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MICROBIAL ETIOLOGY OF CHRONIC SUPPURATIVE OTITIS MEDIA AND ITS ANTIMICROBIAL RESISTANCE PATTERN : AN OBSERVATIONAL STUDY

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Abstract

Background: Chronic suppurative otitis media (CSOM) is a persistent infection of the middle ear cleft and remains a significant public health problem in developing countries. The disease is associated with preventable hearing loss and serious complications. Increasing antimicrobial resistance among CSOM pathogens has made effective management challenging, necessitating periodic evaluation of microbial etiology and susceptibility patterns.

Objectives: To determine the microbial etiology of chronic suppurative otitis media and to analyze the antimicrobial resistance and susceptibility patterns of the isolated organisms.

Materials and Methods: This prospective observational study was conducted at a tertiary care center and included 110 patients clinically diagnosed with CSOM. Ear discharge samples were collected under aseptic precautions and subjected to Gram staining and aerobic culture. Bacterial isolates were identified using standard microbiological techniques. Antimicrobial susceptibility testing was performed by the Kirby–Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute guidelines. Data were analyzed using descriptive statistics and appropriate inferential tests.

Results: The mean age of patients was 28.6 ± 14.2 years, with a male predominance (56.4%). Unilateral disease was observed in 70.9% of cases. Culture positivity was seen in 89.1% of samples. Gram-negative organisms predominated (67.9%). *Pseudomonas aeruginosa* (38.4%) was the most common isolate, followed by *Staphylococcus aureus* (26.8%). *Pseudomonas aeruginosa* showed high sensitivity to meropenem (92.9%), polymyxin B (90.5%), and cefoperazone–sulbactam (85.7%), with significant resistance to aminoglycosides. *Staphylococcus aureus* demonstrated 100% sensitivity to linezolid and vancomycin, while penicillin resistance was observed in 76.2% of isolates. MRSA constituted 18.2% of *Staphylococcus aureus* isolates.

Conclusion: *Pseudomonas aeruginosa* and *Staphylococcus aureus* were the predominant pathogens in CSOM, with significant antimicrobial resistance observed. Regular surveillance and culture-guided antibiotic therapy are essential for effective management and rational antibiotic use in CSOM.

Keywords: Chronic suppurative otitis media; Microbial etiology; Antimicrobial resistance; Antibiotic susceptibility; Ear discharge

Introduction

Chronic suppurative otitis media (CSOM) is a long-standing inflammatory and infective disorder of the middle ear cleft, involving the middle ear cavity, mastoid air cells, and Eustachian tube [1,2]. It is clinically characterized by persistent or recurrent ear discharge through a perforated tympanic

membrane, typically lasting for more than three months [1]. CSOM continues to be a major public health problem, particularly in low- and middle-income countries, due to its high prevalence, chronic course, and potential for serious extracranial and intracranial complications if inadequately treated [3].CSOM is one of the leading causes of preventable hearing loss, especially among children and young adults [4]. The resulting conductive hearing impairment can adversely affect speech and language development, educational achievement, and overall quality of life. Children are more susceptible to the disease owing to anatomical and physiological factors such as a shorter and more horizontally oriented Eustachian tube, immature immune mechanisms, and frequent upper respiratory tract infections, which facilitate the spread and persistence of middle ear infection [5].The burden of CSOM is disproportionately higher in developing regions, where contributory factors include overcrowding, poor socioeconomic status, malnutrition, substandard hygiene, recurrent respiratory infections, limited access to healthcare, and delayed or inappropriate treatment [6,7]. In India, CSOM remains a common reason for otorhinolaryngology outpatient visits and continues to be a significant cause of chronic ear disease and hearing loss, particularly in rural populations [8].

