

## ORIGINAL ARTICLE

## Community- and hospital-acquired bacteremia and pattern of antibiotic resistance in children hospitalized with severe acute malnutrition.

Amrita<sup>1</sup>, Mohsina Noor Ibrahim<sup>2</sup>, Misbah Anjum<sup>3</sup>, Wajid Hussain<sup>4</sup>

**ABSTRACT... Objective:** To determine the frequency of community- and hospital-acquired bacteremia and to evaluate the pattern of antibiotic resistance in children hospitalized with severe acute malnutrition (SAM). **Study Design:** Analytical, Cross-sectional study. **Setting:** Department of Pediatric Medicine, The National Institute of Child Health, Karachi, Pakistan. **Period:** February 2025 to July 2025. **Methods:** A total of 128 children aged 6 months to 5 years with SAM were enrolled using non-probability, consecutive sampling. Demographic details, clinical features, and anthropometric measurements were recorded. Necessary laboratory investigations and blood culture evaluations were performed. Data were analyzed in SPSS 26 using chi-square/Fisher's exact test and Mann-Whitney U test, with  $p < 0.05$  as significant. **Results:** In 128 children, 71 (55.5%) were males, and the median age was 14.5 months (IQR 10.0–22.6). Bacteremia was identified in 19 (14.8%), of which 15 (78.9%) were community-acquired. Gram-negative organisms accounted for 57.9% of isolates, with *E. coli* (31.6%) and *S. aureus* (26.3%) most frequent. Gram-negative isolates accounted for 57.9%, with *E. coli* (31.6%), and *Klebsiella pneumoniae* (21.1%) showing high resistance to ampicillin and ceftriaxone. *S. aureus* isolates were universally susceptible to vancomycin and linezolid. Duration of fever  $> 3$  days was associated with bacteremia (OR 2.7; 95% CI 1.0–7.5;  $p = 0.045$ ). Mortality in children with SAM was 12.5% and strongly associated with bacteremia (OR 5.5;  $p = 0.007$ ). **Conclusion:** There is significant burden of bacteremia and the high prevalence of antimicrobial resistance among children with SAM.

**Key words:** Antimicrobial Resistance, Bacteremia, Blood Culture, Mortality, Severe Acute Malnutrition.

**Article Citation:** Amrita, Ibrahim MN, Anjum M, Hussain W. Community- and hospital-acquired bacteremia and pattern of antibiotic resistance in children hospitalized with severe acute malnutrition. *Professional Med J* 2026; 33(05):875-882. <https://doi.org/10.29309/TPMJ/2026.33.05.10257>

### INTRODUCTION

Malnutrition is responsible directly or indirectly for 60% of the 10.9 million deaths annually children below 5 years, while two-thirds of these deaths occur during the first year of life.<sup>1-3</sup> There is a bidirectional linkage between malnutrition and infection, as infection contributes to malnutrition, and being malnourished impairs the immune system, leading to a high risk of developing infections such as persistent diarrhea, pneumonia, and bacteraemia.<sup>4,5</sup>

Bacteremia is a serious medical condition that can lead to severe complications if left untreated or inadequately managed.<sup>6</sup> Worldwide reported prevalence of bacteremia in malnourished children is estimated to be between 5-36%.<sup>7</sup> Malnourished children with bacteremia have increased mortality and prolonged risk of hospital stay.<sup>8</sup> Community-acquired bacteremia at admission ranges between 9.1-13%, while the cumulative incidence of hospital-acquired bacteremia is around 1.2%.<sup>9,10</sup> At present,

there is a worldwide rise in antibiotic resistance regardless of nutritional status, which emphasizes the importance of monitoring the positivity of blood culture for community- and hospital-acquired infections (HAIs).<sup>8</sup> As malnutrition has high mortality, it is of the utmost importance to closely monitor the prevalence of bacteremia in order to appropriately start antibiotics, according to the blood culture report, in order to reduce mortality associated with infection in severe acute malnutrition (SAM).<sup>10</sup>

Unfortunately, there is a dearth of data among children with SAM in terms of community- and hospital-acquired bacteremia and patterns of antimicrobial susceptibility in LMICs such as Pakistan. Therefore, the current study was planned with the objective to determine the frequency of community- and hospital-acquired bacteremia and to evaluate the pattern of antibiotic resistance in children hospitalized with SAM at the National Institute of Child Health (NICH).

