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Association of Clinical Presentation, Laboratory Findings with Outcome among Under 5 Children with Moderate and Severe Malnutrition: A Prospective study

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ABSTRACT

Background: Malnutrition remains a major public health problem and an important cause of morbidity and mortality among under-five children, particularly in developing countries. Severe acute malnutrition is frequently associated with infections, metabolic disturbances, and poor clinical outcomes. Early identification of clinical and laboratory predictors of adverse outcomes may help improve survival and treatment response in malnourished children.

Objectives: To determine the association of clinical findings and laboratory findings with outcome among under-five children with moderate and severe malnutrition.

Methods: This hospital-based prospective observational study was conducted in the Nutritional Rehabilitation Centre (NRC), District Hospital, Tumkur and Department of Paediatrics, Shridevi Institute of Medical Sciences and Research Hospital, Tumkur over a period of 18 months. A total of 120 children aged 6–59 months diagnosed with moderate or severe acute malnutrition according to WHO criteria were included using consecutive sampling. Detailed demographic data, clinical features, anthropometric measurements, and laboratory investigations including hemoglobin, serum electrolytes, blood glucose, serum albumin, C-reactive protein, and blood culture were recorded. Patients were managed according to WHO guidelines and followed until discharge or death. Statistical analysis was performed using SPSS version 25.0, and p-value <0.05 was considered statistically significant.

Results: Among the 120 children studied, 72 (60%) had severe acute malnutrition and 48 (40%) had moderate acute malnutrition. Fever, Diarrhea, pneumonia, edema, and severe anemia were significantly more common among severely malnourished children. Hypoalbuminemia, hyponatremia, hypoglycemia, elevated C-reactive protein, and positive blood cultures were significantly associated with unfavorable outcomes. Pneumonia, shock, altered sensorium, hypoglycemia, and serum albumin level <2.5 g/dL emerged as independent predictors of poor outcome on multivariate logistic regression analysis.

Conclusion: Clinical complications and laboratory abnormalities were significantly associated with poor outcomes among malnourished under-five children. Early recognition of high-risk clinical features and metabolic disturbances may help reduce morbidity and mortality through timely intervention and appropriate management.

Keywords*: Severe acute malnutrition; Moderate acute malnutrition; Under-five children; Clinical profile; Laboratory parameters; Treatment outcome; Hypoalbuminemia; Pediatric malnutrition.*

INTRODUCTION

Malnutrition remains one of the leading causes of morbidity and mortality among under-five children worldwide, particularly in low- and middle-income countries. According to the Lancet maternal and child nutrition series, undernutrition contributes to nearly 45% of deaths among children younger than five years of age.[1] Severe acute malnutrition (SAM) is a major public health problem characterized by severe wasting, nutritional edema, and significant metabolic derangements that increase susceptibility to infections and poor clinical outcomes.[2]

Children with moderate acute malnutrition (MAM) and Severe acute malnutrition (SAM) frequently present with fever, Diarrhea, pneumonia, anemia, edema, dehydration, and altered sensorium, which significantly influence disease severity and prognosis.[3,4] Several studies have shown that coexisting infections and systemic complications are major determinants of mortality among hospitalized malnourished children.[5] Talbert et al. demonstrated that Diarrhea and severe infections substantially increased mortality risk in children with SAM.[6] Similarly, Chiabi et al. observed that pneumonia, shock, severe anemia, and sepsis were strongly associated with poor outcomes among severely malnourished children.[7]

Laboratory abnormalities are also important indicators of prognosis in acute malnutrition. Hypoglycemia, hypoalbuminemia, electrolyte disturbances, and positive blood cultures are commonly encountered among children with SAM and are associated with increased mortality.[8,9] Dramaix et al. reported that low serum albumin levels and edema were significant predictors of mortality in hospitalized malnourished children.[10] Furthermore, Kerac et al. highlighted those persistent metabolic and nutritional deficits contribute to adverse post-discharge outcomes and increased mortality risk.[11]

Despite advances in nutritional rehabilitation and implementation of WHO treatment protocols, mortality among children with severe malnutrition remains high in many developing countries.[12] Early identification of clinical and biochemical predictors of poor outcome is essential for timely intervention and improved survival. Although several international studies have evaluated predictors of mortality in SAM, there is limited data correlating both clinical presentation and laboratory findings with treatment outcomes among under-five children in the local setting.

