Research Article

Microbiological Profile and Drug Sensitivity Pattern in Atticoantral Type Chronic Suppurative Otitis Media (CSOM) Presenting with Intracranial Complications

Irfan Ahmed Shaikh*, Syed Faizan Ali, Qurat ul Ain, Ramsha Khalid, Ramsha Moin, Syed Muhammad Husain Rizvi

Department of ENT-Head & Neck Surgery, Dow University of Health Sciences, Karachi, Pakistan.

Abstract: Background: Chronic Suppurative Otitis Media Atticoantral Disease (CSOM-AAD) involves posterosuperior part of middle ear cleft (attic, antrum and. posterior tympanum and mastoid) and is associated with cholesteatoma, which, because of its bone eroding properties, causes risk of serious complications. A potentially fatal sequalae of CSOM-AAD is its intracranial complications (ICC) which can be life threatening and need to be dealt with caution.

Objective: The aim of the study is to determine the clinical presentation of CSOM-AAD patients with ICC and to evaluate the microbiological composition of the causing organisms and their drug sensitivity pattern.

Materials and Methods: Retrospective descriptive, cross-sectional design study which was conducted in the Department of ENT, head, and neck surgery, DUHS, DMC, Dr. Ruth K.M Pfau Civil Hospital Karachi. The analysis was made on 40 patients presented to in between 1st January 2017 and 31st December 2024 with Atticoantral type CSOM with any of the intracranial complication were included in the study. Inclusion criteria qualifying patients' medical records were examined for pertinent information which include demographic data(age, gender, etc.), clinical background pertaining to intracranial problems and CSOM, microbiological data, such as sensitivity testing and culture results and regimens for treatment.

Result: Out of 40 patients, 22(55%) were male and 18(45%) were female. The most common presenting complaints other than ear discharge were Headache, n= 32(80%) and fever n=30(75%), otalgia 28(70%) while the most frequent intracranial complication was temporal lobe abscess n =15(37.5%). Of all the bacterial isolates n=13 (32.5%) were Gram Positive microorganisms while n= 27(67.5%) were Gram Negative Bacteria. The commonest organism was *Pseudomonas Aeruginosa* n=13 (32.5%) followed by *Proteus Mirabilis* n=11(27.5%). The most sensitive antibiotics against *Pseudomonas Aeruginosa* and *Proteus Mirabilis* were imipenem, meropenem, Piperacillin/tazobactam, linezolid and vancomycin.

Conclusion: Intracranial complications of CSOM are slightly more common in male and in young age group. The most common intracranial complication is Temporal lobe abscess while most common clinical presentations are headache, fever, and ear pain. Most of the issues are brought on by Gram Negative Bacteria. Carbapenem, vancomycin, linezolid and piperacillin/tazobactam offer empirical support for both Gram-Positive Bacteria and Gram- Negative Bacteria.

Keywords: Chronic suppurative otitis media, Atticoantral disease, Cholesteatoma, Microbiological profile, Antibiotic sensitivity, Debris.

INTRODUCTION

The condition known as Chronic Suppurative Otitis Media (CSOM) is characterized by recurrent ear discharge or otorrhea due to tympanic membrane perforation, as well as chronic inflammation of the middle ear and mastoid cavity [1]. The WHO defines Otitis Media as chronic if otorrhea is present for 2 weeks however in most of the clinical practice guidelines by otolaryngologists otorrhea of >3 months is labelled as CSOM [2]. Moreover, in accordance with CSOM, there are 65–330 million people with a worldwide burden of illness, with over 90% of those people being born in Southeast Asia, the Western Pacific, and Africa [3].