1. MBBS, Postgraduate Trainee Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
2. MBBS, FCPS, Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
3. MBBS, FCPS, Assistant Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
4. MBBS, FCPS, Assistant Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.

**Correspondence Address:**

Dr. Amrita  
Department of Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.  
[dharamdasaniamrita@gmail.com](mailto:dharamdasaniamrita@gmail.com)

Article received on:

30/10/2025

Accepted for publication:

03/01/2026



The findings of this study would not only add to the existing statistics but would also enhance the understanding of the types of infections in this sub-population, as well as address inappropriate empirical antibiotic treatments and promote effective antibiotic stewardship.

## METHODS

This analytical, cross-sectional study was conducted at the Pediatric Medicine Department of the National Institute of Child Health, Karachi, Pakistan from February 2025 to July 2025. The study began only after receiving prior approval from the Institutional Ethical Review Board (IERB-30/2023, dated: 19-07-2024). A sample size of 128 was calculated by using the WHO sample size calculator, considering the anticipated frequency of bacteremia 9.1%<sup>10</sup>, with 95% confidence level and 5% margin of error. The inclusion criteria were children aged 6 months to 5 years, who were admitted to the medicine department with SAM. The exclusion criteria were children who had a previous history of hospitalization within 48 hours or who had taken antibiotics at least one week ago. Children with congenital malformations, neurological disorders such as cerebral palsy (CP), or neurodegenerative disorders were also excluded. SAM was labeled according to the WHO criteria as weight-for-height < -3 Z score, or < 70% of expected weight-for-height, bilateral edema, or MUAC less than 11.5cm.<sup>11</sup> The sample selection was carried out employing the non-probability consecutive sampling technique. Parents/caregivers were briefed about the objectives and safety of the study to obtain informed and written consent from them.

All the enrolled subjects (admitted to medical units with any diagnosis and categorized as SAM) went through complete documentation of their demographics, like gender (male/female), age (months), weight (kgs), height (cm), and MUAC (cm). Clinical symptoms, which included degree of fever (Fahrenheit scale), duration of fever (hours/days), and primary diagnosis, were recorded. The nutritional status of each child was assessed using MUAC classification WHO guidelines. At the time of admission, about 2-3 ml of venous blood of each child was drawn using a standardized method, under aseptic measures, for blood culture and antimicrobials susceptibility and resistance

evaluation. The samples were inoculated in a blood culture bottle and inserted in a culture media. The positive cases were considered as bacteria (presence of viable bacteria circulating in blood) and labeled as community-acquired bacteremia on the basis of clinically relevant positive blood cultures taken within 48 hours of hospital admission, or when blood culture is drawn after 48 hours and clinical presentation and identified pathogen were consistent with community-acquired disease. Blood samples of positive cases were subcultured onto agar plates to isolate the pathogenic organism for culture and sensitivity testing. The antibiotic sensitivity test was performed by using the disc diffusion technique. Microbial growth and sensitivity patterns were noted. For the assessment of hospital-acquired bacteremia, repeat blood culture was done after 48 hours only in those children with clinical indication by the treating physician as either due to clinical deterioration or no improvement. Hospital-acquired bacteremia was defined as a positive blood culture infection that was obtained after at least 48 hours of admission to the hospital, provided the blood culture at the time of admission was negative or showed a different blood culture from the admission blood culture. All SAM children were given standard care with initially F-75 and, during the stabilization phase, F-100. Outcomes in the form of discharge, LAMA, or death were also recorded.