Therefore, the present study was undertaken to evaluate the association between clinical presentations and laboratory parameters with outcomes among under-five children with moderate and severe malnutrition.

MATERIAL AND METHODS

This hospital-based prospective observational study was conducted in the Nutritional Rehabilitation Centre (NRC), District Hospital, Tumkur and Department of Paediatrics, Shridevi Institute of Medical Sciences and Research Hospital, Tumkur. The study was carried out over a period of 18 months after obtaining approval from the Institutional Ethics Committee.

Children aged 6 months to 59 months admitted to the Pediatric ward or NRC with moderate acute malnutrition (MAM) or severe acute malnutrition (SAM) were included in the study. Moderate acute malnutrition was defined as weight-for-height/length Z-score between -2 and -3 standard deviations according to WHO growth standards or Mid Upper Arm Circumference (MUAC) between 11.5 cm and 12.5 cm without nutritional edema. Severe acute malnutrition was defined as weight-for-height/length Z-score less than -3 standard deviations, MUAC less than 11.5 cm, or presence of bilateral pitting edema according to WHO criteria.

The sample size was calculated using the for formula: $n = Z^2pq/d^2$. Mortality was used as one of the outcomes to estimate the sample size from the study by Munthali et al.,[14] Mortality among children with severe acute malnutrition was 16%. With a confidence interval of 95%, allowable error of 7%, and after accounting for a 10% non-response rate, the final sample size was calculated to be 120 children.

A convenient sampling method was used, and all eligible children admitted during the study period who fulfilled the inclusion criteria were enrolled until the required sample size was achieved. Children aged 6–59 months diagnosed with MAM or SAM whose parents or guardians provided written informed consent were included in the study. Children with congenital malformations, congenital heart disease, chronic liver disease, chronic kidney disease, malignancy, genetic or metabolic disorders, and those whose caregivers refused consent were excluded.

After obtaining written informed consent from the parents or guardians, detailed demographic history, feeding practices, immunization status, and socioeconomic details were recorded using a predesigned structured proforma. Thorough clinical examination was performed in all children. Clinical features including fever, Diarrhea, vomiting, pneumonia, respiratory distress, dehydration, shock, edema, pallor, skin and hair changes, hepatomegaly, appetite status, and altered sensorium were assessed and documented.

Anthropometric measurements including weight, length/height, and MUAC were recorded using standard WHO-recommended techniques. Weight was measured using a calibrated electronic weighing scale accurate to 100 grams. Length or height was measured using an infantometer or stadiometer accurate to 0.1 cm, and MUAC was measured using a standard MUAC tape at the midpoint between the acromion and olecranon process. WHO growth standards were used to calculate Z-scores.

Baseline laboratory investigations including hemoglobin, total leukocyte count, platelet count, blood glucose, serum sodium, serum potassium, serum albumin, liver function tests, renal function tests, C-reactive protein, and blood culture where indicated were performed within 24 hours of admission.

All children received treatment according to WHO protocols for management of acute malnutrition, including stabilization and rehabilitation phases. Patients were monitored throughout the hospital stay, and treatment outcomes including recovery, duration of hospital stay, complications, referral, discharge, and death were recorded.

Children who showed clinical improvement and were discharged after nutritional rehabilitation were categorized as having favorable outcomes, whereas those who died, developed severe complications, required referral due to deterioration, or left against medical advice were categorized as having unfavorable outcomes.

The collected data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Chi-square test or Fisher's exact test was used to assess associations between categorical variables, and the independent t-test or Mann–Whitney U test was used for comparison of continuous variables wherever appropriate. Univariate and multivariate logistic regression analyses were performed to identify predictors of unfavorable outcomes. A p-value of less than 0.05 was considered statistically significant.

