Section: Pediatrics

Original Research Article

CLINICO-BIOCHEMICAL PROFILE OF SEVERE ACUTE MALNUTRITION WITH SPECIAL REFERENCE TO INFECTION

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Abstract

Background: Childhood undernutrition is a major global health problem. Severe Acute Malnutrition (SAM) is both a medical and social disorder. A child with SAM is highly vulnerable and has a high mortality risk & has an approximately eight to nine-fold increased risk of mortality. Severe acute malnutrition (SAM) results from a nutritional deficit that is often complicated by marked anorexia and concurrent infective illness. Biochemical abnormalities are associated frequently in SAM children. Such children are in danger of death from hypoglycaemia, hypothermia, fluid overload, dyselectrolytemia, and undetected infections. Biomarkers are currently used in clinical practice which aid differentiating bacterial from non-bacterial infections in SAM children. Biomarkers for bacterial infections classically include total white blood cell count (WBC), absolute neutrophil count (ANC), C-reactive protein (CRP) and Erythrocyte sedimentation rate (ESR), Serum ferritin. **Materials and Methods:** This is a Hospital based, Prospective and observational study was conducted in the Dept of Pediatrics, Maharaja Krushna Chandra Gajapati Medical College. Children aged 1-59 months admitted at Pediatrics department of MKCG MCH. After obtaining informed consent from parents, 60 cases of SAM satisfying the WHO criteria were enrolled. Demographic data like age, sex and locality and socioeconomic status of the family whether they belong to upper, middle or lower class according to modified Kuppusamy scale was collected. Detailed clinical examination including anthropometry like weight, height/length, mid upper arm circumference measured as per prequisites was done. Presence of edema or wasting was noted. All relevant investigations done were noted down. All children were followed up during the course of hospital stay, presence or absence of various comorbidities and duration of hospital stay and outcome was noted down and recorded in predesigned case report forms. **Result:** Among the 60 SAM children who were enrolled, hyponatremia was most common observed electrolyte abnormality 21(35%), followed by hypokalemia 18(30%) and hypocalcemia 15(25%). Metabolic acidosis was seen in 13(21.6%) cases and hypoglycemia in 4(6.7%) cases and metabolic alkalosis in 2(3.3%) cases. The relationship between presence of hyponatremia (p=0.010), hypocalcemia (p=0.025) and metabolic acidosis (p=0.008) on ABG analysis and outcome was found to be statistically significiant. Among the 60 SAM children who were enrolled, raised WBC counts was most common lab investigation finding 47(78.3%), followed by elevated CRP(q) levels 40(66.6%), raised ANC 37(61.6%) and hypoalbuminemia was observed in 24(40%) cases, raised ESR 19(31.6%), raised ferritin 19(31.6%), severe anemia 15(25%), abnormal Liver Enzymes 9(15%), abnormal RFT 4(6.6%) & increased urinary Pus Cells 3(5%). **Conclusion:** SAM and infection are like two sides of a coin and there exists a synergism between infection and SAM. Electrolyte imbalance is an important offending agent that affects the

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prognosis of the SAM patients. The factors associated with poor prognosis in SAM patients were absence of breast feeding, desaturation and hypotension at admission, hyponatremia, hypocalcemia and metabolic acidosis on ABG analysis, hypoalbuminemia and severe anemia on serum analysis and presence of Pneumonia as comorbidity in our study.

INTRODUCTION

Childhood undernutrition is a major global health problem. Severe Acute Malnutrition (SAM) is both a medical and social disorder.[1] Out of 19 million SAM children in all developing countries 8 million (42%) are in India.[2] National family health survey-4(2015-2016) shows that 7.5% of under 5 children suffer from SAM and the NFHS-4 data for Odisha state shows the prevalence for SAM to be 6.4%.[3]

The case fatality rate of SAM in under 5 children ranges from 30-50% and 35% of deaths among under 5 children is directly or indirectly contributed by malnutrition.[4] A child with SAM is highly vulnerable and has a high mortality risk & has an approximately eight to nine-fold increased risk of mortality.[5] Severe acute malnutrition (SAM) results from a nutritional deficit that is often complicated by marked anorexia and concurrent infective illness.[5] Such children have increased frequency and intensity of common infections and also delayed recovery in spite of nutritional rehabilitation. Lack of exclusive breast feeding, late introduction of complementary feeds, feeding diluted feeds containing less amount of nutrients, repeated respiratory tract infections, ignorance and poverty are some of factors responsible for SAM.[6]

