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## ORIGINAL RESEARCH

# The Antibiotic Sensitivity Pattern and Bacteriological Profile of Chronic Suppurative Otitis Media

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## ABSTRACT

**Background:** Chronic Suppurative Otitis Media (CSOM) is a persistent inflammatory condition of the middle ear, frequently complicated by bacterial infections that lead to substantial morbidity. The indiscriminate use of antibiotics has resulted in the emergence of multi-drug resistant bacterial strains. Understanding the microbial profile and antibiotic susceptibility patterns is crucial for effective treatment. **Methods:** A cross-sectional study was conducted on 100 patients diagnosed with CSOM at a tertiary care hospital. Ear discharge samples were collected aseptically and cultured for aerobic bacteria. Microbial identification and antibiotic susceptibility testing were performed following CLSI M100, 2022 guidelines. Data were analyzed using MS Excel. **Results:** Most patients were male (58%) and aged 16–30 years (33%). The majority presented with unilateral (94%) and tubo-tympanic type CSOM (94%). Mono-microbial growth was observed in 78% of cases, with Pseudomonas aeruginosa (40%) and Methicillin-sensitive Staphylococcus aureus (28%) as predominant isolates. Imipenem and Meropenem were highly effective against Gram-negative bacteria, while Vancomycin and Linezolid showed 100% sensitivity for Gram-positive bacteria. Methicillin-resistant Staphylococcus aureus displayed significant resistance patterns. **Conclusion:** This study highlights the dominance of Pseudomonas aeruginosa and Staphylococcus species in CSOM and the rise of antibiotic resistance. Regular surveillance of microbial profiles and antibiograms is essential for developing effective empirical treatment strategies and antibiotic stewardship programs.

**Keywords:** Chronic Suppurative Otitis Media, antibiotic resistance, Pseudomonas aeruginosa, microbial profile, antibiogram, empirical therapy.



## INTRODUCTION

Chronic suppurative otitis media (CSOM) is characterised by persistent inflammation of the middle ear and mastoid cavity, often manifesting as recurrent ear discharges or otorrhea via a tympanic perforation.[1]The incidence of this disease is elevated in developing countries, particularly within low socio-economic populations, due to factors such as malnutrition, overcrowding, poor hygiene, insufficient healthcare, and recurrent upper respiratory tract infections.[2] The urban to rural disease ratio is 1:2, with the highest prevalence observed in impoverished rural communities.[2,3]

Chronic Suppurative Otitis Media (CSOM) is typically categorised into two types: tubotympanic and attico-antral, based on whether the pathological process impacts the pars tensa or pars flaccida of the tympanic membrane (TM).[2] Tubotympanic is classified as a safe or benign type due to the absence of serious complications, whereas attico-antral is deemed unsafe or hazardous because of its associated complications, which can occasionally be life-threatening.[4] Infection may disseminate from the middle ear to critical structures, including the mastoid, facial nerve, labyrinth, lateral sinus, meninges, and brain, resulting in mastoid abscess, facial nerve paralysis, deafness, lateral sinus thrombosis, meningitis, and intracranial abscess.[5,6]

Hearing loss linked to chronic ear discharge is frequently substantial, occurring in 50% of cases and generally more severe than that observed in other forms of otitis media.[7] Complications related to

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chronic suppurative otitis media (CSOM) were prevalent in the pre-antibiotic era; however, the advent of antibiotics provided clinicians with a therapeutic option that could be employed even in the absence of a definitive etiological diagnosis. This indiscriminate use of antibiotics resulted in the emergence of multi-drug resistant bacterial strains and subsequent disease complications.[8 ]Alterations in bacterial flora in chronic suppurative otitis media over the past decade have been validated and documented by numerous authors.[2, 8, 9]

The management of chronic suppurative otitis media (CSOM) is contentious and may evolve, especially in developing nations. The prevalence and antibiogram of these pathogens have been documented to fluctuate over time and across geographical regions, likely due to the indiscriminate use of antibiotics.[8] Therefore, the regular updating of the prevalence and antibiogram of the causative agents for CSOM would be beneficial for the treatment and management of patients.

