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"EPIDEMIOLOGICAL SURVEILLANCE AND RESISTANCE PROFILING OF MULTIDRUG-RESISTANT BACTERIAL ISOLATES FROM PEDIATRIC PATIENTS: INSIGHTS FROM A TERTIARY CARE CENTER IN NORTHERN INDIA"

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Background: The rise of antimicrobial resistance presents a significant global challenge for healthcare professionals. Infections resulting from multidrug-resistant organisms (MDROs) pose a considerable threat within Paediatric Intensive Care Units (PICUs). **Aim:** The current study investigates aims to evaluate the impact of antimicrobial agent resistance in hospital isolates from pediatric patients and to examine the resistance patterns exhibited by MDROs. **Materials and Methods:** This research involved clinical specimens collected from pediatric patients, both in outpatient and inpatient settings. The samples were developed on blood agar, chocolate agar, and MacConkey agar, with urine cultures being specifically carried out on CLED agar. Bacterial isolates were identified through conventional biochemical testing, and antibiotic susceptibility was evaluated following the 2019 CLSI guidelines using the Kirby-Bauer disk diffusion method. **Findings:** The overall total is 256 clinical samples were analyzed, leading to the identification of 100 bacterial isolates, which accounts for 39.07% of the samples. The predominant source of these isolates was urine, contributing 65 samples, followed by blood with 22, exudates with 9, and respiratory samples with 4. Among the identified isolates, 22 were classified as multidrug-resistant organisms (MDROs), with 14 originating from urine, 5 from blood, 2 from exudates, and 1 from respiratory samples. The most frequently identified MDROs included *E. coli* (54%), *Klebsiella spp*. (36%), and *Enterococcus spp*. (0.9%). In terms of antibiotic sensitivity for Gram-negative bacteria, polymyxin-B exhibited the highest efficacy at 100%, followed closely by imipenem at 98% and meropenem at 90%. For Gram-positive bacteria, the most potent antibiotics were linezolid (100%), vancomycin (97%), and teicoplanin (94%). **Conclusion:** This investigation reveals the prominent prevalence of multidrug-resistant (MDR) pathogens within the pediatric age group. The primary multidrug-resistant organisms (MDROs) identified included E. coli, Klebsiella species, and Enterococcus species, which were mainly sourced from urine culture samples.

Key Words: Bacterial pathogens, Resistance to drugs, *Escherichia coli*, Infections of the urinary tract.

Introduction: The rise of multidrug-resistant (MDR) bacterial infections poses a significant challenge globally, especially within healthcare environments such as hospitals, where individuals with compromised immune systems, including pediatric patients, face heightened risks. The emergence of MDR pathogens, which exhibit resistance to various antibiotic classes, has complicated infection management, resulting in extended hospitalizations, escalated healthcare expenses, and increased rates of morbidity and mortality. Pediatric patients are particularly susceptible to MDR infections due to their immature immune systems and the frequent administration of antibiotics for common childhood ailments, which may foster the Research conducted by Tate et al. (2020) and Papp-Wallace et al. (2019) highlights the progression of resistance. In India, the situation regarding antibiotic resistance has reached a critical level, with a notable rise in reports of MDR bacterial isolates among pediatric patients. Research indicates that Among the The pathogens Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa. represent notable examples of gram-negative bacteria, are prevalent MDR pathogens in pediatric populations and are often associated with nosocomial infections in tertiary care hospitals (Kumar et al., 2020; Thakur et al., 2022). The extensive and at times inappropriate use of antibiotics in both hospital and community contexts has significantly contributed to the escalation of antimicrobial resistance (AMR) in the nation (Bhat et al., 2021). Tertiary care hospitals in India frequently act as referral centers for intricate pediatric cases, and the presence of MDR organisms in these facilities can greatly affect treatment outcomes. Specifically, infections caused by Enterobacteriaceae species, Staphylococcus aureus, and Acinetobacter baumannii are increasingly challenging to manage due to their resistance to commonly utilized antibiotics, such as β-lactams, aminoglycosides, and carbapenems (Rai et al., 2021). Furthermore, there is an escalating concern regarding the resistance of Gram-positive pathogens like *Staphylococcus aureus* to methicillin.

Materials and Method

Study area and design: The research was conducted as a cross-sectional study at CSJMU in collaboration with GSVM Medical College, at a tertiary care hospital in Kanpur, Uttar Pradesh, over a period of six months, from January 2025 to June 2025."

Study Population: The study focused on pediatric patients aged 0 to 17 years who were admitted with suspected bacterial infections**.**

Inclusion criteria: Bacterial infections including urinary tract infections, pneumonia, sepsis, wound infections, and meningitis. Collection of clinical samples (blood, urine, sputum, wound swabs, cerebrospinal fluid) for bacteriological analysis**.**

Exclusion criteria: Patients not suspected of having bacterial infections. Patients who had received antibiotics for less than 48 hours prior to sample collection.