Biochemical abnormalities are associated frequently in SAM children. Such children are in danger of death from hypoglycaemia, hypothermia, fluid overload, dyselectrolytemia, and undetected infections.[7] Children with severe acute malnutrition have profoundly disturbed physiology and metabolism and these imbalances are need to be corrected before starting nutritional management.[8] Their fluids, feeds and micronutrients must be carefully controlled to avoid complications during management.[9]

Biomarkers are currently used in clinical practice which aid differentiating bacterial from non-bacterial infections in SAM children. Biomarkers for bacterial infections classically include total white blood cell count (WBC), absolute neutrophil count (ANC), C-reactive protein (CRP) and Erythrocyte sedimentation rate (ESR), Serum ferritin. Coexisting clinico-biochemical morbidities may be a consequence of malnutrition per se or predisposes the children to develop nutritional deficit yet to establish.[10]

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.[11] Hence the different comorbidities complicating SAM cases should be identified at earliest and treatment should be started accordingly for the prompt management and better chance of survival of these children.[12]

With this background, we conducted a study to describe the clinico-biochemical profile in children with severe acute malnutrition at time of admission and the co-relation with infection. Our Medical college being a tertiary health centre caters such patients from South Odisha and adjacent states & this study would further help in future holistic management of these children.[13]

MATERIALS AND METHODS

This is a Hospital based, Prospective and observational study was conducted in the Dept of Pediatrics, Maharaja Krushna Chandra Gajapati Medical college. Children aged 1-59 months admitted at Pediatrics department of MKCG MCH

Inclusion Criteria

Diagnosis of SAM made by any one of the following features:

1. Weight for length <-3 Z-scores of the WHO Child Growth Standards median
2. Visible severe wasting
3. Presence of bilateral pedal pitting edema
4. MUAC <115mm in children 6-60 months of age

Exclusion Criteria

1. Children with non-nutritional causes of SAM secondary to congenital, chromosomal, endocrine or other systemic disorders like neurological or surgical problems.
2. Those whose parents refuse to give consent for the study.

Methodology: After obtaining informed consent from parents, 60 cases of SAM satisfying the WHO criteria were enrolled. Demographic data like age, sex and locality and socioeconomic status of the family whether they belong to upper, middle or lower class according to modified Kuppusamy scale was collected. Detailed clinical examination including anthropometry like weight, height/length, mid upper arm circumference measured as per prequisites was done. Presence of edema or wasting was noted. All relevant investigations done were noted down. All children were followed up during the course of hospital stay, presence or absence of various comorbidities and duration of hospital stay and outcome was noted down and recorded in predesigned case report forms.

ABG Analysis: We used following definitions to characterize various co-morbidities: Metabolic acidosis (pH < 7.35 with HCO3 <22 mmol/l), hypocalcaemia (serum calcium<9mg/dl),

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hypokalaemia (serum K <3.5 mmol/l), hyperkalaemia (serum K >5.5 mmol/l), hyponatremia (serum Na <130 mmol/l), and hypernatremia (serum Na >145 mmol/l).[1]

Labrotary investigations: Investigations like Random blood sugar (RBS), complete hemogram (CBC), ESR, Ferritin, ICTC, routine urine examination, urine and blood culture, renal and liver function tests were done. Digital chest X-ray, Mantoux and GA AFB CBNAAT done to diagnose tuberculosis.

Severe Anemia was defined as Hb levels < 7 gm%.[14]

Raised CRP(Q) was defined as CRP(Q) levels > 6.0 mg/L.[22]

Raised ESR was defined as ESR levels ≥ 13 mm/hr & Raised Ferritin was defined as ferritin levels > 220 ng/ml as per our laboratory standards.

Abnormal WBC counts was defined as WBC levels >11000/µL or <4000/µ.[14]

Raised ANC defined as levels >8000/µL.[14]

Hypoglycaemia was defined as blood sugar level less than 54 mg/dl.[4]

Increased urinary pus cells is defined as >10 leucocytes per high power field or Gram stain for bacteria.[14]

Hypoproteinaemia is defined as protein levels less than 6g/dl and Hypoalbuminemia is defined as albumin levels than 3.5 g/dl.[1]

Statistical Analysis: Data was entered in excel sheet. Statistical analysis of data was performed by statistical software SPSS version 21. Outcome variables were expressed as proportion. Risk factor analysis was done using univariate and multivariate analysis.