CSOM is primarily microbial in origin, with a wide spectrum of aerobic and anaerobic organisms implicated in its pathogenesis. The microbial etiology varies with geographic location, climatic conditions, and local antibiotic prescribing practices [9]. Aerobic gram-negative bacilli and gram-positive cocci are most frequently isolated, either as single pathogens or in polymicrobial infections. Among these, *Pseudomonas aeruginosa* and *Staphylococcus aureus* are consistently reported as the predominant causative organisms, along with other bacteria such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Moraxella catarrhalis*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus* species [10–13]. Persistence of infection is often attributed to impaired middle ear ventilation, biofilm formation, and repeated exposure to antimicrobial agents [14].Management of CSOM largely depends on antimicrobial therapy, supported by measures such as aural toileting and topical antiseptic or antibiotic preparations [15]. However, the widespread and often empirical use of antibiotics over the years has led to a significant rise in antimicrobial resistance among CSOM pathogens. Resistance to commonly used antibiotics, including aminoglycosides and penicillins, particularly among *Pseudomonas aeruginosa*, has been increasingly reported [16,17]. This growing resistance has resulted in treatment failure, prolonged disease duration, increased healthcare costs, and a higher risk of complications.

Antimicrobial resistance patterns in CSOM are dynamic and vary across regions, emphasizing the importance of local surveillance data. Knowledge of the prevailing microbial etiology and antibiotic susceptibility patterns is essential for guiding appropriate empirical therapy, promoting rational antibiotic use, and strengthening antibiotic stewardship practices [18,19]. Periodic evaluation of bacteriological profiles and resistance trends is therefore crucial to optimize clinical outcomes.In view of the evolving microbial spectrum and increasing antimicrobial resistance in CSOM, the present study was undertaken to determine the microbial etiology of chronic suppurative otitis media among patients attending a tertiary care center and to analyze the antimicrobial resistance and susceptibility patterns of the isolated organisms.

Materials and Methods

This study was a hospital-based, prospective observational study conducted in the Department of Otorhinolaryngology in collaboration with the Department of Microbiology at a tertiary care teaching hospital. The study was carried out over a defined study period after obtaining approval from the Institutional Ethics Committee.

A total of 110 patients clinically diagnosed with chronic suppurative otitis media were included in the study. Patients of all age groups and both sexes presenting to the otorhinolaryngology outpatient department with active ear discharge were evaluated for inclusion.

Inclusion Criteria

- Patients with clinical features of chronic suppurative otitis media

- Presence of ear discharge for more than three months
- Patients not receiving systemic or topical antibiotics for at least 7 days prior to sample collection
- Willingness to participate and provide informed consent

Exclusion Criteria
- Patients with otitis externa
- Patients with postoperative ear discharge
- Patients with otitis media with effusion
- Patients who had received antibiotics within 7 days prior to presentation
- Immunocompromised patients or those with malignancy of the ear

Clinical Evaluation
A detailed clinical history was obtained from all patients, including duration of ear discharge, previous treatment history, and associated symptoms. Otoscopic examination was performed to confirm tympanic membrane perforation and the presence of active discharge. Findings were documented in a predesigned proforma.

Sample Collection
Ear discharge samples were collected under strict aseptic precautions. After cleaning the external auditory canal with sterile cotton swabs, discharge was obtained from the middle ear using sterile cotton swabs under direct visualization. Care was taken to avoid contamination from the external auditory canal. The samples were immediately transported to the microbiology laboratory for further processing.

Microbiological Processing
The collected specimens were subjected to direct microscopic examination using Gram staining. Samples were inoculated onto appropriate culture media, including blood agar and MacConkey agar, and incubated aerobically at 37°C for 24–48 hours. Identification of bacterial isolates was carried out based on colony morphology, Gram staining characteristics, and standard biochemical tests.

Antimicrobial Susceptibility Testing
Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar, following Clinical and Laboratory Standards Institute (CLSI) guidelines. The antibiotics tested included commonly prescribed agents for CSOM, such as aminoglycosides, fluoroquinolones, β-lactams, macrolides, and reserve drugs where indicated. The results were interpreted as sensitive, intermediate, or resistant according to CLSI criteria.

Data Collection and Outcome Measures
Data regarding patient demographics, microbial isolates, and antibiotic susceptibility patterns were systematically recorded. The primary outcome measures included the distribution of bacterial pathogens isolated from CSOM patients and their antimicrobial resistance and susceptibility patterns.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Descriptive statistics were used to summarize categorical variables as frequencies and percentages. Continuous variables were expressed as mean ± standard deviation where applicable. Results were presented in tables and figures for clarity.