The statistical analysis was performed using "IBM-SPSS Statistics" version 26.0. The qualitative data were represented as frequency and percentage. For the quantitative data, means and standard deviations (SD) or medians and interquartile ranges (IQR) were calculated after checking the normality distribution through the Shapiro-Wilk test. Effect modifiers, including clinical parameters, laboratorial parameters, and outcomes were controlled by constructing a stratified table with respect to presence or absence of bacteremia. Associations were measured applied chi-square or fisher's exact test between categorical variables, and Mann-Whitney U test (as data were non normally distributed) for quantitative variables, taking  $p < 0.05$  as significant.

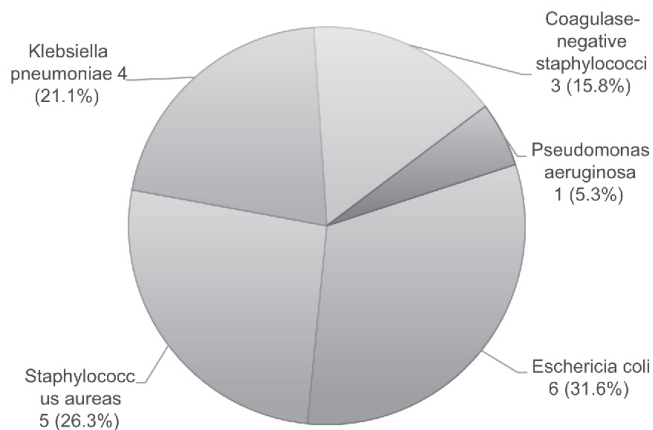
## RESULTS

In a total of 128 children, 71 (55.5%) were males,

and 57 (44.5%) females. The median age was 14.5 (IQR 10.0-22.6) months, ranging between 6 to 60 months. Residential affiliation was urban among 70 (54.7%) children, rural in 58 (45.3%) children. A weight-for-height z score below minus three standard deviations was observed in 98 (76.6%) children, while 30 (23.4%) had z scores above or equal to minus three standard deviations. MUAC < 11cm was documented in 98 children (76.6%), and bilateral edema in 20 children (15.6%). Fever at presentation was observed in 91 (71.1%) children, and the median duration of fever was 3 days (IQR 2-4). Diarrhea was the primary diagnosis in 47 (36.7%) children, pneumonia in 39 (30.5%), sepsis in 27 (21.1%) and other diagnoses in 15 (11.7%) children. Bacteremia was diagnosed in 19 (14.8%) children, and it was community-acquired in 15 (78.9%) cases, and hospital-acquired in 4 (21.1%) cases. Gram-negative organisms represented 11 of 19 isolates (57.9%), whereas Gram-positive organisms accounted for 8 isolates (42.1%). The distribution of etiological agents isolated from blood cultures is presented in figure-1. *Escherichia coli* was identified in 6 (31.6%) 6, followed by *Staphylococcus aureus* in 5 (26.3%), *Klebsiella pneumoniae* 4 (21.1%) isolates, while coagulase-negative staphylococci were isolated in 3 (15.8%), and *Pseudomonas aeruginosa* 1 (5.3%) child.

FIGURE-1

## Etiological agents causing bacteremia (N=19)



Among *Escherichia coli* isolates (n=6), resistance to ampicillin was present in 100% isolates, resistance to ceftriaxone in 83.3%, and resistance to ciprofloxacin in 66.7%, while susceptibility

to amikacin and carbapenems was observed in 66.7%, and 83.3% isolates, respectively. *Klebsiella pneumoniae* demonstrated resistance to ampicillin and ceftriaxone in all 4 isolates (100%), resistance to ciprofloxacin in 3 (75.0%), and susceptibility to amikacin and carbapenems in 3 isolates (75.0%) each. Among Gram-positive isolates, *Staphylococcus aureus* showed susceptibility to vancomycin and linezolid in all 5 isolates (100%), while methicillin resistance was documented in 3 isolates (60.0%). Susceptibility to cloxacillin and macrolides was observed in 2 isolates (40.0%) each. Coagulase-negative staphylococci were uniformly susceptible to vancomycin and linezolid (3 of 3 isolates, 100%) and resistant to penicillin in all 3 isolates (100%). The pathogen-specific antimicrobial patterns are summarised in Table-I.

