International Journal of Otorhinolaryngology and Head and Neck Surgery
Selvi I et al. Int J Otorhinolaryngol Head Neck Surg. 2025 Dec;11(6):685-690
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20253804

Original Research Article

Antibacterial susceptibility profiling of otitis media isolates: a tertiary care centre based retrospective study

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Received: 30 July 2025
Revised: 13 September 2025
Accepted: 20 September 2025

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ABSTRACT

Background: Otitis media is an inflammation of the middle ear, posing a significant public health burden across all age groups. Timely identification of causative organisms and their antibiotic susceptibility is essential for effective treatment and for curbing antibiotic resistance.
Objectives: To determine the bacterial profile and antibacterial susceptibility patterns of isolates from otitis media cases in a tertiary care centre.
Methods: A retrospective study was conducted on 576 ear discharge samples from clinically diagnosed otitis media cases between January and December 2024. Standard microbiological techniques were employed for culture and identification. Antibacterial susceptibility testing was performed using the Kirby-Bauer disc diffusion method in accordance with CLSI guidelines.
Results: Of the 576 samples, 385 (66.8%) showed microbial growth, with bacterial isolates identified in 349 (90.6%) samples. *Pseudomonas aeruginosa* was the predominant organism (50.5%), followed by *Staphylococcus aureus* (30.4%) and *Enterobacterales* (15%). The isolates showed varied susceptibility to commonly used antibiotics, with notable resistance to Ciprofloxacin, Amoxicillin-clavulanic acid, and Aminoglycosides.
Conclusion: The findings emphasize seasonal variations and evolving trends in the bacterial aetiology of otitis media and the importance of continuous surveillance of antibacterial susceptibility patterns. These data are essential for guiding and formulating effective antimicrobial stewardship strategies in clinical practice.

Keywords: Otitis media, Bacteria, Isolates, Antibacterial susceptibility

INTRODUCTION

Otitis media is an inflammation of the middle ear that affects both adults and children, and is a leading cause of hearing loss, particularly in developing countries.[1,2] Hearing impairment in children can significantly hinder speech development, contribute to cognitive delays, and can adversely affect academic performance.[3] The World Health Organization estimates that around 430 million people worldwide currently suffer from hearing loss due to ear infections. By 2050, this number is projected to rise to nearly 2.5 billion, with over 700 million requiring rehabilitation.[4] A systematic review by Bhatia et al focusing on individuals under 18 years of age, reported a prevalence of otitis media ranging from 4.5% to 25.7%.[5] The human ear is anatomically divided into three parts: the outer, middle, and inner ear. Infections affecting these regions are termed otitis externa, otitis media, and otitis interna, respectively, as described in Harrison's Principles of Internal Medicine. Among these, otitis media an infection of the middle ear is the most prevalent.[6] The middle ear is an air-filled cavity located between the tympanic membrane (eardrum) and the inner ear. Its main role is to amplify sound vibrations from the eardrum and transmit them to the inner ear. It communicates with the nasopharynx through the eustachian tube (ET), which helps maintain pressure balance and facilitates drainage. Obstruction of the ET by fluid or mucus, commonly due to upper respiratory tract infections, can predispose individuals to infection. Other contributing factors include atopy, exposure to tobacco smoke, and a family history of acute otitis media (AOM).[7] Ear infections can be broadly classified as suppurative and non-suppurative. Suppurative infections are further divided based on duration into acute suppurative otitis media (ASOM) and chronic suppurative otitis media (CSOM), while non-suppurative infections are referred to as otitis media with effusion (OME).[2] The etiological spectrum of otitis media includes bacteria, viruses, and fungi, with bacteria being the predominant cause. Among bacterial pathogens, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and members of the *Enterobacterales* order such as *Escherichia coli*, *Klebsiella spp* and *Proteus spp* are most commonly implicated.[8-10]

Ear infections are commonly managed empirically. Beta-lactam antibiotics, either alone or in combination with beta-lactamase inhibitors, and Fluoroquinolones are frequently prescribed for the treatment of otitis media. However, the extensive and often inappropriate use of antibiotics has facilitated the emergence and proliferation of antibiotic-resistant bacteria. Therefore, current knowledge of the antibacterial susceptibility patterns of bacterial isolates causing otitis media is essential to guide the rational and effective use of antibiotics in clinical practice.

