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Original Research Article

Microbial Profile and Antimicrobial Resistance Trends in Patients of Chronic Suppurative Otitis Media: A Study from a Tertiary Care Hospital in Central India

Ruchi Ganvir[1], Arti Jain[2]

[1]Assistant Professor, Department of Microbiology, Ram Krishna Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh

[2]Assosiate Professor, Department of Microbiology, ABVGMC, Vidisha, Madhya Pradesh

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Corresponding Author: Dr. Ruchi Ganvir
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Abstract:

Introduction: Chronic suppurative otitis media (CSOM) constitutes a significant public health concern globally, especially prevalent in regions with limited healthcare access and resources. It imposes various societal implications, including hearing impairment, language and speech development, intracranial and extra cranial complications. Effective management includes infrastructure improvement, medication access, hygiene education, and antimicrobial stewardship. Early prevention and management are critical to reducing CSOM's global impact.

Material & Methods: This cross-sectional study was conducted in the Department of Microbiology of a tertiary care centre for duration of 6 months to identify the bacterial isolates causing CSOM and their antibiogram profile. Isolation and identification was done by standard microbiological techniques and antimicrobial susceptibility testing by Modified Kirby-bauer disk diffusion method on Muller Hinton agar (MHA) medium, as per Clinical and Laboratory Standards Institute (CLSI) guidelines.

Results: Pseudomonas aeruginosa was the most common organism isolated, followed by Staphylococcus aureus, Klebsiella spp., Acinetobacter spp., Coagulase-negative Staphylococci (CONS), & Escherichia coli. Pseudomonas aeruginosa was most susceptible to Meropenem, Ciprofloxacin and Gentamicin. Staphylococcus aureus was highly susceptible to Vancomycin.

Conclusion: Knowledge of the predominant organisms implicated in CSOM and their antibiotic susceptibility profiles is essential for establishing effective antibiotic policies and initiating empirical therapy. The alarming upward trend in multi-drug resistant organisms emphasizes the critical need for continuous and stringent surveillance of resistant bacteria, thereby advocating against the indiscriminate use of antibiotics. In addition, having insight of risk factors, seasonal changes, and the local antibiotic susceptibility policy helps in achieving optimal outcomes in the medical management of CSOM.

Keywords: Chronic suppurative otitis media (CSOM), Bacterial profile, Antibiotic susceptibility testing, Pseudomonas aeruginosa, Staphylococcus aureus.

Introduction

Chronic suppurative otitis media (CSOM) constitutes a significant public health concern globally, especially prevalent in regions with limited healthcare access and resources. Chronic suppurative otitis media (CSOM) develops as a consequence of an initial acute otitis media episode, leading to chronic inflammation within the middle ear and mastoid cavity. It manifests with persistent discharge from the middle ear through a tympanic perforation, lasting from 6 weeks to 3 months.

Prevalence figures suggest that globally, there may be between 65 and 330 million individuals affected by CSOM. A 2004 WHO study identified particularly high prevalence rates (> 6%) among Australian aborigines, in Greenland, India, the United Republic of Tanzania, and the Solomon Islands, with India exhibiting one of the highest rates (>4%). This underscores the urgent need for attention to address this significant public health challenge. [1]

CSOM imposes various societal implications, including hearing impairment, language and speech development issues, as well as the strain on already limited resources. CSOM is influenced by a range of factors, including low socioeconomic status, inadequate healthcare facilities, age, poor hygiene practices, upper respiratory tract infections, anatomical predispositions such as a more horizontal eustachian tube in children, malnutrition, facial anomalies, immunocompromised status, and environmental conditions. [2,3] CSOM is commonly categorized into two types: tubo-tympanic and atticoantral, based on the involvement of the pars tensa or pars flaccida of the tympanic membrane. The prevalent bacterial isolates in CSOM include aerobic bacteria such as Pseudomonas aeruginosa, Staphylococcus aureus, Proteus mirabilis, Klebsiella pneumonia, Escherichia coli, anaerobic bacteria like Bacteroids, Pepostreptococcus, Peptococcus, and fungal species including Aspergillus and Candida. However, the distribution of these isolates varies across different geographical regions. [4-6] Complications arising from middle ear infections can extend to critical structures like the mastoid, facial nerve, labyrinth, lateral sinus, meninges, and brain, resulting in conditions such as mastoid abscess, facial nerve paralysis, deafness, lateral sinus thrombosis, meningitis, and intracranial abscesses. This highlights the potential severity of the condition when left untreated or inadequately managed. [3,4,7]

The rise of CSOM as a public health concern is linked to its frequent occurrence, tendency to recur, the evolution of drug-resistant microorganisms, and the related complications. Although topical antibiotics and maintaining ear hygiene are fundamental methods for managing CSOM, the indiscriminate use of antibiotics, including those available over-the-counter, has contributed to the widespread appearance of strains resistant to multiple drugs. The ever-changing patterns of antibiotic usage, shifts in bacterial flora, and variances in the prevalence and antibiotic sensitivity profiles in different geographical areas have been thoroughly studied and documented. [8]Conducting cross-sectional studies to identify bacterial pathogens and their antibiogram in CSOM is essential for guiding evidence-based treatment strategies, especially in settings with limited resources.

