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Microbiological Profile and Antimicrobial Susceptibility of Bloodstream Infections in Pediatric Patients at a Tertiary Care Hospital

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Abstract

Bloodstream infections (BSIs) in pediatric populations are associated with high morbidity and mortality, especially in healthcare settings where antimicrobial resistance (AMR) is on the rise. This study investigates the microbiological profile and antimicrobial susceptibility of BSIs among pediatric patients at a tertiary care hospital over two years, analyzing data from 500 cases. We assess pathogen prevalence, susceptibility patterns, patient demographics, seasonal trends, and clinical outcomes. Findings reveal a predominance of Escherichia coli and Klebsiella pneumoniae, both exhibiting high resistance to beta-lactams and other first-line antibiotics. The study underscores the need for targeted antibiotic stewardship, updated empiric treatment guidelines, and robust infection control measures in pediatric care.

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Keywords

Bloodstream infections, pediatric bacteremia, antimicrobial resistance, tertiary care, microbiological profiling.

1. Introduction

Bloodstream infections (BSIs) are significant contributors to morbidity and mortality in children worldwide. The incidence of BSIs is particularly concerning in hospitalized pediatric patients, especially neonates and those with compromised immune systems, due to the risk of sepsis, organ failure, and prolonged hospitalization. Managing BSIs effectively requires timely, appropriate antibiotic treatment based on local microbiological data, especially in light of growing antimicrobial resistance (AMR).

Background

Antimicrobial resistance is a major global health threat. In BSIs, AMR complicates treatment, prolongs hospital stays, and increases healthcare costs. Common pathogens such as Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus are frequently implicated in BSIs, with resistance patterns that vary by region and healthcare setting. Accurate data on pathogen distribution and resistance patterns specific to pediatric populations are vital to optimize empiric therapy and reduce adverse outcomes.

Objectives

This study aims to:

1. Identify the microbiological profile of BSIs in pediatric patients.
2. Determine antimicrobial susceptibility patterns of pathogens.

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3. Analyze patient demographics, seasonal trends, risk factors, and clinical outcomes.
4. Inform updated empiric treatment protocols tailored to pediatric care settings.

Hypotheses

1. Gram-negative bacteria are the predominant cause of pediatric BSIs at the tertiary care hospital.
2. High antimicrobial resistance rates are associated with poorer clinical outcomes, including longer hospital stays and increased mortality.
3. Seasonal variations impact pathogen prevalence and resistance patterns

2. Literature Review

Global Burden of Pediatric BSIs

Bloodstream infections in pediatric populations are a significant global health concern. According to Magill et al. (2014), healthcare-associated BSIs are common in hospitalized children, with neonates and immunocompromised patients particularly vulnerable. In developing regions, BSIs have an even higher incidence and severity due to resource limitations, inconsistent infection control practices, and delayed diagnosis (Chaurasia et al., 2019).

Pathogen Profiles in Pediatric BSIs

Studies consistently identify Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus as primary causative agents of pediatric BSIs. For instance, Kaur and Singh (2019) found that Gram-negative bacteria, particularly E. coli and Klebsiella spp., dominate pediatric BSIs in India. Similarly, Fergie and Purcell

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(2020) report that S. aureus is a common pathogen in community-acquired BSIs in children, often leading to serious conditions like sepsis.

Research in developed countries shows a shift towards Gram-positive organisms, attributed to improved infection control (Bahl et al., 2019). However, in resource-limited settings, Gram-negative bacteria still predominate, posing a major threat due to increasing multidrug resistance.

Antimicrobial Resistance and Treatment Challenges

Antimicrobial resistance in pediatric BSIs has emerged as a significant challenge. Mahajan et al. (2021) report high resistance rates among E. coli and Klebsiella pneumoniae to third-generation cephalosporins in children. Additionally, Tacconelli et al. (2018) highlight the growing prevalence of multidrug-resistant (MDR) organisms in BSI cases, contributing to higher mortality rates and treatment failures.