METHODS

A retrospective cross-sectional study was carried out based on the review of records from 576 ear swab samples collected from discharging ears, submitted for microbial identification, culture, and susceptibility testing. The study included samples processed in the Department of Microbiology, SUTAMS, during the period from January to December 2024. Demographic and clinical details available in the records were retrieved for analysis. All ear pus samples collected as double swabs were included, while single swab samples were excluded. One swab from each pair was used for direct microscopic examination, and the other was inoculated onto culture plates-blood agar, chocolate agar, and MacConkey agar, followed by incubation at 37°C for 24–48 hours. Bacterial isolates were identified using standard microbiological methods.[11]

Antibacterial susceptibility testing

The test was performed on Mueller–Hinton agar using the Kirby–Bauer disk diffusion method. The antimicrobial agents tested included: Penicillin (10 IU), Ampicillin (10 µg), Amikacin (30 µg), Gentamicin (10 µg), Ciprofloxacin (5 µg), Cotrimoxazole (25 µg), Tetracycline (30 µg), Erythromycin (15 µg), Clindamycin (30 µg), Cefazolin (30 µg), Cefoxitin (30 µg), Ceftriaxone (30 µg), Ceftazidime (30 µg), Cefepime (30 µg), Amoxicillin/clavulanic acid (20/10 µg), Cefoperazone/sulbactam (75/10 µg), Piperacillin/tazobactam (100/10 µg), Linezolid (30 µg), Vancomycin (30 µg), Imipenem (10 µg), and Meropenem (10 µg) (Oxoid, England). The results were interpreted in accordance with the clinical and laboratory standards Institute (CLSI) performance standards, M100, 33rd edition, 2023.[12]

RESULTS

A total of 576 ear swab samples from clinically suspected otitis media cases were analyzed. The highest number of cases occurred in July, suggesting a seasonal trend in incidence. Of the 576 ear swab samples, 244 (42.4%) were from male patients and 332 (57.6%) from female patients, with a mean age of 42 years. Microbial growth was observed in 385 samples (66.8%), while 191 samples (33.2%) showed no growth, as illustrated in the accompanying pie chart. The proportion of positive cultures was 170 (69.7%) in males and 215 (64.7%) in females (p=0.216). Across age groups, microbial isolates were most frequently detected in patients aged 41–60 years (70.3%) and 21–40 years (66.9%), as presented in Table 1. The associations between age, gender, and culture positivity were not statistically significant (p>0.05).

Table 1: Distribution of otitis media isolates in relation to age and sex.

Variable	Growth present (%)	Total (%)	P value
Sex			0.216
Male	170 (69.7)	244 (42.4)	
Female	215 (64.7)	332 (57.6)	
Age (in years)			
0-20	57 (59.4)	96 (16.7)	0.193
21-40	113 (66.9)	169 (29.3)	
41-60	142 (70.3)	202 (35.1)	
61-80	68 (65.8)	104 (18.1)	
>80	5 (100)	5 (0.8)	
Total	385 (66.8)	576 (100)	

Table 2: Bacterial profile of isolates from ear infection cases.

Organism	Frequency (N)	%
P. aeruginosa	181	46.5
S. aureus	109	27.8
Klebsiella spp.	29	0.5
E. coli	11	20.8
Enterobacter spp.	10	0.6
Enterococcus spp.	6	0.55
Acinetobacter spp.	6	0.55
Proteus spp.	4	0.0
Streptococcus pneumoniae	2	0.6
Total	358	0.1

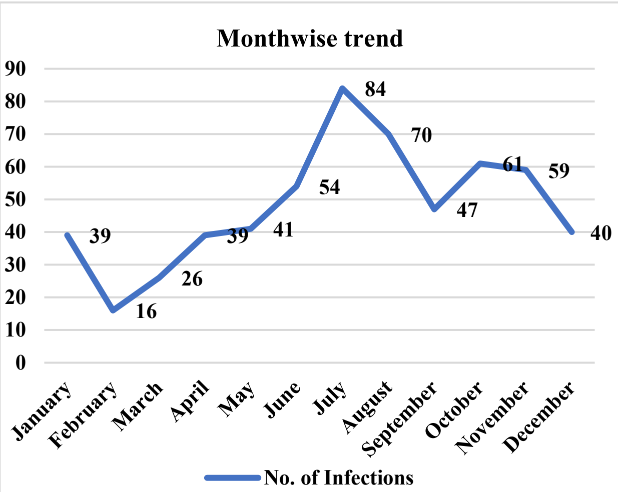

Figure 1: Line graph illustrates the seasonal variation.

