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Identification of Common Bacterial Pathogens from Blood Culture in Pediatric Patients Admitted to a Tertiary Care Hospital in Bangladesh

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ABSTRACT

Background: Blood Stream Infections (BSIs) are a significant cause of illness and death among pediatric patients worldwide, particularly in middle-income countries like Bangladesh. Understanding the common bacterial pathogens responsible for BSIs and their antibiotic resistance patterns is critical to improving clinical outcomes. This study aims to identify the common bacterial pathogens causing blood culture confirmed BSIs in pediatricpatients admitted to a tertiary care hospital in Bangladesh.

Materials and methods: This cross-sectional study was conducted during the period from January to December 2024 at the Outpatient Pediatric Department of Women's Medical College Hospital, Dhaka, Bangladesh. Blood samples were collected from suspected pediatric patients having bloodstream infections. Bacterial isolates were identified using standard microbiological techniques. Antibiotic susceptibility testing was performed according to Clinical and Laboratory Standards Institute guidelines. The distribution of pathogens was analyzed across different age groups and by gender. Statistical analysis was done to assess associations between demographic variables and pathogen types.

Results: Among 58 positive blood cultures, Staphylococcus aureus was the most common pathogen (27.4%) followed by Escherichia coli (23.9%) Klebsiella pneumoniae (22.2%) and Streptococcus pneumoniae (15.4%). S. aureus infections were significantly more frequent in male patients (p=0.045) while age was not significantly associated with pathogen type. High resistance rates were observed against Ciprofloxacin, Cefotaxime, Penicillin and Oxacillin. E. coli showed lower resistance to Imipenem (5%) and higher resistance to Ciprofloxacin (60%) and Cefotaxime (55%). S. pneumoniae was fully sensitive to Vancomycin (100%) but highly resistant to Penicillin (85%). K. pneumoniae exhibited 50% resistance to Ceftriaxone and S. aureus showed 70% Oxacillin resistance and 25% Vancomycin resistance. Pediatric BSIs in this setting are dominated by S. aureus, with a high prevalence of multidrug-resistant pathogens.

Conclusion: Continuous local surveillance, rational antibiotic use and strengthened infection control measures are essential to optimize empiric therapy and improve pediatric treatment outcomes.

KEY WORDS

Antibiotic resistance; Blood culture; Pediatric bloodstream infections; Pediatric sepsis; Staphylococcus aureus.

INTRODUCTION

Antimicrobial Resistance (AMR) represents a critical global threat to the continued effectiveness of antibiotics, severely impacting the management of Bloodstream Infections (BSIs). Mild, self-limiting illnesses to severe, life-threatening sepsis need urgent antimicrobial treatment.[1,2] The spectrumn of pathogens causing BSIs varies geographically due to differences in local microbial ecology, healthcare infrastructure, and antibiotic usage patterns.[1,3] The dissemination of multidrug-resistant bacteria is particularly pronounced in developing countries, including Bangladesh, where challenges such as limited diagnostic facilities and rising antibiotic misuse exacerbate the burden of BSIs.[4,5] 20-50% people with bacteremia die globally, among an estimated 200,000 cases annually.[6] In the United States, BSIs rank as the eighth leading cause of death and account for up to 20% of nosocomial infections.[6] Pediatric populations, particularly in low- and middle-income countries, bear a disproportionate share of this burden, with infectious diseases accounting for 30-40% of childhood deaths in Bangladesh and neighboring regions.[5,7]

