



Original Research Article

A STUDY ON MICROBIOLOGICAL PROFILE AND ANTIMICROBIAL SUSCEPTIBILITY PATTERN IN PATIENTS WITH CSOM ATTENDING ENT DEPARTMENT AT A TERTIARY CARE CENTRE

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ABSTRACT

Background: Chronic Suppurative Otitis Media (CSOM) is a common cause of persistent ear discharge and hearing impairment. Identification of causative bacterial and fungal pathogens and their antimicrobial susceptibility is essential for effective treatment and prevention of antimicrobial resistance.

Aims: To identify the microorganisms (Bacterial and Fungal isolates) associated with Chronic Suppurative Otitis Media and their antimicrobial susceptibility pattern of the isolates in patients attending ENT department at a tertiary care center, Mahabubnagar.

Materials and Methods: This was a hospital-based cross-sectional descriptive study conducted to determine the microbiological profile and antimicrobial susceptibility pattern in patients with Chronic Suppurative Otitis Media (CSOM). A total of 100 patients clinically diagnosed with CSOM were included in the study. The study was carried out in the Department of Microbiology in collaboration with the Department of Otorhinolaryngology (ENT) at Government Medical College and associated tertiary care hospital, Mahabubnagar during the period one year from June 2024 to August 2025 after obtaining approval from the Institutional Ethics Committee.

Results: The present study evaluated 100 patients presenting with ear discharge, and the majority of patients belonged to the 21–30 years age group, accounting for 27% of cases, followed by the 31–40 years age group (25%) and 41–50 years age group (19%). Left ear discharge was observed in 38% of cases, while bilateral involvement was seen in 10% of patients. Microbiological culture positivity was observed in 56% of cases, while 44% of samples showed no microbial growth. Antibiotic susceptibility patterns revealed that Gram-positive organisms showed excellent sensitivity to Vancomycin, Linezolid, and Clindamycin, while Gram-negative organisms, particularly *Pseudomonas* species, showed highest sensitivity to carbapenems, third-generation cephalosporins, and aminoglycosides. However, increasing resistance to commonly used antibiotics such as Ciprofloxacin, Erythromycin, and Cotrimoxazole was observed, indicating the need for careful antibiotic selection. Fungal isolates accounted for 6% of cases, with *Candida albicans* and *Aspergillus* species each contributing 3% of total isolates. These findings highlight the role of fungal pathogens in chronic and recurrent ear infections, particularly in patients with prolonged antibiotic exposure.

Conclusion: Routine microbiological culture and antimicrobial susceptibility testing are essential for the effective management of CSOM. Early pathogen identification and targeted antimicrobial therapy improve clinical outcomes, reduce recurrence, and help curb antimicrobial resistance. Continuous

surveillance of microbial trends and rational antibiotic use remain crucial for optimal patient care.

Keywords: Chronic Suppurative Otitis Media, antimicrobial susceptibility, bacterial isolates, fungal pathogens, antimicrobial resistance.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is a disease of multifactorial etiology and is well known for its persistence and tendency to recur despite appropriate treatment.^[1] It continues to be a major public health problem, particularly in developing countries, and remains one of the leading causes of preventable hearing loss. The global burden of CSOM is significant, affecting more than 20 million people worldwide.^[2]

CSOM is defined as a stage of chronic infection of the middle ear cleft, including the Eustachian tube, middle ear, and mastoid, characterized by a non-intact tympanic membrane and persistent or recurrent ear discharge (otorrhea) for at least two weeks or more (WHO, 1996).^[3] In India and other developing nations, CSOM is highly prevalent due to unfavourable socioeconomic and environmental conditions. It is one of the most common chronic diseases affecting infants and children and is an important cause of conductive hearing loss. The infection commonly occurs during the first five years of life, with a peak incidence around two years of age.^[4] If not addressed in a timely manner, the resulting hearing impairment may lead to delayed speech and language development, adversely affecting cognitive and educational outcomes.^[5] Factors such as malnutrition, overcrowding, poor hygiene, inadequate healthcare facilities, and recurrent upper respiratory tract infections significantly contribute to the increased incidence of CSOM in low socioeconomic populations.^[6]