Comprehensive measures to manage CSOM require enhancements in healthcare infrastructure, ensuring access to essential medication, public education on hygiene practices, and the implementation of antimicrobial stewardship programs to counter antibiotic resistance. In conclusion, emphasizing prevention, early identification, and proper management of CSOM is crucial for alleviating its impact on affected individuals and healthcare systems globally.

Materials and Methods

Objectives:

1. To determine the bacterial isolates causing CSOM
2. To determine antibiotic susceptibility profile of bacterial isolates causing CSOM

Study Design: Cross-sectional study

This cross-sectional study was conducted in the Department of Microbiology of a tertiary care centre of Madhya Pradesh, India for duration of 6 months from June 2023 to November 2023. A total of 80 patients attending ENT department were included in this study after obtaining informed consent.

Inclusion Criteria

1. Patient with persistent ear discharge lasting more than 6-12 weeks with perforated tympanic membrane.
2. Patient who had not used any local or systemic antibiotics in previous week.

Exclusion Criteria

1. Ear drainage lasting for less than 12 weeks.
2. Patients who have taken systemic or local antibiotics within the past week.
3. Discharge with an intact eardrum
4. Patients who have not provided informed consent.

Sample Collection and Processing

External auditory canal (EAC) was cleaned using spirit to avoid contamination with normal flora of EAC. Two aural swabs were collected, one for microscopy and other for culture. Collected swabs were labelled properly and transported to the Microbiology laboratory at the earliest. Out of 2 swabs one was used for direct microscopy (Gram staining) and other swab was inoculated on Blood and MacConkey agar, incubated aerobically at 37°C for 18-24 hours. Isolated organisms were identified on the basis of gram staining, morphological, culture and various biochemical characteristics. Antimicrobial Susceptibility Testing (AST) was done by Modified Kirby-bauer disk diffusion method on Muller Hinton agar (MHA) medium, as per Clinical and Laboratory Standards Institute (CLSI) guidelines. The data was compiled and subjected to statistical analysis utilizing Microsoft Excel.

Results

In the study of 80 cases, 46 (57.5%) were male, while 34 (42.5%) were female. The male-to-female ratio, as depicted in [Figure 1], was 1.35:1. The age group with the highest number of cases of CSOM was 21-30 years, comprising 24 cases (30%), followed by the 31-40 years age group, with 18 cases (22.5%). [Table 1]