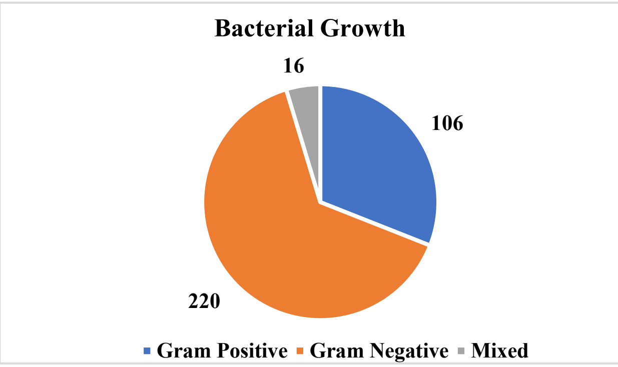

Figure 2: The proportional distribution of bacterial isolates identified from ear infection cases.

Of the 385 culture-positive isolates (including both bacterial and fungal), 349 (90.6%) were bacterial. Among these, 342 isolates (97.9%) showed significant growth, while 7 isolates had insignificant growth. Gram-negative organisms predominated (n=220) over Gram-positive organisms (n=106). Additionally, 16 isolates were identified as mixed organisms, each containing two distinct bacterial species. The most frequently isolated bacterium was *P. aeruginosa* (181; 50.5%), followed by *S. aureus* (109; 30.4%).

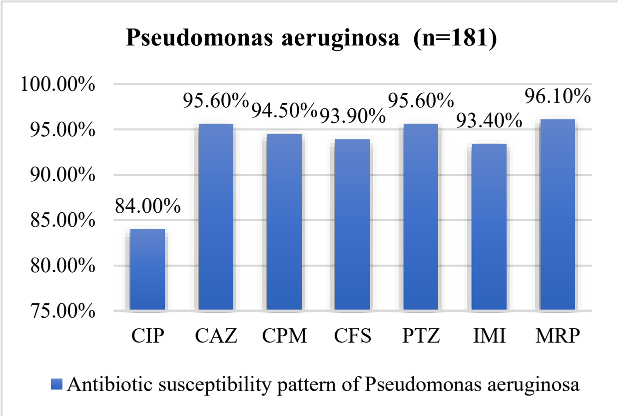

Figure 3: Antibiotic susceptibility pattern of P. aeruginosa.

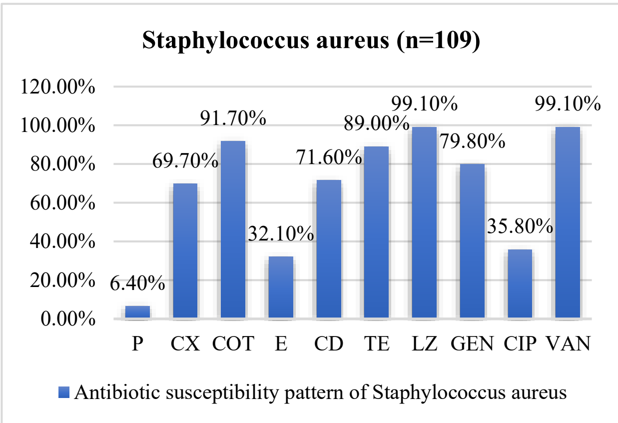

Figure 4: Antibiotic susceptibility pattern of *S. aureus*.

Members of the order *Enterobacterales* accounted for 54 isolates (15%), comprising *Klebsiella pneumoniae* (29/54; 53.7%), *E. coli* (11/54; 20.3%), *Enterobacter spp.* (10/54; 18.5%), and *Proteus spp.* (4/54; 7.4%). Other Gram-positive isolates included *Enterococcus spp.* and

Streptococcus pneumoniae. The overall bacteriological profile is summarized in Table 2.