The microbiological profile of CSOM is diverse and varies with geographical region, patient population, and antibiotic usage patterns. Aerobic bacteria are the most frequently implicated pathogens, with *Pseudomonas aeruginosa* and *Staphylococcus aureus* being the most commonly isolated organisms. Other Gram-negative bacilli such as *Proteus* species, *Klebsiella* species, *Escherichia coli*, *Haemophilus influenzae*, and *Moraxella catarrhalis* have also been reported with variable frequency.^[7] Fungal pathogens also play a significant role particularly in chronic and recurrent cases with *Aspergillus* species especially *Aspergillus niger* and *Candida* species being the most commonly isolated fungi.^[8]

If left untreated or inadequately managed, CSOM can lead to a wide range of complications, including persistent otorrhea, mastoiditis, labyrinthitis, and facial nerve paralysis, as well as serious intracranial complications such as meningitis, brain abscess, and lateral sinus thrombosis. Therefore, early diagnosis

and appropriate management are essential to prevent these potentially life-threatening sequelae.^[9]

In recent years, indiscriminate use of broad-spectrum antibiotics, empirical treatment without microbiological guidance, and poor patient compliance have contributed to the emergence of multidrug-resistant organisms, resulting in treatment failure, recurrence, and persistence of infection. Moreover, changes in microbial flora following the widespread use of newer antibiotics highlight the need for periodic evaluation of the causative organisms and their antimicrobial susceptibility patterns.^[1] Knowledge of the local microbiological profile and antibiotic sensitivity is crucial for effective and rational management of patients with chronically discharging ears.

Hence, the present study was undertaken to determine the local pattern of aerobic bacterial and fungal pathogens causing CSOM and to evaluate the antimicrobial susceptibility patterns of aerobic bacterial isolates prevalent in our hospital, with the aim of guiding appropriate antimicrobial therapy and improving patient outcomes.

Aims and Objectives

Aims

To identify the microorganisms (Bacterial and Fungal isolates) associated with Chronic Suppurative Otitis Media and their antimicrobial susceptibility pattern of the isolates in patients attending ENT department at a tertiary care center, Mahbubnagar.

Objectives of the study

1. To isolate and identify the bacterial and fungal pathogens from patients suffering with chronic suppurative otitis media.
2. To study the antimicrobial susceptibility pattern of the isolates.

MATERIALS AND METHODS

Study Design

This was a hospital-based cross-sectional descriptive study conducted to determine the microbiological profile and antimicrobial susceptibility pattern in patients with Chronic Suppurative Otitis Media (CSOM).

Study Setting

The study was carried out in the Department of Microbiology in collaboration with the Department of Otorhinolaryngology (ENT) at Government Medical College and associated tertiary care hospital, Mahabubnagar.

Study Duration

The study duration was one year from June 2024 to August 2025 after obtaining approval from the Institutional Ethics Committee.

Sample Size

A total of 100 patients clinically diagnosed with CSOM were included in the study.

Inclusion Criteria

- Patients presenting with ear discharge irrespective of age, sex and comorbidities.
- Patients who had not received topical, systemic antibiotic or antifungal therapy in the 5 preceding days from the onset of symptoms.
- Patients willing to provide informed consent.

Exclusion Criteria

- Patients with recent ear surgery or with insitu grommet or patients with obstructed middle ear.
- Patients with complications of CSOM.
- Patients not willing to provide any informed consent.

ETHICS COMMITTEE APPROVAL:

Approval was obtained from the institutional ethical committee (IEC) before starting the study and study was conducted from June 2024 to August 2025. IEC certificate number:

GMC/MBNR/IECBMR/AP/05/22/2024.

Clinical Evaluation

A detailed clinical and personal history was obtained using a structured case proforma. Information recorded included duration and nature of ear discharge, hearing loss, laterality, previous treatment history, history of surgery and associated comorbidities.

Otoscopic examination findings were documented.

Sample Collection and Processing

Specimens Collected

□ Pus discharge in the form of two aural swab's was collected.

Sample processing

Part of the first ear discharge swab was used for direct smear and gram staining was done and the rest is used for bacterial culture by inoculating it onto Nutrient agar (Basal media), 5% Sheep Blood agar (enriched media) and Mac Conkey agar (Differential media) and Mannitol salt agar (selective media) (Himedia). The inoculated plates were incubated aerobically at 37°C for 18- 24 hours and observed for colony morphology. If no growth was reported after 24 hours, the plates were further incubated and observed for any growth after 48hrs and then reported.