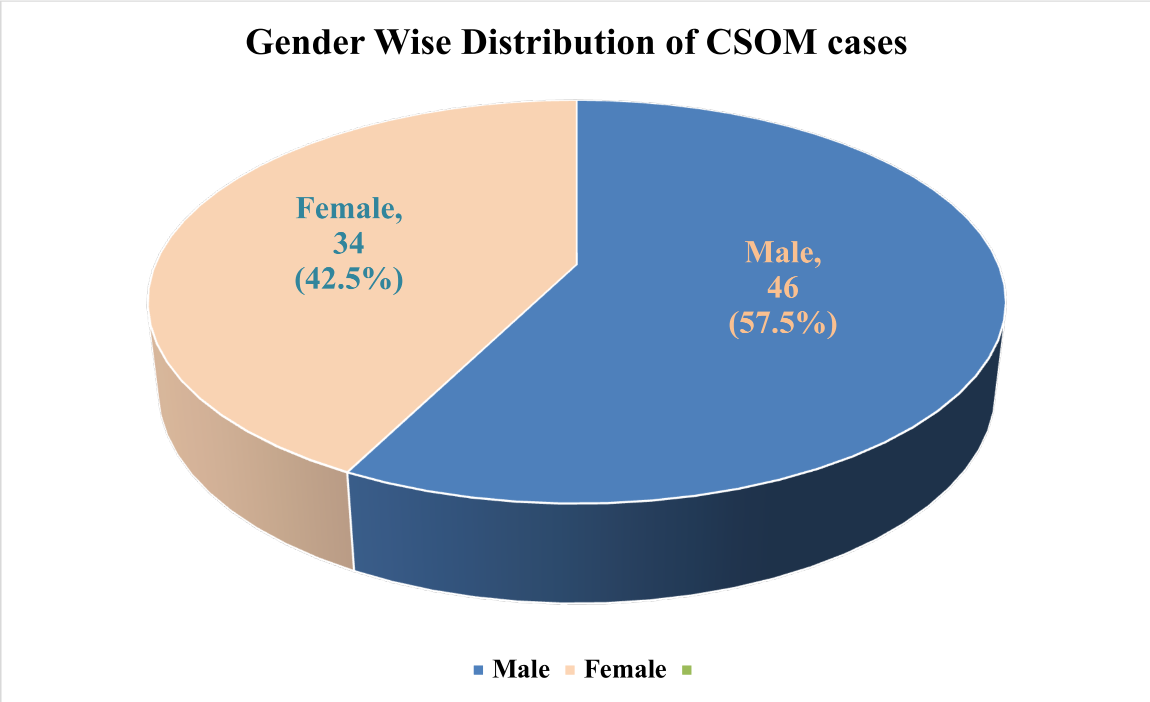

Figure 1: Gender wise distribution of CSOM cases

Table 1: Age wise distribution of CSOM cases

Age (in years)	Number	Percentage
1-10	09	11.3
11-20	14	17.5
21-30	24	30
31-40	18	22.5
41-50	08	10
>50	07	8.6

Out of 80 samples, 9 (11.2%) were found to be sterile, while 71 samples exhibited monomicrobial growth of organisms. Among these, 44 (55%) were identified as Gram-negative bacilli, and 27 (33.8%) as Gram-positive cocci. Pseudomonas aeruginosa was the most frequently isolated species among Gram-negative bacilli, accounting for 35 (43.8%), followed by Klebsiella spp.-04 (5%), Acinetobacter spp.-03 (3.7%) and Escherichia coli-02 (2.5%). Staphylococcus aureus-24 (30%) was second most common species isolated overall and predominant species among Gram-positive cocci, followed by Coagulase-negative Staphylococci-03 (3.8%). [Table2] [Figure2]

Table 2: Distribution of bacterial isolates in CSOM cases

	Number (n=80)
Sterile	**09 (11.2%)**
Gram negative bacilli	**44 (55%)**
Pseudomonas aeruginosa	35 (43.8%)
Acinetobacter spp.	03 (3.7%)
Klebsiella spp.	04 (5%)
Escherichia coli	02 (2.5%)
Gram positive cocci	**27 (33.8%)**
Staphylococcus aureus	24 (30%)
Coagulase negative Staphylococci	03 (3.8%)

