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Burden of Otorrhea: Microbial Profile with AntimicrobialSusceptibility of A Cross-Sectional Study from a Tertiary Care Teaching Hospital

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ABSTRACT

Introduction: Otorrheais a prevalent clinical symptom associated with various forms of ear infections, particularly in developing countries such as India. These infections are a significant cause of morbidity, leading to complications such as hearing loss, especially among children. The microbial etiology of otorrhea is diverse, encompassing bacteria, fungi, and viruses, with the antimicrobial susceptibility of these pathogens evolving due to changes in antibiotic use patterns.

Aim and Objectives: The purpose of this study is to find the burden of otorrhea and its microbial profile with antimicrobial susceptibility patterns of the isolates.

Materials and Methods: This Observational cross-sectional study was carried out in the Department of Microbiology at Central Laboratory, Sharda Hospital, on all the aural discharge(swab) samples received in the bacteriology unit. The Culture preparation and bacterial identification were performed using standard microbiological techniques. Antibiotic susceptibility testing was performed by Kirby-Bauer's disc diffusion method as per the CLSI guidelines 2024guidelines.

Results: A total of 291 patients presenting with aural discharge were included in the study. Of the 291 ear swab samples processed, microbial growth was observed in 222 samples (76.28%), while 69 samples (23.71%) showed no growth. Among the positive cultures, Staphylococcus aureus (33.78%) was the most frequently isolated bacterial pathogen, followed by Pseudomonas aeruginosa (28.82%). Analysis of the antibacterial susceptibility patterns revealed that 22.07% of the Staphylococcus aureus isolates were identified as Methicillin-resistant Staphylococcus aureus (MRSA). Staphylococcus aureus isolates demonstrated a high level of resistance to Penicillin G, and Pseudomonas aeruginosa showed notable resistance to fluoroquinolones and cephalosporins.

Conclusion: The study underscores the evolving microbial profile and antibiotic resistance in aural discharge. Regular surveillance and prudent antibiotic use are crucial for effective management and resistance control, thereby supporting improved clinical outcomes and antimicrobial stewardship in otorrhea.

Keywords: *Otorrhea, Staphylococcus aureus, Pseudomonas aeruginosa, Antibiotic Susceptibility, CLSI guidelines, MRSA*

1. INTRODUCTION

Otorrhea, defined as drainage from the ear, has been a persistent medical challenge since its first description by Hippocrates in 450 BC. Historically, ear infections were recognized for their potential severity, with Hippocrates noting that "Acute ear pain, with continued fever, is to be dreaded, for there is danger that the man may become delirious and die"[1]. Today, ear discharge remains a common clinical presentation worldwide, affecting approximately 65-330 million people globally, with 60% experiencing significant hearing impairment[2].The problem is particularly pronounced in developing countries like India, where the prevalence is estimated to be as high as 11% due to poor socioeconomic conditions, inadequate nutrition, and limited health education[2][3]. The urban-to-rural ratio of the disease is approximately 1:2, with poorer rural communities bearing the highest burden [4].

Otorrhea is a disease of multiple etiologies, primarily caused by bacteria, fungi, viruses, and anaerobes. The bacterial profile commonly includes Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus pneumoniae, Streptococcus pyogenes, Haemophilus influenzae, and Proteus species[5]. Recent studies have highlighted regional variations in the predominant pathogens, with one study from Bangladesh identifying non-typeable Haemophilus influenzae (21%) and Streptococcus pneumoniae (18%) as the most common isolates [6].

Fungal infections, often associated with immunocompromised states, diabetes, corticosteroid use, and unhygienic ear-cleaning practices, typically involve Candida species, Aspergillus species, Rhizopus species, and Penicillium species[7]. Additionally, various anaerobes, including Bacteroides, Peptostreptococcus, Fusobacterium, and Propionibacterium species, contribute to the complex microbial landscape of otorrhea[8].

The significance of studying otorrhea extends beyond its high prevalence. Untreated ear infections can lead to serious complications, including persistent discharge, mastoiditis, facial nerve paralysis, lateral sinus thrombosis, labyrinthitis, meningitis, and brain abscess, which can arise as severe consequences of untreated or inadequately managed ear infections.[9]. Furthermore, ear infections represent a leading cause of preventable hearing loss, with potentially profound impacts on communication, education, and quality of life.