Identification of Bacterial Isolates (AEROBIC CULTURE)

GRAM POSITIVE COCCI IDENTIFICATION

After 18-24hours of incubation, colonies were examined for size, shape, pigmentation, hemolysis, consistency. Identification of gram positive cocci was performed using standard microbiological techniques based on:

- Gram staining
- Hanging drop method for motility
- Catalase test
- Oxidase test
- Coagulase test

Direct smear examination

Aural swab from Amies transport medium after inoculation into media, a smear was made on a clean glass slide, air dried, heat fixed and stained by Gram stain and observed for morphology of the bacteria, presence of any inflammatory cells. (Konemann text book 7th edition).

For Gram negative bacilli:

The gram negative bacilli were identified based on the following staining methods growth on culture media and biochemical reactions.

- Gram staining
- Hanging drop for motility
- Indole test
- Citrate utilization test
- Urease hydrolysis test
- Triple Sugar Iron (TSI) test
- Nitrate reduction test
- Hugh Leifson oxidative-fermentative test.

On day 3 the bacterial isolates were identified based on culture characteristics and biochemical reactions according to standard microbiological techniques (Mackie & McCartney 14th edition).

Antimicrobial Susceptibility Testing (AST)

Antibiotic susceptibility testing was performed by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar as per standard CLSI guidelines

A bacterial suspension equivalent to 0.5 McFarland standard was prepared and lawn cultured onto Mueller–Hinton agar plates. Antibiotic discs were placed on the surface of Muller Hinton agar and plates were incubated at 37°C for 18-24 hours. Zones of inhibition were measured in millimeter's and interpreted as Sensitive, Intermediate or Resistant according to CLSI criteria.

Antibiotics Tested

For Gram-negative bacilli

- Cotrimoxazole (25 mcg)
- Gentamicin (10mcg)
- Ampicillin (10 mcg)
- Ciprofloxacin (5 mcg)
- Ceftazidime (30 mcg)
- Piperacillin–tazobactam (30/6 mcg)
- Imipenem (10 mcg)
- Meropenem (10 mcg)

For Gram-positive cocci

- Ciprofloxacin (5 mcg)
- Cefotaxime (30 mcg)
- Clindamycin (2 mcg)
- Gentamicin (10 mcg)
- Vancomycin (30 mcg)
- Linezolid (30 mcg)
- Doxycycline (30 mcg)
- Tetracycline (30 mcg)
- Teicoplanin (30 mcg)

Fungal Culture and Identification

The second aural swab was used for KOH mount and then inoculated onto Sabouraud Dextrose Agar with (Gentamicin and chloramphenicol) and without antibiotics. These Sabouraud Dextrose agar tubes

were incubated aerobically at 25–37°C for 48–72 hours. Tubes were examined daily for first week and then weekly fungal growth. The growth was observed for rate of growth, texture, pigmentation and colony morphology on both the obverse and reverse sides.

Lactophenol cotton blue stain

Microscopic identification was done based on Lactophenol cotton blue mount. The colony was picked up with a bent inoculating wire or spud. Teasing was done on clean glass slides with teasing needles with a drop of LPCB and cover slip was placed over it, which was then observed under low power objectives. Based on the microscopic appearance and the colony morphology the isolate was identified and speciation was done.

Gram Stain

Gram staining was done for the identification of yeast and yeast like fungi. Gram positive budding yeast cells were observed on gram stain which were further identified and differentiated based on germ tube test.

Germ Tube Test

A positive germ tube test (formation of germ tube without constriction at base after incubation in human serum at 37°C for 2 hours) was confirmed for *Candida albicans*. Further antifungal susceptibility for yeasts was done based on standard CLSI guidelines.

Antifungal Susceptibility Testing

Disc Diffusion Method

Candida isolates were tested on Mueller–Hinton agar as per CLSI M44A guidelines. A suspension was prepared by picking five colonies of 1mm diameter from a 24-hour old culture of *Candida* species on SDA. Colonies were then inoculated in 5ml of sterile saline, and its turbidity was adjusted to 0.5 McFarland standard visually. A sterile swab was moistened in the inoculum suspension and then the excess fluid was rinsed by rolling the swab on the inside surface of the tube above the fluid surface. The swab was streaked on to the surface of a Muller-Hinton agar with 2% Glucose with Methylene blue plate. And the MHA plate was allowed to air dry and then the antifungal discs were placed on the lawn cultured MHA plate. The plates were incubated at 35°C and read at 24 hours. The antifungal discs used were.

