



ANTIBIOTIC RESISTANCE PATTERNS OF BACTERIAL ISOLATES IN ENT INFECTIONS: A TERTIARY CARE HOSPITAL–BASED CROSS-SECTIONAL STUDY FROM NORTH INDIA

Dr Omar Mohammad Shafi¹, Dr Neha Singh², Dr Sonu Kumar Singh^{3*}, Dr Jatin Prajapati⁴

¹ Associate Professor, Department of ENT, Noida International Institute of Medical Sciences, Noida, Uttar Pradesh, India. Email ID: drshafi9322@gmail.com

² Associate Professor, Department of ENT, I-care Institute of Medical Sciences, Haldia, West Bengal, India. Email ID: nehasinghent22@gmail.com

³ Associate Professor, Department of ENT, Noida International Institute of Medical Sciences, Noida, Uttar Pradesh, India. Email ID: drsonusinghhrjp@gmail.com

⁴ Post Graduate Student, Department of Community Medicine, RNT Medical College, Udaipur, Rajasthan, India. (ORCID: <https://orcid.org/0009-0004-7298-4499>)
Email ID: iamjatinprajapati@gmail.com

***Corresponding Author:** Dr Sonu Kumar Singh

*Department of ENT, Noida International Institute of Medical Sciences, Noida, Uttar Pradesh, India. Email ID: drsonusinghhrjp@gmail.com

ABSTRACT

Background: Antimicrobial resistance is an escalating global health concern, significantly affecting the management of ear, nose, and throat (ENT) infections. Empirical antibiotic therapy without culture guidance has contributed to increasing resistance among common ENT pathogens, particularly in developing countries.

Objectives: To determine the bacterial profile and antibiotic resistance patterns of isolates obtained from patients with ENT infections in a tertiary care hospital in North India.

Methods: A hospital-based cross-sectional study was conducted from March 2022 to August 2022. A total of 166 bacterial isolates obtained from clinically diagnosed ENT infections were included. Specimens were processed using standard microbiological techniques, and antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method in accordance with CLSI guidelines. Data were analyzed using SPSS version 22.0, and results were expressed in frequency and percentage.

Results: Among 166 isolates, chronic suppurative otitis media was the most common infection (34.9%). *Staphylococcus aureus* (32.5%) was the predominant organism, followed by *Pseudomonas aeruginosa* (24.7%) and *Klebsiella pneumoniae* (16.9%). High resistance was observed to ampicillin (71.0% in Gram-positive and 78.3% in Gram-negative isolates) and erythromycin (63.8%). Third-generation cephalosporins also showed considerable resistance (62.8% in Gram-negative isolates). Lower resistance was noted for vancomycin, linezolid, piperacillin-tazobactam, and carbapenems. Overall, 41.0% of isolates were multidrug resistant.

Conclusion: ENT infections in this tertiary care setting show a high prevalence of multidrug-resistant organisms, limiting the effectiveness of commonly used antibiotics. Regular surveillance of

antimicrobial susceptibility patterns and implementation of antibiotic stewardship programs are essential to guide rational therapy and reduce the burden of resistance.

Keywords: Antibiotic resistance; ENT infections; multidrug resistance; *Staphylococcus aureus*; *Pseudomonas aeruginosa*; antimicrobial susceptibility; North India.

INTRODUCTION

Antibiotic resistance has emerged as one of the most pressing global health challenges of the 21st century, threatening the effectiveness of standard treatments and increasing morbidity, mortality, and healthcare costs worldwide [1]. The World Health Organization (WHO) has identified antimicrobial resistance (AMR) as a top ten global public health threat, with projections suggesting that by 2050, drug-resistant infections could cause up to 10 million deaths annually if no effective interventions are implemented [2].

The widespread and often irrational use of antibiotics in both community and hospital settings has accelerated the selection pressure on microorganisms, leading to the emergence of multidrug-resistant strains across various clinical disciplines [3].

