

Research article

Bacteriological Profile and Antibiotic Sensitivity Patterns of Blood Culture Isolates Among Pediatric Patients with Suspected Septicemia: A Hospital-Based Cross-Sectional Study

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Abstract: Neonatal and paediatric septicaemia remains a leading cause of morbidity and mortality in low- and middle-income countries. Empirical antibiotic therapy depends on knowledge of the prevailing bacteriological spectrum and local resistance patterns, which shift over time and geography. This study characterised the bacterial isolates and their antibiotic sensitivity profiles among paediatric patients with clinically suspected septicaemia. A hospital-based cross-sectional study was conducted from 15 November 2021 to 15 February 2022. A total of 101 blood culture samples were collected from patients aged newborn to 15 years with suspected septicaemia. Samples were processed by standard microbiological methods and antibiotic sensitivity was determined by the Kirby–Bauer disc-diffusion technique. Proportions were compared using the chi-square test and Fisher's exact test, and 95% confidence intervals (CI) were calculated using the Wilson method; $p < 0.05$ was considered statistically significant. Of 101 samples, 49 (48.5%; 95% CI 39.0–58.1%) were culture-positive. Gram-negative organisms accounted for 30/49 (61.2%) and Gram-positive for 19/49 (38.8%) of isolates. *Staphylococcus aureus* was the commonest isolate (19; 18.8%), followed by *Pseudomonas aeruginosa* (10; 9.9%), *Klebsiella pneumoniae* (9; 8.9%), *Acinetobacter baumannii* (7; 6.9%) and *Escherichia coli* (4; 4.0%). Culture positivity did not differ significantly by age ($p = 1.00$) or gender ($p = 0.75$), whereas most positive cases were from urban residents (41/49; 83.7%; $p < 0.001$). *S. aureus* was uniformly sensitive to vancomycin (100%; 95% CI 83.2–100%). Ceftazidime and linezolid showed broadly favourable activity across isolates, whereas amoxicillin–clavulanic acid and ceftriaxone performed poorly against Gram-negative organisms. Gram-negative organisms predominated among paediatric bloodstream isolates, with substantial resistance to commonly used agents. Vancomycin for Gram-positive and ceftazidime for Gram-negative organisms retained the best in-vitro activity, supporting their role in empirical therapy pending local antibiograms.

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Introduction

Septicemia is a life-threatening systemic response to bloodstream infection and remains a major contributor to pediatric and neonatal mortality worldwide, disproportionately affecting low- and middle-income

countries [1]. Early and appropriate antimicrobial therapy substantially improves outcomes, yet the choice of empirical treatment is frequently made before culture results are available [2]. Effective empirical regimens therefore rely on up-to-date

knowledge of the local bacteriological spectrum and its antibiotic susceptibility profile [3]. The causative organisms of bloodstream infection and their resistance patterns vary considerably across regions, institutions and time periods, driven by differences in patient populations, infection-control practices and antibiotic-prescribing behavior [4].

The global rise of antimicrobial resistance (AMR) has further complicated empirical management, with once-reliable agents losing activity against common pathogens [5]. Continuous surveillance of blood culture isolates and their susceptibilities is essential to inform rational antibiotic policy and antibiotic-stewardship efforts [6]. Despite the clinical importance of pediatric septicemia, contemporary local data from many settings in Pakistan remain limited [7]. Therefore, this study aimed to determine the bacteriological profile of blood culture isolates and their antibiotic sensitivity patterns among pediatric patients with suspected septicemia, and to examine the association between culture positivity and demographic and socioeconomic variables.

Materials and Methods

Study design and setting

This hospital-based, descriptive cross-sectional study was conducted over three months, from 15 November 2021 to 15 February 2022, in the microbiology laboratory of a tertiary-care hospital.

Study population and sampling

Patients aged from newborn to 15 years presenting with clinical features suggestive of septicemia were eligible for inclusion. A total of 101 blood culture samples were collected from consecutive eligible patients. Relevant demographic and socioeconomic information (age, gender, residence and socioeconomic class) was recorded on a structured proforma.

Specimen collection and processing

Blood samples were collected aseptically before the initiation of antibiotic therapy where possible and inoculated into culture broth [8]. Cultures were incubated and examined for growth; positive cultures were subcultured onto standard media, and isolates were identified using colony morphology, Gram staining, and standard biochemical tests [9].