- Fluconazole (25mcg)
- Itraconazole (10mcg)
- Voriconazole (1mcg)
- Amphotericin B (100units)

MHA plates were incubated at 37°C and read at 24 hours. Results were interpreted as Susceptible, Susceptible Dose Dependent (SDD) or Resistant as per CLSI standard guidelines.

Statistical Analysis: Data were entered in Microsoft Excel and analyzed using appropriate statistical software. Descriptive statistics such as frequency and percentage were used to describe the microbiological profile and antimicrobial susceptibility pattern.

RESULTS

Table 1: Age Distribution of Study Participants

Age	Frequency	Percentage
0-10 years	7	7.00%
11-20 years	15	15.00%
21-30 years	27	27.00%
31-40 years	25	25.00%
41-50 years	19	19.00%
51-60 years	4	4.00%
> 60 years	3	3.00%
Total	100	100.00%

The age-wise distribution of the study population showed that the majority of participants belonged to the 21–30 years age group (27%), followed closely by 31–40 years (25%) and 41–50 years (19%).

Participants aged 11–20 years constituted 15% while 7% were in the 0–10 years group. Only a small proportion were in the 51–60 years (4%) and above 60 years (3%) categories.

Table 2: Gender Distribution of Study Participants

Gender	Frequency	Percentage
Male	49	49.00%
Female	51	51.00%
Total	100	100.00%

Among the 100 study participants, females constituted a slightly higher proportion (51%) compared to males (49%).

Table 3: Side of Ear Discharge

Ear discharge	Frequency	Percentage
Right ear	52	52.00%
Left ear	38	38.00%
Bilateral	10	10.00%
Total	100	100.00%

Analysis of the side of ear discharge revealed that right ear involvement was most common, accounting for 52% of cases. Left ear discharge was observed in 38% of participants while bilateral involvement was noted in 10%.

Table 4: Culture Results

Culture Results	Frequency	Percentage
Positive	56	56.00%
Negative	44	44.00%
Total	100	100.00%

Out of the total 100 samples processed, 56% yielded positive culture growth while 44% showed no growth.

Table 5: Organism Isolated

Organism Isolated	Frequency	Percentage
Gram negative Bacilli	22	22.00%
Pseudomonas species	11	11.00%
Klebsiella species	6	6.00%
Escherichia coli	2	2.00%
Proteus	2	2.00%
Acinetobacter species	1	1.00%
Gram Positive Cocci	28	28.00%
Staphylococcus aureus	25	25.00%
CONS	3	3.00%
Fungal isolates	6	6.00%
Candida albicans	3	3.00%
Aspergillus species	3	3.00%

Among the isolates obtained, Gram-positive cocci were most common (28%) followed by Gram-negative bacilli (22%). Staphylococcus aureus was the predominant organism isolated (25%) followed by Pseudomonas species (11%) and Klebsiella

species (6%). Escherichia coli and Proteus species each accounted for 2%, while Acinetobacter species constituted (1%). Fungal isolates were identified in 6% of cases, with Candida albicans and Aspergillus species each contributing 3%.

Table 6: Gram Negative Sensitivity Pattern

Gram negative sensitivity pattern	Pseudomonas species (n=11)		Klebsiella species (n=6)		Escherichiacoli (n=2)		Proteus (n=2)		Acinetobacterspecies (n=1)	
	N	%	N	%	N	%	N	%	N	%
Amikacin	10	90.91%	5	83.33%	2	100.00%	2	100.00%	1	100.00%
Ceftazidime	11	100.00%	6	100.00%	2	100.00%	2	100.00%	1	100.00%
Ciprofloxacin	7	63.64%	4	66.67%	0	0.00%	1	50.00%	0	0.00%
Cotrimoxazole	0	0.00%	2	33.33%	1	50.00%	0	0.00%	0	0.00%
Gentamicin	7	63.64%	4	66.67%	1	50.00%	2	100.00%	1	100.00%
Piperacillin- Tazobactam	10	90.91%	1	16.67%	2	100.00%	0	0.00%	1	100.00%
Meropenem	10	90.91%	6	100.00%	2	100.00%	2	100.00%	1	100.00%

Among Gram-negative organisms, Pseudomonas species showed highest sensitivity to Ceftazidime (100%), Meropenem (90.91%), Amikacin (90.91%), and Piperacillin– Tazobactam (90.91%), while resistance was noted to Cotrimoxazole (0%). Klebsiella species demonstrated complete sensitivity to Meropenem and Ceftazidime (100%), but low sensitivity to Piperacillin–Tazobactam (16.67%).

