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Research Article

Bacteriological Profile and Antibiotic Susceptibility Pattern of Chronic Suppurative Otitis Media: A Cross-Sectional Study from a Tertiary Care Center

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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) is a common cause of hearing loss, especially in developing countries, with changing bacterial patterns and rising antimicrobial resistance.
Aim: To determine the bacteriological profile and antibiotic susceptibility pattern of CSOM.
Methods: This cross-sectional study included 100 clinically diagnosed CSOM cases over one year at a tertiary care center. Aural swabs were collected and processed for aerobic culture, and antibiotic susceptibility testing was performed using the Kirby–Bauer method as per CLSI guidelines.
Results: Culture positivity was 94.23%, with Gram-negative organisms (54.80%) predominating. Pseudomonas aeruginosa (31.48%) was the most common isolate, followed by Staphylococcus aureus (29.62%). MRSA accounted for 38.70% of S. aureus, while 34.54% of Gram-negative isolates were ESBL producers. High sensitivity was observed to imipenem and amikacin among Gram-negative bacteria, and to vancomycin and linezolid among Gram-positive bacteria.
Conclusion: CSOM is mainly caused by Pseudomonas aeruginosa and Staphylococcus aureus. Increasing antimicrobial resistance highlights the importance of culture-based therapy and regular surveillance.

Keywords: *Chronic suppurative otitis media, bacteriology, antibiotic susceptibility, Pseudomonas aeruginosa, MRSA, ESBL.*

INTRODUCTION

Chronic suppurative otitis media (CSOM) is defined as a long-standing inflammation of the middle ear cleft characterized by tympanic membrane perforation and persistent or recurrent ear discharge lasting more than 6–12 weeks [1]. It is a disease of multifactorial etiology and is well known for its persistence and recurrence despite adequate treatment [2].

CSOM is broadly classified into tubotympanic (safe) and attico-antral (unsafe) types based on the presence or absence of cholesteatoma, with each type differing in bacteriology and clinical behavior [3]. The disease commonly results from inadequately treated acute otitis media or recurrent middle ear infections, leading to chronic inflammation and structural damage [4].

Otitis media is one of the most common childhood illnesses worldwide, particularly affecting children under two years of age. Early onset of infection predisposes to recurrent episodes and progression to chronic disease [5]. Hearing impairment

associated with CSOM significantly affects speech development, language acquisition, and academic performance, thereby contributing to long-term educational and social disadvantages [6].

The burden of CSOM is disproportionately higher in developing countries due to poor socioeconomic conditions, overcrowding, malnutrition, and inadequate healthcare access [7]. Environmental and host factors such as eustachian tube dysfunction, recurrent upper respiratory infections, and immunological deficiencies further contribute to the pathogenesis of the disease [8].

Microbiologically, CSOM is predominantly associated with aerobic bacteria such as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Proteus spp.*, *Klebsiella spp.*, and *Escherichia coli*, although anaerobic bacteria and fungi may also play a role [9–11]. Among these, *Pseudomonas aeruginosa* is particularly implicated in persistent and destructive infections due to its virulence factors and antibiotic resistance mechanisms [12].

The indiscriminate and irrational use of antibiotics has led to changes in the microbial flora and increased antimicrobial resistance, making empirical treatment increasingly challenging [13]. Therefore, knowledge of the local bacteriological profile and antibiotic susceptibility pattern is essential for selecting appropriate therapy and improving treatment outcomes [14].

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Otorhinolaryngology (ENT), P.B.M. Hospital, with microbiological analysis carried out in the Department of Microbiology, Sardar Patel Medical College, Bikaner, Rajasthan, over a period of one year from 1st December 2023 to 30th November 2024 . A total of 100 clinically diagnosed cases of chronic suppurative otitis media (CSOM) were included in the study. Patients of all age groups and both sexes presenting to the ENT outpatient and inpatient departments with complaints of ear discharge were enrolled. Only those patients who fulfilled the inclusion criteria were included, while those who had received systemic or topical antibiotics prior to presentation were excluded from the study .

