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Micro-Organisms and Antibiotic Susceptibility in Children with Severe Acute Malnutrition

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ABSTRACT

Objective: To determine the frequency of positive blood culture, micro-organisms and antibiotic resistance in children having severe acute malnutrition with positive blood cultures.

Methodology: A total of 285 children with severe acute malnutrition of both genders and ranging in age from 6 months to five years were included. Children who had congenital syndrome, cancer, heart problems, chronic liver illness, or chronic renal disease or had taken antibiotics within the week before presentation were not included. Two blood culture bottles with 20 millilitres of Brain-Heart Infusion (BHI) broth were used to inoculate the blood. The microorganisms were evaluated. Positive blood cultures were subjected to antibiotic susceptibility testing (AST) using the E-test and the Kirby-Bauer disk diffusion technique in compliance with the European Committee on Antimicrobial Susceptibility Testing's standards. Antibiotic resistance was assessed.

Results: Seventy-five (26.32%) of the children in our research with severe acute malnutrition had positive blood cultures. Staphylococcus aureus was found in 11 (14.67%), pneumococcus streptococcus in 08 (10.67%), enterobacterales in 29 (38.67%), non-fermented GNB in 23 (30.67%), and enterococcus in 04 (5.33%) of the children with severe acute malnutrition who had positive blood cultures. Resistance was documented to ciprofloxacin (38.67%), erythromycin (45.33%), amikacin (29.33%), ceftriaxone (64.0%), gentamycin (33.33%), and penicillin (74.67%).

Conclusion: In order to guarantee prompt and effective care, these results highlight the vital necessity of routine blood culture testing, locally customized antibiograms, and evidence-based treatment procedures.

Keywords: Antibacterial Agents, Bacteraemia, Drug Resistance, Bacterial, Infant, Severe Acute Malnutrition

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [3,4]Critical analysis and manuscript review; [5]Data analysis; Manuscript Editing.

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Introduction

Malnutrition is defined as excesses, imbalances, or deficiencies in an individual's energy and nutritional intake. Malnutrition ranks among the world's top causes of illness and child mortality, especially in developing countries.[1] Indicators of severe acute malnutrition (SAM) include nutritional edema and a very low weight for height/length (less than 70% of the median of the National Centre for Health Statistics reference or below −3-z scores of the median World Health Organization (WHO) growth reference).[2] Children who suffer from severe acute malnutrition have a nine-fold greater mortality risk than youngsters who receive adequate nutrition.[3] 32% of Pakistani children under five are underweight, 45% are stunted, and 15% suffer from

severe malnutrition.[1] Children under the age of five are at high rates of sickness and mortality as a result of this circumstance, endangering their bodily and mental well-being and having a major negative economic influence on the growth and prosperity of the nation.[1] One About 10% of children with SAM need inpatient management throughout therapy due to clinical problems, even though the majority of SAM cases are straightforward and can be handled in an outpatient setting.[1] Bacterial infections, such as bloodstream infections (bacteremia), are frequently the cause of these problems. Septic shock, multiple organ failure syndrome, systemic inflammatory response syndrome, and even death can result from these infections.[4] A study found that the average prevalence of bacteraemia in children with SAM is 17%, however more recent investigations have found a lower rate of roughly 5%. Staphylococcus aureus, Streptococcus pneumoniae, Salmonella, and Escherichia coli are the most frequent causes of bacteraemia in children with SAM.[5] When treating uncomplicated severe acute malnutrition in outpatient settings, the WHO advises using a broad-spectrum antibiotic as part of the treatment plan.6 Antibiotics are empirically used to treat children with SAM: oral amoxicillin is given to outpatients and parenteral penicillin and gentamicin is given to hospitalized patients.[5] In low- and middle-income nations, the primary empirical treatment for bacteremia is third-generation cephalosporins, specifically ceftriaxone. However, in nations where third-generation cephalosporins are utilized as first-line empirical antibiotics, the rise of Enterobacterales strains that are multidrug resistant to these drugs may have an impact on the results of clinical treatment.[4]