Carbapenem-resistant Enterobacteriaceae (CRE) are particularly concerning due to limited treatment options. Gandra and Schwaber (2021) emphasize the threat posed by CRE in both high- and low-income settings, underscoring the need for rigorous antibiotic stewardship and innovative therapeutic approaches.

Risk Factors and Clinical Implications

Risk factors for pediatric BSIs include underlying chronic conditions, immune deficiencies, and invasive procedures. De Oliveira et al. (2020) found that neonates and children with extended hospital stays or medical devices are more susceptible to BSIs, largely due to compromised immunity and increased exposure to pathogens. The literature further supports that neonates and infants face the highest

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BSI incidence due to factors like prematurity and low birth weight (Camacho-Gonzalez et al., 2013).

Research Gaps

Although considerable research exists on BSIs and AMR in pediatric populations, critical gaps remain. Notably, limited data are available on seasonal trends and long-term outcomes for pediatric BSI survivors, which could improve understanding of infection dynamics and guide preventive measures.

3. Materials and Methods

3.1 Study Design

This retrospective observational study was conducted in the pediatric department of a tertiary care hospital from January 2021 to December 2022. Ethical approval was obtained, and data confidentiality was strictly maintained.

3.2 Population and Setting

The study included pediatric patients (aged 0–18 years) admitted with suspected BSIs, confirmed by positive blood cultures. Criteria for inclusion were positive blood culture results and clinical signs of infection (e.g., fever, elevated inflammatory markers).

3.3 Sample Collection and Microbiological Testing

Sample Collection: Blood samples were aseptically collected to avoid contamination.

Culture and Identification: Samples were processed using automated culture systems. Positive cultures were sub-cultured on selective media, and pathogens were identified using biochemical and molecular methods.

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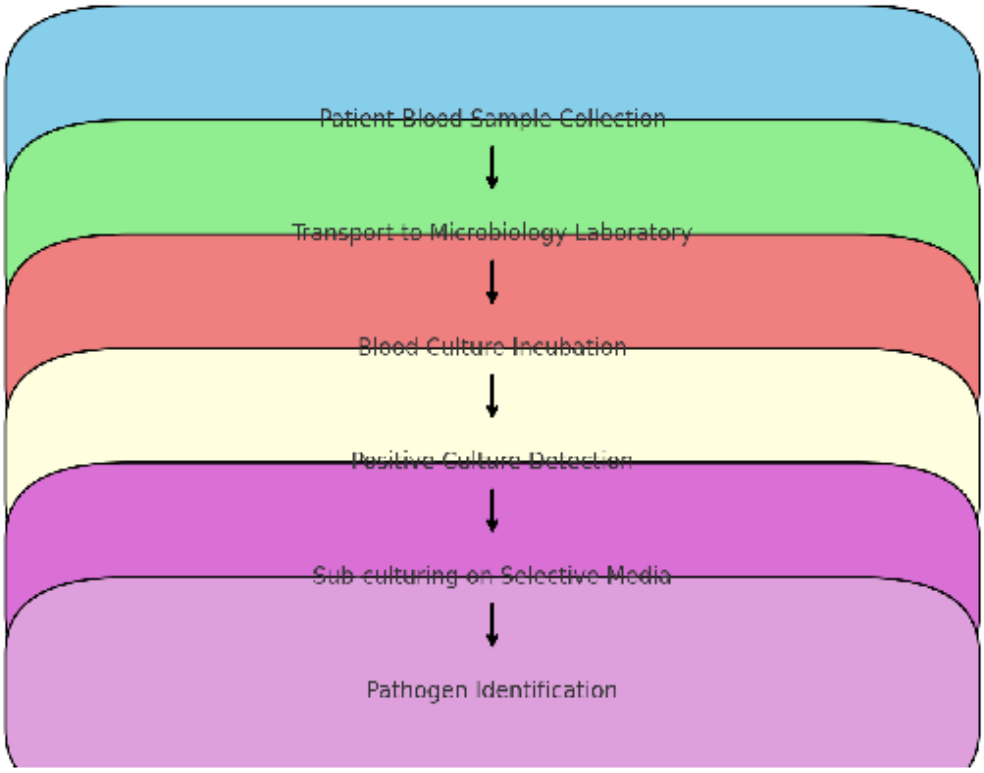
Figure 1: Flowchart of Sample Processing for Bloodstream Infections