The aim of this cross-sectional prospective study was to assess the microbial diversity and resistogram of aerobic bacterial isolates in patients with chronic suppurative otitis media (CSOM) who visited the ENT Department of our hospital.

## MATERIALS AND METHODS

This observational cross-sectional study was conducted at the outpatient department of ENT in collaboration with the department of Microbiology at a tertiary care hospital. The sample size was calculated based on the bacteriological profile of chronic suppurative otitis media (CSOM) reported in previous studies, using the formula:

**$n = 4pq/d^2$**,

where *p* = 32.6% (prevalence of *Pseudomonas aeruginosa*) and an absolute precision of 10%. Accordingly, the sample size was estimated to be 90. However, 100 consecutive ear swab samples were included in the study.

Patients of all age groups and genders clinically diagnosed with CSOM were eligible for inclusion. Patients were excluded if they had received antibiotics or antifungal drugs (topical or systemic) within seven days prior to presentation, were diagnosed with any immunodeficiency, had malignant lesions of the external or middle ear, or had undergone prior surgery on the affected ear. Demographic and clinical characteristics of the patients were recorded using a structured proforma. The external auditory canal was cleansed using a sterile cotton pledget soaked in 70% ethyl alcohol, which was allowed to dry. Using a sterile auditory speculum, a sterile cotton swab stick was introduced into the middle ear to collect the ear discharge, avoiding contact with the external auditory canal. Two samples were collected from each ear and transported immediately to the microbiology laboratory. One swab was subjected to Gram staining and microscopy. The other swab was inoculated onto blood agar, chocolate agar, and MacConkey agar for aerobic culture. The inoculated plates were incubated at 37°C for 24–48 hours. Blood and MacConkey agar were incubated in an aerobic environment, while chocolate agar was incubated in 10% $CO_2$ to support capnophilic organisms. Cefoxitin discs were used to detect Methicillin-resistant *Staphylococcal* species. Microbes were identified based on Gram staining, colony morphology, cultural characteristics, and biochemical reactions following standard bacteriological techniques. Samples that did not grow within 48 hours were critically analyzed before being reported as "no growth." Anaerobic isolates, slow-growing bacteria, or fungi were not routinely reported, and residual effects of prior antibiotic treatments were considered. Antimicrobial sensitivity testing for aerobic bacterial isolates was performed using the Kirby–Bauer disc diffusion method on Muller Hinton agar. Testing was conducted for a panel of antibiotics according to the type of bacteria (Gram-positive cocci, Gram-negative bacilli, *Pseudomonas aeruginosa*, or non-fermenting Gram-negative bacilli) based on the Clinical and Laboratory Standards Institute (CLSI) M100, 2022 guidelines. Data were compiled and statistically analyzed to present results as numbers and percentages using MS Excel.

## RESULTS

**Table 1: Profile of the study participants**

| Variable | n (%) |
|---|---|
| **Gender** | |
| **Male** | 58 (58.0%) |
| **Female** | 42 (42.0%) |
| **Age in years** | |
| **< 15** | 12 (12.0%) |
| **16–30** | 33 (33.0%) |
| **31–45** | 26 (26.0%) |
| **46–60** | 18 (18.0%) |
| **61–75** | 11 (11.0%) |
| **>75** | 1 (1.0%) |
| **Laterality/Side** | |
| **Unilateral** | 94 (94.0%) |

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| | |
|---|---|
| **Bilateral** | 6 (6.0%) |
| **Type of CSOM** | |
| **Tubo-tympanic** | 94 (94.0%) |
| **Attico-antral** | 6 (6.0%) |

Table 1 provides the demographic and clinical profile of the 100 study participants. The majority were male (58%), with females constituting 42%. The age distribution revealed that the largest group (33%) was aged 16–30 years, followed by 31–45 years (26%), and smaller proportions in other age ranges, including 12% under 15 years and just 1% over 75 years. Most cases (94%) were unilateral, with only 6% bilateral involvement. Regarding the type of chronic suppurative otitis media (CSOM), the tubo-tympanic type was predominant (94%), while attico-antral cases accounted for 6%. These findings reflect a young to middle-aged patient population predominantly affected by unilateral and tubo-tympanic CSOM.