Twenty-four percent of the children with severe acute malnutrition yielded positive blood cultures with Staphylococcus aureus, Pneumococcus/Streptococcus, Enterobacterales, and non-fermenting gram negative bacteria being detected in 19.6, 4.5, 3.5, 6.53, and 3% of the study, respectively. In Enterobacterales, the resistance rates of gentamycin, ceftriaxone, amikacin and ciprofloxacin were 26.9, 61.5, 15.4 and 7.7 respectively. Non-fermented GNB had frantic resistance to gentamycin, ceftriaxone, amikacin, and ciprofloxacin of 33.3, 66.7, 33.3 and 33.3, respectively. The erythromycin and penicillin resistance rates were 42.9% and 85.7, respectively, in the case of Staphylococcus aureus. In the case of Pneumococcus and Streptococcus Erythromycin and Penicillin levels of resistance were 18.2 and 27.3, respectively. One-third of the Enterococcus bacteria were resistant to gentamycin.[4]

Despite the high rate of malnutrition in this area and the microorganisms' resistance to antibiotics, relatively little is known about the microorganisms that infected Pakistani infants suffering from severe acute malnutrition (SAM). In order to better prompt therapy of these patients and lower mortality and morbidity, this study was carried out to evaluate the organisms that impact SAM and the precise antibiotic resistance of these microorganisms.

Methodology

Between June and August of 2025, this descriptive cross-sectional study was conducted at the Department of Pediatrics, Allied Hospital, Faisalabad, with ethical review committee permission. The WHO sample size calculator shows that the sample size is 285 with the frequency of positive blood culture in children with severe acute malnutrition = 24%1, margin of error = 5%, and confidence level = 95%. Children aged 6 months to 5 years who exhibit severe acute malnutrition (weight for height Z-scores (WHZ) <-3 SD) or mid-upper arm circumference <11.5 cm, with or without bilateral pitting edema (enlarged abdomen, shiny or stretched skin, skin that retains a dimple (called "pitting") after being pressed for a few seconds, and swelling or puffiness of the tissue directly beneath the skin). Children who had congenital syndrome, cancer, heart problems, chronic liver illness, chronic

renal disease, or had taken antibiotics within the week before presentation were not included.

Following a minimum of 30 seconds of 70% ethyl alcohol cleaning of the intact skin, a concentric circle of 10% Povidone Iodine was applied for an additional 30 seconds away from the puncture site, covering a circular area of 1 to 2 inches in diameter. Blood was then extracted for culture by venepuncture at the time of admission. The pathologist reported that two milliliters of blood had been extracted and submitted to the hospital's pathology lab. Two blood culture bottles with 20 milliliters of Brain-Heart Infusion (BHI) broth were used to inoculate the blood. Following a 24-hour incubation period at 370C, subcultures were carried out onto blood agar, chocolate agar, and Mac Conkey agar plates. If a specific pathogen could be isolated from blood cultures, the culture was deemed positive. The Gram reaction, colony morphology, and biochemical tests were used to identify the bacterial isolates. Mixed growths were viewed as negative or pollutants. Lastly, culture bottles that failed to develop were incubated for an additional seven days. Before being reported as negative, a tiny amount of the culture broth was inoculated on the previously mentioned media if no turbidity was still visible. The microorganisms were evaluated.

Antibiotic susceptibility testing (AST) was performed on positive blood cultures using the Kirby-Bauer disk diffusion technique and the E-test in compliance with the European Committee on Antimicrobial Susceptibility Testing's standards. Antibiotic resistance was evaluated. If there is no change (no obvious ring or zone of inhibition appears) in the immediate area of a disc, then antibiotic resistance is present. In accordance with the guidelines set forth by the European Committee on Antimicrobial Susceptibility Testing, the Kirby-Bauer disk diffusion technique and the E-test were used to conduct antibiotic susceptibility testing (AST). Penicillin, Gentamycin, Ceftriaxone, Amikacin, Ciprofloxacin, and Erythromycin were the antibiotics that were used to check for resistance.

SPSS version 25 was used to enter and evaluate the data. The mean and standard deviation of numerical quantities, such as age and BMI, are examples of descriptive statistics. For every qualitative variable, including gender, positive blood culture, microorganism, and antibiotic resistance, frequency and percentage were computed. Using stratification, effect modifiers such as gender, age, and BMI were managed. The chi-squared post-stratification test was used. A p-value of less than 0.05 was deemed significant.

Ethical approval of the study was taken from Faisalabad Medical University, Faisalabad, (NO.48.ERC/FMU/2023-24-404) dated 06-03-2024.

Results

The mean age in this study was 2.25 ± 1.56 years, with a range of 6 months to 5 years. With a male to female ratio of 1.9:1, 156 (54.74%) of the 85 patients were men and 129 (45.26%) were women. Table I displays the distribution of patients with additional confounding variables. Our study's mean height was 87.96 ± 9.43 cm. Weight was 11.09 ± 4.53 kg on average. A mean BMI of 13.23 ± 3.21 kg/m2 was recorded.