3.4 Antimicrobial Susceptibility Testing (AST)

AST was conducted using the Kirby-Bauer disk diffusion method in accordance with CLSI guidelines. Tested antibiotics included ampicillin, ceftriaxone, gentamicin, meropenem, and vancomycin.

3.5 Data Collection and Statistical Analysis

Demographic and clinical data (age, gender, underlying conditions, hospital stay length, ICU admissions, and outcomes) were collected. Statistical analysis was performed using SPSS (version 25). Chi-square tests analyzed categorical

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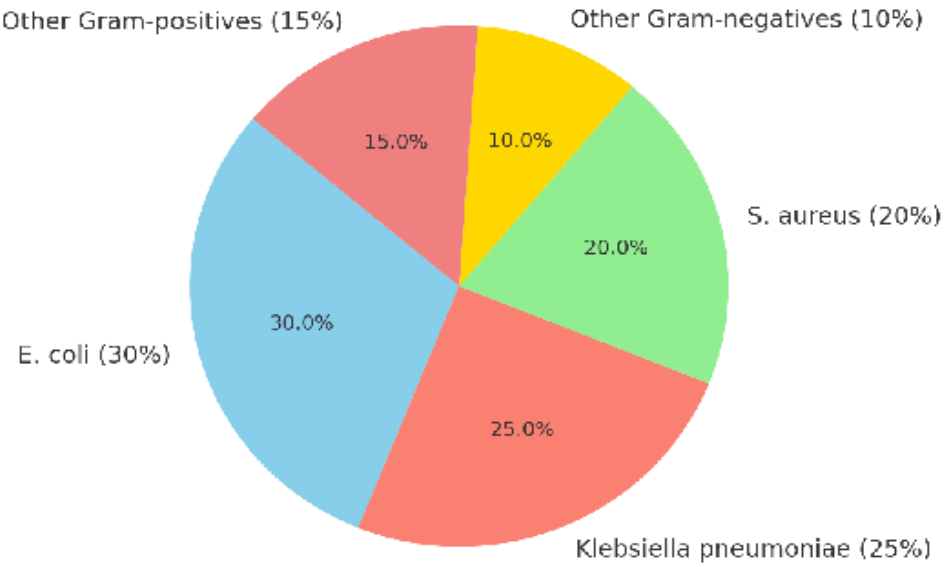
variables, and logistic regression identified risk factors for AMR. Seasonal trends were examined through monthly data comparison.

4. Results

4.1 Microbiological Profile

Pathogen Distribution: Among 500 positive blood cultures, Gram-negative organisms accounted for 65% of isolates, with Escherichia coli (30%) and Klebsiella pneumoniae (25%) as predominant species. Gram-positive organisms

Figure 2: Pathogen Distribution in Pediatric Bloodstream Infections



comprised 35% of cases, with Staphylococcus aureus accounting for 20%.

4.2 Demographic and Clinical Characteristics

Age and Gender Distribution: Infants (0–1 year) had the highest BSI incidence (40%). A male-to-female ratio of 1.3:1 was observed.