Sample Collection and Processing: The study involved a total of 278 pediatric patients. Clinical samples were collected according to the suspected type of infection. The samples included: Blood (for suspected sepsis), Urine (for suspected urinary tract infections), Sputum (for suspected pneumonia), Wound swabs (for suspected skin and soft tissue infections), Cerebrospinal fluid (CSF) (for suspected meningitis). The samples were promptly transported to the microbiology laboratory for processing. Standard microbiological techniques were employed to isolate bacterial pathogens, which included culturing on appropriate media, Biochemical analysis and evaluation of susceptibility to antibiotics.

Testing for Antibiotic Sensitivity: Antibiotic susceptibility testing was performed utilizing the Kirby-Bauer disk diffusion technique, consistent with the standards provided This was established by the Clinical and Laboratory Standards Institute (CLSI) in the year 2021. Isolates that showed resistance to a minimum of one antibiotic from three or more categories of antimicrobial agents were classified as multidrug-resistant (MDR).

Data Analysis: Data analysis involved the application of descriptive statistics, allowing for a comparison of bacterial species resistance rates across different age demographics and infection categories

Statistical analysis: An analysis of the distribution of different bacterial isolates and their sensitivity patterns was performed, with the results being interpreted through the use of Microsoft Excel.

Fig 1: Biochemical test of *klebsiella spp.*

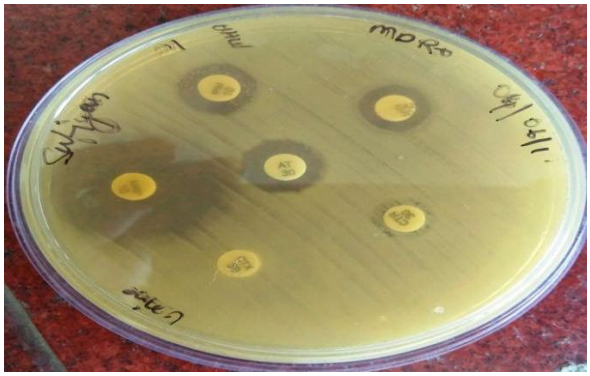

Fig 2: AST of Klebsiella spp. (ESBL) on Muller Hinton agar

Fig 3: Biochemical Test of *Pseudomonas aeruginosa*

***Fig* 4: AST Of *Pseudomonas aeruginosa* on Muller Hinton agar**

Result: Total, 256 samples were examined, sourced from 233 pediatric patients, which included 175 urine samples, 54 blood samples, 12 exudates, and 15 respiratory samples. From these clinical samples, 100 bacteria were isolated, out of this 66 were males and 34 from female patients. representing 39.07% of the total. The largest proportion of these isolates, 65, was obtained from urine, followed by 22 from blood, 9 from exudates, and 4 from respiratory samples. Additionally, 22 of the isolated bacteria were classified as multidrug-resistant organisms (MDROs), with 14 sourced from urine, 5 from blood, 2 from exudates, and 1 from respiratory samples.

Urine samples had the highest bacterial yield, contributing 65 bacterial isolates, of which 14 were MDROs.

- Blood samples had 22 bacterial isolates, with 5 being identified as MDROs.
- Exudate samples produced 9 bacterial isolates, with 2 being MDROs.
- Respiratory samples yielded 4 bacterial isolates, with 1 identified as an MDRO.

The distribution of MDROs reflects the varying incidence of resistance across different types of clinical samples. Urine samples had the largest proportion of MDROs, followed by blood, exudates, and respiratory samples. This finding may indicate higher rates of antimicrobial resistance in urinary tract infections compared to other infection sites in pediatric patients.

Table No.1: Age and Gender wise Distribution

S.NO	AGE	MALE	FEMALE	TOTAL PATIENTS
1	03-06	08	05	13
2	07-09	19	08	27
3	10-12	39	21	60

Among the cases examined, 66 were identified as male and 34 as female. The highest number of male patients fell within the age range of 10 to 12 years, while the largest group of female patients also resided in the same age category of 10 to 12 years.

Table no. 2: Sensitivity Profile of Multidrug-Resistant Gram-Negative Bacilli (%).