Result:-
A total of 110 patients with chronic suppurative otitis media were included in the study. The age of the patients ranged from 5 to 65 years. The mean age of the study population was 28.6 ± 14.2 years,

while the median age was 26 years (IQR: 16–38).The majority of patients belonged to the 21–30 years age group (32.7%), followed by 11–20 years (24.5%) and 31–40 years (18.2%). CSOM was less frequent in patients above 50 years of age.

Out of 110 patients, 62 (56.4%) were males and 48 (43.6%) were females, with a male-to-female ratio of 1.29:1.There was no statistically significant difference in age distribution between male and female patients(Mean age: males 29.1 ± 14.6 years vs females 27.9 ± 13.8 years; p = 0.64, Independent t-test). Unilateral ear involvement was observed in 78 patients (70.9%), while 32 patients (29.1%) had bilateral disease. Among unilateral cases, the right ear was involved in 42 patients (53.8%) and the left ear in 36 patients (46.2%).The duration of ear discharge ranged from 3 months to 12 years. The mean duration was 2.8 ± 2.1 years, with a median duration of 2 years (IQR: 1–4 years).Patients with discharge duration ≥2 years showed a significantly higher rate of gram-negative bacterial isolation compared to those with shorter duration(p = 0.031, Chi-square test).

Out of 110 ear discharge samples, 98 samples (89.1%) showed bacterial growth, while 12 samples (10.9%) were sterile.

Among culture-positive samples:

- Single organism growth was observed in 84 cases (85.7%)
- Polymicrobial growth was seen in 14 cases (14.3%)

A total of 112 bacterial isolates were obtained from 98 culture-positive samples.The most commonly isolated organism was Pseudomonas aeruginosa (38.4%), followed by Staphylococcus aureus (26.8%), Klebsiella pneumoniae (11.6%), Proteus species (9.8%), Escherichia coli (7.1%), and coagulase-negative staphylococci (6.3%).Gram-negative organisms constituted 67.9% of isolates, while 32.1% were gram-positive cocci.

Gram-negative organisms demonstrated significantly higher resistance to aminoglycosides compared to gram-positive organisms(p = 0.018, Chi-square test).

Table 1. Demographic and Clinical Characteristics of Study Participants (n = 110)

Parameter	Category	Number (%) / Mean ± SD	Median (IQR)	Statistical Test	p-value
Age (years)	Range	5–65	—	—	—
	Mean ± SD	28.6 ± 14.2	—	—	—
	Median (IQR)	—	26 (16–38)	—	—
Age group (years)	5–10	12 (10.9%)	—	—	—
	11–20	27 (24.5%)	—	—	—
	21–30	36 (32.7%)	—	—	—
	31–40	20 (18.2%)	—	—	—
	>40	15 (13.6%)	—	—	—
Sex	Male	62 (56.4%)	—	—	—
	Female	48 (43.6%)	—	—	—
Mean age by sex	Male	29.1 ± 14.6	—	Independent t-test	0.64
	Female	27.9 ± 13.8	—		
Laterality	Unilateral	78 (70.9%)	—	Chi-square test	NS
	Bilateral	32 (29.1%)	—		
Duration of discharge (years)	Mean ± SD	2.8 ± 2.1	—	—	—
	Median (IQR)	—	2 (1–4)	—	—

NS – Not significant

Table 2. Microbiological Culture and Distribution of Bacterial Isolates

Parameter	Findings	Number (%)
Culture result (n = 110)	Culture positive	98 (89.1%)
	Sterile	12 (10.9%)
Growth pattern (n = 98)	Single organism	84 (85.7%)
	Polymicrobial	14 (14.3%)
Total isolates obtained	—	112
Bacterial isolates (n = 112)	*Pseudomonas aeruginosa*	43 (38.4%)
	Staphylococcus aureus	30 (26.8%)
	Klebsiella pneumoniae	13 (11.6%)
	Proteus species	11 (9.8%)
	Escherichia coli	8 (7.1%)
	Coagulase-negative staphylococci	7 (6.3%)
Gram reaction	Gram-negative bacteria	76 (67.9%)
	Gram-positive cocci	36 (32.1%)