Detailed clinical and demographic data, including age, sex, residential address, and duration of illness, were recorded using a structured proforma. Aural discharge samples were collected under strict aseptic precautions. The external auditory canal was cleaned with sterile cotton followed by 70% alcohol and allowed to dry. Using a sterile speculum, two sterile cotton swabs were carefully introduced into the middle ear without contaminating the external auditory canal. One swab was used for Gram staining, while the other was used for culture, and both samples were immediately transported to the microbiology laboratory for further processing .

Direct microscopy was performed using Gram staining to identify pus cells, epithelial cells, and the morphology of organisms. Samples showing more than five epithelial cells were considered contaminated and were repeated. The second swab was inoculated onto blood agar, MacConkey agar, and Brain Heart Infusion (BHI) broth, followed by incubation at 37°C for 24–48 hours under aerobic conditions. In cases where no growth was observed on solid media but turbidity was present in BHI broth, subculture was performed. Identification of bacterial isolates was based on colony morphology, Gram staining, motility testing, enzymatic reactions such as catalase, oxidase, and coagulase, and standard biochemical tests. Gram-negative bacilli were further identified using tests including indole, methyl red, citrate utilization, urease, phenylalanine deaminase, triple sugar iron test, and sugar fermentation tests (glucose, lactose, and sucrose). Gram-positive cocci were identified using catalase, coagulase, mannitol fermentation, and bacitracin sensitivity tests .

Antibiotic susceptibility testing was performed using the modified Kirby-Bauer disc diffusion method on Mueller-Hinton agar as per CLSI guidelines. A standardized inoculum equivalent to 0.5 McFarland turbidity was prepared, and lawn culture was done before placing antibiotic discs aseptically. The plates were incubated at 37°C for 24 hours, after which the zones of inhibition were measured and interpreted as sensitive or resistant. The antibiotics tested included erythromycin, co-trimoxazole, gentamicin, ciprofloxacin, oxacillin, amoxiclav, linezolid, and vancomycin for Gram-positive organisms, and tetracycline, ciprofloxacin, cefotaxime, amikacin, amoxiclav, ceftazidime, netilmicin, and imipenem for Gram-negative organisms. For *Pseudomonas* species, antibiotics such as piperacillin, amikacin, ceftazidime, and imipenem were also included. In cases where isolates showed resistance to first-line antibiotics, second-line drugs were tested using the same procedure.

RESULTS

A total of 100 clinically diagnosed cases of chronic suppurative otitis media (CSOM) were included in the study. The majority of patients belonged to the age group of 11–20 years (29%), followed by 21–30 years (22%) and 0–10 years (21%). Males (52%) were slightly more affected than females (48%), with a male-to-female ratio of 1.08:1 .

Table 1: Age and Sex Distribution of Patients

Age Group (Years)	Male	Female	Total (%)
0–10	14	7	21 (21%)
11–20	17	12	29 (29%)

21–30	8	14	22 (22%)
31–40	3	8	11 (11%)
41–50	1	3	4 (4%)
51–60	5	1	6 (6%)
>60	4	3	7 (7%)
Total	52	48	100

Most patients were from rural areas (67%), compared to urban areas (33%). Seasonal variation showed that the highest number of cases occurred during November to February (64%) .

Table 2: Area-wise Distribution

Area	Number of Cases	Percentage
Rural	67	67%
Urban	33	33%
Total	100	100%

Table 3: Seasonal Distribution

Season (Months)	Cases	Percentage
March–June	11	11%
July–October	25	25%
November–February	64	64%
Total	100	100%

The left ear was more commonly affected (50%), followed by the right ear (46%), while bilateral involvement was seen in 4% of cases .

Table 4: Laterality of Ear Involvement

Side	Cases	Percentage
Left	50	50%
Right	46	46%
Bilateral	4	4%
Total	100	100%

A total of 104 culture samples (including bilateral cases) were analyzed. Gram-negative organisms predominated (54.80%), followed by Gram-positive organisms (35.57%) .

Table 5: Gram Reaction of Isolates

Gram Reaction	Number	Percentage
Gram-negative	57	54.80%
Gram-positive	37	35.57%
Mixed	4	3.84%
No growth	6	5.76%
Total	104	100%

Most cases showed monomicrobial growth (90.38%), while polymicrobial growth was seen in 3.84% cases.