Gender (p=0.807), age groups (p=0.629), residence (p=0.422), weight for height Z score (p=0.748), MUAC (p=0.748), existence of bilateral edema (p=0.989), presence of fever (p=0.172), and primary diagnosis (p=0.118) were not found to have significant association with bacteremia (Table-I). Duration of fevery > 3 days was found among 12 (63.2%) children with bacteremia versus 42 (38.5%) without bacteremia (odds ratio [OR]: 2.7; 95% confidence interval [CI]: 1.0-7.5; p=0.045). The median Hb, TLC, Neutrophils, platelets, serum creatinine, and random blood glucose levels were 8.6 g/dL (IQR: 7.4 to 9.8),  $14.8 \times 10^3/\text{mm}^3$  (IQR: 10.2 to 19.4), 68.0% (IQR: 54.3% to 78.8%), 182.4 (IQR: 128.6 to 244.2), 0.6 (IQR: 0.4 to 0.8), and 82 mg/dL (IQR: 62 to 104 mg/dL), respectively. Higher TLC (p=0.006), and neutrophils (p=0.003) were more frequently observed among children with bacteremia (Table-II).

There were 101 (78.9%) children who were discharged successfully, 11 (8.6%) left against medical advice (LAMA), and 16 children (12.5%) died. Mortality was found to have significant association with bacteremia with OR 5.5 and 95% CI 1.6 to 18.2, p<0.007 (table-2). The overall median duration of hospitalization was 7 days (IQR: 5.6-10.8), and duration of hospitalization was significantly higher among children with bacteremia (16.4 (11.5-8.3-15.7) days vs. 6.6 (4.9-9.4) days, p<0.001 as the details are given in Table-III.

TABLE-I

## Pathogen-specific antimicrobial patterns

Antimicrobial Pattern	Escherichia coli (n=6)	Klebsiella Pneumoniae (n=4)	Staphylococcus Aureus (n=5)	CoNS (n=3)
Ampicillin (n=6)	Susceptible	-	-	-
	Resistant	6 (100%)	4 (100%)	-
Ceftriaxone	Susceptible	1 (16.7%)	-	-
	Resistant	5 (83.3%)	4 (100%)	-
Ciprofloxacin	Susceptible	2 (33.3%)	1 (25.0%)	-
	Resistant	4 (66.7%)	3 (75.0%)	-
Gentamicin	Susceptible	3 (50.0%)	2 (50.0%)	-
	Resistant	3 (50.0%)	2 (50.0%)	-
Amikacin	Susceptible	4 (66.7%)	3 (75.0%)	-
	Resistant	2 (33.3%)	1 (25.0%)	-
Piperacillin - tazobactam	Susceptible	3 (50.0%)	2 (50.0%)	-
	Resistant	3 (50.0%)	2 (50.0%)	-
Cabapenems	Susceptible	5 (83.3%)	3 (75.0%)	-
	Resistant	1 (16.7%)	1 (25.0%)	-
ESBL	Susceptible	2 (33.3%)	1 (25.0%)	-
	Resistant	4 (66.7%)	3 (75.0%)	-
Cloxacillin	Susceptible	-	-	2 (40.0%)
	Resistant	-	-	3 (60.0%)
MRSA	Susceptible	-	-	2 (40.0%)
	Resistant	-	-	3 (60.0%)
Macrolides	Susceptible	-	-	2 (40.0%)
	Resistant	-	-	3 (60.0%)
Vancomycin	Susceptible	-	-	5 (100%)
	Resistant	-	-	-
Linezolid	Susceptible	-	-	5 (100%)
	Resistant	-	-	-
Penicillin	Susceptible	-	-	-
	Resistant	-	-	3 (100%)

ESBL: Extended spectrum beta-lactamases; MRSA: Methicillin-Resistant Staphylococcus aureus