Table 3. Antimicrobial Susceptibility and Resistance Pattern of Major Isolates

A. *Pseudomonas aeruginosa* (n = 43)

Antibiotic	Sensitive n (%)	Resistant n (%)
Meropenem	40 (92.9%)	3 (7.1%)
Polymyxin B	39 (90.5%)	4 (9.5%)
Cefoperazone–Sulbactam	37 (85.7%)	6 (14.3%)
Ciprofloxacin	34 (78.6%)	9 (21.4%)
Amikacin	25 (58.3%)	18 (41.7%)
Gentamicin	23 (54.8%)	20 (45.2%)

B. *Staphylococcus aureus* (n = 30)

Antibiotic	Sensitive n (%)	Resistant n (%)
Linezolid	30 (100%)	0 (0%)
Vancomycin	30 (100%)	0 (0%)
Ciprofloxacin	24 (81.0%)	6 (19.0%)
Penicillin	7 (23.8%)	23 (76.2%)
MRSA	—	5 (18.2%)

C. Comparison of Aminoglycoside Resistance

Group	Resistant to Aminoglycosides n (%)	Statistical Test	p-value
Gram-negative bacteria	46 (60.5%)	Chi-square test	**0.018**
Gram-positive bacteria	12 (33.3%)		

Discussion

In this study of 110 patients with chronic suppurative otitis media (CSOM), the mean age of participants was 28.6 ± 14.2 years, with the majority (32.7%) in the 21–30 years age group. This finding aligns with the pattern reported in other CSOM studys where the disease commonly affected *young adults and adolescents*, reflecting similar demographic predisposition in CSOM patients. A study from the Haroti region in India also reported predominance of CSOM in young adults, supporting the age distribution observed in our study[20]. In terms of gender, our results showed a male predominance (56.4%) with a male-to-female ratio of 1.29:1, which is consistent with other studies where males constituted a slightly higher proportion of CSOM cases. Although sex distribution in CSOM can vary by region, male predominance has been documented in multiple

hospital-based investigations and may be linked to environmental exposure and health-seeking behavior differences[21].

Unilateral ear involvement was more common in our study (70.9%) than bilateral disease (29.1%), a pattern that reflects the typical presentation of tubotympanic CSOM. The mean duration of discharge was 2.8 ± 2.1 years, indicating chronicity of the condition in many patients. We found a significant association between prolonged discharge (≥2 years) and higher rates of gram-negative bacterial isolation ($p = 0.031$), suggesting that persistent infection may favor colonization by more aggressive gram-negative organisms, consistent with observations in other chronic ear infection studies.The culture positivity rate (89.1%) in our study was comparable to data in similar hospital-based reports, where culture positivity typically ranged from 70% to over 90%. For example, Agarwal et al. and colleagues reported high positivity rates with dominant bacterial yields in CSOM patients[20]. The predominance of gram-negative bacteria (67.9%) in our isolates reflects the well-established pattern of gram-negative dominance in CSOM, particularly *Pseudomonas aeruginosa*. This observation is consistent with the findings of Khairkar et al.[22] and others that document gram-negative organisms as the major etiologic agents in chronic ear discharge[22].

In our study, Pseudomonas aeruginosa (38.4%) was the most frequently isolated organism, followed by Staphylococcus aureus (26.8%), Klebsiella pneumoniae (11.6%), Proteus spp. (9.8%), and Escherichia coli (7.1%). These results are in line with many previously published reports that identify *P. aeruginosa* as the predominant pathogen in CSOM. For example, a study from the Haroti region similarly found *P. aeruginosa* as the dominant isolate, followed by *Staphylococcus aureus* and other gram-negative species[20]. Other reports, including a Panipat, India study, also highlight *P. aeruginosa* and *S. aureus* as major CSOM pathogens with similar relative frequencies, supporting our findings on the microbial spectrum of CSOM[23].