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Common bacterial pathogens isolated from pediatric BSIs include Gram-negative bacteria such as Escherichia coli, Klebsiella pneumoniae and Pseudomonas aeruginosa, as well as Gram-positive organisms like Staphylococcus aureus and coagulase-negative Staphylococci.[1,8] Alarmingly, antimicrobial susceptibility profiles have worsened over recent years, with increased resistance to third-generation cephalosporins and carbapenems reported in pediatric patients.[9] This evolving resistance pattern underscores the urgent need for continuous local surveillance to inform empirical antibiotic therapy and mitigate the spread of resistant strains.[10,11] Although blood culture remains the gold standard for diagnosing BSIs, variable positivity rates and pathogen diversity across regions complicate clinical management.[3] Empirical antimicrobial therapy is often started before culture results are available, potentially contributing to irrational antibiotic use and accelerating resistance development.[12] Therefore, reliable epidemiological and antimicrobial susceptibility data are vital for optimizing treatment regimens, reducing morbidity and mortality, and implementing effective infection control measures. The World Health Organization (WHO) advocates global monitoring of AMR trends and the adaptation of empirical treatment protocols based on localized data.[13] Within Bangladesh, marked regional variations in pathogen profiles and resistance patterns highlight the necessity of localized research to tailor clinical management strategies appropriately.[14] This study aims to identify the common bacterial pathogens causing blood culture confirmed BSIs in pediatric patients admitted to a tertiary care hospital in Bangladesh and to analyze their antimicrobial susceptibility patterns. By providing updated, region-specific data, the study intends to guide empirical treatment decisions, improve clinical outcomes and strengthen antibioticstewardship and infection control programs in pediatric healthcare settings.

MATERIALS AND METHODS

This cross-sectional study was conducted during the period from January to December 2024 at the Outpatient Pediatric Department of Women's Medical College Hospital, Dhaka, Bangladesh. The study aimed to identify the spectrum of bacterial pathogens isolated from blood cultures of pediatric patients diagnosed with culture-proven blood stream infections. Ethical approval forthis study was obtained from the IRB of Women's Medical College Hospital, Bangladesh. Verbal informed consent was obtained from the parents or legal guardians of all pediatric patients prior to data collection. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki to ensure the rights, safety, and confidentiality of all participants.

A non-probability consecutive sampling technique was employed. The study included all pediatric outpatients, diagnosed with positive blood culture for bacterial pathogens, aged 1 to 12 years. Patients without confirmed culture results or with contaminated blood cultures were excluded to ensure accuracy of microbiological data. Positive cultures underwent further identification and antimicrobial susceptibility testing through conventional microbiological methods, including Gram staining, biochemical assays and the Kirby-Bauer disc diffusion method following Clinical and Laboratory Standards Institute (CLSI) guidelines. Demographic and clinical information, including age, gender, and clinical presentation, were recorded using a structured data collection form. Bacterial isolates were categorized according to species, and their frequency and antimicrobial resistance patterns were documented. Data entry and statistical analysis were performed using SPSS version 26. Categorical variables such as gender, bacterial species and antibiotic susceptibility were expressed as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test, with a p-value <0.05 considered statistically significant.

RESULTS

Table I summarizes the demographic characteristics of the study population. Of the total 72 pediatric patients, the largest proportion was observed in the 1-4 years age group. In terms of gender distribution, males accounted about 56.6% (n=41) of the participants. These findings indicate a predominance of younger children and a higher proportion of male patients within the study.

Table I Distribution of study participants by age group and gender (n=72)

Variables	Frequency (n)	Percentage
Age Groups		
1-4 years	30	41.4%
5-8 years	25	34.5%
9-12 years	18	24.1%
Gender		
Female	31	43.4%
Male	41	56.6%

Figure 1 illustrates the distribution of bacterial pathogens isolated from blood cultures of pediatric patients (n=58). The most prevalent pathogen was Staphylococcus aureus, followed by Escherichia coli, Klebsiella pneumoniae, Streptococcus pneumoniae and other bacterial species, including Pseudomonas spp., of the isolates.

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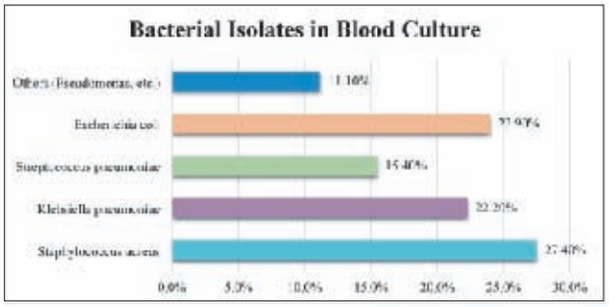