On clinical grounds, CSOM can be divided into two types based on the region of tympanic membrane perforation. First one is Tubo-tympanic (mucosal) type, which is considered as benign or safe type of CSOM, involving anteroinferior part of Tympanic membrane causing central perforation. Serious complications are not observed in this variety, while the other one is Attico-Antral Disease (AAD) (squamosal) type, which is considered as dangerous or unsafe type of CSOM, involving antral or attic part of tympanic membrane and associated with marginal perforation. The attico-antral CSOM is associated with serious intracranial complications with an overall prevalence of ICC to be 0.04 to 4% in our population [1, 4]. Also, Tubo-tympanic type of CSOM can be classified on the basis of presence or absence of otorrhea into Active and Inactive CSOM. When the CSOM presents with recurrent bouts of otorrhea, it is regarded as Active CSOM while inactive CSOM presents with dry ear but with

* Address correspondence to this author at the Department of ENT-Head & Neck Surgery, Dow University of Health Sciences, Karachi, Pakistan.
Email: drirfanorl@gmail.com

permanent tympanic perforation. Similarly, active squamous CSOM presents with Tympanic membrane perforation, retained squamous epithelium, debris and pus and cholesteatoma formation. On the contrary, inactive squamous CSOM presents with retracted tympanic membrane liable to undergo cholesteatoma formation [5, 6].

Otorrhea can be caused by Otitis externa, AOM or CSOM. Among all the causes, CSOM has accounted for most cases of otorrhea. It is observed that patients presenting with otorrhea and cholesteatoma formation in CSOM has a higher tendency to develop intracranial complications which can manifest as meningitis, brain abscess, subdural empyema, epidural abscess, lateral sinus thrombophlebitis and otitic hydrocephalus [5]. It can also lead to extracranial complications like temporal osteitis, labyrinthitis facial nerve palsy, mastoiditis, permanent sensorineural hearing loss, etc. Therefore, it is of prime importance to isolate common pathogens from ear discharge in patients with CSOM, and their antibiotic sensitivities.

Several researches to look for the common pathogens isolated from ear discharge in patients with CSOM and their pharmacologic sensitivity and resistance were being conducted in different regions of the world. One such study which was conducted in Pondicherry, India about the microorganisms involved and their antibiotic sensitivity among pediatric patient with cholesteatomatous CSOM and it shows *Pseudomonas aeruginosa* as the most common pathogen (32%) isolated (sensitive to ceftazidime), followed by *Proteus mirabilis* (20%) (sensitive to ceftazidime and ciprofloxacin), and *Staphylococcus aureus* (19%), both MRSA and MSSA were sensitive to vancomycin [7]. Another study from Fudan university, China shows similar results with *Staphylococcus aureus* as the most common pathogen (42.1%) isolated from the patient with CSOM with cholesteatoma and (44.9%) in patients without cholesteatoma, followed by *Pseudomonas aeruginosa* as the second most common pathogen isolated from 16.9% of the cases. All Staph. aureus which was isolated were sensitive to vancomycin and all the *Pseudomonas aeruginosa* were sensitive to piperacillin, piperacillin/tazobactam, and meropenem [8]. A retrospective study on intracranial complications due to CSOM-Atticoantral disease was carried out in Karnataka, India published their study result after isolating the bacteria from ear discharge as well as from the regions of complication. The most common pathogen isolated from ear discharge was Gram negative bacilli *Pseudomonas aeruginosa* responsible for 30% of the cases responding to carbapenem and piperacillin/tazobactam [5].

Based on this literature review, there is limited number of studies present about the pathogens commonly isolated from ear discharge in patients with Atticoantral disease of CSOM with ICC and their sensitivity status, especially in our country and which organisms are more likely to be present in different age groups of people. Therefore, the main target of this study is to find out the common pathogens present in patients of Atticoantral type CSOM with otorrhea and their drug sensitivity and resistance to make the empirical antibiotic therapy more targeted which will be helpful in prevention or at least decreasing the frequency of future serious intracranial complications.

MATERIALS AND METHODS

This was a retrospective, descriptive, cross-sectional design study which was conducted in the department of ENT, head, and neck surgery, DUHS, DMC, Dr. Ruth K.M Pfau Civil Hospital Karachi for two months following the approval of Institution Review Board of Dow University of Health Sciences (IRB-3530/DUHS/EXEMPTION/2024/234, Dated: 27th August 2024). Our inclusion criteria included patients with perforated ear drum and active ear discharge persisting for more than 12 weeks, all those patients who have not received any antibiotic in the past five days were when the sample of pus culture and sensitivity was taken, and we included both genders. The exclusion criteria were individuals who had previously had surgery on the afflicted ear, individuals who identified as having an autoimmune disease or immunodeficiency and patients receiving steroids, chemotherapy, or radiotherapy. All patients with Atticoantral type CSOM and intracranial complications who presented to the ENT Department of Dr. Ruth K. M. Pfau Civil Hospital Karachi between 1st January 2017 to 31st December 2022 were included in the study.