Antibiotics	*E. coli* (11)	*Klebsiella* spp. (04)	*Pseudomonas* spp. (02)
Amikacin	(45.4 %)	(50 %)	(50 %)
Ampicillin	(81.8 %)	(75 %)	(100 %)
Piperacillin-tazobactam	(90.9 %)	(75 %)	(50 %)
Cefepime	(54.5 %)	(50 %)	(50 %)
Cefotaxime	(100 %)	(100 %)	(50 %)
ceftriaxone	(100 %)	(100 %)	(50 %)
ceftazidime	(100 %)	(100 %)	(50 %)
Cefuroxime	(63.6 %)	(75 %)	(50 %)
Imipenem	(100 %)	(100 %)	(100 %)
Meropenem	(90.9 %)	(100 %)	(100 %)
Ciprofloxacin	(63.6 %)	(50 %)	(50 %)
Levofloxacin	(54.5 %)	(50 %)	(50 %)
Norfloxacin	(81.8 %)	(75 %)	(50 %)
Ofloxacin	(54.5 %)	(50 %)	(50 %)
Netilmycin	(72.7 %)	(50 %)	(50 %)
Tobramycin	(54.5 %)	(75 %)	(50 %)
Polymyxin-B	(100 %)	(100 %)	(100 %)
Colistin	(100 %)	(100 %)	(100 %)
Nitrofurantoin	(81.8 %)	(75 %)	(50 %)

Table no. 3: Sensitivity Profile of Multidrug-Resistant Gram-Positive Cocci (%).

Antibiotics	*Enterococcus* spp. (04)	*MRSA* (02)
Ampicillin	(75 %)	(0 %)
Amikacin	(0 %)	(50 %)
Cefoxitin	(0 %)	(0 %)
Oxacillin	(0 %)	(0 %)
Ciprofloxin	(0 %)	(0 %)
Clindamycin	(0 %)	(0 %)
Erythromycin	(0 %)	(0 %)
Ofloxacin	(0 %)	(50 %)
Vancomycin	(75 %)	(100 %)
Linezolid	(100 %)	(100 %)
Penicillin	(25 %)	(0 %)

Teicoplanin	(100 %)	(100 %)
Norfloxacin	(25 %)	(0 %)
Nitrofurantoin	(75 %)	(0 %)
Levofloxacin	(25 %)	(50 %)

DISSCUSION

The study found that multidrug-resistant organisms (MDROs), the most common organisms identified were Escherichia coli and Klebsiella species. common pathogen identified in pediatric infections, primarily from urinary tract infections (UTIs). This study found that 22% of bacterial isolates from pediatric patients were MDROs. The primary pathogens identified, E. coli (54%) and Klebsiella spp. (36%), are recognized as significant etiological agents responsible for urinary tract infections in both community and hospital environments. Comparable research has indicated a substantial prevalence of Escherichia coli in pediatric urinary tract infections, accompanied by rising resistance patterns among hospital isolates (Mellon et al., 2017; Khan et al., 2016). These results underscore the fact that urinary tract infections continue to be a leading cause of morbidity among hospitalized pediatric patients, consistent with observations from other healthcare institutions (Saiman et al., 2016). In line with the results of this study, several research efforts have observed Klebsiella spp. as a significant contributor to pediatric infections, particularly in intensive care settings (Simmons et al., 2019). These bacteria are frequently involved in hospital-acquired infections and have increasingly demonstrated resistance to commonly used antibiotics, complicating treatment regimens. Antimicrobial Resistance Patterns The antibiotic susceptibility testing revealed high resistance patterns among Escherichia coli and Klebsiella species are examples of Gram-negative bacteria which were predominantly resistant to Common antibiotics, including third-generation cephalosporins. However, Polymyxin-B (100% sensitivity), Imipenem (98%), and Meropenem (90%) remained effective against these organisms. This is consistent with a broader body of research indicating that carbapenems and polymyxins are among the last-line treatment options for multidrug-resistant Enterobacteriaceae (Tumbarello et al., 2017). The use of Polymyxin-B, while highly effective, carries a risk of nephrotoxicity, which limits its frequent use (Sharma et al., 2021). This reinforces the importance of antimicrobial stewardship to ensure these critical drugs are used appropriately and not overprescribed, which may accelerate resistance development. Similarly, while Imipenem and Meropenem are potent against many Gram-negative pathogens, carbapenem resistance, especially in Klebsiella pneumoniae and E. coli, has been documented globally (Pitout & Laupland, 2020). The effectiveness of these antibiotics in this study may be encouraging, but it must be interpreted with caution due to the potential for evolving resistance. For Gram-positive bacteria, such as Enterococcus spp., the study observed high sensitivity to Linezolid (100%) and Vancomycin (97%). This is in line with other studies, where Linezolid has shown consistently high efficacy against vancomycin-resistant Enterococci (VRE) and other resistant Gram-positive organisms (Müller et al., 2020). However, Vancomycin resistance is rising in certain strains of Enterococcus faecium, suggesting the need for ongoing surveillance and research to identify new therapeutic options. Implications for Urinary Tract Infections (UTIs) A key finding of the study was the high number of MDROs isolated from urine cultures, accounting for 64% of MDROs. UTIs are among the most common infections in pediatric populations and are particularly prevalent in hospitalized children. Studies have shown that E. coli remains the leading pathogen for UTIs in children, with an increasing trend in antimicrobial resistance to ampicillin, trimethoprim-sulfamethoxazole, and cephalosporins (Nicolle, 2019). The prevalence of resistant E. coli in UTIs in this study is consistent with other regional studies that document increasing resistance to first-line antibiotics (Hernandez et al., 2017). This emphasizes the importance of proper diagnostic testing and tailoring antibiotic treatment based on local resistance patterns to avoid unnecessary broad-spectrum antibiotic use.