The antibiotic susceptibility patterns of *P. aeruginosa*, *S. aureus*, and *Enterobacterales* are illustrated in Figures 3, 4, and 5, respectively. Among the 181 *P. aeruginosa* isolates, the highest susceptibility was observed to Meropenem (96.1%), followed by Piperacillin–tazobactam and Ceftazidime (95.6% each), while the lowest susceptibility was noted for Ciprofloxacin (84%). Of the *S. aureus* isolates, 30.5% were MRSA. The highest susceptibility was recorded for Cotrimoxazole (91.7%), followed by Tetracycline (89%) and Gentamicin (79.8%), with the lowest susceptibility observed for Erythromycin (32.1%).

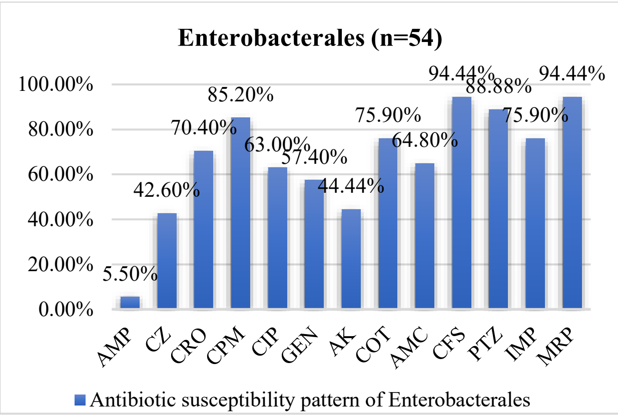

Figure 5: Antibiotic susceptibility pattern of Enterobacterales.

Within the *Enterobacterales* group, the highest susceptibility was observed for Meropenem and Cefoperazone–sulbactam (94.4%), followed by Piperacillin–tazobactam (88.8%) and Cefepime (85.1%). Susceptibility to aminoglycosides was comparatively lower (57.4%). Susceptibility data for *Acinetobacter*, *Enterobacter spp.* and *Streptococcus pneumoniae* are not shown.

DISCUSSION

Ear infections are a common health problem affecting both children and adults, with a higher prevalence in low- and middle-income countries. The severity of these infections, however, varies across geographical regions. Globally, approximately 5% of the population suffers from debilitating hearing loss, which significantly impairs quality of life.

Although otitis media is more frequently reported in children than in adults, the present study observed the highest incidence among patients aged 41–60 years, followed by those aged 21–40 years.[13] This finding contrasts with earlier studies by Danraka et al and Bello et al who reported the majority of cases in the 0–20 years age group, and Jabbo et al who found the peak incidence in the 1–10 years age group. The higher prevalence in middle-aged adults in the study may be explained by compromised immune status, co-existing health conditions such as respiratory infections or allergies, and climatic variations.[14-16]

Seasonal distribution of cases further revealed a peak incidence in July, which may be linked to prevailing weather conditions. Frequent respiratory infections, combined with heavy rainfall during this period, could have increased the risk of otitis media. The proportion of ear infections was higher in females than in males ($p=0.216$). This observation is consistent with the findings of Garg et al although several other studies reported a higher prevalence among males.[15-17,19] Interestingly, the study by Danraka et al and Bello et al demonstrated an almost equal distribution between the two genders.[14] In the present study, 90.6% of ear pus swab isolates yielded bacterial growth. Similar findings were reported by other authors, with isolation rates of 93.4%, 97.6% and 87.3%respectively.[9,18,20] These results support that ear infections are predominantly bacterial in origin. Both Gram-positive and Gram-negative organisms were implicated in middle ear infections. Monomicrobial growth accounted for 326 isolates (220 Gram-negative vs. 106 Gram-positive), while 16 isolates exhibited polymicrobial growth. Comparable findings of polymicrobial infections have been reported by Gaur et al, Agarwal et al and Danraka et al Bello et al.[10,14,21] In contrast, Kumar et al and Prakash et al documented exclusively monomicrobial growth.[8,17]

The present study on the microbiology of otitis media demonstrated that *P. aeruginosa* (181; 50.5%) was the most frequently isolated bacterium, followed by *S. aureus* (109; 30.4%). This finding is consistent with bacteriological investigations conducted in countries such as Malaysia, Nigeria, and Ethiopia as well as with several Indian studies.[8-10,14,18] However, a few studies have reported *S. aureus* as the predominant isolate.[13,20]