A total of 40 candidates' data was included in the study. The sampling technique was non-probability consecutive sampling. Since all eligible patients who presented throughout the study period were included consecutively this approach was used.

There was no in-person survey because the data was gathered retrospectively from patient medical records. A detailed examination of microbiological lab reports and hospital case files was necessary for the data extraction process.

Relevant variables were extracted from patient records using a pre-made structured data extraction form. Age, gender, clinical presentation, type of intracranial problem, culture and sensitivity results, and antibiotic medication details were all recorded on this form.

STATISTICAL ANALYSIS

SPSS version 26 was used to enter and evaluate the gathered data. Continuous variables were summarized as mean ± standard deviation, and categorical variables as frequencies and percentages using descriptive statistics. The distributions of bacterial isolates, patterns of antibiotic sensitivity, and clinical features were shown in tables and graphs.

RESULT

Total of 40 individual were reviewed retrospectively. Out of those 40 individuals 22 were male and 18 were females in the study population with the average age of population is 33.17 ±13.39 years (Fig. **1**).

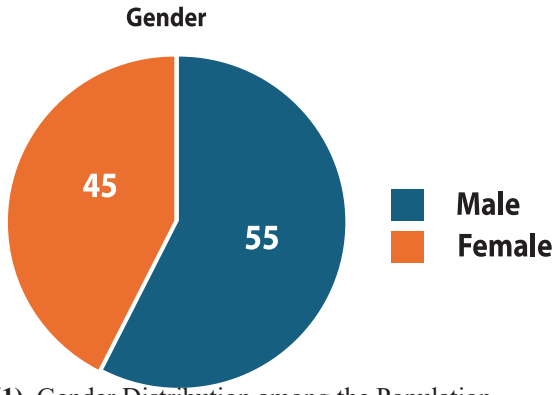

Fig. (1). Gender Distribution among the Population.

Table **1** represents the different age group of the population included in our study according to which patients belonging to the age bracket of 21-30 years of age were the most common who presented with intracranial complications, followed by the patients belonging to 31-40 years of age and then the patients falling into 41-50 years of age group. The least common age group was 0-10 year's age group having only one patient presented to that age group.

Table 1. Age Distribution among the Population.

Age Distribution	Frequency, n	Percentage %
0-10	1	2.5
11-20	6	15
21-30	11	27.5
31-40	09	22.5
41-50	08	20
51-60	03	7.5
>60	02	5

About the statistics presented in Table **2** shows the pattern of bacterial isolates taken from the Ear Pus Swab of the patients of Atticoantral Disease it shows that Gram Negative bacteria make the most of the bacteria harvested in pus swab which is 27 (67.5%). The most common organism harvested is *Pseudomonas Aeruginosa* which was present in 13 cases making a percentage of 32.5 %, which is then followed by *Proteus Mirabilis* 11(27.5%), Methicillin Resistant *Staphylococcus aureus* (MRSA) 05 (12.5%), Coagulase Negative *Staphylococcus aureus* 03 (7.5%) Methicillin Sensitive *Staphylococcus aureus* (MSSA) 03(7.5%) while the least common bacteria include *Corynebacterium*, *Morganella Morgagni*, *Acinetobacter baumannii*, *Streptococcus* Viridans and *Escherichia Coli* coming only 1 Bacterial isolates and 2.5% each.

Table 2. Percentage of Different Organism Cultured from Ear Pus Swab of Intracranial Complication Patient.

Bacteria	Frequency n, (%)
Gram Negative Organism	
Pseudomonas Aeruginosa	13(32.5)
Proteus Mirabilis	11(27.5)
Escherichia Coli	01(2.5)
Acinetoacter Baumanii	01(2.5)
Morganella Morgagni	01(2.5)
Total	**27(67.5)**
Gram Positive Organism	
Methicillin Resistant *Staphylococcus aureus (MRSA)*	05(12.5)
Cornebacterium Species	01(2.5)
Methicillin Sensitive *Staphylococcus aureus* (MSSA)	03(7.5)
Coagulase Negative *Staphylococcus aureus*	03(7.5)
Streptococcus Viridans	01(2.5)
Total	**13 (32.5)**

Among the complications showed in Table **3** the most common intracranial complication is temporal lobe abscess 15 (37.5%) followed by meningitis 12 (30%). In contrast the least common complication is sigmoid sinus thrombosis which was present in only 1 individual.