Table 6: Culture Characteristics

Type of Growth	Number	Percentage
Monomicrobial	94	90.38%
Polymicrobial	4	3.84%
No growth	6	5.76%
Total	104	100%

Among isolates, *Pseudomonas aeruginosa* (30.76%) was the most common organism, followed by *Staphylococcus aureus* (29.80%) .

Table 7: Distribution of Bacterial Isolates (Single Isolates)

Organism	Number	Percentage
Pseudomonas aeruginosa	32	30.76%
Staphylococcus aureus	31	29.80%
Klebsiella pneumoniae	11	10.57%
Proteus mirabilis	7	6.73%
Enterococcus faecalis	4	3.84%
CONS	3	2.88%
E. coli	2	1.92%
Citrobacter freundii	2	1.92%
Others	2	1.92%

No growth	6	5.76%

When total isolates (including mixed infections) were considered, *Pseudomonas aeruginosa* remained the most common (31.48%).

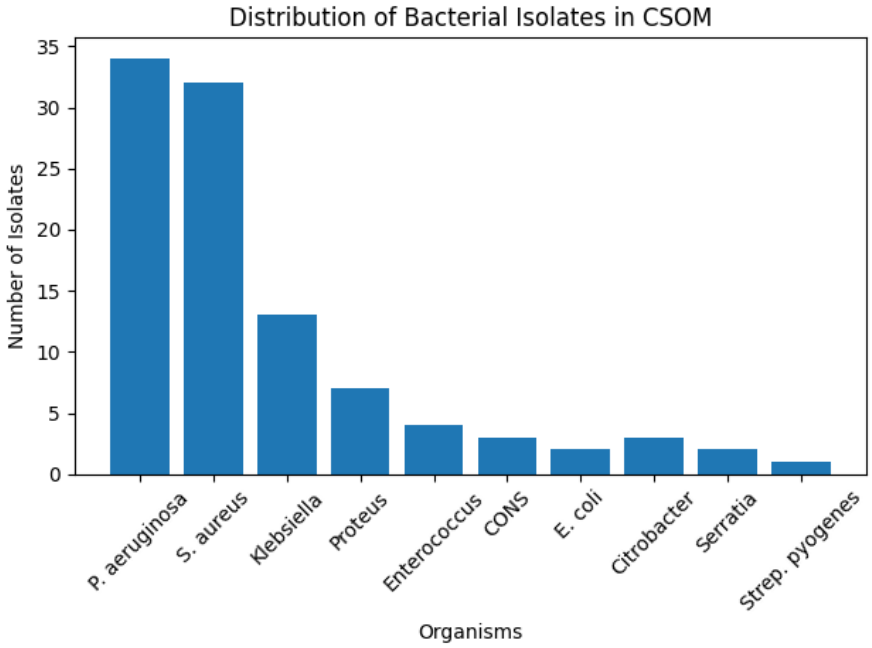

Figure 1: Distribution of bacterial isolates in chronic suppurative otitis media. *Pseudomonas aeruginosa* was the most common isolate followed by *Staphylococcus aureus*, with other organisms contributing to a smaller proportion.

Table 8: Total Isolates (Single + Mixed)

Organism	Number	Percentage
Pseudomonas aeruginosa	34	31.48%
Staphylococcus aureus	32	29.62%
Klebsiella pneumoniae	13	12.03%
Proteus mirabilis	7	6.48%
Others	Remaining	—

Among *Staphylococcus aureus*, 38.70% were MRSA.

Table 9: MRSA Distribution

Type	Number	Percentage
MRSA	12	38.70%
MSSA	19	61.29%

Among Gram-negative isolates, 34.54% were ESBL producers.

Table 10: ESBL Production

Type	Number	Percentage
ESBL Producers	19	34.54%
Non-ESBL	36	65.45%

Antibiotic sensitivity testing showed that Gram-positive organisms were highly sensitive to vancomycin and linezolid, while Gram-negative organisms showed maximum sensitivity to amikacin and imipenem .