RESULTS

Among the 60 SAM children who were enrolled, 39 (65%) were male and 21 (35%) were female with a Male: Female ratio of 1.8:1.

Among the 60 Severe Acute Malnutrition (SAM) children who were enrolled, 22(36.6%) were aged 1-6 months, 33(55%) were 7 months - <2 years of age & 5(8.4%) were 2 – 5 years of age.

Mean age of presentation (SD) was 11.98 ± 12.11 months; Median age of presentation was 9 months. Among 60 children, 55 children were less than 2 years of age.

Among the 60 SAM children who were enrolled, hyponatremia was most common observed electrolyte abnormality 21(35%), followed by hypokalemia 18(30%) and hypocalcemia 15(25%). Metabolic acidosis was seen in 13(21.6%) cases and hypoglycemia in 4(6.7%) cases and metabolic alkalosis in 2(3.3%) cases. The relationship between presence of hyponatremia (p=0.010), hypocalcemia (p=0.025) and metabolic acidosis (p=0.008) on ABG analysis and outcome was found to be statistically significiant. We also found out a significant correlation between duration of stay and presence of metabolic alkalosis on ABG analysis (p=0.009).

Among the 60 SAM children who were enrolled, raised WBC counts was most common lab investigation finding 47(78.3%), followed by elevated CRP(q) levels 40(66.6%), raised ANC 37(61.6%) and hypoalbuminemia was observed in 24(40%) cases, raised ESR 19(31.6%), raised ferritin 19(31.6%), severe anemia 15(25%), abnormal Liver Enzymes 9(15%), abnormal RFT 4(6.6%) & increased urinary Pus Cells 3(5%). The relationship between presence of hypoalbuminemia (p=0.035), severe anemia (p=0.025) and hypoproteinemia (p=0.035) on labrotary serum analysis and outcome was found to be statistically significiant. We also found out a significant correlation between duration of stay and presence of abnormal RFT (p=0.001), abnormal liver enzymes (p=0.042) and raised Ferritin (p=0.048) on labrotary serum analysis.

Table 1: Sex Distribution of Sam Patients

Sex	N =60	Percentage
Male	39	65%
Female	21	35%

Table 2: Age Group Distribution of Sam Patients

Age (in Months)	N =60	Percentage
1 to 6	22	36.6%
7 to 23	33	55%
24 to 59	5	8.4%

Table 3: Analysis of Biochemical Abnormalities (Abg/Serum Analyis

Biochemical Abnormalities	Value	Percentage	P – Value (Outcome)	P – Value (Stay Of Duration)
Hyponatremia	21	35%	0.010	0.122
Hypokalemia	18	30%	0.778	0.670
Hypocalcemia	15	25%	0.025	0.338
Metabolic Acidosis	13	21.6%	0.008	0.091
Metabolic Alkalosis	2	3.3%	0.472	0.009
Hypoglycemia	4	6.7%	0.121	0.070

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Table 4: Analysis of Labrotary Investigation Findings

LAB INVESTIGATIONS	VALUE	PERCENTAGE	P – VALUE (OUTCOME)	P – VALUE (DURATION OF STAY)
HYPOALBUMINEMIA	24	40%	0.035	0.286
RAISED CRP(Q)	40	66.6%	1.00	0.737
RAISED ESR	19	31.6%	0.127	0.625
ABNORMAL RFT	4	6.6%	0.121	0.001
RAISED FERRITIN	19	31.6%	0.890	0.048
HAEMOGLOBIN (<7)	15	25%	0.025	0.071
ABNORMAL WBC COUNTS	47	78.3%	0.638	0.642
RAISED ANC	37	61.6%	0.084	0.427
HYPOPROTEINEMIA	24	40%	0.035	0.286
INCREASED URINARY PUS CELLS	3	5%	0.325	0.125
ABNORMAL LIVER ENZYMES	9	15%	0.278	0.042

Table 5: Distribution and Analysis of Cases as Per the Final Diagnosis

FINAL DIAGNOSIS	N=60	PERCENTAGE	P – VALUE (OUTCOME)	P – VALUE (DURATION OF STAY)
PNEUMONIA	**25**	**41.6%**	**0.009**	**0.350**
DIARRHEA	**17**	**28.3%**	**0.31**	**0.172**
SEPTICEMIA	**7**	**11.6%**	**0.159**	**0.142**
UTI	**8**	**13.3%**	**0.569**	**0.807**
MENINGITIS	**2**	**3.3%**	**0.472**	**0.985**
TUBERCULOSIS	**1**	**1.6%**	**0.614**	**0.252**