Table 3. Distribution of Intracranial Complications in Attico-antral type CSOM Patients.

	Frequency (n)	Percentage (%)
Cerebellar Abscess	2	5
Temporal Lobe Abscess	15	37.5
Extradural Abscess	04	10
Subdural Abscess	03	7.5
Meningitis	12	30
Lateral Sinus Thrombosis	03	7.5
Sigmoid Sinus Thrombosis	01	2.5

Out of 40 individuals presented with Atticoantral CSOM with intracranial complications 32 individual had headache (80%) as the presenting complaint making it the most common symptoms among the patients followed by fever in 30 individual (75%), 28 patients had ear pain (70%), altered sensorium presented in 6 individual (15%), neck rigidity in 5 individual (12.5%) while seizures and blurring of vision in 4 individuals(10%) (Fig. **2**).

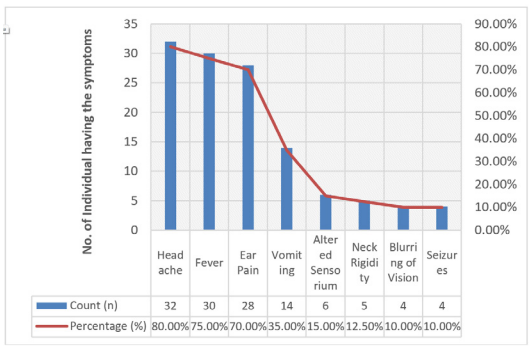

Fig. (2). Symptoms at Presentation to the Hospital other than the Ear Discharge.

The percentage susceptibility of different Gram-positive and Gram-negative bacterial isolates to a panel of widely used antibiotics is shown in Table **4**. *Pseudomonas aeruginosa* was the most susceptible of the Gram-negative organisms to meropenem (100%), imipenem (92.3%), and piperacillin/tazobactam (100%). Of the Gram-positive bacteria, Methicillin-resistant *Staphylococcus aureus* (MRSA) which is the commonest one and showed considerable susceptibility to imipenem and vancomycin (75%) and complete susceptibility to meropenem, clindamycin, and linezolid.

Table 4. Percentage (%) Susceptibility of Different Bacteria Towards Antibiotics.

	ERY	CAZ	LEV	CRO	IMP	TSX	MRO	DA	VAN	LZ	CIP	GN	PTZ
Gram Negative Organism													
Pseudomonas aeruginosa	-	7 (53.8)	3 (23)	9 (69.2)	12 (92.3)	-	13 (100)	7 (53.8)	10 (77)	11 (84.6)	5 (38.4)	6 (46)	13 (100)
Proteus mirabilis	2 (18)	5 (54.5)	11 (100)	4 (36.4)	8 (72.7)	-	11 (100)	5 (45.4)	9 (81.9)	11 (100)	-	7 (63.7)	10 (91)
Escherichia coli	-	1 (100)	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	1 (100)	-	1 (100)	-
Morganella morganii	0	0	0	-	1 (100)	0	1 (100)	-	1 (100)	0	0	0	0
Acinetobacter baumannii	0	1 (100)	0	1 (100)	-	1 (100)	-	1 (100)	1 (100)	-	-	-	1 (100)
Gram Positive Organisms													
Methicillin Resistant *Staphylococcus Aureus* (MRSA)	1 (25)	0	1 (25)	1 (25)	3 (75)	3 (75)	4 (100)	4 (100)	3 (75)	4 (100)	2 (50)	0	3 (75)
Coagulase Negative *Staphylococcus Aureus*	1 (33.3)	-	1 (33.3)	0	3 (100)	0	3 (100)	-	2 (66.6)	-	2 (66.6)	1 (33.3)	3 (100)
Methicillin Sensitive *Staphylococcus Aureus* (MSSA)	1 (33.3)	2 (66.6)	-	2 (66.6)	-	3 (100)	3 (100)	2 (66.6)	3 (100)	3 (100)	3 (100)	0	-
Cornybacterium Species	-	1 (100)	-	1 (100)	1 (100)	0	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	-	1 (100)
Streptococcus Viridans	0	-	-	0	0	0	1 (100)	-	0	1 (100)	0		1 (100)