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from parents or guardians before enrolment, and confidentiality of patient information was strictly maintained throughout the study.

RESULTS

A total of 120 under-five children diagnosed with moderate and severe acute malnutrition were included in the study, of whom 48 (40%) had moderate acute malnutrition (MAM) and 72 (60%) had severe acute malnutrition (SAM). The mean age of the study participants was 22.1 ± 10.9 months. Children with SAM were significantly younger compared to those with MAM (19.6 ± 10.1 months vs 25.8 ± 11.4 months, p=0.006). Male predominance was observed in both groups (56.7%). Rural residence and low socioeconomic status were more common among severely malnourished children, though the association was not statistically significant. The mean MUAC was significantly lower among SAM children compared to MAM children (10.6 ± 0.7 cm vs 12.0 ± 0.5 cm, p<0.001). Bilateral pedal edema was observed exclusively among SAM children (19.4%), which was statistically significant. (Table 1)

Among the clinical presentations, fever was the most common symptom, observed in 55.6% of SAM children compared to 37.5% of MAM children, showing statistical significance (p=0.049). Diarrhea was present in 47.2% of SAM children and 27.1% of MAM children (p=0.028). Pneumonia was significantly more common among severely malnourished children (34.7% vs 14.6%, p=0.015). Severe anemia was also significantly associated with SAM (27.8% vs 10.4%, p=0.024). Although dehydration, vomiting, shock, and altered sensorium were more frequent among SAM children, these differences did not achieve statistical significance. Bilateral edema was present only among SAM children and showed a strong association with severity of malnutrition (p=0.001). (Table 2)

Regarding laboratory parameters and outcomes, children with unfavorable outcomes had significantly lower mean hemoglobin levels compared to those with favorable outcomes (7.3 ± 1.4 g/dL vs 8.9 ± 1.6 g/dL, p<0.001). Serum albumin levels were also significantly reduced among children with poor outcomes (2.3 ± 0.4 g/dL vs 3.1 ± 0.5 g/dL, p<0.001). Hyponatremia was observed in 52.6% of children with unfavorable outcomes compared to 19.8% among those with favorable outcomes (p=0.002). Similarly, hypokalaemia, hypoglycemia, elevated CRP, and positive blood cultures were significantly more common among children with poor outcomes. These findings indicate that biochemical abnormalities and evidence of systemic infection were strongly associated with adverse clinical outcomes. (Table 3)

Analysis of the association between clinical presentations and treatment outcomes showed that diarrhea, pneumonia, shock, edema, altered sensorium, and severe anemia were significantly associated with unfavorable outcomes. Children presenting with shock had nearly 15 times higher odds of poor outcome (OR=15.0; 95% CI: 3.2–69.1; p<0.001). Altered sensorium was another strong predictor of poor outcome with an odds ratio of 22.9 (95% CI: 4.1–126.4; p<0.001). Pneumonia increased the odds of unfavorable outcome by more than five-fold (OR=5.2; p=0.001). Severe anemia and edema were also significantly associated with adverse outcomes. (Table 4)

Multivariate logistic regression analysis was performed to identify independent predictors of unfavorable outcomes after adjusting for confounding variables. Pneumonia (AOR=3.9; p=0.01), shock (AOR=6.8; p=0.004), hypoglycemia (AOR=4.5; p=0.02), serum albumin level <2.5 g/dL (AOR=5.7; p=0.002), positive blood culture (AOR=3.4; p=0.048), and altered sensorium (AOR=5.9; p=0.01) emerged as independent predictors of poor outcome among malnourished under-five children. These findings suggest that severe systemic illness, metabolic derangements, and sepsis significantly contribute to mortality and unfavorable treatment outcomes in acute malnutrition. (Table 5)

Table 1. Baseline Sociodemographic and Nutritional Characteristics of Study Participants