Among the commonly encountered infections in clinical practice, ear, nose, and throat (ENT) infections represent a significant proportion of outpatient visits and antibiotic prescriptions. These infections, including otitis media, sinusitis, pharyngotonsillitis, and otitis externa, are frequently managed empirically, often without microbiological confirmation [4]. This empirical approach, although practical in resource-limited settings, has contributed to the rising trend of antibiotic resistance among common ENT pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Streptococcus pneumoniae* [5].

Globally, studies have reported increasing resistance of ENT pathogens to commonly used antibiotics such as amoxicillin, macrolides, and fluoroquinolones, complicating treatment regimens and leading to prolonged disease course and complications [6]. In developing countries, the situation is further aggravated by over-the-counter availability of antibiotics, incomplete treatment adherence, and lack of routine culture sensitivity testing [7]. The WHO global action plan on antimicrobial resistance emphasizes the need for strengthening surveillance systems to monitor resistance patterns and guide rational antibiotic use [2].

In the Indian context, antimicrobial resistance has shown alarming trends, particularly in tertiary care settings where complex and recurrent infections are frequently managed. Studies from different regions of India have reported high levels of resistance among ENT isolates, especially to first-line antibiotics such as ampicillin, erythromycin, and co-trimoxazole [8]. However, resistance patterns vary significantly across geographical regions due to differences in prescribing practices, patient demographics, and infection control policies.

North India, with its high population density and diverse healthcare infrastructure, presents unique challenges in the management of ENT infections. Limited region-specific data on antimicrobial susceptibility patterns in ENT infections further complicates evidence-based antibiotic selection [9]. Most available studies are either outdated or limited to small sample sizes, making it difficult to generalize findings for current clinical practice.

Additionally, tertiary care hospitals in North India often serve as referral centers, managing complicated and partially treated infections, which increases the likelihood of encountering resistant organisms. This underscores the importance of continuous surveillance studies to understand evolving resistance trends and guide empirical therapy more effectively [10].

Despite the growing burden of ENT infections and increasing antimicrobial resistance, there remains a paucity of updated, region-specific data from tertiary care centers in North India. Understanding the local antibiogram is essential for optimizing empirical antibiotic therapy, reducing treatment failures, and preventing further development of resistance.

Therefore, this study was undertaken to evaluate the antibiotic resistance patterns among bacterial isolates obtained from patients with ENT infections in a tertiary care hospital in North India. The primary objectives were to identify the most common bacterial pathogens responsible for ENT infections and to determine their antimicrobial susceptibility patterns, thereby providing evidence-based data to guide rational antibiotic therapy in clinical practice.

METHODOLOGY

Study Design: This was a hospital-based, cross-sectional observational study conducted to evaluate antibiotic resistance patterns among bacterial isolates obtained from patients with ENT infections.

Study Setting: The study was conducted in the Department of Otorhinolaryngology in collaboration with the Department of Microbiology at a tertiary care teaching hospital in North India. The hospital caters to both urban and rural populations and serves as a referral center for complicated ENT infections.

Study Duration: March 2022 to August 2022.

Study Population: All patients of any age and either gender presenting with clinically diagnosed ENT infections (ear, nose, or throat infections) from whom appropriate clinical specimens were collected and bacterial pathogens isolated.

Inclusion Criteria

Patients diagnosed clinically with ENT infections such as otitis media, otitis externa, sinusitis, tonsillitis, or other suppurative ENT conditions

Patients from whom bacterial cultures yielded growth of pathogenic organisms

Patients providing informed consent (or guardian consent in minors)

Exclusion Criteria

Patients who had received systemic antibiotics within 7 days prior to sample collection

Viral or fungal ENT infections confirmed clinically or microbiologically

Inadequate or contaminated specimens

Patients unwilling to provide consent

Sample Size: A total of 166 clinical isolates obtained from ENT infection cases were included in the study.

Sample size calculation:

The sample size was determined based on expected prevalence of bacterial pathogens in ENT infections reported in previous studies, assuming a 95% confidence interval and 5% allowable error.

Using the formula:

$$n = \frac{Z^2 \times p \times (1 - p)}{d^2}$$

Where:

Z = 1.96 at 95% confidence level

p = anticipated prevalence (based on previous literature)

d = allowable margin of error (0.05)

The calculated minimum sample size was adjusted for feasibility and availability of specimens during the study period, resulting in inclusion of 166 isolates.