Antibiotic sensitivity testing

Antibiotic susceptibility testing was performed by the modified Kirby–Bauer disc-diffusion method on Mueller–Hinton agar [10], and results were interpreted according to the applicable Clinical and Laboratory Standards Institute (CLSI) breakpoints [11]. The panel included cefoperazone, ceftazidime, ertapenem, linezolid, amoxicillin–clavulanic acid, moxifloxacin, ceftriaxone, vancomycin, trimethoprim–sulfamethoxazole, and azithromycin, applied according to organism [12].

Statistical analysis

Data were analyzed using descriptive and inferential statistics. Categorical variables were expressed as frequencies and percentages [13]. Associations between culture positivity and categorical variables (age group, gender, residence) were assessed using the Pearson chi-square test with Yates' continuity correction, and Fisher's exact test where expected cell counts were small [14, 15]. Ninety-five per cent confidence intervals for key proportions were calculated using the Wilson score method. A two-sided p-value < 0.05 was considered statistically significant [16].

Results

Demographic characteristics

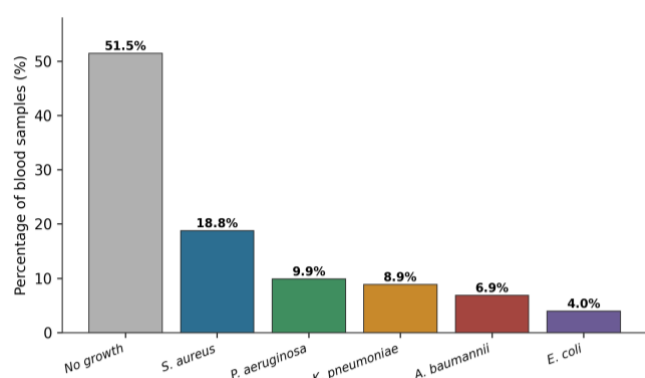
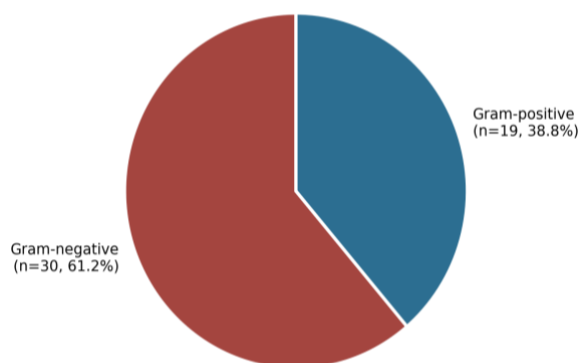
A total of 101 blood culture samples were collected from pediatric patients with suspected septicemia. Seventy (69.3%) samples were from children younger than 7 years and 31 (30.7%) from those aged 7.1–15 years. Males accounted for 53 (52.5%) and females for 48 (47.5%). By socioeconomic class, 43.6% were classified as poor, 40.6% as middle class, and 15.8% as upper-middle class.

Culture positivity and bacterial spectrum

Of the 101 samples, 49 (48.5%; 95% CI 39.0–58.1%) yielded bacterial growth, while 52 (51.5%) showed no growth. Gram-negative bacteria constituted 30/49 (61.2%) of isolates and Gram-positive bacteria 19/49 (38.8%). *Staphylococcus aureus* was the most frequently isolated organism (19; 18.8% of all samples), followed by *Pseudomonas aeruginosa* (10; 9.9%), *Klebsiella pneumoniae* (9; 8.9%), *Acinetobacter baumannii* (7; 6.9%), and *Escherichia coli* (4; 4.0%) (Table 1, Figures 1 and 2).

Table 1. Frequency and percentage distribution of organisms isolated (n = 101).

Organism isolated	Frequency	Percentage
No growth	52	51.5%
<i>Staphylococcus aureus</i>	19	18.8%
<i>Pseudomonas aeruginosa</i>	10	9.9%
<i>Klebsiella pneumoniae</i>	9	8.9%
<i>Acinetobacter baumannii</i>	7	6.9%
<i>Escherichia coli</i>	4	4.0%
Total	101	100.0%

**Figure 1.** Distribution of bacterial isolates in blood cultures of patients with suspected septicemia (n = 101).**Figure 2.** Gram-stain distribution of bacterial isolates (n = 49).