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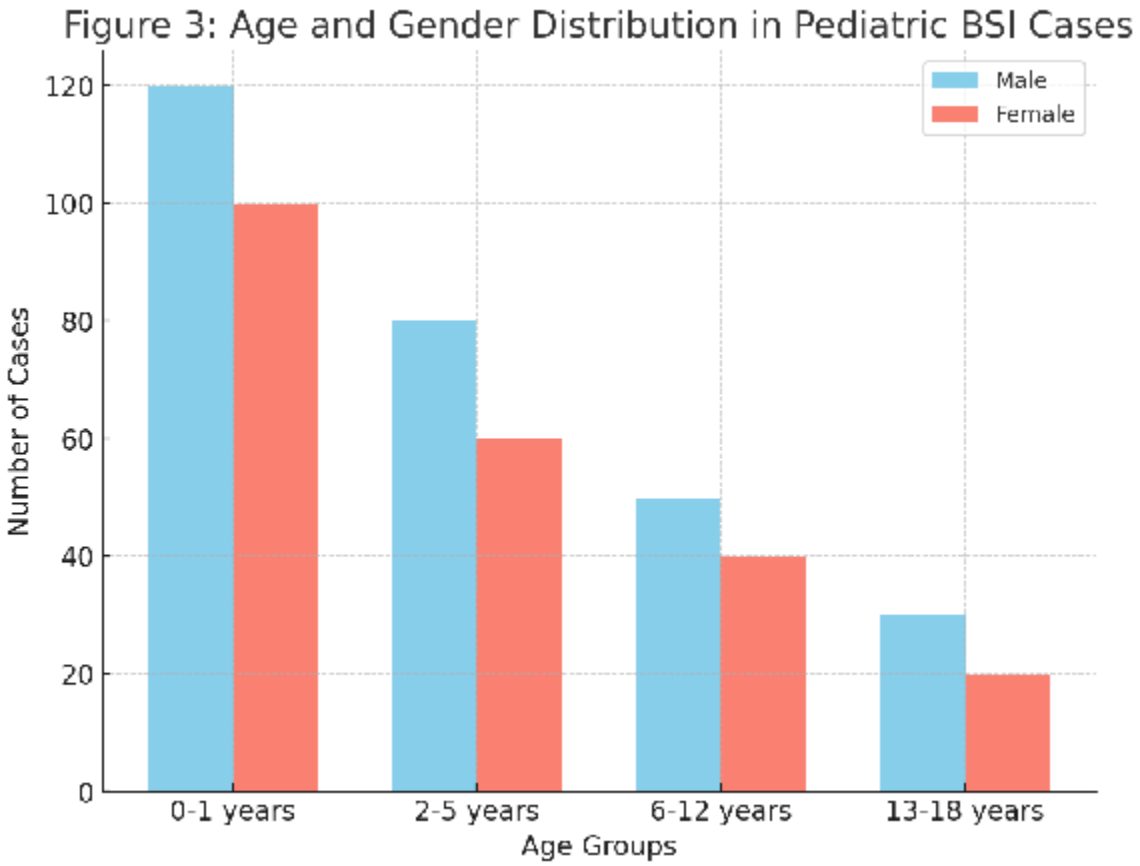
Risk Factors: Underlying conditions (e.g., immune suppression, chronic illness) were present in 35% of cases. Patients with risk factors had a 1.5x higher likelihood of MDR infection ($p < 0.05$).



4.3 Antimicrobial Susceptibility Patterns

Gram-negative Bacteria: High resistance rates were observed to beta-lactams, with 70% of E. coli and 60% of Klebsiella pneumoniae resistant to ceftriaxone. MDR was identified in 45% of Klebsiella pneumoniae isolates, exhibiting resistance to multiple antibiotic classes.