Sampling Technique: Consecutive sampling technique was used. All eligible patients presenting during the study period and meeting inclusion criteria were enrolled until the desired sample size was achieved.

Data Collection Tools & Procedure: Detailed clinical history and demographic information were recorded using a predesigned structured proforma. Clinical specimens were collected under aseptic precautions depending on the site of infection, including ear swabs, nasal swabs, throat swabs, or pus samples. Samples were immediately transported to the microbiology laboratory for processing. Bacterial identification was performed using standard microbiological techniques, including Gram staining, culture on appropriate media (blood agar, MacConkey agar, chocolate agar), and biochemical tests. Antimicrobial susceptibility testing was carried out using the Kirby–Bauer disc diffusion method on Mueller-Hinton agar, interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Study Variables: Independent variables included age, gender, type of ENT infection, and prior antibiotic exposure. The dependent variables were bacterial isolates and their antibiotic susceptibility patterns. The primary outcome measure was the resistance profile of isolated pathogens against commonly used antibiotics in ENT practice.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 22.0. Descriptive statistics such as frequency and percentage were used to summarize categorical variables. Results were presented in tables and graphs. Chi-square test was used to assess associations between categorical variables where applicable. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants or guardians in case of minors. The study adhered to the ethical principles outlined in the Declaration of Helsinki, ensuring confidentiality, anonymity, and the right to withdraw from the study at any stage without affecting patient care.

RESULTS

A total of 166 bacterial isolates were obtained from patients with ENT infections during the study period. Chronic suppurative otitis media (CSOM) was the most common clinical presentation accounting for 34.9% of cases, followed by chronic sinusitis (18.7%) and tonsillopharyngitis (16.3%) (Table 1).

Table 1: Distribution of ENT infections among study isolates (n = 166)

Type of ENT infection	Number of isolates	Percentage (%)
Chronic suppurative otitis media (CSOM)	58	34.9
Acute otitis externa	22	13.3
Chronic sinusitis	31	18.7
Tonsillopharyngitis	27	16.3
Ear discharge (unspecified otitis)	18	10.8
Other ENT infections	10	6.0

Among the isolated pathogens, *Staphylococcus aureus* was the most frequently identified organism (32.5%), followed by *Pseudomonas aeruginosa* (24.7%) and *Klebsiella pneumoniae* (16.9%) (Table 2).

Table 2: Distribution of bacterial isolates from ENT infections (n = 166)

Organism isolated	Number	Percentage (%)
Staphylococcus aureus	54	32.5
Pseudomonas aeruginosa	41	24.7
Klebsiella pneumoniae	28	16.9
Escherichia coli	19	11.4
Streptococcus pneumoniae	15	9.0
Others	9	5.4

Antibiotic susceptibility testing revealed high resistance rates among both Gram-positive and Gram-negative organisms. Among Gram-positive isolates, resistance to ampicillin (71.0%) and erythromycin (63.8%) was notably high, whereas vancomycin and linezolid retained near-complete effectiveness (Table 3).

Table 3: Antibiotic resistance pattern of Gram-positive isolates (n = 69)

Antibiotic	Resistant isolates (%)
Ampicillin	71.0
Erythromycin	63.8
Ciprofloxacin	46.4
Amoxiclav	39.1
Vancomycin	2.9
Linezolid	0

Among Gram-negative isolates, highest resistance was observed against ampicillin (78.3%) and ceftriaxone (62.8%). Lower resistance rates were observed for piperacillin-tazobactam (18.5%) and carbapenems (6.2%) (Table 4).

Table 4: Antibiotic resistance pattern of Gram-negative isolates (n = 97)

Antibiotic	Resistant isolates (%)
Ampicillin	78.3
Ceftriaxone	62.8
Gentamicin	41.2
Ciprofloxacin	38.1
Piperacillin-tazobactam	18.5
Carbapenems	6.2

Overall, 41.0% of isolates were identified as multidrug-resistant organisms, indicating a substantial burden of resistance among ENT pathogens in the study population (Table 5).