Variables	Moderate Malnutrition (n=48)	Severe Malnutrition (n=72)	Total (n=120)	p-value
Mean age (months)	25.8 ± 11.4	19.6 ± 10.1	22.1 ± 10.9	0.006*
Male sex, n (%)	27 (56.3%)	41 (56.9%)	68 (56.7%)	0.940#
Rural residence, n (%)	29 (60.4%)	50 (69.4%)	79 (65.8%)	0.310#
Incomplete immunization, n (%)	17 (35.4%)	36 (50.0%)	53 (44.2%)	0.110#
Low socioeconomic status, n (%)	30 (62.5%)	55 (76.4%)	85 (70.8%)	0.100#
Mean MUAC (cm)	12.0 ± 0.5	10.6 ± 0.7	11.2 ± 0.9	<0.001*
Bilateral pedal edema, n (%)	0 (0%)	14 (19.4%)	14 (11.7%)	0.001*#

Independent t-test for continuous variables
#Chi-square test for categorical variables

Table 2. Clinical Presentations among Moderate and Severe Malnourished Children

Clinical Features	Moderate Malnutrition (n=48)	Severe Malnutrition (n=72)	p-value
Fever, n (%)	18 (37.5%)	40 (55.6%)	0.049*
Diarrhea, n (%)	13 (27.1%)	34 (47.2%)	0.028*
Vomiting, n (%)	9 (18.8%)	20 (27.8%)	0.260
Pneumonia, n (%)	7 (14.6%)	25 (34.7%)	0.015*
Dehydration, n (%)	10 (20.8%)	24 (33.3%)	0.140
Shock, n (%)	1 (2.1%)	8 (11.1%)	0.08
Edema, n (%)	0 (0%)	14 (19.4%)	0.001*
Altered sensorium, n (%)	1 (2.1%)	7 (9.7%)	0.11
Severe anemia, n (%)	5 (10.4%)	20 (27.8%)	0.024*

Chi-square test/Fisher's exact test

Table 3. Comparison of Laboratory Parameters with Clinical Outcome

Laboratory Parameter	Favourable Outcome (n=101)	Unfavourable Outcome (n=19)	p-value
Mean hemoglobin (g/dL)	8.9 ± 1.6	7.3 ± 1.4	<0.001*
Serum albumin (g/dL)	3.1 ± 0.5	2.3 ± 0.4	<0.001*
Hyponatremia, n (%)	20 (19.8%)	10 (52.6%)	0.002*#
Hypokalemia, n (%)	14 (13.9%)	7 (36.8%)	0.01*#
Hypoglycemia, n (%)	7 (6.9%)	5 (26.3%)	0.01*#
Elevated CRP, n (%)	31 (30.7%)	13 (68.4%)	0.002*#
Positive blood culture, n (%)	5 (5.0%)	4 (21.1%)	0.03*#

#Chi-square test for categorical variables, Independent t-test, *Statistically significant

Table 4. Association of Clinical Presentations with Treatment Outcome

Clinical Variable	Favourable Outcome (n=101)	Unfavourable Outcome (n=19)	Odds Ratio (95% CI)	p-value
Diarrhea	34 (33.7%)	13 (68.4%)	4.2 (1.5–11.5)	0.005*
Pneumonia	21 (20.8%)	11 (57.9%)	5.2 (1.9–14.0)	0.001*
Shock	3 (3.0%)	6 (31.6%)	15.0 (3.2–69.1)	<0.001*
Edema	9 (8.9%)	5 (26.3%)	3.6 (1.0–12.4)	0.04*
Altered sensorium	2 (2.0%)	6 (31.6%)	22.9 (4.1–126.4)	<0.001*
Severe anemia	17 (16.8%)	8 (42.1%)	3.6 (1.3–10.0)	0.01*

Univariate logistic regression

Table 5. Multivariate Logistic Regression Analysis Showing Independent Predictors of Unfavourable Outcome

Variables	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Pneumonia	3.9	1.3–11.6	0.01*
Shock	6.8	1.8–25.7	0.004*
Hypoglycemia	4.5	1.2–16.1	0.02*