The higher incidence of *P. aeruginosa* observed in our study aligns with previous reports and may be attributed to its dual role as both a colonizer and an opportunistic pathogen. Its pathogenicity is supported by multiple virulence factors, including toxins, enzymes, and OprF-a major outer membrane porin that enhances intracellular survival within macrophages.[23] These mechanisms contribute to progressive damage of the middle ear and mastoid structures, thereby playing a major role in the pathogenesis of CSOM.[9]

Antibacterial susceptibility testing revealed that *P. aeruginosa* isolates were highly susceptible to Piperacillin–tazobactam (95.6%) and Ceftazidime (95.6%), findings that are consistent with those reported by Vaid et al.[24] The lowest susceptibility was observed with Ciprofloxacin (84%). Gaur et al[10] similarly reported high susceptibility to Piperacillin (94%), but comparatively lower rates for Ceftazidime (83%) and Ciprofloxacin (63%). Reduced susceptibility to

Fluoroquinolones, ranging between 77.3% and 86.2%, has also been documented by Jabbo et al.[15]

In the present study, 30.5% of *S. aureus* isolates were MRSA, with the majority being community-acquired. Higher proportions have been reported by Henok et al (38.4%) and Shangali et al (44.4%).[20,25] The increased incidence of MRSA may, in part, be related to the use of inanimate objects for earwax removal, which could be contaminated through environmental exposure. Erythromycin (32.1%) and Ciprofloxacin (35.8%) demonstrated the lowest susceptibility rates, findings that are consistent with those of Prakash et al.[8] Notably, quinolones exhibited reduced activity against both *P. aeruginosa* and *S. aureus*, in line with earlier CSOM studies by Gaur et al and Vaid et al.[24] A global decline in Fluoroquinolones susceptibility has been observed in recent decades, largely attributed to mutations in the gyrA gene encoding DNA gyrase, coupled with the widespread use of Fluoroquinolones particularly Ciprofloxacin-in both clinical practice and livestock production.[26]

Enterobacterales in this study demonstrated variable susceptibility profiles. The highest susceptibility was recorded with Cefoperazone/sulbactam (94.4%) and Meropenem (94.4%), followed by Imipenem (75.9%). In contrast, the lowest susceptibility was observed with Ciprofloxacin (63%) and Aminoglycosides (57.4%). These results diverge from earlier reports. For example, Iqbal et al reported 100% susceptibility to Meropenem, Ceftriaxone, Amikacin, and Cotrimoxazole, and 80% to Gentamicin and Ciprofloxacin.[27] Similarly, Kombade et al found 100% susceptibility to Imipenem, Piperacillin–tazobactam, and Aminoglycosides.[19] Conversely, Agarwal et al reported only 70–80% susceptibility to Cephalosporins and Aminoglycosides.[21] Such discrepancies may be explained by regional variations in antimicrobial resistance patterns, differences in prescribing practices, or variations in sample size and study design.

This study highlights the bacterial causative agents of otitis media and underscores the variability in antibiotic efficacy across cases. Such variation may be attributed to multiple factors, including injudicious antibiotic use particularly over-the-counter availability, inappropriate dosing, genetic mutations in bacteria, selective pressure within microbial ecosystems, and the circulation of resistant strains. Community education remains crucial, as many patients tend to discontinue antibiotics prematurely once symptomatic relief is achieved. This practice fosters the survival and proliferation of partially resistant organisms, thereby accelerating the development and spread of antimicrobial resistance.

Limitations

The study was limited by the lack of clinical details and prior antibiotic history in laboratory records. As it was conducted in a single tertiary care centre, the findings may not be generalizable to other populations.

CONCLUSION

In the current study, *P. aeruginosa* and *S. aureus* were identified as the predominant bacterial isolates associated with otitis media. A marked decline in susceptibility was noted against several commonly prescribed antibiotics, including Ciprofloxacin, Amoxicillin–clavulanic acid, and Aminoglycosides. Although empirical therapy remains a common practice in the management of ear infections, these findings highlight the importance of continuous surveillance of the local bacteriological profile and antimicrobial susceptibility trends. To address these challenges, the implementation of robust antibiotic stewardship policies is essential. Such measures will aid in minimizing complications, curbing the emergence of resistant strains, and strengthening diagnostic stewardship within clinical practice.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Selvi I, Murugesan K. Antibacterial susceptibility profiling of otitis media isolates: a tertiary care centre based retrospective study. Int J Otorhinolaryngol Head Neck Surg 2025;11:685-90.