

Strengthening antibiotic sensitivity patterns of *Klebsiella pneumoniae* isolated from urine samples: impact of an antimicrobial stewardship program in a tertiary care hospital in central India

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Background: Gram-negative pathogens, notably *Klebsiella pneumoniae*, pose a global challenge due to their propensity for multidrug resistance, particularly in nosocomial infections like urinary tract infections (UTIs). Antimicrobial stewardship programs (ASPs) have been instituted to address the rampant misuse of antibiotics, aiming to foster judicious prescribing practices. This study evaluates the impact of an ASP on antibiotic sensitivity patterns of *K. pneumoniae* in a tertiary care hospital in Central India.

Methods: Urine samples positive for *K. pneumoniae* collected during 2023 and 2024 were subjected to antimicrobial susceptibility testing.

Results: Results demonstrate significant improvements in sensitivity patterns, notably in carbapenems and chloramphenicol. These findings underscore the effectiveness of ASPs in guiding antibiotic prescribing practices, attributed to enhanced acceptance among healthcare professionals.

Conclusion: Sustained initiatives to encourage responsible antibiotic utilization and garner support from healthcare professionals remain crucial in effectively tackling antibiotic resistance. Additionally, further research is needed to assess the long-term viability and scalability of such interventions.

Keywords: antibiotics, gram negative bacilli, urine

Introduction

Gram-negative pathogens pose a significant threat in both community and hospital settings worldwide. Among them, *Klebsiella pneumoniae* stands out as a prevalent cause of infections, especially concerning the emergence of multidrug-resistant strains implicated in nosocomial diseases. Notably, *Klebsiella pneumoniae* frequently contributes to urinary tract infections (UTIs) and belongs to the Gram-negative, non-motile, encapsulated, lactose-fermenting, facultative anaerobic bacteria of the Enterobacteriaceae family, as highlighted by Chaudhary et al (2014). Currently, drug resistance to human pathogenic bacteria is frequently being reported worldwide. However, the situation is alarming in both developing as well as developed countries due to the injudicious use of antibiotics despite pharmaceutical industries producing a large number of newer antibiotics in the last three decades, as noted by Shilpa et al., (2016) and Kumar (2013). Antimicrobial misuse is indeed a global concern, as emphasized by Aiesh et al. (2023), with antimicrobial resistance presenting a formidable challenge in healthcare. Reports suggest that a substantial portion, up to 30–50%, of antimicrobial prescriptions in hospitals are considered unnecessary or inappropriate. To address this issue, antibiotic

stewardship programs (ASPs) have been implemented, aiming to manage antimicrobial use judiciously in clinical settings. These programs are instrumental in combating antibiotic resistance by promoting prudent antibiotic use and reducing unnecessary prescriptions. This study examines the impact of such a program on the antibiotic sensitivity patterns of *K. pneumoniae* within a tertiary care hospital setting.

Materials and Methods

Urine samples containing *Klebsiella pneumoniae* were obtained from patients receiving care at a tertiary hospital in Central India across the span of 2023 and 2024. The study encompassed 68 isolates from 2023 and 79 isolates from 2024 to compare their sensitivity profiles. Antimicrobial susceptibility testing was carried out utilizing two methodologies: the Vitek 2 compact automated ID and AST machine by Biomerieux, and the Kirby-Bauer disc diffusion method adhering to CLSI guidelines. Various antibiotics were assessed for their efficacy, including amikacin, gentamicin, levofloxacin, cefotaxime, ceftriaxone, ceftiofloxacin, meropenem, ertapenem, and chloramphenicol, via the Vitek 2 compact system. Additionally, the combination of ceftriaxone-sulbactam-EDTA was analyzed using the Kirby-Bauer disc diffusion method. The Kirby-Bauer disc diffusion technique evaluates bacterial response to antimicrobial substances. Initially, a standardized bacterial suspension is distributed on agar plates, onto which antibiotic-laden paper discs are deposited. After incubation, zones of inhibition surrounding the discs reveal bacterial susceptibility. These zones' diameters are cross-referenced with predefined standards to determine sensitivity. This approach furnishes swift and economic data for directing antibiotic treatment strategies in clinical microbiology. Percentage sensitivity calculations were performed for each antibiotic across both years, providing insights into potential shifts in susceptibility patterns over time. This approach aimed to comprehensively evaluate the antimicrobial sensitivity of *Klebsiella pneumoniae* strains within the hospital, facilitating informed treatment decisions and the formulation of effective antimicrobial management strategies.