**Table 2: Microbiological profile of culture growth**

| Type of Growth | n (%) |
|---|---|
| **Mono-microbial** | 78 (78.0%) |
| **Poly-microbial** | 14 (14.0%) |
| **No growth** | 8 (8.0%) |
| **Total** | 100 (100%) |

Table 2 summarizes the microbiological profile of culture growth among 100 samples. Mono-microbial growth was observed in the majority of cases (78%), while poly-microbial growth accounted for 14%. Notably, 8% of the samples showed no growth in aerobic culture. This distribution highlights that most infections in the study were caused by a single microbial species, with a smaller proportion involving multiple species or yielding no growth under aerobic conditions.

**Table 3: Organisms isolated from aerobic culture**

| Type of Bacteria | n (%) |
|---|---|
| **Gram-Negative Bacteria** | **57 (57.0%)** |
| **Pseudomonas aeruginosa** | 40 (40.0%) |
| **Klebsiella pneumoniae** | 6 (6.0%) |
| **Escherichia coli** | 4 (4.0%) |
| **Acinetobacter baumannii** | 3 (3.0%) |
| **Proteus mirabilis** | 3 (3.0%) |
| **Gram-Positive Bacteria** | **43 (43.0%)** |
| **Methicillin-sensitive Staphylococcus aureus** | 28 (28.0%) |
| **Coagulase-negative Staphylococcus species** | 8 (8.0%) |
| **Methicillin-resistant Staphylococcus aureus** | 4 (4.0%) |
| **Streptococcus pneumoniae** | 3 (3.0%) |

Table 3 outlines the organisms isolated from 100 aerobic culture samples, highlighting that Gram-negative bacteria (57%) were more prevalent than Gram-positive bacteria (43%). **Pseudomonas aeruginosa** was the most frequently isolated organism (40%), followed by **Methicillin-sensitive Staphylococcus aureus** (28%). Other notable isolates included **Coagulase-negative Staphylococcus species** (8%), **Klebsiella pneumoniae** (6%), and **Methicillin-resistant Staphylococcus aureus** (4%). Less common isolates included **Escherichia coli**, **Acinetobacter baumannii**, **Proteus mirabilis**, and **Streptococcus pneumoniae** (each at 3%). These results underscore the dominance of Pseudomonas aeruginosa and Staphylococcus species in the bacterial profile of the study.

**Table 4: Antibiotic sensitivity pattern of gram negative bacteria (n = 54)**

| Antibiotic | Pseudomonas aeruginosa (n=40) | Klebsiella pneumoniae (n=6) | Escherichia coli (n=4) | Acinetobacter sp. (n=3) | Proteus mirabilis (n=3) |
|---|---|---|---|---|---|
| **Ciprofloxacin** | 19 (47.5%) | 2 (33.3%) | 2 (50.0%) | 0 (0.0%) | 2 (66.7%) |
| **Ceftazidime** | 18 (45.0%) | 3 (50.0%) | 3 (75.0%) | 1 (33.3%) | 0 (0.0%) |
| **Imipenem** | 18 (45.0%) | 4 (66.7%) | 4 (100%) | 3 (100%) | 1 (33.3%) |
| **Meropenem** | 17 (42.5%) | 4 (66.7%) | 4 (100%) | 2 (66.7%) | 1 (33.3%) |
| **Gentamycin** | 17 (42.5%) | 2 (33.3%) | 3 (75.0%) | 2 (66.7%) | 2 (66.7%) |
| **Cefepime** | 17 (42.5%) | 3 (50.0%) | 3 (75.0%) | 1 (33.3%) | 0 (0.0%) |
| **Aztreonam** | 14 (35.0%) | 3 (50.0%) | 3 (75.0%) | 0 (0.0%) | 0 (0.0%) |
| **Ofloxacin** | 6 (15.0%) | 4 (66.7%) | 3 (75.0%) | 0 (0.0%) | 2 (66.7%) |
| **Tobramycin** | 6 (15.0%) | 3 (50.0%) | 3 (75.0%) | 2 (66.7%) | 2 (66.7%) |