## DISCUSSION

The frequency of bacteremia in children between 6 to 60 months with SAM in this study was 14.8%, indicating a substantial burden of invasive bacterial infection in this vulnerable population. Regional data by Selvagandhi et al.<sup>12</sup>, reported bacteremia to be documented in 11.6% of malnourished children. Mugheri et al.<sup>13</sup>, in a local study found a higher rates of bacteremia at 31% in children with SAM in Larkana. That study included a broader symptomatic spectrum and a high proportion of dehydrated and edematous children, which may explain the comparatively higher prevalence. Ahmed

et al.<sup>14</sup>, in a larger Tanzanian cohort reported a comparable prevalence of 13.9% in malnourished children. The combined evidence suggests that bacteremia remains consistently prevalent across regions where SAM is common. Hospital acquired bacteremia in this study was substantially lower than community acquired bacteremia yet remained clinically important. A similar proportion was reported by Andersen et al.<sup>10</sup>, who identified a cumulative hospital acquired bacteremia incidence of 1.2% in a large cohort of children receiving inpatient nutritional rehabilitation.

TABLE-II

Association of demographic and clinical characteristics with presence or absence of bacteremia (N=128)

Characteristics		Bacteremia Present (n=19)	Bacteremia Absent (n=109)	OR (95% CI)	P-Value
Gender	Male	11 (57.9%)	60 (55.0%)	1.1 (0.4-3.0)	0.807
	Female	8 (42.1%)	49 (45.0%)	Reference	
Age groups (months)	≤12	7 (36.8%)	53 (48.6%)	0.6 (0.2-2.0)	0.629
	>12-24	7 (36.8%)	34 (31.2%)	0.9 (0.3-3.2)	
	>24 to 60	5 (26.4%)	22 (20.2%)	Reference	
Residence	Urban	12 (63.2%)	58 (53.2%)	1.5 (0.6-4.1)	0.422
	Rural	7 (36.8%)	51 (47.8%)	Reference	
Weight for height Z score	< -3SD	14 (73.7%)	84 (77.1%)	0.8 (0.3-2.5)	0.748
	≥ -3 SD	5 (26.3%)	25 (22.9%)	Reference	
Middle upper arm circumference (cm)	< 11	14 (73.7%)	84 (77.1%)	0.8 (0.3-2.5)	0.748
	≥ 11	5 (26.3%)	25 (22.9%)	Reference	
Bilateral edema	Present	3 (15.8%)	17 (15.6%)	Reference	0.989
	Absent	16 (84.2%)	92 (84.4%)	0.9 (0.3-3.8)	
Fever	Yes	16 (84.2%)	75 (68.8%)	2.4 (0.7-8.9)	0.172
	No	3 (15.8%)	34 (31.2%)	Reference	
Fever duration (days)	≤3	7 (36.8%)	67 (61.5%)	Reference	0.045
	>3	12 (63.2%)	42 (38.5%)	2.7 (1.0-7.5)	
Primary diagnosis	Diarrhea	4 (21.1%)	43 (39.4%)	Reference	0.118
	Pneumonia	10 (52.6%)	29 (26.6%)	3.7 (1.1-12.9)	
	Sepsis	4 (21.1%)	23 (21.1%)	1.9 (0.4-8.2)	
	Others	1 (5.2%)	14 (12.8%)	0.8 (0.1-7.5)	
Hemoglobin (g/dl)	<8	8 (42.1%)	37 (33.9%)	1.4 (0.5-3.8)	0.492
	≥8	11 (57.9%)	72 (66.1%)	Reference	
Total leukocytes count (10 <sup>3</sup> /mm <sup>3</sup> )	<15	5 (26.3%)	66 (60.6%)	Reference	0.006
	≥15	14 (73.7%)	43 (39.4%)	4.3 (1.4-12.8)	
Neutrophils (%)	<70%	5 (26.3%)	68 (62.4%)	Reference	0.003
	≥70%	14 (73.7%)	41 (37.6%)	4.6 (1.6-13.8)	
Platelets (10 <sup>3</sup> /mm <sup>3</sup> )	<150	9 (47.4%)	28 (25.7%)	2.6 (0.9-7.1)	0.902
	≥150	10 (52.6%)	81 (74.3%)	Reference	
Serum creatinine	≤1.0	17 (89.5%)	101 (92.7%)	Reference	0.633
	>1.0	2 (10.5%)	8 (7.3%)	1.5 (0.3-7.6)	
Random blood glucose (mg/dl)	≤54.0	5 (26.3%)	18 (16.5%)	1.8 (0.6-5.6)	0.304
	>54.0	14 (73.7%)	91 (83.5%)	Reference	