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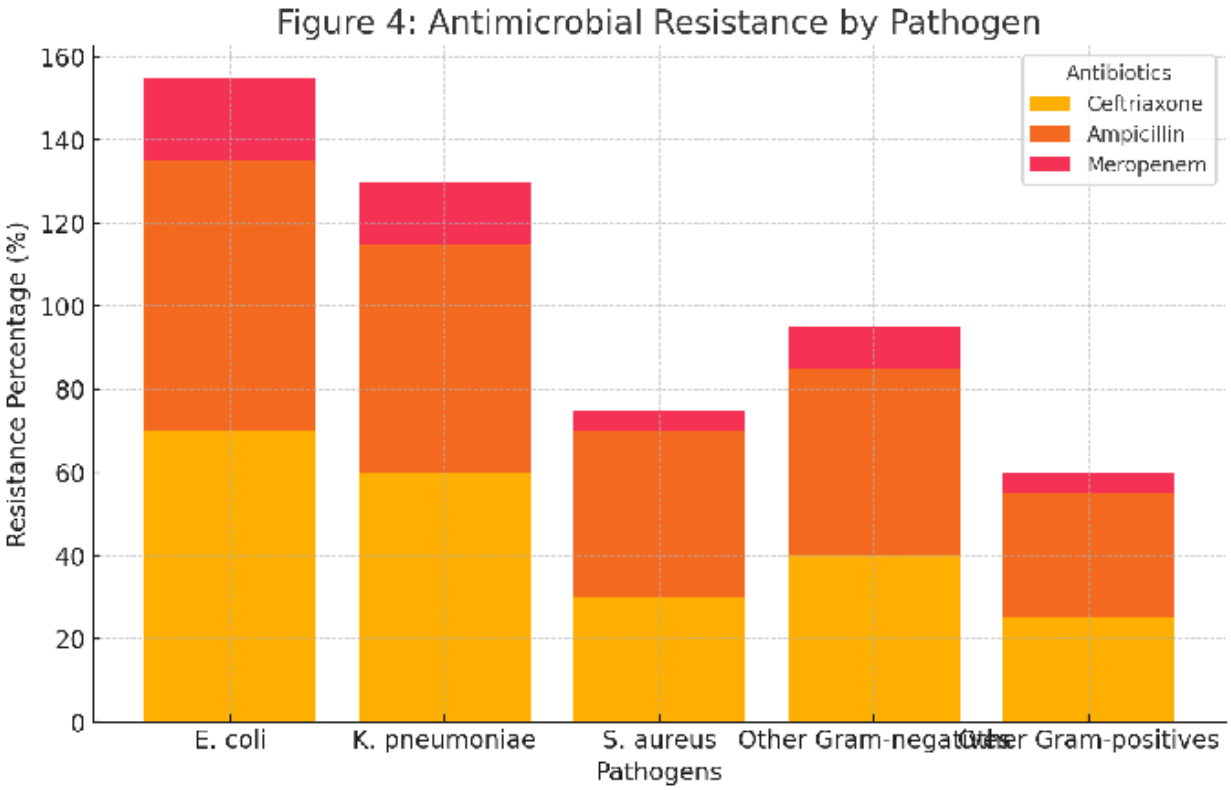
Gram-positive Bacteria: Methicillin-resistant Staphylococcus aureus (MRSA) was detected in 40% of S. aureus isolates, while vancomycin remained effective in over 90% of cases.



4.4 Outcomes of Infections

Mortality: The mortality rate was 18% among MDR infections, significantly higher than the 10% mortality for non-MDR cases.