Table 11: Antibiotic Susceptibility Pattern of Gram-Positive Isolates

Antibiotic	*Staphylococcus aureus* (n=31)	CONS (n=3)	*Enterococcus faecalis* (n=4)	*Streptococcus pyogenes* (n=1)
Ampicillin	0% S / 100% R	66.7% S	50% S	100% S
Amoxyclav	64.5% S	100% S	100% S	100% S
Ciprofloxacin	51.6% S	66.7% S	50% S	100% S
Cotrimoxazole	32.3% S	66.7% S	0% S	0% S
Gentamicin	71.0% S	100% S	100% S	100% S
Erythromycin	32.3% S	100% S	75% S	100% S
Linezolid	93.5% S	100% S	100% S	100% S
Oxacillin	61.3% S	100% S	100% S	100% S
Vancomycin	100% S	100% S	75% S	100% S

Table 12: Antibiotic Susceptibility Pattern of *Pseudomonas aeruginosa*

Antibiotic	Sensitivity (%)
Amikacin	100%
Imipenem	100%
Piperacillin	68.75%
Ceftazidime	62.5%
Cefotaxime	56.25%
Ciprofloxacin	56.25%
Amoxyclav	56.25%
Tetracycline	50%

Table 13: Antibiotic Susceptibility Pattern of Gram-Negative Isolates (Excluding Pseudomonas)

Organism	Amikacin	Amoxyclav	Ciprofloxacin	Cefotaxime	Ceftazidime	Imipenem	Tetracycline
Klebsiella pneumoniae (n=11)	72.7%	18.2%	18.2%	72.7%	63.6%	100%	54.5%
Proteus mirabilis (n=7)	100%	71.4%	28.6%	71.4%	85.7%	100%	14.3%
E. coli (n=2)	100%	50%	50%	50%	50%	100%	50%
Citrobacter freundii (n=1)	100%	50%	50%	100%	50%	100%	50%
Serratia marcescens (n=1)	100%	100%	0%	100%	100%	100%	0%

Table 14: Antibiotic Susceptibility Pattern of MRSA Isolates

Antibiotic	Sensitivity (%)
Vancomycin	100%
Linezolid	90.62%
Gentamicin	75%
Amoxyclav	78.12%
Oxacillin	59.37%
Ciprofloxacin	28.13%
Erythromycin	59.38%
Cotrimoxazole	28.12%
Ampicillin	0%

Table 15: Antibiotic Susceptibility Pattern of ESBL-Producing Gram-Negative Isolates

Antibiotic	Sensitivity (%)
Imipenem	100%
Amikacin	91.93%
Amoxyclav	67.74%
Cefotaxime	66.12%
Ceftazidime	66.12%
Tetracycline	66.12%
Ciprofloxacin	37.09%

Follow-up was completed in 59% of patients, with further management guided by culture and sensitivity reports.

DISCUSSION

The present study was conducted to evaluate the bacteriological profile and antibiotic susceptibility pattern in chronic suppurative otitis media (CSOM), with emphasis on emerging antimicrobial resistance. The findings were compared with previously published studies to assess epidemiological and microbiological trends.

In this study, the highest incidence of CSOM was observed in the age group of 11–20 years (29%), followed by 21–30 years (22%) and 0–10 years (21%). Similar age distribution has been reported by Vijay D et al., Gupta V et al., and Maji PK et al., indicating that CSOM predominantly affects younger individuals [2–4]. This may be attributed to increased susceptibility to upper respiratory tract infections, immature immune response, and anatomical predisposition such as eustachian tube dysfunction.

A slight male predominance (52%) was observed, which is consistent with studies by Alsaimary et al. and Siva Santhi et al. [5,6]. The higher prevalence among males may be related to increased environmental exposure and health-seeking

behavior differences. Additionally, a significantly higher proportion of cases were from rural areas (67%), which correlates with studies by Gupta A et al. and Mohan U et al. [7,8]. Poor hygiene, overcrowding, limited healthcare access, and lack of awareness are important contributing factors in rural populations.

Unilateral involvement was observed in 96% of cases, which is comparable to previous studies reporting unilateral disease in 80–94% of cases [9–11]. The predominance of unilateral disease suggests localized infection, although bilateral involvement, though less frequent, may indicate prolonged or severe disease.