Conclusion

This research underscores the considerable impact of multidrug-resistant organisms (MDROs) on pediatric patients, particularly those admitted to Pediatric Intensive Care Units (PICUs). The main pathogens identified were E. coli and Klebsiella spp., which were particularly prevalent in instances of urinary tract infections. These findings highlight the critical necessity for robust antimicrobial stewardship programs and rigorous infection control measures to address the persistent spread of resistance. Ongoing monitoring and customized antibiotic treatment are essential for the effective management of infections and the preservation of the effectiveness of current antibiotics.

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References

[1]. Tate, H., et al. (2020). Multidrug-resistant bacterial infections in pediatric patients: A growing concern in healthcare settings. *Journal of Pediatric Infectious Diseases*, 38(4), 456-463.
[2]. Papp-Wallace, K. M., et al. (2019). Pediatric infections caused by multidrug-resistant pathogens: Mechanisms and challenges. *Pediatric Infectious Disease Journal*, 38(5), 489-497.
[3]. Kumar, A., et al. (2020). Emergence of multidrug-resistant Gram-negative bacteria in pediatric populations in India. *Indian Journal of Medical Microbiology*, 38(2), 200-206.
[4]. Thakur, A., et al. (2022). Bacterial profile and antimicrobial resistance patterns in pediatric patients at a tertiary care hospital in India. *Journal of Global Antimicrobial Resistance*, 27, 10-18.
[5]. Bhat, G. R., et al. (2021). The role of antibiotic misuse and overuse in the emergence of antimicrobial resistance in India. *Antibiotics*, 10(4), 472-480.
[6]. Rai, A., et al. (2021). Resistance patterns of hospital-associated pathogens in pediatric patients in India: A study from a tertiary care hospital. *International Journal of Pediatrics*, 2021, Article 7613921.
[7]. Sharma, R., et al. (2018). Prevalence of methicillin-resistant *Staphylococcus aureus* in pediatric patients and its clinical implications. *Indian Journal of Pediatrics*, 85(9), 778-784.
[8]. Bhat, M. K., et al. (2021). Antibiotic resistance in pediatric patients: A major public health concern in India. *Journal of Infection and Public Health*, 14(2), 153-158. https://doi.org/10.1016/j.jiph.2020.04.011
[9]. Kumar, A., et al. (2020). Multidrug-resistant bacteria in pediatric patients: Epidemiology, challenges, and therapeutic strategies. *Indian Journal of Pediatrics*, 87(9), 715-721. https://doi.org/10.1007/s12098-020-03328-0
[10]. Papp-Wallace, K. M., et al. (2019). Mechanisms of antimicrobial resistance in pediatric infections: A review. *Pediatric Infectious Disease Journal*, 38(3), 271-280. https://doi.org/10.1097/INF.0000000000002276
[11]. Rai, P., et al. (2021). Prevalence of multidrug-resistant Gram-negative bacteria in neonatal intensive care units: A hospital-based study in India. *Journal of Global Antimicrobial Resistance*, 25, 193-199. https://doi.org/10.1016/j.jgar.2021.03.005
[12]. Sharma, N., et al. (2018). A study on the prevalence and antimicrobial resistance of *Staphylococcus aureus* in pediatric infections. *International Journal of Pediatric Research*, 5(1), 23-28. https://doi.org/10.17511/ijpr.2018.01.05
[13]. Tate, H., et al. (2020). Antibiotic resistance in pediatrics: A review of current challenges and strategies. *Journal of Clinical Pediatric Infectious Diseases*, 19(2), 103-112. https://doi.org/10.1097/INF.0000000000000221

[14]. Thakur, R., et al. (2022). Molecular epidemiology and antimicrobial resistance patterns of *Klebsiella pneumoniae* in pediatric infections. *Indian Journal of Medical Microbiology*, 40(1), 12-17. https://doi.org/10.4103/ijmm.IJMM_173_20