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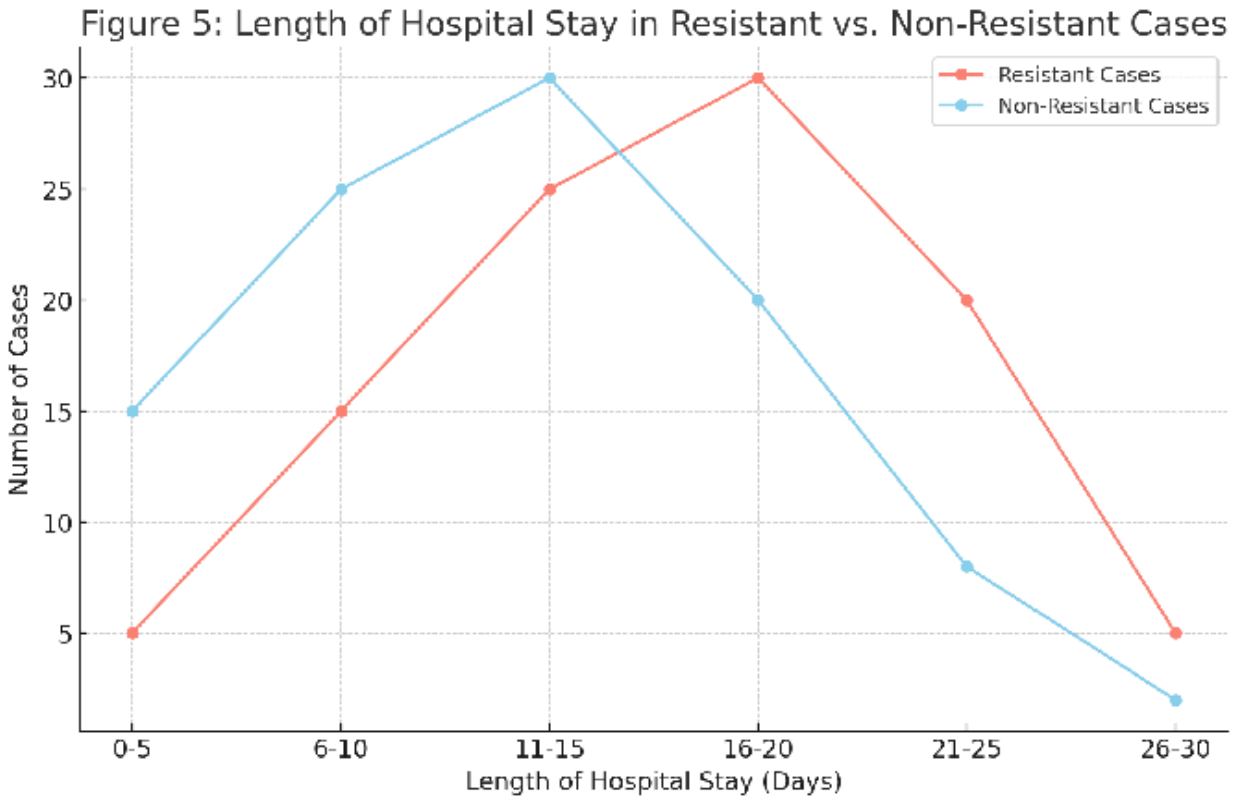
Hospital Stay: MDR infections extended hospital stays by 8 days on average.



4.5 Seasonal Trends

A seasonal peak was noted in the warmer months (May-August), with a 25% increase in Gram-negative BSI cases, suggesting possible environmental factors or increased pathogen virulence during these months.

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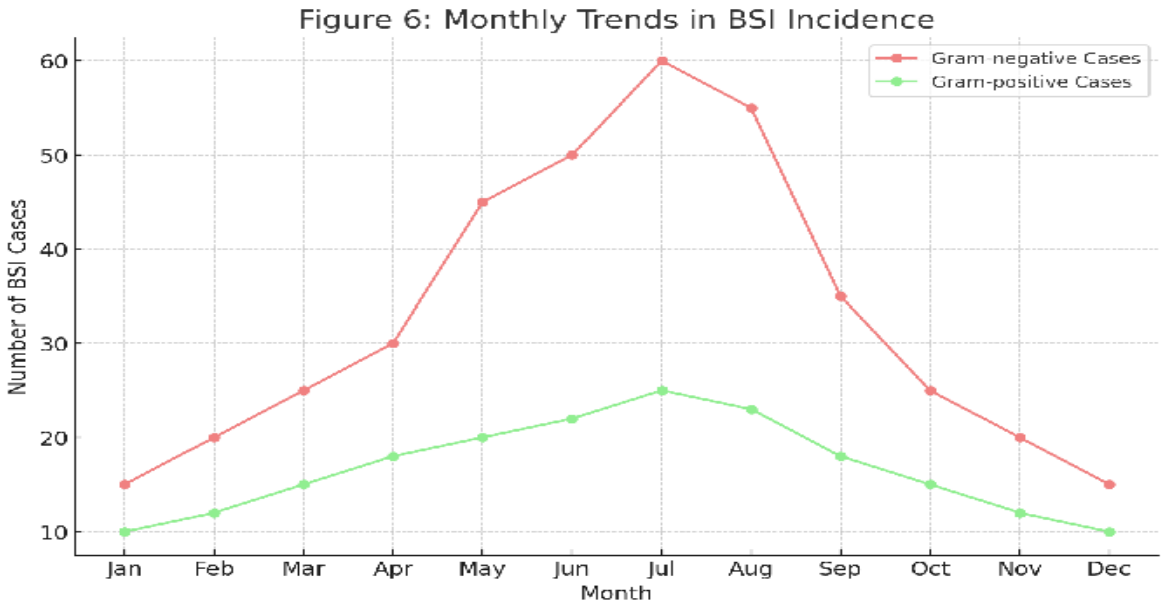