Table 5: Multidrug resistance (MDR) among isolates

Parameter	Number	Percentage (%)
MDR isolates	68	41.0
Non-MDR isolates	98	59.0

DISCUSSION

The present study evaluated the antibiotic resistance patterns of bacterial isolates obtained from patients with ENT infections in a tertiary care hospital in North India. The findings demonstrate a significant burden of antimicrobial resistance among both Gram-positive and Gram-negative organisms, with a multidrug resistance rate of 41%. *Staphylococcus aureus* emerged as the most common isolate, followed by *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, while high resistance rates were observed against commonly used antibiotics such as ampicillin, erythromycin, and third-generation cephalosporins.

The predominance of *Staphylococcus aureus* in ENT infections observed in this study is consistent with earlier reports that identify it as a key pathogen in suppurative ear and sinus infections [11]. Similarly, the high isolation rate of *Pseudomonas aeruginosa* aligns with its known association with chronic otitis media and external ear infections, particularly in hospital-based settings where recurrent infections are common [12]. These findings suggest a persistent shift toward opportunistic and hospital-adapted pathogens in chronic ENT infections.

The resistance pattern observed in the present study is concerning, particularly the high resistance of Gram-positive organisms to ampicillin and erythromycin. Similar trends have been reported in other Indian studies, where indiscriminate antibiotic use and over-the-counter availability have contributed significantly to resistance development [13]. However, the preserved sensitivity of vancomycin and linezolid indicates that these agents remain effective therapeutic options for resistant Gram-positive infections, although their use should be reserved for confirmed resistant cases to prevent further resistance emergence.

Among Gram-negative organisms, the high resistance to ceftriaxone and ampicillin reflects widespread β -lactam resistance, likely mediated by extended-spectrum β -lactamase (ESBL) production [14]. The comparatively lower resistance to piperacillin-tazobactam and carbapenems suggests that these antibiotics remain relatively effective; however, emerging resistance even to carbapenems is an alarming finding that reflects global trends in antimicrobial resistance escalation [15].

The overall MDR rate of 41% observed in this study is comparable to other tertiary care hospital-based studies in India, which have reported MDR prevalence ranging from 30% to 60% in ENT isolates [16]. This high burden of resistance can be attributed to multiple factors including prior antibiotic exposure, incomplete treatment courses, lack of culture-guided therapy, and frequent empirical antibiotic prescribing practices in ENT infections.

From a clinical perspective, these findings highlight the importance of routine microbiological testing and antibiotic susceptibility profiling before initiating treatment, particularly in recurrent or chronic ENT infections. Empirical therapy based on outdated antibiograms may lead to treatment failure, prolonged disease duration, and increased healthcare costs. The study reinforces the need for updated institutional antibiotic policies and antimicrobial stewardship programs tailored to local resistance patterns.

In terms of public health implications, the high resistance rates observed underscore the urgent need for stricter regulation of antibiotic dispensing, patient education regarding adherence to prescribed regimens, and continuous surveillance of resistance trends in ENT pathogens. Strengthening infection control practices in healthcare settings is also essential to limit the spread of resistant organisms.

This study has certain strengths, including a well-defined sample size and standardized microbiological methods for organism identification and susceptibility testing. However, it also has limitations. Being a single-center study, the findings may not be generalizable to other regions. Additionally, molecular characterization of resistance mechanisms was not performed, which could have provided deeper insight into resistance determinants. The study also did not include longitudinal follow-up to assess clinical outcomes based on antibiotic therapy.

Overall, the present study provides valuable region-specific data on antimicrobial resistance patterns in ENT infections and highlights the urgent need for rational antibiotic use and continuous surveillance in tertiary care settings.