This research aims to characterize the microbial profile of aural discharge and determine antimicrobial susceptibility patterns of isolated organisms. By understanding the evolving nature of these infections and their resistance patterns, clinicians can develop more effective treatment strategies, implement antimicrobial stewardship, and ultimately reduce the burden of otorrhea-related complications.

2. MATERIAL AND METHODS

Study design & Setting: This cross-sectional microbiological study was conducted at the Bacteriology section, Department of Microbiology at Sharda Hospital, a tertiary care center in Greater Noida, India, from December 2023 to December 2024.The study included patients of all age groups who presented with ear discharge at the ENT outpatient and inpatient departments.

Inclusion Criteria: The bacteriological section, Department of Microbiology, Central Laboratory, received all aural discharge (Swab) samples for culture and sensitivity.

Identification & AST: The identification of the recovered microorganisms was carried out by analyzing their colony appearance, microscopic features, growth patterns, and results from various biochemical assays, all in line with standard laboratory protocols. Antimicrobial susceptibility profiles were assessed using the Kirby-Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines 2024.

3. RESULTS

A total of 291 patients with aural discharge were included in this study. The majority of samples were received from the outpatient department, 287(98.6%), while the rest were from the inpatient department, 04(1.3%).The male-to-female ratio was 1.36:1, indicating a slightly higher prevalence among males. The age-wise distribution of the bacterial isolates among different age groups is shown in [Table 01].Of the 291 samples processed, the culture showed growth in 222(76.2%) and showed no growth in 69(23.7%) samples, as shown in [Figure 01].Gram-positive bacteria predominated (54.05%) over gram-negative bacteria (45.04%). The Species distribution of the isolates, among the 222 culture-positive isolates (76.28%), the most frequently identified organisms were Staphylococcus aureus (33.78%), followed by Pseudomonas aeruginosa (28.82%), Coagulase-negative Staphylococcus (18.01%), Proteus mirabilis (6.30%), Escherichia coli (4.95%), Enterococcus faecalis (2.25%), and the least common isolates included Acinetobacter spp. (1.80%) Proteus vulgaris (1.35%), Klebsiella oxytoca (1.35%), Citrobacter koseri (0.45%), and Candida spp. (0.90%) are presented in [Figure 02].

The antimicrobial susceptibility pattern was determined by the disc diffusion method, which assesses the antibiotic susceptibility profile of all bacterial isolates according to CLSI guidelines (2024).Among 75(33.78%) isolates of Staphylococcus aureus,26 isolates (34.66%) were Methicillin-sensitive, and the rest isolates were Methicillin-resistant Staphylococcus aureus 49(65.33%). Staphylococcus aureus [MSSA & MRSA]and Enterococcus spp. were found to be highly sensitive to Linezolid, Teicoplanin, and Vancomycin,completely resistant to Penicillin G and fluoroquinolones as shown in [Table 02]. Coagulase-negative Staphylococcus (18.01%) were reported as skin contaminants.Pseudomonas aeruginosaand Acinetobacter spp. were highly sensitive to Aztreonam and Piperacillin/Tazobactam, Carbapenem, whereas resistant to fluoroquinolones and aminoglycosides depicted in [Table 03]. Proteus spp., Escherichia coli, Klebsiellaoxytoca, and Citrobacter koseri were mostly sensitive to Piperacillin/Tazobactam, Carbapenem, whereas resistant to Fluoroquinolones and 3rd generation Cephalosporins, as depicted in [Table 04].

Table 01. Demographic Parameters(n=291)

Gender	Number	Percentage %	P value
Male	168	57.7	0.092
Female	123	42.2	0.567
Age	**Number**	**Percentage %**	**P value**
<10 years	30	10.30	0.070
11-20	54	18.55	0.232
21-30	81	27.83	0.051
31-40	58	19.93	0.035
41-50	33	11.34	0.160
>50 years	35	12.02	0.086

Figure 01. Distribution based on Gram stain (n=222)

