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A Study On The Prevalence and Antibiotic Resistance Patterns of Pseudomonas Aeruginosa Isolates in Chronic Suppurative Otitis Media

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ABSTRACT

Introduction: CSOM is often associated with recurrent infections, leading to permanent damage to the ear structures. While the pathogenesis of CSOM is complex and multifactorial, bacterial infections play a major role, with Pseudomonas aeruginosa emerging as one of the most frequent pathogens responsible for this condition

Objective: This study aims to determine the prevalence of Pseudomonas aeruginosa isolates in patients with chronic suppurative otitis media (CSOM) and to evaluate the antibiotic resistance patterns of these isolates, with a specific focus on imipenem resistance.

Methods: A retrospective study was conducted on 60 patients diagnosed with CSOM at a tertiary care hospital. Ear swab samples were collected and cultured for bacterial isolation. The isolates were identified, and antibiotic susceptibility testing was performed using the disk diffusion method to assess resistance, especially to imipenem.

Results: Out of the 60 CSOM-positive cases, 44% were infected with Pseudomonas aeruginosa. The majority of isolates were Gram-negative bacteria (78%), with Pseudomonas aeruginosa being the most prevalent. Of the 26 Pseudomonas aeruginosa isolates, 42.3% showed resistance to imipenem. Other significant pathogens included Klebsiella spp. and Escherichia coli. Resistance to multiple antibiotics, including imipenem, was observed, underscoring the challenge of treating CSOM infections effectively.

Conclusion: Pseudomonas aeruginosa is a significant pathogen in CSOM, with a high rate of imipenem resistance. The study highlights the importance of regular bacterial cultures and antibiotic susceptibility testing for the proper management of CSOM and the need for strict antibiotic stewardship programs to combat resistance.

Keywords: *Chronic Suppurative Otitis Media, Pseudomonas aeruginosa, Antibiotic Resistance, Imipenem, Gram-negative Bacteria, Otitis Media, Culture, Antibiotic Susceptibility Testing.*

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1. INTRODUCTION

Chronic Suppurative Otitis Media (CSOM) is a persistent ear infection characterized by the presence of otorrhea, ear pain, and hearing loss. It is considered one of the leading causes of conductive hearing loss worldwide, particularly affecting children in low- and middle-income countries. CSOM is often associated with recurrent infections, leading to permanent damage to the ear structures. While the pathogenesis of CSOM is complex and multifactorial, bacterial infections play a major role, with *Pseudomonas aeruginosa* emerging as one of the most frequent pathogens responsible for this condition [1-3]. For a treatment to be effective and to prevent both medical problems and antibiotic resistance, it is essential to understand the etiological agents of CSOM and their antibiogram. It is imperative that wide spectrum antibiotics like imipenem be used for the need of the hour [1].

Pseudomonas aeruginosa is a Gram-negative bacterium commonly found in both community and hospital settings. It is known for its ability to form biofilms, making it particularly difficult to treat with antibiotics. The bacteria's versatility in acquiring resistance to a wide range of antimicrobial agents complicates the management of CSOM, as traditional treatments often become ineffective due to the development of multidrug resistance (MDR)[4,5]. Studies have indicated that *Pseudomonas aeruginosa* is often resistant to commonly used antibiotics such as beta-lactams and aminoglycosides, including imipenem, which is considered a last-resort treatment option .[6]

The prevalence of *Pseudomonas aeruginosa* in CSOM cases has been observed to vary based on geographic location and clinical practices, but it consistently ranks as one of the most frequently isolated organisms from ear discharge. In addition to *Pseudomonas aeruginosa*, other bacteria such as *Klebsiella spp.*, *Staphylococcus aureus*, and *Escherichia coli* are also implicated in the development of CSOM [7]. Given the high rates of antibiotic resistance observed in these bacteria, there is a growing concern regarding the efficacy of empirical treatment regimens in managing CSOM infections [8-10].

This study aims to investigate the prevalence of *Pseudomonas aeruginosa* among CSOM patients and evaluate the antibiotic resistance patterns of these isolates, with a particular focus on resistance to imipenem. The results of this study may offer critical insights into the current trends of antibiotic resistance in CSOM pathogens and guide clinicians in making informed decisions regarding the management and treatment of the condition. Moreover, this research highlights the importance of surveillance for antibiotic resistance in CSOM, as well as the need for targeted therapy based on the microbial etiology and susceptibility patterns of the isolated pathogens.