ERY-Erythromycin,CAZ-Ceftazidime,LEV-Levofloxacin,TSX- Trimethoprim/sulphamethoxazole, CRO-Ceftriaxone, IMP-Imipenem, MRO- Meropenem, VAN-Vancomycin, DA-Clindamycin, LZ-Linezolid, CIP-Ciprofloxacin, GN-Gentamicin, PTZ-Piperacillin/Tazobactam.

DISCUSSION

Based on our research, in 40 individuals 22 were male (55%) and 18 were females (45%) in the study population which makes male a slight dominant gender .These similar findings are also reported in the existing literature as well [9]. The age group between 21 and 30 years old had the highest incidence of intracranial problems in this study (27.5%), followed by those between 31 and 40 years old (22.5%) and those between 41 and 50 years old (20%). According to this pattern, persons in their early to middle years are more vulnerable to the severe aftereffects of chronic otitis media (COM). Similar age-related vulnerability has been documented by Anwar *et al.* and Lathi *et al.* with most cases in the 21–30-year range, [10,11] and Chandrashekharayya *et al.* where the mean age of presentation was 23.65 years [12] and similarlary Maji *et al.* Reported 10 -19 years of age group which also belongs to young individual group [13]. Higher work exposure, a delayed health-seeking habit, or an underestimation of chronic ear problems in otherwise healthy people could be the reasons for this demographic's preponderance. The elderly (>60 years) and paediatric (<10 years) populations, on the other hand, made up a comparatively smaller percentage (2.5% and 5%, respectively). This could be because older adults had a lower prevalence of untreated COM, which could be related to earlier interventions or a natural decline in disease activity, and children had better parental vigilance.

As far as the microbiological profile is concerned the major bulk of the organism causing Squamosal type CSOM with Intracranial complications comes from the Gram-Negative Organism in which the *Pseudomonas Aeruginosa* stands first 32.5 % followed by the Proteus Mirablis 27.5%. This is in accordance with the literature reported by Sammal *et al.* in Uttarkhand, by Ahmed *et al.* in Aligarh, Anowar in Bangladesh, Gopal *et al.* in Bagalkot and by Vaid *et al.* in Pune India [14-18]. Additionally in case of Gram-Positive Bacteria MRSA is the most common type of organism Here our findings deviated from some existing literature as many claims conventional *Staphylococcus aureus* to be the most common organism in the bacterial isolates in term of gram positives bacteria. So, an increase in trend of resistant version of *Staphylococcus aureus* is alarming which indicates the increasing pattern antimicrobial resistance in treating the patient

of CSOM [5,14, 15, 19-21]. Similarly, our study reported temporal lobe abcess asmost common intracranial complication with headache being the most common symtom in ICC this depict deviation from the existing literature as Haqdad *et al.* reported meningitis as most common ICC with fever as the most common symptom however the role use of Ct Scan and MRI in diagnosing these ICC still remain important [22, 23].