Results

A total 68 isolates from the year 2023 and 79 isolates from year 2024 were included in the study for the comparison of the sensitivity pattern. Comparative analysis of antibiotic sensitivity patterns between 2023 and 2024 revealed significant improvements (Table 1, Figure 1), indicative of the impact of the antimicrobial stewardship program and changing acceptance behavior among healthcare professionals. Special mention point is that there is a significant improvement noted in the sensitivity pattern of Carbapenems group of antibiotics like Meropenem and Ertapenem.

Antibiotic	2023 (%)	2024 (%)
AMIKACIN	31	49
GENTAMYCIN	19	45
LEVOFLOXACIN	13	26
CEFOTAXIME	6	16
CEFTRIAZONE	13	16
CEFFOXITIN	6	33
MEROPENEM	19	38
ERTAPENEM	19	37
CHLORAMPHENICOL	6	52
Ceftriaxone+ Salbactum+EDTA	88	97

Table1. Comparison of sensitivity pattern of *Klebsiella pneumoniae* between 2023 and 2024.

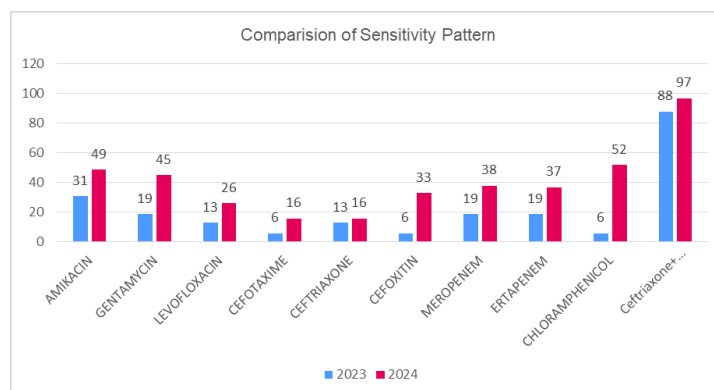


Figure 1. Comparison of sensitivity pattern of *Klebsiella pneumoniae* between 2023 and 2024.

Discussion

The effectiveness of the antimicrobial stewardship program in guiding antibiotic prescription practices is underscored by the observed enhancements in antibiotic sensitivity patterns. Shilpa et al., (2016) and Kumar (2013) have highlighted the significant impact of high antibiotic resistance in *K. pneumoniae* on prolonged infections, increased hospitalization, elevated therapy costs, and heightened morbidity and mortality rates. Moreover, as noted by Aiesh et al. (2023), antimicrobial misuse remains a global concern, exacerbating antimicrobial resistance challenges within healthcare systems. Studies indicate that a substantial proportion, ranging from 30% to 50%, of antimicrobial prescriptions in hospital settings are considered unnecessary or inappropriate. According to Nathwani et al. (2019), who studied multiple publications, half the studies demonstrated a decrease in resistance for at least one microbial strain against an antimicrobial agents used after successful implementation of antimicrobial stewardship program at their hospital. The program's effectiveness is attributed to enhanced acceptance among healthcare professionals, which fosters adherence to guidelines and advocates for judicious antibiotic usage. Particularly notable is the marked increase in chloramphenicol sensitivity, underscoring how optimized prescribing practices facilitate the combat against multidrug-resistant infections.

Conclusion

This study emphasizes the significance of antimicrobial stewardship programs in enhancing antibiotic sensitivity patterns of *Klebsiella pneumoniae* within a tertiary care hospital in Central India. Sustained initiatives to encourage responsible antibiotic utilization and garner support from healthcare professionals remain crucial in effectively tackling antibiotic resistance. Additionally, further research is needed to assess the long-term viability and scalability of such interventions.

Author contributions

Kamlesh Patel was involved in study design and development of research articles including data collection. Sandeep Shrivastava, Sanjay Geed, Mallika Kawatra helped in writing the entire manuscript including data analysis and interpretation.

Purnima Manikpuri and Sandeep Nayak helped in data collection.

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Conflict of interest

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Ethics approval

Not applicable

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