2. MATERIALS AND METHODS

Study Design

This was a retrospective, cross-sectional study conducted at a tertiary care centre to evaluate the prevalence of *Pseudomonas aeruginosa* in patients diagnosed with Chronic Suppurative Otitis Media (CSOM) and to assess the antibiotic resistance patterns of the isolated strains. The study included a total of 60 clinically diagnosed CSOM cases over a period of 12 months from December 2024 to December 2025.

Inclusion Criteria

1. Patients of all age groups diagnosed with CSOM based on clinical and otoscopic examination.
2. Patients who provided informed consent for participation in the study.
3. Patients with active ear discharge and symptoms of CSOM such as ear pain, hearing loss, or otorrhea.

Exclusion Criteria

1. Patients with a history of recent ear surgeries or trauma.
2. Patients on antibiotics or antifungals at the time of enrollment.
3. Patients with non-bacterial infections (e.g., fungal infections).

Sample Collection

Ear swab samples were collected from the external auditory canal of patients with CSOM by a trained microbiologist. The samples were collected using sterile cotton swabs, and the process was carried out under aseptic conditions to prevent contamination. The swabs were immediately transported to the microbiology laboratory in a sterile transport medium.

Bacterial Isolation and Identification
Upon receipt in the laboratory, the ear swabs were streaked onto standard microbiological media, including Nutrient Agar (NA), MacConkey Agar (for Gram-negative organisms), and Blood Agar (for aerobic bacteria). The cultures were incubated at 37°C for 24-48 hours. The bacterial isolates were identified based on their colony morphology, Gram staining, and biochemical tests according to standard protocols. The identification of *Pseudomonas aeruginosa* was confirmed using standard biochemical tests, including the oxidase test, motility test, and growth on cetrimide agar.

Antibiotic Susceptibility Testing
The antibiotic resistance patterns of the bacterial isolates were determined using the disk diffusion method (Kirby-Bauer method). The following antibiotics were tested for each isolate:

- **Imipenem** (10 µg)
- **Ciprofloxacin** (5 µg)
- **Amikacin** (30 µg)
- **Ceftriaxone** (30 µg)
- **Gentamicin** (10 µg)
- **Azithromycin** (15 µg)

Antibiotic disks were placed on the surface of an agar plate inoculated with the bacterial isolate, and the plates were incubated at 37°C for 24 hours. The diameter of the zone of inhibition was measured and interpreted based on the Clinical and Laboratory Standards Institute (CLSI) guidelines for susceptibility testing.

Multi-drug Resistance (MDR) Criteria
Isolates resistant to three or more different classes of antibiotics were categorized as multi-drug resistant (MDR) strains, according to the definition established by the World Health Organization (WHO).

Data Collection and Statistical Analysis
Data on demographic characteristics, including age, gender, and side of ear involvement, were collected from patient records. The prevalence of *Pseudomonas aeruginosa* and other bacterial pathogens in CSOM was calculated as a percentage of the total number of culture-positive cases. The antibiotic resistance data were summarized using descriptive statistics. The resistance patterns of *Pseudomonas aeruginosa* were analyzed, and comparisons were made with other bacterial species isolated in the study. Statistical analysis was performed using SPSS version 22.0. A p-value of <0.05 was considered statistically significant.

3. RESULTS

In this study, 60 cases of chronic suppurative otitis media (CSOM) were analyzed, out of 185 ears clinically diagnosed with the condition, resulting in a positive bacterial culture rate of 32.4%. Among these 60 culture-positive cases, a male predominance was observed, with 36 (60%) male patients and 24 (40%) female patients. The highest number of cases were observed in the 0-10 years age group, accounting for 46.6%, followed by the 11-20 years age group at 26.6%. The age distribution showed a decrease in cases as the age increased, with only 3.3% of cases found in the ≥80 years age group.
Regarding the side of the ear affected, 51.6% of cases involved the left ear, 45% the right ear, and 3.3% had bilateral involvement. This indicates a relatively equal distribution of infection between the left and right ears. When examining the bacterial species isolated from the patients, a predominance of Gram-negative bacteria was noted, comprising 78% of the isolates, with *Pseudomonas aeruginosa* being the most common at 44%. Other Gram-negative isolates included *Klebsiella spp.* (13.3%), *Proteus mirabilis* (6.6%), and *Escherichia coli* (8.3%). Gram-positive isolates accounted for 22% of the cases, with *Staphylococcus aureus* being the most frequent (13.3%) and *Streptococcus pneumoniae* making up a smaller proportion (3.3%). In terms of fungal isolates, *Candida spp.* was identified in 1.6% of the samples, and there were 3.3% cases where no growth was observed.