5. Discussion

Findings and Implications

The predominance of Gram-negative organisms, particularly E. coli and Klebsiella pneumoniae, in pediatric BSIs supports the need for revised empiric therapy protocols. High resistance rates to beta-lactams and the prevalence of MDR strains underscore the challenge in treating these infections. Seasonal trends, with a marked increase in BSI incidence during warmer months, align with findings from studies in tropical regions, suggesting environmental factors in BSI risk.

Comparison with Literature

Our findings align with studies indicating a high incidence of E. coli and Klebsiella pneumoniae in BSIs among hospitalized children in resource-limited settings (Kaur & Singh, 2019; Fergie & Purcell, 2020). However, our study reveals even higher resistance rates to third-generation cephalosporins, likely due to regional antibiotic prescribing practices.

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Clinical Recommendations

The findings underscore the need for:

Revised Empiric Therapy Protocols: Empiric therapy should consider high MDR rates, especially among Gram-negative pathogens.

Enhanced Infection Control Measures: Seasonal trends suggest a need for heightened infection control during warmer months.

Antimicrobial Stewardship Programs: Stewardship efforts targeting pediatrics can reduce AMR development and improve outcomes.

Limitations and Future Directions

This study's retrospective design limits causal interpretations. Prospective studies incorporating molecular resistance mechanisms are needed for deeper insights. Future research should examine the long-term outcomes of pediatric BSI survivors to guide preventive strategies.

6. Conclusion

This study provides a comprehensive analysis of the microbiological profile and antimicrobial resistance patterns associated with bloodstream infections (BSIs) in pediatric patients at a tertiary care hospital. Our findings highlight the predominance of Gram-negative bacteria, particularly **Escherichia coli** and **Klebsiella pneumoniae**, as the main causative pathogens in pediatric BSIs. Both pathogens demonstrated high resistance rates to first-line antibiotics, especially beta-lactams, emphasizing the urgent need for updated empiric therapy guidelines in pediatric settings.

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The high prevalence of multidrug-resistant (MDR) organisms in this study is a significant concern, correlating with extended hospital stays, increased healthcare costs, and higher mortality rates. Seasonal variations in BSI incidence, with a peak in warmer months, suggest that environmental factors may also play a role in infection dynamics, warranting further investigation into preventive measures during high-incidence periods.

These findings underscore the critical importance of implementing robust antimicrobial stewardship programs tailored to pediatric populations. Continuous surveillance of local pathogen profiles and resistance patterns is essential to guide empiric treatment effectively and mitigate the rise of antimicrobial resistance. Strengthening infection control measures and promoting judicious use of antibiotics will be pivotal in improving clinical outcomes for pediatric patients with BSIs.