\*Chi-square test applied

The major organisms identified in this study were *Escherichia coli* in 31.6%, *Staphylococcus aureus* in 26.3%, and *Klebsiella pneumoniae* in 21.1% children with bacteremia. Gram-negative organisms formed 57.9% of all positive isolates. These patterns are

similar to findings from Mugheri et al.<sup>13</sup>, where *Escherichia coli*, and *Klebsiella pneumoniae* were frequently isolated in children with SAM in Larkana, Sindh, Pakistan.

TABLE-III

## Association of bacteremia and final outcomes (N=128)

Outcomes	Bacteremia Present (n=19)	Bacteremia Absent (n=109)	OR (95% CI)	P-Value
Discharged	10 (52.6%)	91 (83.5%)	Reference	
Left against medical advice	3 (15.8%)	8 (7.3%)	3.4 (0.8-14.9)	0.007*
Death	6 (31.6%)	10 (9.2%)	5.5 (1.6-18.2)	
Duration of hospital stay (days), median (IQR)	16.4 (11.5-8.3-15.7)	6.6 (4.9-9.4)	-	<0.001#

\*Chi-square test applied; #Mann-Whitney U test applied

Predominance of Gram-negative pathogens was also noted by Alcoba et al.<sup>15</sup>, in a pooled estimate of multiple susceptibility studies conducted in populations with SAM. Andersen et al.<sup>10</sup>, reported lower isolation of *Escherichia coli*, and a higher frequency of non-typhoidal *Salmonella* in Niger, reflecting regional variation in infectious exposures. In contrast, Ahmed et al.<sup>14</sup>, documented a much higher frequency of *Pseudomonas* species with 35.7%, far exceeding the 5.3% identified in this study. The marked variation can be linked to differing environmental exposures, healthcare practices and local antimicrobial use patterns. The consistent presence of both Gram-negative, and Gram-positive pathogens across settings reinforces the need for empiric antimicrobial strategies in malnourished children.<sup>16,17</sup> The antimicrobial susceptibility patterns observed in this study highlight significant resistance among most commonly involved pathogens.<sup>18</sup> *Escherichia coli* isolates demonstrated complete resistance to ampicillin, and high resistance to ceftriaxone, and ciprofloxacin along with retained susceptibility to amikacin, and carbapenems. These findings are consistent with the susceptibility profiles described by Afsharpaiman et al.<sup>19</sup>, in Iranian children with urinary tract infections where *Escherichia coli* showed high sensitivity to imipenem and amikacin and substantial resistance to first line agents including ampicillin and early generation cephalosporins. Mugheri et al.<sup>13</sup>, similarly documented elevated resistance to ampicillin and multiple cephalosporins in *Escherichia coli* and *Klebsiella pneumoniae* isolates from severely malnourished children. Andersen et al.<sup>10</sup>, reported high resistance to amoxicillin and amoxicillin clavulanate among both community and hospital acquired bacteremia isolates in Niger. The convergence of findings

across diverse populations points toward a widespread pattern of declining effectiveness of older beta lactams. *Staphylococcus aureus* isolates in this study showed complete susceptibility to vancomycin and linezolid while methicillin resistance was noted in sixty percent of isolates. The prevalence of methicillin resistant *Staphylococcus aureus* parallels findings by Selvagandhi et al.<sup>12</sup>, who identified methicillin resistant *Staphylococcus aureus* as a predominant pathogen in malnourished children with bacterial infections. The repeated identification of methicillin resistant *Staphylococcus aureus* across settings underscores the importance of caution when selecting empiric therapy for Gram-positive coverage in settings with high malnutrition prevalence.<sup>20,21</sup>