Among the 60 SAM children who were enrolled, after detailed evaluation a final diagnosis of Respiratory tract infection in 25(41.6%) cases, followed by Diarrhoea in 17(28.3%) cases, Septicemia in 7(11.6%), UTI in 8(13.3%) cases, Meningitis was seen in 2(3.3%) cases and Tuberculosis in 1(1.6%) case was made. The relationship between presence of Pneumonia and outcome (p=0.009) was found to be statistically significant and indicates poor outcome of these patients.

DISCUSSION

In our study 65% of cases belonged to male sex and 35 % belonged to female sex with a Male: Female ratio of 1.8:1. The sex distribution in our study was male predominant. It was consistent with the results of Susheel ku Saini et al. (61% male vs 39% female),[14] and B. Dakshayani et al. (53.3% male vs 46.7 % female).[15] Although other studies such as Rakesh ku et al. (48.1% male vs 51.9% female),[9] and Suman Das et al. (45% male vs 55% female),[16] showed predominantly female sex distribution. This discrepancy in sex distribution can be explained by the ritual and social norms because of which parents are biased for seeking health care attention for male child while female children are neglected.

We observed in our study hypothermia in 15% cases. This result was consistent with findings of study done by Hanifa et al. (21.3%).[17] Hypothermia is contributed to low fat reserves and decreased metabolism due to weight loss in SAM patients. Hypotension was recorded in our study in 13.8% cases similar to finding in study by Chisti et al. (18%).[18] Hypotension may be the result of ongoing septic processes along with excessive fluid loss from body.

Analysis of the collected data of ABG analysis showed that Hyponatremia was observed in 35% cases. Studies by B.Dakshayani et al,[15] reported hyponatremia in 43.7% cases, Dhilip kumar et al,[19] reported in 22.1% cases and Hanifa et al,[17] reported in 21.8% cases. Mean sodium value was calculated to be 135.4±7.7meq/L which was consistent with results of study by B.Dakshayani et al,[15] that reported it to be 134.6±5.23 meq/L. In SAM extracellular sodium concentration is reduced despite a significant increase in total body and cellular sodium content. The fall of serum sodium is caused by the expansion of extracellular fluid volume, diarrhoeal loses and failure of energy supply for the sodium pump resulting in sodium accumulation in cell.

Hypocalcemia was seen in 25% cases which was similar to studies by Dhilip ku et al. (35.2%),[19] and M. Lakshmi et al. (35%).[20]. Hypocalcemia is due to poor feeding intake and malabsorption from gut and due to various micronutrient deficiencies that lead to decreased calcium levels in body.

Metabolic acidosis was observed in 20% cases of our study which was similar to study by Dhilip ku et al,[19] who reported metabolic acidosis in 18.3% cases. In SAM children there is increased release of cytokines and other inflammatory mediators as a result of ongoing sepsis that causes damage to vascular endothelium resulting in hypoxia that causes anerobic cellular metabolism leading to lactate synthesis resulting in metabolic acidosis.

In our study hypoglycemia was reported in 5% cases. Suman das et al. (3%),[16] Chisti et al. (6%),[18] and Goyal S et al. (6%),[21] reported similar results. Studies such as M.Lakshmi et al. (15%),[20] reported a higher incidence of hypoglycemia. Hypoglycaemia is due to less supply of glucose from the liver and muscle while at the

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same time, the demand for glucose is high to fight infections.

CONCLUSION

SAM and infection are like two sides of a coin and there exists a synergism between infection and SAM. Electrolyte imbalance is an important offending agent that affects the prognosis of the SAM patients. The factors associated with poor prognosis in SAM patients were absence of breast feeding, desaturation and hypotension at admission, hyponatremia, hypocalcemia and metabolic acidosis on ABG analysis, hypoalbuminemia and severe anemia on serum analysis and presence of Pneumonia as comorbidity in our study. Apart from nutritional rehabilitation timely identification and treatment of co morbidities like diarrhoea, pneumonia, anemia and metabolic abnormalities is vital in malnourished children so as to break the undernutrition – disease cycle and decrease mortality and to improve outcome. There is a need to improve the diagnosis and treatment of infection and optimise nutritional rehabilitation in children with SAM.

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