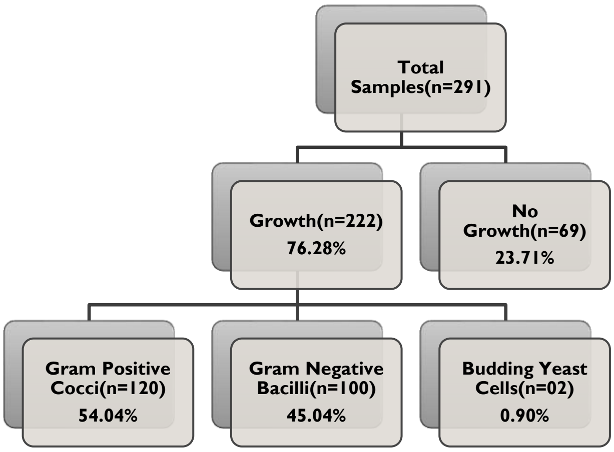

Figure 02: Distribution of the Isolates

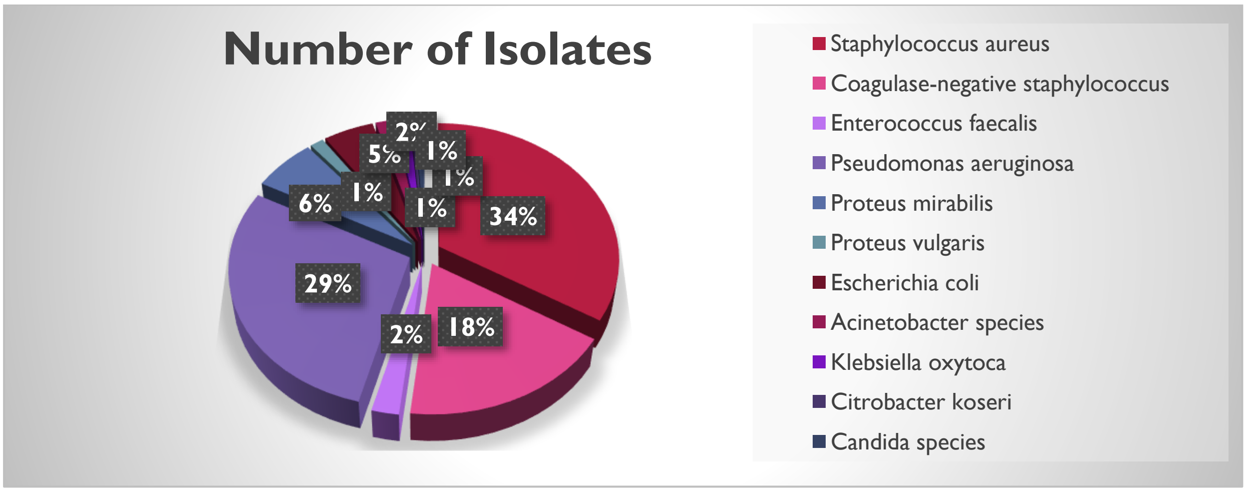

Table 02. Antibiotic susceptibility pattern of Sensitive Gram-positive isolates.

Antibiotics	Staphylococcus aureus(n=75)	Enterococcus faecalis (n=05)
	Sensitive%	**Sensitive%**
Penicillin G	0	03(60)
Ampicillin	NA	03(60)
Cefoxitin	26(34.66)	NA
Vancomycin	75(100)	05(100)
Teicoplanin	71(94.66)	05(100)
Gentamycin	62(82.66)	NA
High-Level Gentamycin	NA	05(100)
High-Level Streptomycin	NA	05(100)
Tetracycline	56(74.66)	01(20)
Erythromycin	22(29.33)	02(40)
Azithromycin	26(34.66)	NA
Clindamycin	35(46.66)	NA
Linezolid	75(100)	05(100)
Ciprofloxacin	07(9.33)	01(20)
Levofloxacin	07(9.33)	03(60)
Cotrimoxazole	63(84)	NA

NA: Nonapplicable

Table 03. Antibioticsusceptibility pattern ofNon-fermenters.

Antibiotics	***Pseudomonas aeruginosa*(n=64)**	***Acinetobacter* spp. (n=4)**
	Sensitive %	**Sensitive%**
Piperacillin-tazobactam	54(84.38)	03(75)
Ceftazidime	45(70.31)	0
Cefepime	49(76.56)	0
Imipenem	48(75)	04(100)
Meropenem	48(75)	04(100)
Aztreonam	54(84.38)	0
Amikacin	43(67.19)	03(75)
Tobramycin	47(73.44)	02(50)
Ciprofloxacin	44(68.75)	0
Levofloxacin	45(70.31)	0
Ceftriaxone	NA	0

Cefotaxime	NA	0
Tetracycline	NA	04(100)
Minocycline	NA	04(100)
Tigecycline	NA	04(100)
Cotrimoxazole	NA	03(75)
Gentamicin	NA	0

NA: Nonapplicable

Table 04.Antibiotic susceptibility pattern in Enterobacterales.