Pseudomonas aeruginosa showed the greatest susceptibility to piperacillin/tazobactam (100%), imipenem (92.3%), and meropenem (100%) among Gram-negative bacteria in the study conducted, while levofloxacin (23%) and ciprofloxacin (38.4%) showed the lowest susceptibility. Our findings about the effectiveness of carbapenem are further supported by research by Kombade *et al.* (AIIMS Jodhpur) Garg *et al.* (Kota) and Mehta *et al.* (Hisar), which identified *Pseudomonas aeruginosa* as the prevalent isolate with over 80–100% sensitivity to piperacillin/tazobactam, imipenem, and meropenem [24-26]. In this investigation, *Proteus mirabilis* was completely susceptible to levofloxacin and meropenem but not to trimethoprim/sulfamethoxazole. This pattern is in line with studies by Ullah *et al.* in Peshawar, where P. mirabilis similarly exhibited 70% sensitivity to imipenem and 91% sensitivity to ciprofloxacin [21]. Similar to the findings of Kombade's and Ullah's investigations, *Escherichia coli* demonstrated widespread susceptibility to important antibiotics, but there was considerable geographical variation in cephalosporin sensitivity [21, 24]. Significantly, our group of *Morganella morganii* was multidrug resistant, which is comparable to the AIIMS study, which found resistance to most antibiotics with the exception of meropenem and netilmicin. Similar to the findings of Kombade *et al. Acinetobacter baumannii* showed resistance to levofloxacin and erythromycin but maintained high sensitivity to ceftazidime, vancomycin, and trimethoprim/sulfamethoxazole. In our results, *Staphylococcus aureus* (both MRSA and MSSA) shown the highest sensitivity to meropenem, linezolid, and vancomycin among Gram- positive organisms [16, 24, 27]. Mehta *et al.* also found that *S. aureus* was more than 97% sensitive to these substances, with vancomycin and linezolid being the most consistently effective medications [26]. Additionally, Kombade *et al.* found that MRSA isolates lacked vancomycin or linezolid resistance. In line with other research, coagulase-negative *Staphylococcus* species in our investigation exhibited selective resistance but responded favorably to meropenem and piperacillin/tazobactam. Furthermore, our cohort's *Corynebacterium* spp. and *Streptococcus* viridans demonstrated total susceptibility to meropenem and linezolid, which is consistent with a few but comparable patterns observed in previous investigations [24]. Overall, our results support the consistent effectiveness of linezolid and carbapenems against chronic otitis media infections and are in good agreement with previously reported regional data. Nonetheless, a growing trend of fluoroquinolone and trimethoprim/sulfamethoxazole resistance in Proteus and Pseudomonas species highlights the necessity of ongoing antimicrobial management and local antibiogram monitoring.

LIMITATIONS AND RECOMMENDATIONS

Highlights of this study include the identification of important ICC symptoms (ear pain, fever, and headache), the discovery of unique microbiological profiles and the confirmation of carbapenem, piperacillin/tazobactam and vancomycin as efficacious empirical antibiotics. However, generalizability is limited by its drawbacks, which include a single-centre emphasis, uneven anaerobic culturing, retrospective design, non-probability consecutive sampling (selection bias, limiting the external validity of finding) and a small sample size (n=40). However, the reason of limited sample size is, extreme rarity of ICC in Attico antral disease and adherence to strict criteria for inclusion, just like a 22-year cohort from a tertiary center identified only 51 patients with OM-related ICC – about 0.8% of all chronic OM cases [28]. Future studies should include molecular techniques (such as PCR), standardized anaerobic testing, and prospective, multi-centre designs with bigger cohorts. The development of region-specific antibiotic regimens and the prioritization of early cholesteatoma screening in patients with refractory otorrhea are essential for the prevention and management of ICC.

CONCLUSION

Intracranial complications of CSOM are slightly more common in male and in young age group. The most common intracranial complication is Temporal lobe abscess followed by meningitis while most common clinical presentations are headache, fever, and ear pain. Most of the issues are brought on by gram negative bacteria in which *Pseudomonas Aeruginosa* is the commonest one. Carbapenem, vancomycin, linezolid and piperacillin/tazobactam offer empirical support for both gram-positive bacteria and gram- negative bacteria.

AUTHORS' CONTRIBUTION

Irfan Ahmed Shaikh: Study design, Methodology, Data analysis and interpretation, Writing draft.

Syed Faizan Ali: Conceptualization, Study design, Methodology, Data analysis and interpretation, Writing draft.

Qurat ul Ain: Study design, Methodology, Data analysis and interpretation.

Ramsha Khalid: Writing draft, Critical review and revision the manuscript.

Ramsha Moin: Writing draft, Critical review and revision the manuscript, Final approval, final proof to be published.

Syed Muhammad Husain Rizvi: Critical review and revision the manuscript, Final approval, final proof to be published.

ACKNOWLEDGEMENTS

Declared none.

DECLARATIONS

Data Availability Statement

The data used to support the findings of this study are available from the corresponding author upon request.

Ethical Approval

The Institutional Review Board(IRB) of Dow University of Health sciences has issued the IRB Exemption Letter, number: IRB- 3530/DUHS/EXEMPTION/2024/234.