Gender Distribution:
Out of the 185 ears clinically diagnosed with CSOM, 60 (32.4%) were found to be positive for bacterial infection. The gender distribution among the 60 positive cases showed that 36 (60%) were male, and 24 (40%) were female, as illustrated in Table 1.

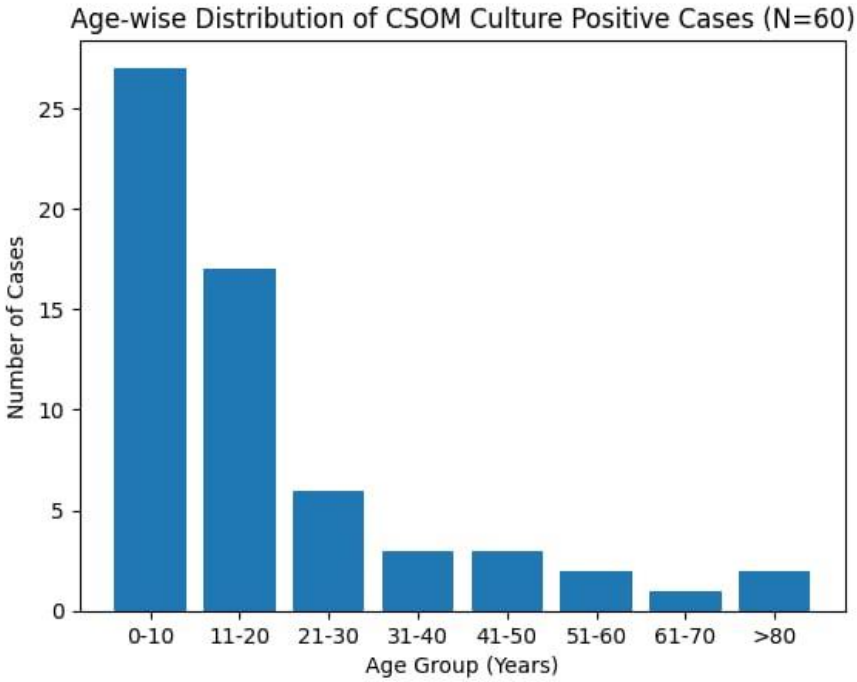
Table 1: Genderwise Distribution of Chronic Suppurative Otitis Media Patients

S.N.	Gender	Isolates (N=60)	Percentage (%)
1.	Male	36	60%
2.	Female	24	40%

Age Distribution:
The highest number of cases was observed in the 0-10 years age group (46.6%), followed by 11-20 years (26.6%). The least number of cases were observed in the age group above 50 years. The detailed age distribution is shown in Table 2.

Table 2: Agewise Distribution of CSOM Culture Positive Isolates

S.N.	Age Group (Years)	Male (N=36)	Female (N=24)	Percentage (%)
1.	0-10	18	9	46.6%
2.	11-20	10	7	26.6%
3.	21-30	4	2	10.0%
4.	31-40	2	1	5.0%
5.	41-50	1	2	5.0%
6.	51-60	1	1	3.3%
7.	61-70	1	0	3.3%
8.	≥80	0	2	3.3%



Graph 1: Agewise Distribution of CSOM Culture Positive Isolates

Ear Side Affected:
The side of the ear affected was nearly equally distributed, with the left ear being affected in 31 (51.6%) cases, the right ear in 27 (45%) cases, and bilateral involvement in 2 (3.3%) cases, as shown in Table 3.