Figure 1 Distribution of bacterial isolates identified from blood cultures of pediatric patients (n=58)

Table II summarizes the antibiotic susceptibility profiles of bacterial pathogens isolated from pediatric blood cultures. Among Escherichia coli isolates, resistance was observed in 5% to Imipenem, 60% to Ciprofloxacin, and 55% to Cefotaxime. Streptococcus pneumoniae showed 0% resistance to Vancomycin and 85% resistance to Penicillin. Klebsiella pneumoniae exhibited 50% resistance to Ceftriaxone. For Staphylococcus aureus, Oxacillin resistance was 70%, while Vancomycin showed 25% resistance. Additionally, Staphylococcus aureus demonstrated complete resistance to Vancomycin (100%)in one subset and 75% resistance in another, indicating variability in response to this antibiotic.

Table II Antibiotic resistance and sensitivity profiles ofcommon bacterial pathogens isolated from pediatric blood cultures

Pathogen	Antibiotic	Resistant (%)	Sensitive (%)
Escherichia coli	Imipenem	5	95
	Ciprofloxacin	60	45
	Cefotaxime	55	40
Streptococcus pneumoniae	Vancomycin	0	100
	Penicillin	85	15
Klebsiella pneumoniae	Ceftriaxone	50	50
Staphylococcus aureus	Oxacillin	70	30
	Vancomycin	25	75

Table III shows the distribution of bacterial pathogens by age group and gender among pediatric patients. Escherichia coli was most common in children aged 1-4 years (37.5%) and was found in similar proportions in males (19.5%) and females (19%). Staphylococcus aureus was also most frequent in the 1-4 years age group (43.8%) and was significantly more common in males (22%) than females (22.2%) (p=0.045). The presence of Streptococcus pneumoniae and other bacteria was fairly even across all age groups and between genders. These results indicate that Staphylococcus aureus infections are significantly associated with male patients, while age does not have a significant effect on the types of bacteria isolated.

Table III Distribution of bacterial pathogens by age group and gender (n=58)

Pathogen	Age Group 1-4 yrs (n=30)	Age Group 5-8 yrs (n=25)	Age Group 9-12 (n=18)	Female (n=41)	Male (n=31)	p-value
Escherichia coli	6(37.5%)	5(20%)	3(17.1%)	8(19.5%)	6(19%)	
Streptococcus pneumoniae	3(15.6%)	5(20%)	2(8.5%)	5(12%)	8(13%)	
Staphylococcus aureus	7(43.8%)	6(24%)	3(17.1%)	9(22%)	7(22.2%)	p=0.045
Streptococcus pneumoniae	2(15.6%)	5(20%)	1(8.5%)	5(12%)	4(13%)	
Others	3(18.8%)	4(16%)	2(14.2%)	4(9.8%)	3(18.8%)	

DISCUSSION

Our findings reveal that Staphylococcus aureus was the predominant pathogen, accounting for 27.4% of isolates, followed closely by Escherichia coli (23.9%) Klebsiella pneumoniae (22.2%) and Streptococcus pneumoniae (15.4%). This pathogen distribution is consistent with multiple studies from South Asia, where S. aureus is frequently reported as a leading cause of pediatric bacteremia.[2,3,15] Such a predominance of S. aureus may be related to its ability to colonize the skin and mucous membranes, making it a common invasive pathogen in children.

Our age-group analysis indicated no statistically significant association between age and pathogen type (p=0.083) which is in line with observations from Khan et al. who reporteda similar uniform distribution of pathogens across pediatric age categories in Pakistani children.[5] However, gender differences were evident, particularly with S. aureus infections being significantly more common in males (p=0.045).This gender disparity has also been reported in other regional studies and might be influenced by sociocultural factors, including differential healthcare access or exposure risks between male and female children.[16] Understanding these gender-specific trends is crucial for tailoring public health interventions and improving equity in healthcare delivery. The antimicrobial resistance patterns identified in this study raise serious concerns Escherichia coli showed low resistance to Imipenem (5%) but high resistance to Ciprofloxacin (60%) and Cefotaxime (55%) with corresponding sensitivities of 95%, 40% and 45%. These findings parallel rising trends of multidrug-resistant gram-negative bacteria reported in pediatric