Antibiotics	**Proteus spp (n=17)**	***Escherichia coli* (n=11)**	***Klebsiellaoxytoca*(n=3)**	***Citrobacterkoseri*(n=1)**
	Sensitive%	**Sensitive %**	**Sensitive%**	**Sensitive%**
Ampicillin	41.17	0	33.33	0
Amoxicillin-clavulanate	64.7	36.36	100	0
Piperacillin-tazobactam	100	72.73	100	100
Cefuroxime	29.41	35.29	33.33	100
Ceftriaxone	35.29	9.09	66.66	100
Cefotaxime	41.17	9.09	33.33	100
Ceftazidime	41.17	18.18	66.66	100
Cefepime	41.14	36.36	100	100
Imipenem	100	90.91	100	100
Meropenem	100	90.91	100	100
Aztreonam	82.35	36.36	66.66	100
Gentamicin	58.82	63.64	100	100
Amikacin	70.58	72.73	100	100
Tobramycin	64.7	72.73	100	100
Tetracycline	47.05	54.55	66.66	0
Minocycline	29.41	72.73	100	0
Tigecycline	64.7	90.91	66.66	100
Ciprofloxacin	35.29	9.09	100	100
Levofloxacin	35.29	9.09	100	100
Cotrimoxazole	29.41	27.27	33.33	100

4. DISCUSSION

This study provides valuable insights into the microbial profile and antimicrobial susceptibility patterns of organisms causing otorrhea in a tertiary care facility in Greater Noida, India. The findings have important implications for empirical antimicrobial therapy and infection control practices.

In the present study, among the 291 total cases, 168 (76.28%) males and 123 (23.71%) females were affected with a male-to-female ratio of 1.36:1, which is similar to a study done by Prakash R [10] et al., however, Teele [11] et al., have found female preponderance and accordance to Pavneet Kaur et.al[12]. As the cases in this study were randomly selected, the higher proportion of male patients compared to females may simply be a coincidental observation rather than a true reflection of gender prevalence, which was not statistically significant.

In the current study, the predominance of ear discharge in the 21-30 years age group (27.83%) aligns with other studies that have identified adolescents and young adults as particularly vulnerable to ear infections. This age distribution corresponds with research by Denboba et al., who reported a higher prevalence in similar age groups [13]. The high prevalence in the higher age group may be attributed to low socioeconomic status and poor awareness among patients in villages near the hospital. Age-wise criteria were also not statistically significant.

In the present study, microbial growth was observed in 222 (76.28%) of the 291 swabs used. 69 samples (23.71%) showed no growth. The culture results are found to be correlated with other studies[14,15].Negative culture results may be due to the presence of nonbacterial or anaerobic organisms, prior administration of antibiotics, or the action of antimicrobial substances such as lysozyme, either alone or in conjunction with immunoglobulins, which can inhibit bacterial proliferation.[16,17].The predominance of gram-positive bacteria (54.05%)over gram-negative bacteria (45.04%) reflects the changing microbial landscape of ear infections and aligns with findings from multiple studies across different geographic regions. This observation aligns with the results of certain studies [18], although it differs from the findings reported by other researchers [19].

Staphylococcus aureus (33.78%) emerged as the leading causative organism, followed by Pseudomonas aeruginosa (28.82%),which is consistent with the observations reported by Prakash M et al[20]., as well as Ahmed S. and Shyamala R[21]et al., and this finding corroborates research by several investigators who have consistently identified these two pathogens as primary etiological agents in otorrhea.

The antimicrobial susceptibility testing revealed concerning resistance patterns across various bacterial isolates. In the current study, Staphylococcus aureus isolates demonstrated significant resistance to ciprofloxacin, potentially attributable to inappropriate prescribing, subtherapeutic dosing, and easy over-the-counter access.Conversely, aminoglycosides exhibited the highest effectiveness, with minimal resistance observed. Among the isolates, 49 were identified as methicillin-resistant Staphylococcus aureus (MRSA), all of which showed excellent susceptibility to vancomycin and linezolid, consistent with findings reported by other investigators[22].