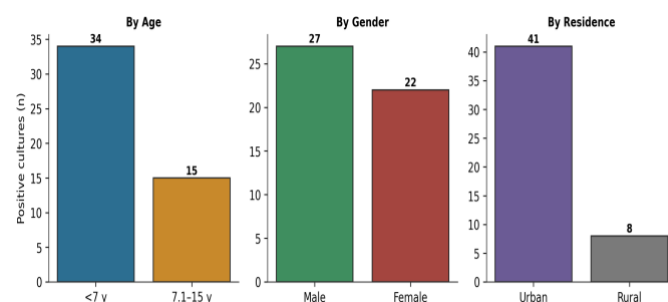
Culture positivity by demographic variables

Among culture-positive cases, 34 (69.4%) were younger than 7 years and 15 (30.6%) were aged 7.1–15 years; culture positivity did not differ significantly between the two age groups (chi-square = 0.00, $p = 1.00$). Positive cultures were obtained from 27 males (55.1%) and 22 females (44.9%), with no significant gender difference (chi-square = 0.10, $p = 0.75$; Fisher's exact p

= 0.69). By residence, 41 (83.7%) positive cases were from urban areas and 8 (16.3%) from rural areas, a significant predominance of urban cases (binomial $p < 0.001$). The socioeconomic distribution of positive cases was 17 (34.7%) poor, 28 (57.1%) middle class, and 4 (8.2%) upper class (Table 2, Figure 3).

Table 2. Distribution of culture-positive cases by demographic and socioeconomic variables (n = 49).

Variable	Category	Frequency (n)	Percentage	p-value
Age group	< 7 years	34	69.4%	1.00
	7.1–15 years	15	30.6%	
Gender	Male	27	55.1%	0.75
	Female	22	44.9%	
Residence	Urban	41	83.7%	< 0.001
	Rural	8	16.3%	
Socioeconomic	Poor	17	34.7%	—
	Middle	28	57.1%	
	Upper	4	8.2%	

**Figure 3.** Distribution of culture-positive cases by age, gender and residence (n = 49).

Antibiotic sensitivity patterns

The antibiotic sensitivity profiles of the five principal isolates are summarised in Table 3 and Figure 4. *Staphylococcus aureus* was uniformly sensitive to vancomycin (19/19; 100%; 95% CI 83.2–100%), followed by linezolid (73.68%), ertapenem (68.42%) and ceftazidime (63.15%), while sensitivity to ceftriaxone was low (36.84%). Among Gram-negative isolates, ceftazidime retained the most consistent activity against *Pseudomonas aeruginosa* (69.90%), *Klebsiella pneumoniae* (66.66%), *Acinetobacter baumannii* (71.42%), and *Escherichia coli* (74.89%). Linezolid showed notably high activity against *Acinetobacter baumannii* (85.71%). In contrast, amoxicillin–clavulanic acid (10.05% against *P. aeruginosa*) and ceftriaxone (20.01% against *P.*

aeruginosa) demonstrated poor activity against Gram-negative organisms, and ertapenem activity against *E. coli* was limited (24.99%).

Table 3. Antibiotic sensitivity profile of bacterial isolates (percentage sensitive).

Antibiotic	<i>S. aureus</i>	<i>P. aeruginosa</i>	<i>K. pneumoniae</i>	<i>A. baumannii</i>	<i>E. coli</i>
Cefoperazone	52.63	50.01	33.33	42.82	50.09
Ceftazidime	63.15	69.90	66.66	71.42	74.89
Ertapenem	68.42	50.00	44.44	57.14	24.99
Linezolid	73.68	59.78	55.56	85.71	51.00
Amoxicillin–clavulanic acid	42.10	10.05	33.37	—	24.67
Moxifloxacin	47.36	—	44.44	42.85	26.45
Ceftriaxone	36.84	20.01	—	—	—
Vancomycin	100	—	—	—	—