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bloodstream infections across South Asia.[9] Streptococcus pneumoniae was fully sensitive to Vancomycin (100%) but exhibited 85% resistance to Penicillin, reflecting regional reports of persistent penicillin resistance in pediatric isolates.[17] The continued Vancomycin susceptibility underscores its role as a reliable treatment option. Klebsiella pneumoniae showed 50% resistance to Ceftriaxone, consistent with findings by Aziz et al. indicating significant cephalosporin resistance among hospitalized children.[17] Staphylococcus aureus demonstrated high Oxacillin resistance (70%) indicative of MRSA prevalence, comparable to Iqbal et al.'s reported rates of 60-75%.[18] Vancomycin retained activity in most isolates (75% sensitivity) though 25% resistance signals emerging reduced susceptibility, warranting vigilant monitoring. This is particularly alarming given Vancomycin's status as a last-resort antibiotic for MRSA infections and aligns with reports by Iqbal et al. and Hussain et al. reflecting an emerging threat of vancomycin resistance in the region.[18,19]

Escherichia coli showed low resistance to Imipenem (5%) but high resistance to Ciprofloxacin (60%) and Cefotaxime (55%) with corresponding sensitivities of 95%, 40% and 45%. This aligns with Khan et al. and Hussain et al. who reported high resistance to cephalosporins and fluoroquinolones among pediatric Gram-negative isolates, while carbapenems remained largely effective.[9.19]

The 50% resistance rate of Klebsiella pneumoniae to Ceftriaxone highlights the increasing challenge of selecting empiric antibiotics, especially in resource-limited settings where rapid susceptibility testing may be unavailable. This resistance pattern underscores the importance of ongoing local surveillance to guide evidence-based antibiotic stewardship and policy-making.[20]

From a clinical and public health perspective,these findings underscore the urgent need for continuous monitoring of pediatric bloodstream infections and antimicrobial resistance trends. Effective stewardship programs should be implemented to optimize antibiotic use, reduce the spread of resistant strains and improve treatment outcomes. In addition, healthcare providers should be trained on current resistance patterns and encouraged to base treatment decisions on local antibiograms rather than empirical protocols alone.

The high resistance rates observed in this study may be partly explained by widespread misuse of antibiotics, including over-the-counter availability, self-medication, and incomplete treatment courses,common in many low- and middle-income countries.[21] Moreover, a lack of adequate diagnostic facilities and poor infection control practices likely contribute to the persistence and spread of resistant pathogens. Social and economic factors such as poverty, limited healthcare access and inadequate caregiver education may also drive inappropriate antibiotic use and delay presentation to healthcare facilities, exacerbating infection severity and resistance development.[22]

LIMITATIONS

This study has some limitations, including a small sample size and single-center design, which may limit generalizability. Data collected through self-report or phone interviews could introduce bias. Molecular analysis of resistance was not performed but would offer important insights.

RECOMMENDATIONS

Future research should involve larger, multicenter studies with molecular diagnostics to better understand resistance patterns.Additonally, public health initiatives must focus on antibiotic misuse education and strengthening healthcare systems for improved pediatric infection management.

CONCLUSION

In this study, Staphylococcus aureus was the most common cause of pediatric bloodstream infections, followed by Escherichia coli, Klebsiella pneumoniae, and Streptococcus pneumoniae, with S. aureus infections significantly more frequent in male patients. High resistance rates were observed against commonly used antibiotics such as Ciprofloxacin, Cefotaxime, Penicillin, and Oxacillin, while Vancomycin and Imipenem remained largely effective. These findings highlight the growing burden of multidrug-resistant pathogens in pediatric populations. Continuous local surveillance, rational antibiotic use and robust infection control measures are essential to guide empiric therapy and reduce the spread of resistant bacteria. Strengthening public awareness and healthcare practices is crucial to optimize pediatric infection management and treatment outcomes.

DISCLOSURE

All the authors declared no competing interest.

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