomic status and male gender. Fifty percent, 28%, 13%, 5% and 4% of children had normal pH, metabolic acidosis, respiratory alkalosis, metabolic alkalosis and respiratory acidosis respectively. Metabolic acidosis is found to be associated with poor outcome. On ABG analysis, most of the children had normal pH. This could be due to the secondary compensation or mixed disorder. The duration of hospital stay and rate of weight gain in any pH group was statistically not significant. Weight gain in patients with normal pH was 1.73 gm/kg/day, whereas it was 1.57 gm/kg/day and 1.65 gm/kg/day in patients with pH < 7.35 and > 7.45 respectively. Weight gain was almost the same irrespective of different pH. By unpaired 't' test the p values show that the difference is statistically not significant p>0.05 (p1 0.2865, p2 0.46550, p3 0.6453). The difference in the duration of hospital stay among all pH groups was statistically insignificant (p>0.05). The mortality rate among SAM patients was 4%. It was highest (14.28%; n=4/28) among those with pH < 7.35. This difference was statistically significant (p 0.0149).

In our study, 25% (n=1/4) deaths occurred within 24 hours of admission. Metabolic Acidosis is an important morbidity among SAM patients leading to statistically significant mortality. High index of suspicion for acidosis and assessment on admission may decrease mortality in SAM.

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