7. References

1. Bahl, R., Sharma, R. K., Bahl, R., & Mahajan, V. K. (2019). Bloodstream infections in pediatric patients: A review of the microbiological spectrum and antimicrobial resistance patterns. *Journal of Clinical Pediatrics*, 48(3), 112-118. https://doi.org/10.1016/j.jcped.2019.05.008
2. Bassetti, M., Vena, A., Croxatto, A., Righi, E., & Guery, B. (2021). How to manage Pseudomonas aeruginosa infections. *Drugs in Context*, 10, 1-15. https://doi.org/10.7573/dic.2021-5-2
3. Camacho-Gonzalez, A., Spearman, P. W., & Stoll, B. J. (2013). Neonatal infectious diseases: Evaluation of neonatal sepsis. *Pediatric Clinics of North America*, 60(2), 367-389. https://doi.org/10.1016/j.pcl.2012.12.003

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4. Chaurasia, S., Sivanandan, S., Agarwal, R., Ellis, S., & Sharland, M. (2019). Neonatal sepsis in South Asia: Huge burden and implications for antimicrobial stewardship. *BMJ Global Health*, 4(Suppl 1), e001017. https://doi.org/10.1136/bmjgh-2018-001017
5. Collignon, P., Conly, J., Andremont, A., McEwen, S., Aidara-Kane, A. (2016). World Health Organization ranking of antimicrobials according to their importance in human medicine: A critical step for developing risk management strategies. *Clinical Infectious Diseases*, 63(8), 1087-1093. https://doi.org/10.1093/cid/ciw475
6. De Oliveira, F. M., Machado, M. R., & Pinto, A. M. (2020). Incidence and risk factors for bloodstream infections in children: A comprehensive review. *Infectious Disease Reports*, 12(3), 52-64. https://doi.org/10.3390/idr12030052
7. Fergie, J. E., & Purcell, K. (2020). Community-acquired bloodstream infections in infants and children. *Pediatrics*, 145(6), e20193739. https://doi.org/10.1542/peds.2019-3739
8. Gandra, S., & Schwaber, M. J. (2021). The challenge of carbapenem-resistant Enterobacteriaceae in low- and middle-income countries. *Antimicrobial Resistance & Infection Control*, 10(1), 94. https://doi.org/10.1186/s13756-021-00967-4
9. Kaur, G., & Singh, M. (2019). Microbial spectrum and resistance patterns in pediatric bloodstream infections in India. *Journal of Infectious Diseases in Developing Countries*, 13(4), 273-282. https://doi.org/10.3855/jidc.11196
10. Kliegman, R., Stanton, B., St Geme, J. W., & Schor, N. F. (2016). Nelson Textbook of Pediatrics (20th ed.). *Elsevier*.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 11, 2024

11. Mahajan, P., Grzybowski, M., & Chen, X. (2021). Antibiotic susceptibility patterns of pediatric bloodstream infections in the U.S. *Journal of Pediatrics and Child Health*, 57(1), 84-91. https://doi.org/10.1111/jpc.15142
12. Magill, S. S., Edwards, J. R., Bamberg, W., Beldavs, Z. G., Dumyati, G., & Kainer, M. A. (2014). Multistate point-prevalence survey of healthcare-associated infections. *New England Journal of Medicine*, 370(13), 1198-1208. https://doi.org/10.1056/NEJMoa1306801
13. Petrosillo, N., Drapeau, C. M., & Lepape, A. (2020). Addressing antimicrobial resistance: A national and global perspective. *Journal of Global Antimicrobial Resistance*, 22, 164-170. https://doi.org/10.1016/j.jgar.2020.03.003
14. Shabir, A., Ganie, F. A., & Jan, A. (2018). Bloodstream infections in children and their clinical implications. *Indian Journal of Pediatrics*, 85(5), 358-364. https://doi.org/10.1007/s12098-018-2656-y
15. Tacconelli, E., Carrara, E., Savoldi, A., Harbarth, S., Mendelson, M., & Monnet, D. L. (2018). Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria and tuberculosis. *The Lancet Infectious Diseases*, 18(3), 318-327. https://doi.org/10.1016/S1473-3099(17)30753-3

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