Consent to Participate

All the study participants were enlisted with their written informed consent.

Consent for Publication

All authors give consent for the publication of this work.

Conflict of Interest

Declared none.

Competing Interest/Funding

Declared none.

Use of AI-Assisted Technologies

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were utilized in the writing of this manuscript, in the creation of images/graphics/tables/captions, or in any other aspect of its preparation.

REFERENCES

[1] Das C, Ghosh R, Mondal T. Bacteriological profile and antibiotic sensitivity pattern in tubo tympanic variety of CSOM in northern part of West Bengal. Indian J Otolaryngol Head Neck Surg 2021; 74(S1): 501-5.

[2] Gotcsik M. Otitis media. In: Elzouki AY, Harki HA, Nazer HM, Stapleton FB, Oh W, Whitley RJ, Eds. Textbook of Clinical Pediatrics. Germany: Springer Nature 2012; pp. 863-71. doi: 10.1007/978-3-64202202-9_70. PMCID: PMC7176158.

[3] Khatun R, Alam MF, Naznin M, Salam MA. Microbiology of chronic suppurative otitis media: An update from a tertiary care hospital in Bangladesh. Pak J Med Sci 2021; 37(3).

[4] Khadkekar S, Benny LM, Gujrathi AB, Gadpayale N, Paikrao Y. A systematic review of complications of attico-antral type of chronic suppurative otitis media in our region. Int J Otorhinolaryngol Head Neck Surg 2021; 7(10); 1636-43. https://doi.org/10.18203/issn.2454-5929.ijohns20213898

[5] Karanth TK, Nayak DR, Balakrishnan R, Gupta AK, Chawla K. Intracranial complications due to chronic suppurative otitis media-atticoantral disease with a reference to its microbiological profile: A retrospective study. J Clin Diagn Res 2022; 16(2): MC04-MC07.

[6] Trinidade A, Page JC, Dorn Hoffer JL. Therapeutic mastoidectomy in the management of chronic otitis media. Otolaryngol Head Neck Surg 2016; 155(6): 914-22.

[7] Madana J, Yolmo D, Raja K, Gopalakrishnan S, Sujatha S. Microbiological profile with antibiotic sensitivity pattern of cholesteatomatous chronic suppurative otitis media among children. International J Paediatr Otorhinolaryngol 2011; 75(9): 1104-8.

[8] Xu J, Du Q, Shu Y, Ji J, Dai C. Bacteriological profile of chronic suppurative otitis media and antibiotic susceptibility in a tertiary care hospital in Shanghai, China. Ear Nose Throat J 2020; 100(9): NP391-6.

[9] Summy S, Rahul SRC. Study of intracranial complications of chronic otitis media. J Cardiovasc Dis Res 2024; 15: 397-410.

[10] Anwar K, Zada B, Ali M, Khan IA. The frequency of otogenic intracranial complications in chronic suppurative otitis media with cholesteatoma. Pak J Neurol Surg 2011; 15: 19-23.

[11] Lathi OP, Sharma A, MaheshwariM. Surveillance of antimicrobial susceptibility pattern of chronic suppurative otitis media in tertiary care hospital of southern Rajasthan. Indian J Otolaryngol Head Neck Surg 2023; 75(Suppl 1): 588-95. DOI: 10.1007/s12070-023-03648-x

[12] Hiremath CS, Ahmed R, Khavasi P. Intracranial and extracranial complications of chronic otitis media and their management at a tertiary care center: a descriptive study. Int J Otorhinolaryngol Head Neck Surg 2021; 7: 499-506.

[13] Maji PK, Chatterjee TK, Chatterjee S, Chakrabarty J, Mukhopadhyay BB. The investigation of bacteriology of chronic suppurative otitis media in patients attending a tertiary care hospital with special emphasis on seasonal variation. Indian J Otolaryngol Head Neck Surg 2007; 59: 128-31.

[14] Sammal M, Pant B, Negi N, Sikarwar V. Current trends in clinicobacteriological profile and antimicrobial susceptibility pattern in active chronic suppurative otitis media (safe and unsafe) at a tertiary care center in Uttarakhand: an Observational study. Cureus 2024; 16(9): e69525.