The culture positivity rate in the present study was 94.23%, which is comparable with findings reported by Mahajan et al. (95.35%) and Siva Santhi et al. (97%) [12,6]. High culture positivity indicates the predominance of aerobic bacterial infection in CSOM. Negative cultures (5.76%) may be due to prior antibiotic use, anaerobic organisms, or technical factors. Monomicrobial growth (90.38%) was significantly higher than polymicrobial growth (3.84%), which is in agreement with studies by Pokharnikar S et al. and Khan JA et al. [13,14]. The lower rate of polymicrobial infection in the present study may be attributed to prior antibiotic exposure, which suppresses multiple organisms.

Among the isolates, *Pseudomonas aeruginosa* (31.48%) was the most common organism, followed closely by *Staphylococcus aureus* (29.62%). This pattern is consistent with studies by Ballal M et al., Saurabh V et al., and Hiremath SL et al., which also reported *Pseudomonas* as the predominant pathogen [15–17]. The ability of *Pseudomonas aeruginosa* to survive in moist environments, form biofilms, and develop multidrug resistance contributes to its predominance in CSOM. *Staphylococcus aureus* was the second most common isolate, consistent with earlier studies [18–20].

Other organisms isolated included *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, *Citrobacter spp.*, *Escherichia coli*, and *Serratia marcescens*. These findings are comparable with previous studies, although variations in prevalence may occur due to geographic and environmental differences [21–23]. These organisms act as opportunistic pathogens and contribute to chronic infection.

Antibiotic susceptibility patterns revealed important findings. *Pseudomonas aeruginosa* showed 100% sensitivity to imipenem and amikacin, followed by moderate sensitivity to piperacillin and cephalosporins. Similar findings have been reported by Maji PK et al. and Gulati et al. [4,24]. Gram-negative organisms overall demonstrated high sensitivity to imipenem and amikacin, indicating their continued efficacy as first-line agents in resistant infections.

Among Gram-positive organisms, *Staphylococcus aureus* showed 100% sensitivity to vancomycin and high sensitivity to linezolid (93.54%) and gentamicin (70.96%), while complete resistance to ampicillin was observed. These findings are consistent with earlier studies and highlight the growing resistance to commonly used antibiotics [25].

A significant finding of the present study was the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) (38.70%). This is comparable to studies by Choi et al. and Park DC et al., which reported MRSA prevalence ranging from 28% to 45.9% [26,27]. MRSA isolates showed high sensitivity to vancomycin and linezolid, confirming their role as drugs of choice for resistant Gram-positive infections.

Among Gram-negative isolates, 34.54% were extended-spectrum beta-lactamase (ESBL) producers. ESBL-producing organisms showed maximum sensitivity to imipenem (100%) and amikacin (91.93%), with significant resistance to ciprofloxacin. These findings are comparable with studies by Varsha G et al., Mathur et al., and Tankhiwale et al., which also highlighted the increasing prevalence of ESBL-producing organisms and their resistance patterns [29–31].

Polymicrobial infections were observed in a small proportion (3.84%), with common combinations including *Staphylococcus aureus* with *Pseudomonas aeruginosa*. Similar patterns have been reported in previous studies [2,25]. The variability in antibiotic sensitivity among mixed infections further emphasizes the importance of culture-guided therapy.

Overall, the present study highlights that *Pseudomonas aeruginosa* and *Staphylococcus aureus* remain the predominant pathogens in CSOM. The increasing prevalence of MRSA and ESBL-producing organisms underscores the growing challenge of antimicrobial resistance. These findings emphasize the need for rational antibiotic use, periodic surveillance of resistance patterns, and implementation of culture-based treatment strategies to improve patient outcomes.

CONCLUSION

Chronic suppurative otitis media is predominantly caused by *Pseudomonas aeruginosa* and *Staphylococcus aureus*, with a significant burden of antimicrobial resistance including MRSA and ESBL-producing organisms. Imipenem, amikacin, vancomycin, and linezolid remain highly effective. Culture-guided therapy and regular surveillance of local resistance patterns are essential for optimal management and prevention of complications.

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