The mortality rate in this study was 12.5% and bacteremia was associated with an odds ratio of 5.5 for death, indicating a markedly elevated risk. This is similar to results reported by Andersen et al.<sup>10</sup>, where community acquired bacteremia increased mortality risk with a relative risk of 2.7 and hospital acquired bacteremia carried an even greater risk. Ahmed et al.<sup>14</sup>, also identified bacteremia as a predictor of death among severely malnourished children, particularly when the infections were caused by multidrug resistant organisms. The consistency in mortality associations highlights the critical need for early detection, prompt initiation of effective antimicrobial therapy, and improved supportive care practices in severe acute malnutrition units.<sup>22-25</sup>

This study has certain limitations. The sample was restricted to a single tertiary care center which may limit the generalizability of findings to other regions with differing antimicrobial resistance patterns.

Only blood cultures were evaluated in this study and potential coinfections from urine, stool, or respiratory samples were not assessed.

## CONCLUSION

There is significant burden of bacteremia and the high prevalence of antimicrobial resistance among children with SAM. Early recognition of bacteremia, selection of empiric therapy guided by local resistance trends, and reinforcement of infection prevention practices are critical for reducing mortality and improving clinical outcomes in children with SAM.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Copyright© 03 Jan, 2026.

## REFERENCES

- World Health Organization. **Malnutrition**. 2024. Available from: <https://www.who.int/news-room/fact-sheets/detail/malnutrition>
- World Health Organization (WHO); **Updates on the management of severe acute malnutrition in infants and children, accessed, September 2021**. <https://www.who.int/publications-detail-redirect>
- World Health Organization. **Levels and trends in child malnutrition: unicef/who/world bank group joint child malnutrition estimates: key findings of the 2023 edition**. 2023; Available from: <https://www.who.int/publications/i/item/9789240073791>
- Mukhula VT, Harawa PP, Phiri C, Khoswe S, Chaziya J, Mbale E, et al. **Childhood malnutrition and bacteraemia at a tertiary hospital in Malawi**. medRxiv. 2021; 1-25.
- Walson JL, Berkley JA. **The impact of malnutrition on childhood infections**. *Curr Opin Infect Dis*. 2018; 31(3):231-36.
- de Morais MS, Gonçalves A, Cristóvão G, Lucena J, Reis AC, Tsisar S, et al. **Managing bacteremia: Insights Into pathogen-specific treatment**. *Cureus*. 2025; 17(2):e78674.
- Yona RH. **Prevalence and predictors of bacteraemia among children with severe acute malnutrition admitted at Dodoma Regional Referral Hospital**. Dodoma, Tanzania (Doctoral dissertation, The University of Dodoma, November 2020). Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://repository.udom.ac.tz/server/api/core/bitstreams/506f0345-cc4e-4339-bbdf-3f58b7d9d662/content>
- Jones KD, Berkley JA. **Severe acute malnutrition and infection**. *Paediatr Int Child Health*. 2014; 34 Suppl 1(Suppl 1):S1-S29.
- Ashraf S, Khan MZ, Khan FA, Sultana N, Sarwar M, Raza AB. **Spectrum of bacterial infections among severely acute malnourished children in a tertiary care center**. *Pak J Med Health Sci*. 2020; 14(2):509-512.
- Andersen CT, Langendorf C, Garba S, Sayinzonga-Makombe N, Mambula C, Mouniaman I, et al. **Risk of community- and hospital-acquired bacteremia and profile of antibiotic resistance in children hospitalized with severe acute malnutrition in Niger**. *Int J Infect Dis*. 2022; 119:163-171.
- World Health Organization. **Identification of severe acute malnutrition in children 6-59 months of age**. Last updated: 9 August 2023.
- Selvagandhi PL, Dhruv S, Phuljhele S. **Study the prevalence of bacterial infection in under-five malnourished children**. *Pediatr Infect Dis*. 2025; 7(2):50-53.
- Mugheri IA, Mugheri D, Ghafar B, Ali A, Jesrani VK, Mugheri AJ. **Antibiotics resistance pattern in malnourished children suffering from acute severe bacterial infections at CMC children's hospital, Larkana**. *Insights J Health Rehab*. 2025; 3(3):331-38.
- Ahmed M, Mirambo MM, Mushi MF, Hokororo A, Mshana SE. **Bacteremia caused by multidrug-resistant bacteria among hospitalized malnourished children in Mwanza, Tanzania: A cross sectional study**. *BMC Res Notes*. 2017; 10(1):62.
- Alcoba G, Kerac M, Breyse S, Salpeteur C, Galetto-Lacour A, Briend A, et al. **Do children with uncomplicated severe acute malnutrition need antibiotics? A systematic review and meta-analysis**. *PLoS One*. 2013; 8(1):e53184.
- Lazzerini M, Tickell D. **Antibiotics in severely malnourished children: Systematic review of efficacy, safety and pharmacokinetics**. *Bull World Health Organ*. 2011; 89(8):594-607.
- Alhumaid S, Al Mutair A, Al Alawi Z, Alzahrani AJ, Tobaiqy M, Alresasi AM, et al. **Antimicrobial susceptibility of gram-positive and gram-negative bacteria: A 5-year retrospective analysis at a multi-hospital healthcare system in Saudi Arabia**. *Ann Clin Microbiol Antimicrob*. 2021; 20(1):43.
- Nicolini G, Frasca Polara V, Calvi M, García-Lorenzo M, Massese M, et al. **When infection hurts: golden rules for managing pediatric skin and soft tissue infections**. *Ital J Pediatr*. 2025; 51(1):194.
- Afsharpaiman S, Bairaghdar F, Torkaman M, Kavehmanesh Z, Amirsalari S, Moradi M, et al. **Bacterial pathogens and resistance patterns in children with community-acquired urinary tract infection: A cross sectional study**. *J Compr Ped*. 2012; 3(1):16-20.
- Samuel P, Kumar YS, Suthakar BJ, Karawita J, Sunil Kumar D, Vedha V, et al. **Methicillin-resistant staphylococcus aureus colonization in intensive care and burn units: A narrative review**. *Cureus*. 2023; 15(10):e47139.