Seventy-five (26.32%) of the children in our research with severe acute malnutrition had positive blood cultures (Figure I). Staphylococcus aureus was found in 11 (14.67%), pneumococcus streptococcus in 08 (10.67%), entero-bacterales in 29 (38.67%), non-fermented GNB in 23 (30.67%), and enterococcus in 04 (5.33%) of the children with severe acute malnutrition who had positive blood cultures, according to Table III. As indicated in Table IV, resistance was documented to ciprofloxacin (38.67%), erythromycin (45.33%), amikacin (29.33%), ceftriaxone (64.0%), gentamycin (33.33%), and penicillin (74.67%).

Table I: Distribution of different variables (n=285)			
		Frequency	**Percentage**
Age (years)	6 months – 3 years	151	52.98
	4-5 years	134	47.02
Gender	Male	156	54.74
	Female	129	45.26
BMI (kg/m2)	≤20	148	51.93
	>20	137	48.07

Table II: Descriptive statistics		
	Mean	**SD**
Age (years)	2.25	1.56
Weight (kg)	11.09	4.53
Height (cm)	87.96	9.43
BMI (kg/m2)	13.23	3.21

Table-III: Frequency micro-organisms in children having severe acute malnutrition with positive blood culture (n=75).		
Bacteria	**No. of Patients**	**Percentage**
Entero-bacterales	29	38.67
Non-fermented GNB	23	30.67
Staphylococcus aureus	11	14.67
Pneumococcus Streptococcus	08	10.67
Enterococcus	04	5.33

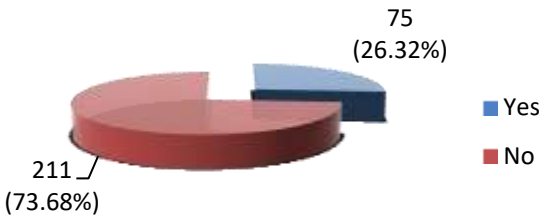

Figure 1: Frequency of positive blood culture in children having severe acute malnutrition (n=285).

Table IV: Frequency of antibiotic resistance in children having severe acute malnutrition with positive blood culture		
Antibiotic	**Sensitive**	**Resistant**
Penicillin	19 (25.33%)	56 (74.67%)
Ceftriaxone	27 (36.0%)	48 (64.0%)
Gentamycin	50 (66.67%)	25 (33.33%)
Ciprofloxacin	46 (61.33%)	29 (38.67%)
Amikacin	53 (70.67%)	22 (29.33%)
Erythromycin	41 (54.67%)	34 (45.33%)

Discussion

The evaluation of 285 children with severe acute malnutrition (SAM) ages 6 months to 5 years provided important new information about the microbiological profiles, clinical signs, and age-related vulnerability of SAM-related illnesses. Early breastfeeding termination, a delayed start to supplemental feeding, and insufficient consumption of vital nutrients during a crucial developmental period could all be contributing factors to this.[7,8] The individuals' mean age was 2.25 ± 1.56 years, and while there was a small male predominance (54.74%) in the gender distribution, infection rates were similar for both sexes, indicating that malnutrition-related immunological impairment is not gender-specific.

In contrast to findings from prior studies where respiratory symptoms predominated, fever was the most commonly reported complaint.[9] This discrepancy could be explained by the immunosuppressive properties of starvation, which attenuate the traditional indicators of infection and result in less severe respiratory symptoms even when underlying disease is present. The significant prevalence of bacterial illnesses, specifically gastroenteritis, respiratory tract infections, bloodstream infections, and urinary tract infections, among undernourished children was highlighted by the study. Particularly common was gastroenteritis, which manifested as watery diarrhea with variable levels of dehydration and was frequently caused by bacterial overgrowth in the small intestine.[10,11] If left

untreated, dehydration raises the risk of death in addition to impairing anthropometric measures like body weight and mid-upper arm circumference. Because of their unusual or subdued clinical manifestations, respiratory infections also presented a diagnostic problem in this group. SAM was frequently linked to infections including measles and tuberculosis, with measles being closely associated with vitamin A insufficiency.[12]

The 26.32% positive rate found in blood cultures was significantly greater than that seen in similar investigations, including one from Niger that found a rate of 9.1%.[4] Timely blood collection prior to the start of antibiotics may account for this greater yield by guaranteeing more precise bloodstream infection diagnosis.