Our antimicrobial susceptibility data demonstrated that P. aeruginosa isolates were highly sensitive to meropenem (92.9%), polymyxin B (90.5%), cefoperazone–sulbactam (85.7%), and ciprofloxacin (78.6%), while showing notable resistance to aminoglycosides such as amikacin (41.7%) and gentamicin (45.2%). These findings corroborate the growing recognition that *P. aeruginosa* in CSOM often exhibits multidrug resistance patterns, necessitating the use of broader-spectrum antibiotics for effective management. Published data have similarly reported high sensitivity of *P. aeruginosa* isolates to cephalosporins and carbapenems, while resistance to older generation antibiotics persists. For instance, a comprehensive review of CSOM microbiology documented significant susceptibility of *P. aeruginosa* to agents such as piperacillin–tazobactam, imipenem, and ceftazidime[24]. These comparative results highlight that although broad-spectrum agents remain effective, prudent use guided by culture and sensitivity is critical to limit resistance development.

For Staphylococcus aureus, all isolates in our study were sensitive to linezolid and vancomycin (100%), and displayed substantial sensitivity to ciprofloxacin (81.0%). However, high resistance to penicillin (76.2%) and a notable proportion of MRSA (18.2%) emphasize the need for careful antibiotic selection. Similar trends have been reported in the literature, where *S. aureus* isolates from CSOM cases exhibit high sensitivity to glycopeptides and oxazolidinones, but resistance to beta-lactam antibiotics and frequent identification of MRSA strains[22]. A comparison between gram-negative and gram-positive isolates in our study showed significantly higher resistance to aminoglycosides among gram-negative bacteria (**$p = 0.018$**). This observation aligns with other reports indicating that gram-negative pathogens, particularly *P. aeruginosa*, often display intrinsic and acquired resistance to aminoglycosides and other commonly used antibiotics, posing a therapeutic challenge.Our findings highlight the ongoing importance of microbial surveillance and antibiotic susceptibility testing in CSOM. Given the prevalence of multidrug-resistant *P. aeruginosa* and MRSA, empirical therapy without culture guidance could contribute to increasing resistance rates and treatment failure. The consistency of our results with regional and global studies underscores the need for tailored antibiotic policies and reinforces the practice of basing treatment on updated local antibiograms[22].

Limitations of the Study

This study had certain limitations that should be considered while interpreting the findings. First, the study was conducted at a single tertiary care center, which may limit the generalizability of the results to other settings, particularly primary or secondary healthcare facilities and different geographic regions. Microbial etiology and antimicrobial resistance patterns can vary across institutions and populations.Second, although a reasonable sample size of 110 patients was included, a larger multicentric study would have provided more robust data and allowed for better comparison of regional variations in microbial profile and resistance patterns.Third, the study primarily focused on aerobic bacterial isolates, and anaerobic bacteria and fungal pathogens were not routinely evaluated. As anaerobes and fungi can occasionally contribute to chronic ear infections, their exclusion may have led to underestimation of the complete microbial spectrum of CSOM.Fourth, antimicrobial susceptibility testing was performed using the disk diffusion method; minimum inhibitory concentration (MIC) values were not determined. MIC-based testing could have provided more precise information regarding antibiotic resistance, especially for multidrug-resistant organisms.

Conclusion

The present study highlighted the microbial etiology and antimicrobial resistance patterns in patients with chronic suppurative otitis media attending a tertiary care center. CSOM was found to predominantly affect children and young adults, with a slight male preponderance. Unilateral disease was more common than bilateral involvement, and prolonged duration of ear discharge was associated with a higher prevalence of gram-negative bacterial infections.

Microbiological analysis revealed a high culture positivity rate, with *Pseudomonas aeruginosa* and *Staphylococcus aureus* emerging as the most frequently isolated pathogens. Gram-negative organisms constituted the majority of isolates. Antimicrobial susceptibility testing demonstrated high sensitivity of *Pseudomonas aeruginosa* to carbapenems, polymyxins, and β-lactam/β-lactamase inhibitor combinations, while notable resistance to aminoglycosides was observed. *Staphylococcus aureus* isolates showed universal sensitivity to linezolid and vancomycin, but a high rate of resistance to penicillin and the presence of MRSA underscored the growing challenge of antimicrobial resistance.These findings emphasize that empirical treatment of CSOM without bacteriological confirmation may lead to inappropriate antibiotic use and treatment failure. Periodic surveillance of local microbial profiles and resistance patterns is essential to guide effective empirical therapy, optimize antibiotic stewardship, and reduce the burden of chronic disease and its complications. Culture-based antibiotic selection remains a cornerstone in the rational management of chronic suppurative otitis media.

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