Escherichia coli and Proteus showed complete sensitivity to Meropenem, Ceftazidime and Amikacin (100%). Acinetobacter species was fully sensitive (100%) to most tested antibiotics except Ciprofloxacin and Cotrimoxazole. Overall carbapenems and third-generation cephalosporins exhibited higher efficacy against Gram-negative isolates.

Table 7: Gram Positive Sensitivity Pattern

Gram positive sensitivity pattern	Staphylococcus aureus (n=25)		CONS (n=3)	
	N	%	N	%
Doxycycline	21	84.00%	3	100.00%
Erythromycin	12	48.00%	3	100.00%
Ciprofloxacin	15	60.00%	2	66.67%
Gentamicin	19	76.00%	3	100.00%
Vancomycin	25	100.00%	0	0.00%
Clindamycin	25	100.00%	2	66.67%
Linezolid	24	96.00%	3	100.00%

Cotrimoxazole	18	72.00%	1	33.33%
Cefoxitin	25	100.00%	3	100.00%

Among Gram-positive organisms, *Staphylococcus aureus* exhibited 100% sensitivity to Vancomycin and Clindamycin, followed by Linezolid (96%) and Doxycycline (84%). Sensitivity to Gentamicin and Cotrimoxazole was 76% and 72% respectively, while Erythromycin showed lower sensitivity

(48%). CONS isolates demonstrated 100% sensitivity to Doxycycline, Erythromycin, Gentamicin, and Linezolid, but showed no sensitivity to Vancomycin. These findings suggest that glycopeptides and oxazolidinones remain highly effective against Gram-positive isolates.

Table 8: Fungal Sensitivity Pattern

Fungal sensitivity pattern	Candida albicans (n=3)	
	N	%
Amphotericin B	3	100.00%
Itraconazole	3	100.00%
Fluconazole	3	100.00%
Voriconazole	3	100.00%

All *Candida albicans* isolates (100%) were sensitive to Amphotericin B, Itraconazole, Fluconazole, and Voriconazole. This indicates excellent antifungal susceptibility among the fungal isolates identified in the study.

DISCUSSION

The present study was conducted to evaluate the microbiological profile and antimicrobial susceptibility pattern of ear discharge among 100 patients presenting with clinical features suggestive of ear infection. Ear infections particularly those associated with ear discharge remain a significant public health concern due to their high prevalence, potential to cause hearing impairment and risk of serious complications if left untreated or inadequately managed. Identification of the causative organisms and their antibiotic sensitivity patterns is crucial for guiding appropriate antimicrobial therapy, reducing morbidity, and preventing the emergence of antimicrobial resistance.

The findings of this study provide valuable information regarding the microbial etiology and antimicrobial susceptibility patterns of ear discharge. These findings emphasize the importance of microbiological evaluation and antibiotic sensitivity testing in guiding appropriate treatment, preventing complications such as chronic infection and hearing loss, and minimizing the development of antimicrobial resistance. The study also highlights the need for rational use of antibiotics and continuous surveillance of microbial patterns to ensure effective management of ear infections.

Age Distribution

In the present study, the majority of patients belonged to the 21–30 years age group (27%), followed by 31–40 years (25%) and 41–50 years (19%). Paediatric cases aged 0–10 years constituted 7%, while elderly patients above 60 years accounted for only 3% of the study population. The higher incidence observed among young adults may be attributed to increased environmental exposure,

occupational hazards and frequent water exposure, all of which predispose individuals to ear infections. Furthermore, individuals in this age group are more likely to seek medical attention, contributing to higher reporting rates. The relatively lower incidence in elderly individuals may be due to reduced exposure to risk factors or underreporting. These findings are consistent with several previous studies. Arshad et al.^[10] reported a mean patient age of 33 ± 9.5 years, with the majority between 25 and 40 years. Similarly, Nair G et al.^[11] observed a mean age of 39 years, with the highest proportion in the 31–40 years age group (24%). Singh et al.^[12] reported that 43.57% of patients were in the 21–40 years age group, supporting the predominance of young adults.