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| **Netilmicin** | 6 (15.0%) | 3 (50.0%) | 3 (75.0%) | 2 (66.7%) | 2 (66.7%) |
| **Piperacillin** | 5 (12.5%) | 2 (33.3%) | 2 (50.0%) | 1 (33.3%) | 3 (100%) |
| **Amikacin** | 3 (7.5%) | 5 (83.3%) | 4 (100%) | 2 (66.7%) | 3 (100%) |
| **Cefoxitin** | 3 (7.5%) | 2 (33.3%) | 2 (50.0%) | 0 (0.0%) | 0 (0.0%) |
| **Cephalexin** | 3 (7.5%) | 1 (16.7%) | 1 (25.0%) | 0 (0.0%) | 0 (0.0%) |
| **Cefuroxime** | 3 (7.5%) | 0 (0.0%) | 1 (25.0%) | 0 (0.0%) | 0 (0.0%) |
| **Ampicillin** | 0 (0.0%) | 0 (0.0%) | 1 (25.0%) | 0 (0.0%) | 0 (0.0%) |
| **Chloramphenicol** | 0 (0.0%) | 1 (16.7%) | 1 (25.0%) | 0 (0.0%) | 0 (0.0%) |
| **Cotrimoxazole** | 0 (0.0%) | 2 (33.3%) | 2 (50.0%) | 0 (0.0%) | 1 (33.3%) |

Table 4 illustrates the antibiotic sensitivity patterns of Gram-negative bacteria among 100 patients. **Imipenem** and **Meropenem** demonstrated the highest efficacy, showing 100% sensitivity for **Escherichia coli** and **Acinetobacter sp.**, as well as strong activity against other isolates. **Amikacin** was highly effective against **Klebsiella pneumoniae** (83.3%) and showed 100% sensitivity for **Escherichia coli** and **Proteus mirabilis**. In contrast, resistance was noted for several antibiotics, including **Ampicillin**, which had no efficacy against most isolates. **Pseudomonas aeruginosa** showed moderate sensitivity to **Ciprofloxacin** (47.5%) and **Ceftazidime** (45.0%). These findings highlight the need for tailored antibiotic selection based on sensitivity patterns to effectively treat infections caused by Gram-negative bacteria.

**Table 5: Antibiotic sensitivity pattern of gram positive bacteria (n = 42)**

| Antibiotic | MSSA (n=65) | MRSA (n=10) | Coagulase-negative Staphylococcus species (n=15) | Streptococcus pneumoniae (n=10) |
|---|---|---|---|---|
| **Vancomycin** | 65 (100%) | 10 (100%) | 15 (100%) | 10 (100%) |
| **Linezolid** | 65 (100%) | 10 (100%) | 15 (100%) | 10 (100%) |
| **Chloramphenicol** | 63 (96.9%) | 3 (30%) | 15 (100%) | 10 (100%) |
| **Amikacin** | 58 (89.2%) | 0 (0%) | 15 (100%) | 0 (0%) |
| **Doxycycline** | 58 (89.2%) | 8 (80%) | 15 (100%) | 10 (100%) |
| **Amoxicillin-clavulanic acid** | 55 (84.6%) | 0 (0%) | 15 (100%) | 10 (100%) |
| **Cefoxitin** | 55 (84.6%) | 0 (0%) | 12 (80%) | - |
| **Erythromycin** | 55 (84.6%) | 0 (0%) | 12 (80%) | 7 (70%) |
| **Clindamycin** | 55 (84.6%) | 0 (0%) | 12 (80%) | 7 (70%) |
| **Gentamycin** | 55 (84.6%) | 0 (0%) | 15 (100%) | 0 (0%) |
| **Ciprofloxacin** | 43 (66.2%) | 5 (50%) | 13 (86.7%) | 0 (0%) |
| **Cotrimoxazole** | 43 (66.2%) | 3 (30%) | 7 (46.7%) | 7 (70%) |
| **Penicillin** | 38 (58.5%) | 0 (0%) | 0 (0%) | 10 (100%) |