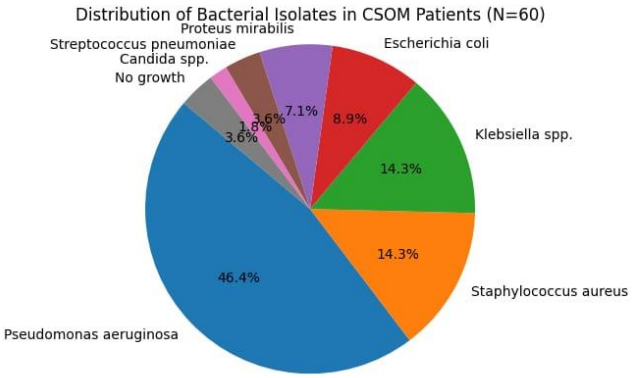
Table 3: Bilateral Distribution of Chronic Suppurative Otitis Media Culture Positive Patients

S.N.	Side Affected	Isolates (N=60)	Percentage (%)
1.	Left	31	51.6%
2.	Right	27	45.0%
3.	Bilateral	2	3.3%
Total		60	100%

Bacterial Isolates:
Among the 60 culture-positive cases, 78% were Gram-negative bacteria, with *Pseudomonas aeruginosa* accounting for 44% of the isolates. Other Gram-negative pathogens included *Klebsiella spp.*, *Proteus mirabilis*, and *Escherichia coli*. Gram-positive bacteria accounted for 22% of the isolates, predominantly *Staphylococcus aureus*. In total, 80% of samples showed growth of a single bacterial isolate, while 20% were mixed infections.

Table 4: Distribution of Bacterial Species Associated with Chronic Suppurative Otitis Media Patients

Bacterial Isolates	No. of Isolates (N=60)	Percentage (%)
Staphylococcus aureus	8	13.3%
Streptococcus pneumoniae	2	3.3%
Gram-negative bacteria		
Pseudomonas aeruginosa	26	44.0%
Klebsiella spp.	8	13.3%
Proteus mirabilis	4	6.6%
Escherichia coli	5	8.3%
No Growth	2	3.3%
Fungal		
Candida spp.	1	1.6%



Graph 2: Distribution of Bacterial Species Associated with Chronic Suppurative Otitis Media Patients

Antibiotic Resistance Patterns:
Among the 26 *Pseudomonas aeruginosa* isolates, 11 (42.3%) were found to be resistant to imipenem. The resistance pattern for other antibiotics showed higher susceptibility to ciprofloxacin (85%) and amikacin (75%). The resistance to multiple antibiotics, including imipenem, highlights the need for better surveillance and antibiotic stewardship in the treatment of CSOM infections.

Table 5: Antibiotic Resistance Profile of *Pseudomonas aeruginosa* Isolates

Antibiotic	Resistance (N=26)	Percentage (%)
Imipenem	11	42.3%
Ciprofloxacin	4	15.4%
Amikacin	6	23.0%
Ceftriaxone	10	38.4%

Regarding the antibiotic susceptibility of the *Pseudomonas aeruginosa* isolates, 42.3% (11 out of 26) showed resistance to imipenem, a key antibiotic used in treating resistant bacterial infections. Despite the resistance to imipenem, the isolates showed higher susceptibility to ciprofloxacin (85%) and amikacin (75%). Ceftriaxone resistance was observed in 38.4% of the *Pseudomonas aeruginosa* isolates, indicating a significant challenge in the treatment of CSOM caused by this pathogen. A total of 80% of samples showed growth of a single bacterial isolate, while 20% exhibited mixed infections, further highlighting the complexity of treating these infections

4. DISCUSSION

Chronic Suppurative Otitis Media (CSOM) continues to be a significant public health concern, particularly in developing countries, due to its association with persistent otorrhea, hearing impairment, and intracranial complications. The present study highlights the microbiological profile of CSOM with a specific focus on *Pseudomonas aeruginosa* and its evolving antimicrobial resistance patterns.

In the current study, culture positivity was observed in 32.4% of clinically diagnosed CSOM cases. Similar culture positivity rates have been reported by Asker et al. and Mandal and Roy, who documented rates ranging from 30% to 45%, emphasizing the chronic and intermittently active nature of the disease where bacterial load may vary over time [1,18]. The male predominance (60%) observed in this study aligns with previous reports suggesting higher exposure of males to environmental risk factors such as swimming in contaminated water and poor ear hygiene practices [2,14].

Age-wise distribution showed a clear predominance in the 0–10 year age group (46.6%). This finding is consistent with studies by Mohamed and Sulaiman and Hossain and Alam, who attributed the higher burden in children to immature immune defenses, frequent upper respiratory infections, and anatomical factors such as a shorter and wider Eustachian tube [14,20]. These factors facilitate bacterial colonization and persistence within the middle ear cavity.