However, some studies have demonstrated a higher prevalence in younger age groups. Goyal et al.^[13] reported 35.38% of patients below 20 years, and Jain et al.^[14] found the highest incidence in the 11–20 years age group (23.57%). These variations may be attributed to differences in study population, geographic location, environmental exposure, and healthcare-seeking patterns. Overall, the present study aligns with the majority of literature showing a predominance of ear infections among young adults.

Gender Distribution

The present study showed a nearly equal gender distribution, with females constituting 51% and males 49% of cases indicating a slight female predominance. This near equal distribution suggests that ear infections affect both sexes almost equally. The slight female predominance observed in this study may be attributed to differences in hygiene practices.

Previous studies have reported variable gender distribution. M Arshad et al.^[10] reported male predominance, with 56.4% males and 43.6% females. Similarly, Singh et al.^[62] observed 67.05% males and 32.94% females, while Goyal et al.^[13] reported 59.2% males and 40.8% females. Jain et al.^[14] also found male predominance, with 58.60% males and 41.40% females. Harshika et al.^[1]

reported 53.07% males and 46.92% females, further supporting male predominance in their study. In contrast, Nair G et al,^[11] reported a nearly equal distribution, with 52% males and 48% females, which is comparable to the findings of the present study.

Side of Ear Involvement

In the present study, right ear discharge was observed in 52% of patients, left ear discharge in 38% and bilateral involvement in 10% of cases. The predominance of unilateral ear discharge, particularly in the right ear, may be incidental or related to behavioural factors such as sleeping position, handedness, or habitual ear manipulation. The relatively lower incidence of bilateral involvement suggests that ear infections typically begin as a localized process and may later progress if untreated.

Similar findings have been reported in previous studies. M Arshad et al,^[10] reported that 86.36% of cases had unilateral involvement, indicating a clear predominance of unilateral disease. Singh et al,^[12] also observed unilateral CSOM in 65.88% of patients, with left ear involvement seen in 58.93% of cases. Nair G et al,^[11] reported right ear discharge in 74% of patients and left ear discharge in 26%, with no bilateral cases observed. These findings are consistent with the present study and support the observation that unilateral ear involvement is more common than bilateral disease. The predominance of one ear over the other varies across studies and may be influenced by environmental, behavioural and anatomical factors.

Culture Positivity Rate

In the present study, culture positivity was observed in 56% of cases, while 44% of samples showed no microbial growth. This culture positivity rate is comparable to the findings of Arshad et al,^[10] who reported bacterial isolates in 52.7% of samples, indicating a similar prevalence of microbiologically confirmed ear infections. Likewise, Nair G et al,^[11] reported a culture positivity rate of 58%, which closely aligns with the present study, suggesting consistency in microbial detection rates across different populations.

However, Singh et al,^[12] reported a significantly higher overall culture positivity rate, with 72.94% of samples showing monomicrobial growth and an additional 16.47% demonstrating polymicrobial growth, resulting in a much lower proportion of cases culture negative (9.41%). Also, Jain et al.^[14] reported a higher culture positive cases in 84.71% of cases. The higher culture positivity observed in their study may be attributed to differences in sample collection techniques, laboratory methods, or inclusion of polymicrobial infections, which increases the likelihood of detecting microorganisms. Similarly, variations in geographic location, patient population, environmental factors, and prior antibiotic use may influence culture yield. Overall, the culture positivity rate observed in the present study is consistent with several published

studies and supports the importance of microbiological evaluation in identifying causative pathogens.

Microbiological Profile of Isolates

Bacterial isolates

In the present study, Gram-positive cocci were the predominant isolates, accounting for 28% of cases, with *Staphylococcus aureus* being the most common organism (25%), followed by coagulase-negative *Staphylococci* (3%).

Gram-negative bacilli accounted for 22% of isolates, with *Pseudomonas* species being the most common Gram-negative organism (11%), followed by *Klebsiella* species (6%), *Escherichia coli* (2%), *Proteus* species (2%) and *Acinetobacter* species (1%). The predominance of *Staphylococcus aureus* in the present study highlights its significant role as an etiological agent in ear infections likely due to its ability to colonize the external auditory canal, produce various virulence factors such as toxins and enzymes, and form biofilms that enhance bacterial survival and persistence within host tissues.