21. Abebe AA, Birhanu AG. **Methicillin resistant staphylococcus aureus: Molecular mechanisms underlying drug resistance development and novel strategies to combat.** Infect Drug Resist. 2023; 16:7641-62.
22. Williams PCM, Berkley JA. **Guidelines for the treatment of severe acute malnutrition: A systematic review of the evidence for antimicrobial therapy.** Paediatr Int Child Health. 2018; 38(sup1):S32-S49.
23. Jamali AN, Siyal H, Qambrani ZA, Memon NA, Baig S, Bilal S. **Prevalence of severe acute malnutrition and associated mortality rate in infants in Tertiary Care Hospital of Hyderabad".** J Pharmaceut Res Int. 2020; 32(34):40-44.
24. Ma Y, Fan S, Xi J. **Recent updates regarding the management and treatment of pneumonia in pediatric patients: A comprehensive review.** Infection. 2025 Aug 5.
25. Kebede F, Kebede T, Negese B, Abera A, Fentaw G, Kasaw A. **Incidence and predictors of severe acute malnutrition mortality in children aged 6-59 months admitted at Pawe general hospital, Northwest Ethiopia.** PLoS One. 2022; 17(2):e0263236.

#### AUTHORSHIP AND CONTRIBUTION DECLARATION

1	<b>Amrita:</b> Data collection, drafting.
2	<b>Mohsina Noor Ibrahim:</b> Study concept, proof reading.
3	<b>Misbah Anjum:</b> Critical revisions.
4	<b>Wajid Hussain:</b> Data analysis, literature review.