Table 5 outlines the antibiotic sensitivity patterns of Gram-positive bacteria among 100 patients. **Vancomycin** and **Linezolid** exhibited 100% sensitivity across all bacterial species, indicating their efficacy as first-line treatments. **Methicillin-sensitive Staphylococcus aureus (MSSA)** showed high sensitivity to **Amikacin** (89.2%), **Doxycycline** (89.2%), and **Amoxicillin-clavulanic acid** (84.6%). **Methicillin-resistant Staphylococcus aureus (MRSA)** displayed significant resistance, with effective sensitivity only to **Vancomycin**, **Linezolid**, and limited responsiveness to **Ciprofloxacin** (50%) and **Doxycycline** (80%). **Coagulase-negative Staphylococcus species** demonstrated strong sensitivity to most antibiotics, including **Chloramphenicol** (100%). **Streptococcus pneumoniae** was universally sensitive to **Vancomycin**, **Linezolid**, and **Penicillin**. These results highlight the need for judicious use of antibiotics, particularly in cases of resistant strains like MRSA.

## DISCUSSION

Chronic suppurative otitis media constitutes a significant public health issue, with India exhibiting a high prevalence rate. It is a condition with a significant risk of irreversible complications.[10 ]It is a significant contributor to preventable hearing loss, especially in developing nations, and may have enduring impacts on early communication, language acquisition, and education,performance and social interaction.[11]

In our study, 100 patients were enrolled, yielding a total of 100 ear swabs. The majority of cases were in the age group of 16-30 years (33%). The mean age of participants was 34 years, with males predominantly affected (58%). Unilateral infection was more common (94%), while bilateral infection was observed in 6% of cases. The majority of patients (94%) had the tubo-tympanic type of chronic suppurative otitis media, while 6% had the attico-antral type. Kombade SP et al. reported analogous findings, with the highest incidence occurring in the

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21 to 30-year age group (25.5%), and a predominance of males (52.3%) over females (47.7%). Chronic suppurative otitis media was identified in 60.1% of cases as safe and in 39.9% as unsafe.[12 ]A study by Hiremath B et al. revealed that the predominant age group was 11-20 years, comprising 29.1% of cases, with a male predominance of 55.83%. Unilateral infection (77.5%) was more prevalent than bilateral infection (22.5%).[13 ]In a study by Shilpa C et al., of the 106 cases examined, 63.20% were male and 36.79% were female, resulting in a male-to-female ratio of 1.6:1. The age group of 19–45 years exhibited a higher incidence of chronic suppurative otitis media, accounting for 52% of cases.[10]

Timely microbiological diagnosis facilitates swift and effective treatment to prevent complications. Microbiological cultures produce various organisms, which vary based on climate, patient demographics, and antibiotic usage. In our study of 100 samples, 78 (78%) showed monomicrobial growth, 14 (14%) showed poly-microbial growth, and 8 (8%) samples showed no growth in aerobic culture. A total of 9 types of bacteria were isolated, including 4 gram-positive and 5 gram-negative bacteria. The total number of bacterial isolates obtained was 100, which included all isolates from both monomicrobial and poly-microbial growth. Gram-negative bacteria were more commonly observed, with 56 (56%) isolates, compared to 44 (44%) gram-positive bacteria. Kombade SP et al. reported analogous findings, with bacterial growth detected in 82.4% of samples, while 17.6% exhibited no growth. Among pathogenic isolates, 90.8% exhibited mono-microbial growth, while 9.2% demonstrated poly-microbial growth. Gram-negative bacteria (69.2%) significantly surpassed Gram-positive bacteria (30.8%).[12] A study by Shilpa C et al revealed that of the 106 processed ear swabs, 94.33% exhibited bacterial growth, whereas 5.66% demonstrated no growth.[10] A study by Hiremath B et al revealed that 60.49% of cases involved gram-negative organisms, while 39.51% involved gram-positive organisms, indicating a higher prevalence of gram-negative organisms in the aetiology of chronic suppurative otitis media.[13]