Although *Staphylococcus aureus* was the most common isolate in the present study, the overall microbiological profile is largely consistent with findings from other studies where *Pseudomonas* species and *Staphylococcus aureus* were the two most predominant pathogens with only slight variations in their relative frequencies. Arshad et al,^[10] reported *Pseudomonas* species as the most common isolate (30.9%), followed by *Staphylococcus aureus* (14.5%), with other Gram-negative organisms such as *Escherichia coli* (4.5%) and *Klebsiella* species (2.7%) contributing to a smaller proportion of cases.

Similarly, Singh et al,^[12] reported *Pseudomonas* species as the predominant isolate (40.45%), closely followed by methicillin-sensitive *Staphylococcus aureus* (38.20%) indicating that both organisms were major contributors to ear infections with only a difference in relative predominance. These findings suggest that *Pseudomonas* and *Staphylococcus aureus* consistently remain the two most important pathogens in ear infections across different study populations.

These findings across multiple studies demonstrate a consistent pattern in which *Pseudomonas* species and *Staphylococcus aureus* together account for the majority of ear infections, with variations mainly in their relative proportions rather than in the types of organisms present.

The slightly higher prevalence of *Staphylococcus aureus* compared to *Pseudomonas* species in the present study may be attributed to differences in geographic location, environmental conditions, patient population and healthcare practices.

Fungal isolates

Fungal isolates were identified in 6% of cases with *Candida albicans* and *Aspergillus* species each accounting for 3% of the total isolates. The presence of fungal pathogens indicates that fungi also play a role in the etiology of ear infections, particularly in

chronic or recurrent cases. Fungal infections of the ear may occur as primary infections or more commonly as secondary infections following prolonged use of broad-spectrum antibiotics, which disrupt the normal microbial flora and create favorable conditions for fungal overgrowth. Fungal otitis is often associated with chronic inflammation, prolonged antibiotic therapy and immunocompromised states, and may contribute to persistent symptoms and delayed healing.

The study findings are comparable with other studies who reported fungal pathogens as an important cause of ear infections. Jain et al,^[14] reported fungal isolates including *Aspergillus Niger* (44.44%), *Candida albicans* (38.89%), and *Candida nonalbicans* species (16.67%), while Harshika et al,^[1] reported *Aspergillus Niger* (6.47%), *Aspergillus flavus* (2.87%), and *Candida albicans* (4.31%) as the common fungal isolates. Goyal et al,^[13] reported *Aspergillus Niger* (33.33%) and *Aspergillus flavus* (33.25%) as the most common fungal isolates.

Antibiotic Sensitivity Pattern of Gram-Positive Organisms

In the present study, Gram-positive organisms, particularly *Staphylococcus aureus* demonstrated a favourable susceptibility pattern to several antibiotics. *Staphylococcus aureus* showed 100% sensitivity to Vancomycin and Clindamycin, indicating that these antibiotics remain highly effective against Gram-positive infections. High sensitivity was also observed with Linezolid (96%) and Doxycycline (84%) indicating their continued effectiveness as therapeutic options. Moderate sensitivity was noted with Gentamicin (76%) and Cotrimoxazole (72%), suggesting that these antibiotics may still be useful in selected cases based on susceptibility results. However, lower sensitivity was observed with Ciprofloxacin (60%) and Erythromycin (48%), indicating the development of resistance to these commonly used antibiotics.

Coagulase-negative *Staphylococci* (CONS), although isolated in smaller numbers, demonstrated high sensitivity to Doxycycline, Erythromycin, Gentamicin, and Linezolid (100%) and moderate sensitivity to Ciprofloxacin and Clindamycin (66.67%). However, CONS showed no sensitivity to Vancomycin in the present study.

These findings are consistent with those reported by Arshad et al,^[10] who observed 100% sensitivity of *Staphylococcus aureus* to amoxicillin/clavulanate, methicillin, ceftriaxone, meropenem, vancomycin, and doxycycline while lower sensitivity was observed with Moxifloxacin (56.2%).

Similarly, Singh et al,^[12] reported very high sensitivity of methicillin-sensitive *Staphylococcus aureus* to amikacin (97%); gentamicin (81%); amoxicillin-clavulanic acid (91%); linezolid (92%) and 100 % susceptible to meropenem and Imipenem. which closely correlates with the present study findings.