[15] Ahmad Z, Zubair MY, Chandra K, Khalique N. A study of complications, sinonasal predispositions and microbiological profile of chronic otitis media. Indian J Otolaryngol Head Neck Surg 2023; 75(Suppl 1):403-8.

[16] Gopal KS, Solabannavar S, Riyas M. Aerobic bacteriology of chronic suppurative otitis media and its antibiotic susceptibility pattern in a tertiary care hospital, Bagalkot. Trop J Pathol Microbiol 2019; 5(11): 911-9.

[17] Anowar MA, Al Mamun MA, Mondal MSI, Mahbub AHMR, Mahdee SN, *et al.* Bacteriological trends of chronic mucosal otitis media in a tertiary care hospital in the northern region of Bangladesh. Mugda Med Coll J 2024; 6(2): 83-7.

[18] Vaid S, Rajashekhar RP, Shah H, Babu M, Moruskar AS. Bacterial profile and antibiotic susceptibility patterns of chronic otitis media at a tertiary care center in Maharashtra. Cureus 2024; 16(8): e67989. DOI: 10.7759/cureus.67989

[19] Wan Draman WNA, Md Daud MK, Mohamad H, Hassan SA, Abd Rahman N. Evaluation of the current bacteriological profile and antibiotic sensitivity pattern in chronic suppurative otitis media. Laryngoscope Investig Otolaryngol 2021; 6(6): 1300-6.

[20] Shrivastava U. Sensitivity and resistance patterns of antimicrobials in chronic otitis media squamosal. Int J Otorhinolaryngol Clin 2023; 15(1): 29- 32.

[21] Ullah M, Faisal MS, Zaki A, Khan A, Khan M, Khan M. Bacteriology and antibiotic sensitivity pattern of ear discharge in patients with chronic otitis media; A cross sectional study conducted in tertiary care hospital of Peshawar. Prof Med J 2021; 28(05): 671-6.

[22] Haqdad M, Aftab AA, Kumar A, Ali SS, Rai D, Ahmed N. Evaluation of complications and management of chronic suppurative otitis media: A retrospective study. Pak J Med Health Sci 2022; 16(5): 461-3.

[23] Govea-Camacho LH, Pérez-Ramírez R, Cornejo-Suárez A, Fierro-Rizo R, Jiménez-Sala CJ, Rosales-Orozco CS. Diagnosis and treatment of the complications of otitis media in adults. Case series and literature review. Cirugía y Cirujanos (English Edition) 2016; 84(5): 398-404. DOI: 10.1016/j.circen.2016.08.001

[24] Kombade SP, Kaur N, Patro SK, Nag VL. Clinico-bacteriological and antibiotic drug resistance profile of chronic suppurative otitis media at a tertiary care hospital in Western Rajasthan. J Fam Med Prim Care 2021; 10: 2572-9.

[25] Garg A, Agarwal L, Gupta M, Mathur R. A study on bacteriological profile and the antibiotic susceptibility pattern in cases of chronic suppurative otitis media in Haroti region. Med J Dr. DY Patil Vidyapeeth 2022; 15: 27-31. DOI: 10.4103/mjdrdypu.mjdrdypu_270_20

[26] Mehta M, Saha P, Kunkulol R, Simar H, Mehta N. Microbiological profile and antibiotic sensitivity pattern of active mucosal chronic otitis media (1) and active squamous chronic otitis media (with cholesteatoma) in a tertiary care hospital of hisar, (Haryana) India. Ann Clin Otolaryngol 2017; 2(3): 1019.

[27] Sahu MC, Santosh KS. Surveillance of antibiotic sensitivity pattern in chronic suppurative otitis media of an Indian teaching hospital. World J Otorhinolaryngol Head Neck Surg 2019; 5(2): 88-94. DOI: 10.1016/j.wjorl.2018.05.008

[28] Penido NdeO, Chandrasekhar SS, Borin A, Maranhão ASdeA, Testa JRG. Complications of otitis media - a potentially lethal problem still present. Braz J Otorhinolaryngol 2016; 82(3): 253-62. doi: 10.1016/j.bjorl.2015.04.007.

Received: April 13, 2025 Revised: August 22, 2025 Accepted: September 09, 2025