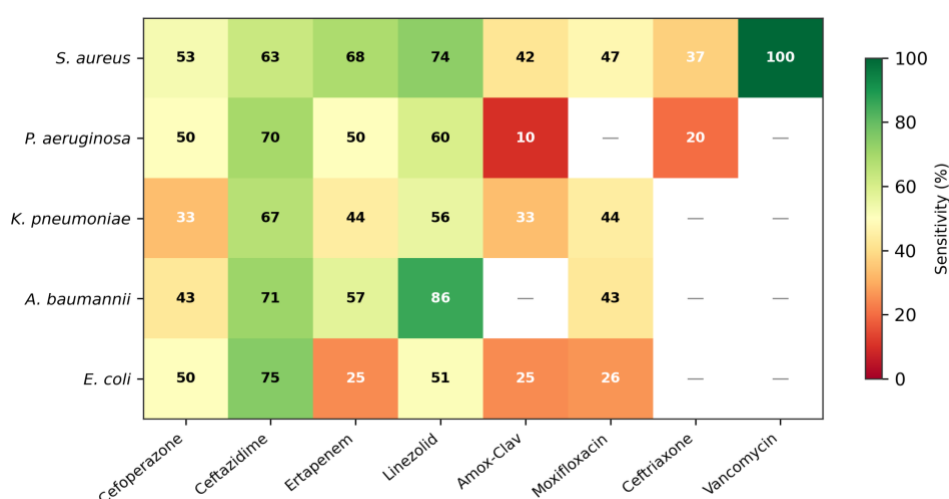


Figure 4. Heat map of antibiotic sensitivity (%) of bacterial isolates. Dashes denote antibiotics not tested against that organism.

Discussion

This study documents the bacteriological profile and antibiotic sensitivity patterns of blood culture isolates among pediatric patients with suspected septicemia [17]. The 48.5% culture-positivity rate is consistent with the range reported in comparable pediatric bloodstream-infection studies, where positivity is commonly influenced by prior antibiotic exposure [18], sample volume, and blood-culture technique. The high proportion of no-growth cultures underscores the recognized limitations of conventional blood culture and the potential value of optimized sampling and automated culture systems. The most common isolate is a pattern frequently observed in pediatric septicemia and consistent with its role as a leading cause of both community- and hospital-acquired bloodstream

infection [19]. The prominence of *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii* is particularly concerning given their well-documented association with healthcare-associated infection and multidrug resistance [20, 21]. The absence of a statistically significant association between culture positivity and age or gender suggests that susceptibility to bloodstream infection in this cohort was not strongly patterned by these variables, although the modest sample size limits statistical power [22, 23]. The marked urban predominance of positive cases most plausibly reflects the catchment population and referral pattern of the study hospital rather than a true difference and should be interpreted with caution [24].

The susceptibility findings have direct implications for empirical therapy. The uniform sensitivity of *S. aureus* to vancomycin supports its continued role as a

reliable agent for serious Gram-positive infection, while linezolid offers a useful alternative [25]. Among Gram-negative isolates, the comparatively preserved activity of ceftazidime is encouraging [26], whereas the poor performance of amoxicillin–clavulanic acid and ceftriaxone against several Gram-negative organisms argues against their empirical use in this setting [27]. These patterns are consistent with the broader escalation of antimicrobial resistance and reinforce the need for antibiotic-stewardship programs and regularly updated local antibiograms [28].

Study limitations: This study has several limitations. It was conducted at a single center over a relatively short period, which may limit the generalisability of the findings and preclude assessment of seasonal variation. The sample size was modest, reducing statistical power to detect associations. Molecular characterization of resistance mechanisms and clinical outcome data were not available. Finally, prior antibiotic exposure, which may reduce culture yield, could not be fully controlled.

Conclusion

Gram-negative organisms predominated among blood culture isolates from pediatric patients with suspected septicemia, with *S. aureus* the commonest single pathogen. Vancomycin retained complete in vitro activity against *S. aureus*, and ceftazidime showed the most consistent activity among Gram-negative isolates, whereas amoxicillin–clavulanic acid and ceftriaxone performed poorly. These findings support vancomycin- and ceftazidime-based empirical strategies pending culture results and highlight the importance of continued local surveillance and antibiotic-stewardship efforts to contain antimicrobial resistance.

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Data Availability Statement: Additional data will be made available upon reasonable request to the corresponding author.

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