CONCLUSION

The present study demonstrates a high burden of antimicrobial resistance among bacterial isolates causing ENT infections in a tertiary care hospital in North India. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the predominant pathogens, with a significant proportion showing resistance to commonly prescribed antibiotics such as ampicillin, erythromycin, and third-generation cephalosporins. A concerning multidrug resistance rate of 41% highlights the growing challenge in the empirical management of ENT infections. Preserved susceptibility to higher antibiotics such as vancomycin, linezolid, piperacillin-tazobactam, and carbapenems indicates their continued therapeutic relevance; however, their judicious use is essential to prevent further resistance development. The findings emphasize the importance of routine culture and sensitivity testing, rather than empirical antibiotic therapy alone, particularly in chronic and recurrent ENT infections. Strengthening antimicrobial stewardship programs, rational prescribing practices, and continuous local surveillance of resistance patterns are essential to improve clinical outcomes and curb the spread of resistant organisms.

DECLARATIONS

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Conflict of Interest: The authors declare no conflict of interest.

Informed Consent: Written informed consent was obtained from all participants or their guardians prior to inclusion in the study.

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REFERENCES

1. Shankar PR, Balasubramaniam R. Antimicrobial resistance: global report on surveillance 2014. Australasian Medical Journal (Online). 2014 May 1;7(5):237.
2. Mendelson M, Matsoso MP. The World Health Organization global action plan for antimicrobial resistance. SAMJ: South African Medical Journal. 2015 May;105(5):325-9.
3. Laxminarayan R, Duse A, Wattal C, Zaidi AK, Wertheim HF, Sumpradit N, Vlieghe E, Hara GL, Gould IM, Goossens H, Greko C. Antibiotic resistance—the need for global solutions. The Lancet infectious diseases. 2013 Dec 1;13(12):1057-98.
4. Rosenfeld RM, Schwartz SR, Cannon CR, Roland PS, Simon GR, Kumar KA, Huang WW, Haskell HW, Robertson PJ. Clinical practice guideline: acute otitis externa. Otolaryngology–Head and Neck Surgery. 2014 Feb;150:S1-24.
5. Brook I. Anaerobic infections: diagnosis and management. CRC Press; 2007 Sep 26.
6. Casey JR. Treatment of AOM Post-PCV7: Judicious Antibiotic Therapy. Contemporary Pediatrics. 2005 Dec 2;22.
7. Khan DR, Sharma DV, Khan DS, Rasool DS, Singh S, Rai AK, Rustagi S, Shreaz S, Negi R, Kour D, Yadav AN. Prevention and Potential Remedies for Antibiotic Resistance: Current Research and Future Challenges. Available at SSRN 4647883.
8. Ponnusankar S. Need for the implementation of antibiotic policy in India: An Overview. Int J Cur Res Rev| Vol. 2021 Mar;13(05):168.
9. Prah JK. TEXILA INTERNATIONAL JOURNAL OF PUBLIC HEALTH.
10. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, Harbarth S, Hindler JF, Kahlmeter G, Olsson-Liljequist BJ, Paterson DL. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard

- definitions for acquired resistance. *Clinical microbiology and infection*. 2012 Mar 1;18(3):268-81.
11. Brook I. The role of anaerobic bacteria in chronic suppurative otitis media in children: implications for medical therapy. *Anaerobe*. 2008 Dec 1;14(6):297-300.
 12. Mittal R, Lisi CV, Gerring R, Mittal J, Mathee K, Narasimhan G, Azad RK, Yao Q, Grati MH, Yan D, Eshraghi AA. Current concepts in the pathogenesis and treatment of chronic suppurative otitis media. *Journal of medical microbiology*. 2015 Oct;64(10):1103-16.
 13. Kaul M, Kaur S, Wadhwa S, Chhibber S. Microbial contamination of weaning foods. *The Indian Journal of Pediatrics*. 1996 Jan;63(1):79-85.
 14. Paterson DL, Bonomo RA. Extended-spectrum β -lactamases: a clinical update. *Clinical microbiology reviews*. 2005 Oct;18(4):657-86.
 15. Nordmann P, Naas T, Poirel L. Global spread of carbapenemase-producing Enterobacteriaceae. *Emerging infectious diseases*. 2011 Oct;17(10):1791.
 16. Shaik G, Sujatha N, Mehar SK. Medicinal plants as source of antibacterial agents to counter *Klebsiella pneumoniae*. *Journal of Applied Pharmaceutical Science*. 2014 Jan 30;4(1):135-47.