Gram-negative bacteria constituted the majority of isolates (78%) in this study, with *Pseudomonas aeruginosa* emerging as the most prevalent pathogen (44%). This observation mirrors findings from multiple regional and international studies, where *P. aeruginosa* has consistently been identified as the dominant organism in CSOM due to its ability to survive in moist environments and form biofilms [3,8,16]. Biofilm formation not only enhances bacterial persistence but also significantly reduces antibiotic penetration, contributing to treatment failure.

The high prevalence of *Pseudomonas aeruginosa* in the present study is comparable to reports by Al-Shahri et al., Sharma et al., and Singh et al., who documented prevalence rates ranging from 38% to 52% [5,9,13]. The organism's intrinsic resistance mechanisms, including efflux pumps and enzyme production, further complicate management and necessitate regular antimicrobial surveillance.

A particularly concerning finding in this study is the high rate of imipenem resistance (42.3%) among *Pseudomonas aeruginosa* isolates. Imipenem is often considered a reserve antibiotic for multidrug-resistant infections. Similar rising resistance trends have been reported by Kumar and Pradhan and Zong et al., indicating global dissemination of carbapenem-resistant *Pseudomonas* strains [3,7]. This resistance is often mediated through carbapenemase production, porin loss, and overexpression of efflux systems, though molecular confirmation was beyond the scope of this study.

Despite significant resistance to imipenem, higher susceptibility was observed for ciprofloxacin (85%) and amikacin (75%). Comparable susceptibility patterns have been reported by Misra et al. and Akinci et al., suggesting that these agents may still remain viable treatment options when guided by culture sensitivity results [12,15]. However, emerging resistance even to these drugs highlights the urgent need to avoid empirical therapy and promote targeted antimicrobial use.

Mixed infections were observed in 20% of cases, underscoring the polymicrobial nature of CSOM. Similar observations have been documented by Lee et al. and Beuchat et al., who emphasized that mixed bacterial growth further complicates therapeutic decisions and may contribute to chronicity and recurrence [10,11]. The presence of other Gram-negative organisms such as *Klebsiella spp.*, *Proteus mirabilis*, and *Escherichia coli* reinforces the need for broad-spectrum initial evaluation followed by tailored therapy.
Overall, the findings of this study strongly support existing literature indicating that *Pseudomonas aeruginosa* remains the cornerstone pathogen in CSOM and that antimicrobial resistance, particularly to carbapenems, is rising at an alarming rate [4,17,19,20]. Regular culture and sensitivity testing, combined with strict antibiotic stewardship programs, are essential to curb the spread of resistant strains and improve patient outcomes.

5. CONCLUSION

The findings of this study reveal a high prevalence of *Pseudomonas aeruginosa* as a significant pathogen in patients with Chronic Suppurative Otitis Media (CSOM), accounting for 44% of the bacterial isolates. The resistance of *Pseudomonas aeruginosa* to imipenem, one of the last-line antibiotics, was a notable concern, with 42.3% of isolates demonstrating resistance. This study underscores the critical need for routine bacterial cultures and antibiotic susceptibility testing in the management of CSOM to ensure effective treatment and reduce the spread of resistant bacteria.

The results highlight that *Pseudomonas aeruginosa* remains a dominant pathogen, requiring targeted therapies based on resistance profiles. Regular monitoring for antibiotic resistance, along with adherence to antibiotic stewardship programs, is essential to mitigate the growing issue of resistance in CSOM. It is essential to focus on the implementation of effective antimicrobial policies and regular surveillance in managing infections caused by multidrug-resistant pathogens.

Limitations

1. **Sample size**: While 60 patients were included, a larger sample size might provide more robust findings, especially regarding less frequent bacterial isolates or resistance patterns.

2. **No molecular analysis**: This study primarily relied on culture-based methods for bacterial identification. Molecular techniques, such as PCR or whole-genome sequencing, could provide deeper insights into the genetic mechanisms behind antibiotic resistance.
3. **Lack of follow-up data**: The study did not include long-term follow-up data on the patients' outcomes post-treatment, which could provide valuable information regarding the recurrence of infections or complications arising from antibiotic resistance.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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