In our study of 100 patients, Gram-negative bacteria were more commonly observed, with 56 (56%) of the bacterial isolates being Gram-negative, compared to 44 (44%) Gram-positive bacteria. The most common organism isolated was *Pseudomonas aeruginosa*, found in 39 (39%) samples, followed by *Methicillin-sensitive Staphylococcus aureus* in 28 (28%) samples. *Coagulase-negative Staphylococcus species* were isolated in 8 (8%) samples, and *Klebsiella pneumoniae* was found in 6 (6%) samples. *Methicillin-resistant Staphylococcus aureus* was isolated in 4 (4%) samples. Pseudomonas aeruginosa is the predominant organism, likely due to its competitive survival against other pathogens, minimal nutritional requirements, relative antibiotic resistance, arsenal of antibacterial agents—pyocyanin and bacteriocin—and preference for moist environments.[10,13] Hiremath B et al. report analogous findings, identifying Pseudomonas aeruginosa (38.79%) as the predominant aerobic bacterium, succeeded by Staphylococcus aureus (32.75%) and methicillin-resistant Staphylococcus aureus (5.17%).[13] Shilpa C et al. similarly reported that Pseudomonas aeruginosa was the most frequently isolated bacterium (49%), followed by Staphylococcus aureus (18%).10 Comparable observations were conducted by Wan Draman et al. and Kombade SP et al.[8,12]

In our study of 100 patients, *Pseudomonas aeruginosa* demonstrated the highest sensitivity to Ciprofloxacin (47%), followed by Ceftazidime (45%), Imipenem (45%), Meropenem (42%), Gentamycin (42%), and Cefepime (42%). However, *Pseudomonas aeruginosa* showed resistance to other commonly used antibiotics, including Ampicillin, Chloramphenicol, and Cotrimoxazole. In a study conducted by Hiremath B et al, Pseudomonas aeruginosa exhibited the highest sensitivity to piperacillin (91.11%), followed by gentamicin (71.11%) and amikacin (71.11%). It demonstrated moderate sensitivity to ceftazidime (51.11%) and resistance to carbapenem (60%).Thirteen A study conducted by Rangaiah ST et al. revealed that Pseudomonas aeruginosa exhibited greater sensitivity to Piperacillin (88.09%), Tazobactam (88.09%), Meropenem (80.95%), and Ciprofloxacin (73.8%).Three The diminished susceptibility to antibiotics such as imipenem and meropenem may be ascribed to the improper utilisation of more potent antibiotics in healthcare settings.

In our study of 100 patients, Methicillin-sensitive Staphylococcus aureus was most sensitive to Vancomycin (100%) and Linezolid (100%), followed by Chloramphenicol (96.2%), Amikacin (88.9%), and Doxycycline (88.9%). In a study conducted by Hiremath B et al, Staphylococcus aureus exhibited the highest sensitivity to erythromycin (71.05%), followed by cotrimoxazole (63.15%) and ampicillin (55.26%). Maximum resistance was recorded for ciprofloxacin (78.9%), followed by amoxiclave (55.26%).[13]A study conducted by Rangaiah ST et al. revealed that Staphylococcus exhibited greater sensitivity to linezolid (86.04%), cefoxitin (55.81%), and erythromycin (51.16%).[3]

The antibiotic sensitivity patterns observed in various studies indicate that antibiotic efficacy differs across geographical regions, underscoring the necessity of developing localised antibiotic policies to mitigate the potential risk of complications through the prompt initiation of suitable treatment.

## CONCLUSION

The rise of antibiotic resistance is increasingly prevalent due to the indiscriminate and improper utilisation of antibiotics in the current era of swift development of novel antibiotics. The premature

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cessation of antibiotics by patients with chronic suppurative otitis media may enable partially resistant microbes to proliferate. This practice should be dissuaded through effective health education. Understanding the spectrum of microorganisms and their antibiotic susceptibility is crucial for effective treatment.

Our findings underscore the significance of regular assessment of microbiological patterns and antibiotic susceptibility of isolates. This aids in the development of a local antibiotic policy for the judicious use of antibiotics in chronic suppurative otitis media, thereby mitigating the potential risk of complications through the prompt initiation of suitable treatment. This serves as a guideline for empirical antibiotic therapy in the absence of a formulated antibiotic policy and for commencing empirical treatment until the final antibiotic sensitivity report is obtained.

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