Entero-bacterales was the most commonly found pathogen among the isolates, which is in line with patterns seen in comparable pediatric settings.[13] While Enterobacterales showed resistance to conventional drugs like ampicillin and ceftriaxone, they showed high susceptibility to imipenem and nitrofurantoin. These resistance patterns are consistent with regional data on bacteria that produce extended-spectrum beta-lactamases (ESBLs), which make treatment plans more difficult and necessitate regular susceptibility testing to direct empirical therapy.[14] Antimicrobial sensitivity patterns previously observed in low- and middle-income countries were reflected in non-fermented GNB, the second most prevalent strain, which likewise showed resistance to older beta lactam antibiotics but preserved susceptibility to amikacin and meropenem. Sahu et al.[13] conducted a study on children with severe acute malnutrition in Odisha, India and reported sensitivity testing of blood and urine cultures where common isolates of Staphylococcus aureus, Klebsiella pneumoniae, and Escherichia coli were common; the urinary isolates tested were highly sensitive to gentamicin supporting its further applicability to SAM-related infections. Tiwari et al.[14] examined UTI infection in children (6 months-5 years) with SAM and identified E. coli as the predominant isolate, 90-100% of which sensitivity to amikacin and gentamicin. The study by Godfrey et al.[15] evaluated blood-culture specimens in children with sepsis in Tanzania and tested various of the mentioned antibiotics; their results showed high resistance to penicillin/ampicillin-class antibiotics, gentamicin and ceftriaxone, whereas ciprofloxacin and amikacin showed a lower degree of resistance.

Similar investigations have also confirmed that Salmonella species and Escherichia coli are the main gastrointestinal pathogens responsible for bacteremia in children with SAM.[16-18] Furthermore, Gram-positive bacteria like Streptococci and Staphylococcus aureus are responsible for a significant percentage of these infections.16-18 But according to a meta-analysis of 11 studies that examined community-acquired pediatric bloodstream infections in Africa from 1992 to 2010, Staphylococcus aureus was the most prevalent pathogen (17.8%).[19] Therefore, the substances that cause bacteremia may differ depending on the location.

Over time, the antibiotics' pattern of sensitivity has evolved. Resistance to routinely used antibiotics is a result of increased antibiotic usage. The study's bacterial isolates exhibit varying degrees of sensitivity to the widely prescribed broad-spectrum antibiotics. Escherichia coli that was isolated showed a high sensitivity to amikacin, gentamicin, and meropenem. The majority of the organisms found in urine were extremely susceptible to meropenem and gentamicin. The blood-derived Staphylococcus aureus was susceptible to meropenem, vancomycin, and linezolid. Therefore, while waiting for the culture findings, unwell children with SAM can be treated with meropenem and vancomycin. However, since microbial resistance profiles varies greatly throughout investigations, this cannot be generalized.[13,14] Although continuous monitoring for antibiotic resistance is still crucial, the efficacy of these medicines highlights their importance in treating serious infections in undernourished

children. The study offers actionable knowledge to direct practical treatment options by providing useful regional data on bacterial profiles and antibiotic sensitivity in children with SAM. The pre-antibiotic scheduling of blood sample collection, which improves culture accuracy, is one of its advantages. Furthermore, the study's emphasis on a susceptible group with little past antibiotic exposure enhances the validity of resistance results. The study's single-region setting was one of its weaknesses, though, and this could restrict its generalizability. Additionally, the evaluation of therapeutic efficacy was limited due to the lack of data on clinical outcomes including recovery duration, death, or antibiotic response. It's possible that the underdiagnosis of picky organisms was caused by the lack of sophisticated diagnostic instruments like molecular tests. Future studies ought to incorporate molecular resistance profiling, outcome tracking, and multicentric data with bigger sample sizes. To stop the emergence of resistance, regular antibiotic stewardship procedures must be implemented in pediatric nutrition units. In order to enhance the treatment and results of infections in children suffering from severe acute malnutrition, this study emphasizes the critical necessity for tailored antibiotic regimens based on local resistance patterns.

Conclusion

According to the study's findings, children who experience severe acute malnutrition are more susceptible to bacterial infections. Gram-negative organisms predominated and showed significant patterns of antibiotic sensitivity, according to the findings. In order to guarantee prompt and effective care, these results highlight the vital necessity of routine blood culture testing, locally customized antibiograms, and evidence-based treatment procedures. In pediatric nutrition wards, improving antimicrobial stewardship and diagnostic procedures can greatly improve clinical outcomes for this high-risk group.

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