Among gram-negative bacteria, Pseudomonas aeruginosa showed variable resistance patterns, with decreased susceptibility to Ciprofloxacin and Amikacin. These findings are consistent with global trends of increasing fluoroquinolone resistance in Pseudomonas isolates. The high susceptibility to Piperacillin-tazobactam and Aztreonam,and Carbapenems suggests these agents remain effective options for severe infections is in accordance with Smitha N R et al [23].

In the present study, Proteus spp., Escherichia coli, and Acinetobacter spps, Klebsiella spp., and Citrobacter spp. - Amikacin, Piperacillin/ Tazobactam, and Carbapenems were found to be equally effective and resistant to Cephalosporins, aminoglycosides (except amikacin), and Fluoroquinolones. These findings are from another study done by K. Pavani, S Krishnamurthy et al[24]. The reason behind this is that aminoglycosides exhibit the lowest resistance rates among Gram-negative bacilli, including Pseudomonas species, likely owing to their infrequent use in clinical practice as a result of concerns regarding ototoxic side effects.

The findings of this study highlight a concerning decline in the efficacy of fluoroquinolones and aminoglycosides against pathogens responsible for ear discharge in our clinical setting. This diminishing susceptibility likely stems from the widespread misuse of antibiotics, including indiscriminate over-the-counter access and suboptimal prescribing practices. To mitigate the rise of multidrug-resistant infections and ensure effective patient care, routine culture and antibiotic sensitivity testing of ear discharge samples must be prioritized. Such measures will enable targeted therapy, reduce reliance on empirical treatment, and prevent complications like hearing impairment or life-threatening intracranial infections.

Furthermore, the observed regional variability in microbial profiles influenced by geographic, demographic, and socioeconomic factorsemphasizes the critical need for ongoing surveillance. Regular updates to local antimicrobial resistance data and pathogen distribution patterns are indispensable for refining empirical treatment guidelines, optimizing antimicrobial stewardship programs, and improving clinical outcomes. These efforts are vital to address the dynamic challenges posed by evolving resistance trends in diverse patient populations.

Proactive monitoring of resistance patterns, coupled with region-specific antimicrobial strategies, is essential to counteract the growing threat of treatment-resistant infections and safeguard public health.

This study underscores the importance of routine antibiotic sensitivity testing for chronic ear infections and regular antibiotic surveillance in hospitals to ensure appropriate antibiotic use and to manage the spread of resistant strains [25,26].

LIMITATION

The study's reliance on a limited sample size may not be representative of the larger population, and future studies could benefit from a more diverse and larger sample.The inability to culture anaerobic, fungal, and viral organisms highlights the need for the development of new culturing techniques or alternative methods for studying these organisms.The limited understanding of antibiotic mechanisms in certain bacteria, such as Non-fermenters and Enterobacterales, underscores the need for further research into the molecular mechanisms underlying antibiotic resistance.

STRENGTH

This study is pioneering in its approach, providing fresh insights into an area that has been largely unexamined in tertiary care hospitals. It makes a substantial contribution to the current body of knowledge and has the potential to enhance the effectiveness of treatment strategies.

5. CONCLUSION

This study reveals the predominance of Staphylococcus aureus and Pseudomonas aeruginosa in aural discharge, along with growing antimicrobial resistance, underscoring treatment challenges. Common antibiotics like fluoroquinolones and cephalosporins show reduced effectiveness, while Piperacillin/tazobactam, Carbapenems, Tetracyclines, Linezolid, and Glycopeptides remain more effective. Given the high burden of otorrhea,public health efforts should prioritize prevention, early diagnosis, hygiene education, and reduced self-medication. Prudent antibiotic use and antimicrobial stewardship are vital to combating resistance and improving outcomes.

DATA AVAILABILITY

All datasets generated or analyzed during this study were included in the manuscript.

ETHICS STATEMENT

The study was approved by the Ethical Committee of the SMR&R and Sharda Hospital. Sharda University, Greater Noida, India, with reference number SU/SMS&R/76-A/2024/302.

DECLARATIONS:

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

Consent to participate: There is consent to participate.

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

Authors' contributions: Each author listed above contributed significantly to carrying out the research

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