Serum albumin <2.5 g/dL	5.7	1.9–17.1	0.002*
Positive blood culture	3.4	1.0–11.5	0.048*
Altered sensorium	5.9	1.4–24.3	0.01*

Multivariate logistic regression
Variables with p<0.2 in univariate analysis included in regression model

DISCUSSION

The present study evaluated the association between clinical presentation, laboratory abnormalities, and treatment outcomes among under-five children with moderate and severe acute malnutrition. The majority of children in the study belonged to the severe acute malnutrition group, and younger age was significantly associated with severe malnutrition. Similar findings were reported by Sachdeva et al. and Munthali et al., where SAM was predominantly observed among younger children, particularly below two years of age.[13,14] This age group is nutritionally vulnerable due to inadequate complementary feeding practices and increased exposure to infections.

Male predominance observed in the present study was comparable to findings reported by Chiabi et al. and Talbert et al.[6,7] Although gender difference was not statistically significant, social and healthcare-seeking practices may partly explain increased hospital admissions among male children in some settings.

Fever, diarrhea, and pneumonia were the most common clinical presentations among severely malnourished children in the present study. Diarrhea was significantly associated with severe malnutrition and poor outcome, consistent with the observations of Talbert et al., who reported increased mortality among SAM children complicated by diarrhea.[6] Pneumonia was another important predictor of poor outcome in the current study, similar to findings by Chiabi et al. and Munthali et al., where respiratory infections substantially increased mortality risk among hospitalized malnourished children.[7,14]

The present study also demonstrated that shock, altered sensorium, edema, and severe anemia were significantly associated with unfavorable outcomes. These findings are comparable with earlier reports showing that systemic complications and organ dysfunction contribute significantly to mortality in SAM.[7,10] Edematous malnutrition was associated with poorer prognosis, which may be attributable to severe metabolic imbalance and hypoalbuminemia.

Among laboratory parameters, low hemoglobin and hypoalbuminemia were strongly associated with poor outcomes. Similar observations were reported by Dramaix et al., who identified serum albumin as an important prognostic marker in severe malnutrition.[10] Hypoglycemia, hyponatremia, and hypokalaemia were significantly more frequent among children with adverse outcomes in the present study. These biochemical abnormalities reflect severe metabolic dysfunction and have been consistently associated with increased mortality in malnourished children.[8,9]

Positive blood culture and elevated inflammatory markers were significantly associated with unfavorable outcomes, emphasizing the important contribution of sepsis to mortality in SAM. Ahmed et al. and WHO guidelines have similarly highlighted the need for early recognition and aggressive management of infections in malnourished children.[4,12]

Multivariate logistic regression analysis in the present study identified pneumonia, shock, hypoglycemia, hypoalbuminemia, altered sensorium, and positive blood culture as independent predictors of unfavorable outcomes. These findings are in agreement with previous studies which identified severe infection, metabolic derangements, and neurological impairment as major determinants of mortality among hospitalized SAM children.[6,7,10,14]

The findings of the present study emphasize the importance of early identification of high-risk clinical and laboratory parameters among malnourished under-five children. Prompt correction of metabolic abnormalities, early management of infections, and strict adherence to WHO treatment protocols may significantly improve survival and treatment outcomes.

CONCLUSION

The present study demonstrated that severe acute malnutrition among under-five children is significantly associated with adverse clinical presentations and laboratory abnormalities that influence treatment outcomes. Clinical features such as pneumonia, diarrhea, shock, edema, altered sensorium, and severe anemia were strongly associated with unfavorable outcomes. Laboratory parameters including hypoalbuminemia, hypoglycemia, electrolyte imbalance, and positive blood cultures emerged as important predictors of poor prognosis. Early identification of high-risk children through careful clinical assessment and timely laboratory evaluation can help reduce morbidity and mortality. Strengthening adherence to WHO management protocols and prompt correction of metabolic and infectious complications are essential for improving survival outcomes in malnourished children.

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