Antibiotic Sensitivity Pattern of Gram-Negative Organisms

In the present study, *Pseudomonas* species showed the highest sensitivity to Ceftazidime (100%), followed by Meropenem (90.91%), Amikacin (90.91%) and Piperacillin–Tazobactam (90.91%). Moderate sensitivity was observed with Gentamicin (63.64%) and Ciprofloxacin (63.64%), while complete resistance was noted to Cotrimoxazole (0%). Similarly, other Gram-negative organisms such as *Klebsiella*, *Escherichia coli* and *Proteus* species demonstrated excellent sensitivity to Meropenem, Ceftazidime and Amikacin, further emphasizing the superior efficacy of carbapenems, third-generation cephalosporins, and aminoglycosides against these pathogens. These antibiotics are known for their broad-spectrum activity, ability to inhibit bacterial cell wall synthesis, and resistance to beta-lactamase enzymes produced by Gram-negative organisms, which contributes to their high effectiveness. The consistent sensitivity of these organisms to higher-generation antibiotics observed in the present study suggests that these agents remain the most effective therapeutic options for treating Gram-negative infections of the ear.

These findings are comparable with the study by Arshad et al,^[10] who reported that *Pseudomonas* species showed 100% sensitivity to Piperacillin–Tazobactam, similar to the high sensitivity observed in the present study. They also reported excellent sensitivity of Gram-negative organisms to Meropenem and third-generation cephalosporins, supporting the continued effectiveness of these antibiotics.

Likewise, Singh et al,^[12] reported that *Pseudomonas* species showed 100% sensitivity to Colistin and Imipenem, and very high sensitivity to Amikacin (97%), Meropenem (93%), Gentamicin (95%), and Ciprofloxacin (92%) which closely correlates with the high sensitivity observed to carbapenems and aminoglycosides in the present study.

Similarly, Goyal et al,^[13] reported that Gram-negative bacilli showed highest sensitivity to Meropenem (95.45%), Amikacin (91%) and Netilmicin (91%), while *Pseudomonas* species demonstrated excellent sensitivity to Imipenem (98.3%). These findings are consistent with the present study, where carbapenems and aminoglycosides showed the highest efficacy.

Overall, consistent findings across multiple studies indicate that carbapenems, aminoglycosides, and third-generation cephalosporins remain the most effective antibiotics against Gram-negative organisms causing ear infections, while resistance to fluoroquinolones and Cotrimoxazole is increasing.

Antifungal Sensitivity Pattern

The antifungal susceptibility pattern observed in the present study demonstrated excellent sensitivity of fungal isolates to all antifungal agents tested. All isolates of *Candida albicans* showed 100% sensitivity to Amphotericin B, Fluconazole,

Itraconazole, and Voriconazole. Amphotericin B, a broad-spectrum antifungal agent, is known for its potent activity against a wide range of fungal pathogens. Similarly, azole antifungal agents such as Fluconazole, Itraconazole, and Voriconazole demonstrated excellent efficacy against *Candida* species. The complete sensitivity observed in the present study suggests that antifungal resistance is currently low among the fungal isolates identified. Similar findings were reported by Jain et al,^[14] who identified fungal isolates in their study. *Candida* showed 100% sensitivity to Amphotericin B and 90% each to Fluconazole, Itraconazole, and Voriconazole.

CONCLUSION

The present study demonstrates that ear infections are most common among young adults, with nearly equal gender distribution and predominantly unilateral involvement. *Staphylococcus aureus* and *Pseudomonas* species were identified as the most common causative organisms, highlighting their major role in the etiology of ear infections. The study also emphasizes the polymicrobial nature of ear infections, with both bacterial and fungal pathogens contributing to disease occurrence. From a clinical perspective, these findings underscore the importance of routine microbiological culture and antibiotic sensitivity testing in the management of ear infections. Early identification of causative organisms and appropriate targeted antimicrobial therapy can improve treatment outcomes, prevent complications, reduce recurrence, and help limit the development of antimicrobial resistance. Carbapenems, aminoglycosides, Vancomycin, and Linezolid remain highly effective therapeutic options and should be reserved for confirmed cases to preserve their efficacy. Rational antibiotic use and continuous surveillance of microbial patterns are essential for effective management of ear infections and prevention of antibiotic resistance.

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