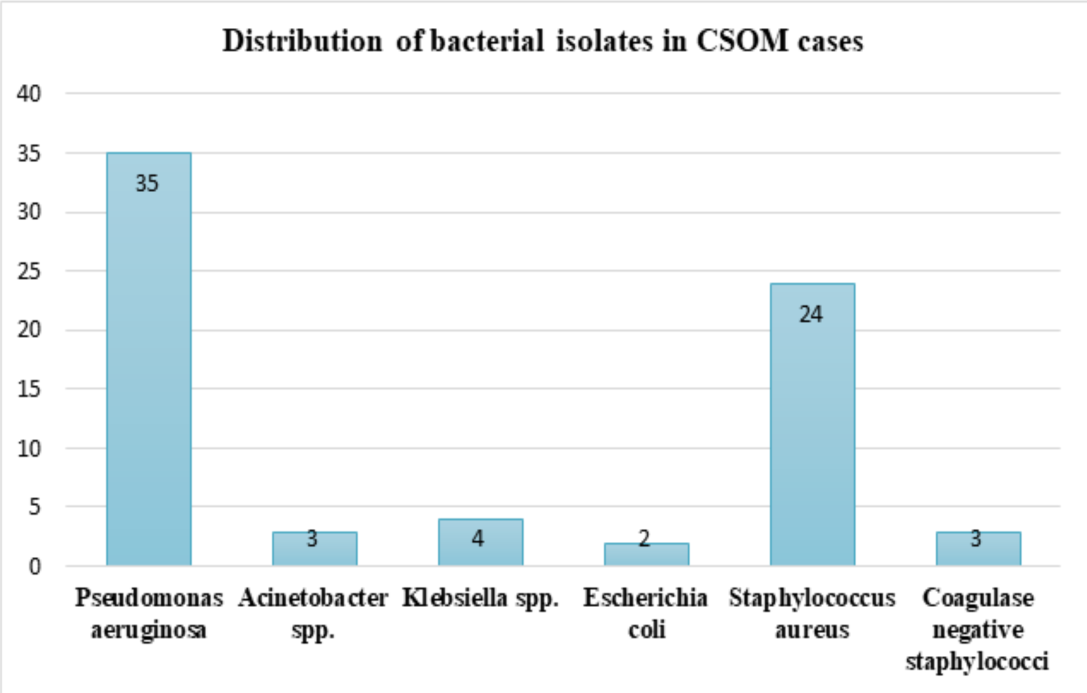

Figure 2: Distribution of bacterial isolates in CSOM

Among non-fermenter gram-negative bacteria, Pseudomonas aeruginosa showed highest susceptibility to Meropenem, with a sensitivity rate of 100%, followed by Ciprofloxacin (91.4%), Gentamicin (91.4%), Amikacin (82.9%), and Piperacillin-Tazobactam (54.3%). It demonstrated complete resistance to ceftazidime. Acinetobacter spp., on the other hand, showed highest susceptibility to Gentamicin (66.7%), Piperacillin-Tazobactam (66.7%), and Meropenem (66.7%), followed by Amikacin (33.3%), while it showed 100% resistance to Ciprofloxacin. [Table 3]

Table 3: Antibiotic Sensitivity pattern of Non- fermenter Gram Negative Bacteria (NFGNB)

	Pseudomonas aeruginosa (n=35)				**Acinetobacter spp. (n=03)**			
	S	**%**	**R**	**%**	**S**	**%**	**R**	**%**
Amikacin	29	82.9	06	17.1	1	33.3	02	66.7
Ciprofloxacin	32	91.4	03	8.6	0	0	03	100
Gentamicin	32	91.4	03	8.6	02	66.7	01	33.3
Ceftazidime	0	0	35	100	NT	-	NT	-
Piperacillin-Tazobactam	19	54.3	16	45.7	02	66.7	01	33.3
Meropenem	35	100	0	0	02	66.7	01	33.3

Note: S=Susceptible, R=Resistant, NT=Not tested

Within the Enterobacteriaceae group, Klebsiella spp. and Escherichia coli showed 100% susceptibility to Amikacin, Gentamicin, Piperacillin-Tazobactam, and Meropenem. Ciprofloxacin demonstrated a resistance rate of 25% for Klebsiella spp. and 100% for Escherichia coli. Both Enterobacteriaceae strains were 100% resistant to ceftriaxone. [Table 4]

Table 4: Antibiotic Sensitivity Pattern of Gram negative Bacteria (GNB)

	Klebsiella spp. (n=04)				**Escherichia coli (n=02)**			
	S	**%**	**R**	**%**	**S**	**%**	**R**	**%**
Amikacin	04	100	0	0	02	100	0	0
Ciprofloxacin	03	75	01	25	0	0	02	100
Gentamicin	04	100	0	0	02	100	0	0
Ceftriaxone	0	0	04	100	0	0	02	100
Piperacillin-Tazobactam	04	100	0	0	02	100	0	0
Meropenem	04	100	0	0	02	100	0	0

Staphylococcus aureus, the second most commonly isolated organism, showed highest susceptibility to Vancomycin (100%), followed by Doxycycline (70.8%), Azithromycin (58.3%), and Clindamycin (37.5%), Gentamicin (37.5%), and Cotrimoxazole (37.5%). Ciprofloxacin demonstrated the lowest susceptibility at 20.8%. Coagulase-negative staphylococci were most susceptible to Vancomycin (100%) and Doxycycline (100%), while being least susceptible to Azithromycin (33.3%).

They showed a 66.7% susceptibility rate to Clindamycin, Gentamicin, Cotrimoxazole, and Ciprofloxacin, respectively.

Table 5: Antibiotic Sensitivity Pattern of Gram positive Bacteria (GPC)

	Staphylococcus aureus (n=24)				**Coagulase negative Staphylococci (n=03)**			
	S	**%**	**R**	**%**	**S**	**%**	**R**	**%**
Clindamycin	09	37.5	15	62.5	02	66.7	01	33.3
Doxycycline	17	70.8	07	29.2	03	100	0	0
Gentamicin	09	37.5	15	62.5	02	66.7	01	33.3
Cotrimoxazole	09	37.5	15	62.5	02	66.7	01	33.3
Azithromycin	14	58.3	10	41.7	01	33.3	02	66.7
Ciprofloxacin	05	20.8	19	79.2	02	66.7	01	33.3
Vancomycin	24	100	0	0	03	100	03	100

Discussion

Chronic Suppurative Otitis Media (CSOM) is a global public health concern, especially prevalent in resource-limited regions. Complications can be severe, affecting critical structures like the mastoid and leading to deafness and meningitis. The rise of drug-resistant microorganisms emphasizes the need for evidence-based treatment strategies. Addressing CSOM requires improvements in healthcare infrastructure, medication access, and public education on hygiene. Prevention, early identification, and proper management are crucial for mitigating its impact.

In our study, among 80 cases, 46 (57.5%) were male and 34 (42.5%) were female, resulting in a male-to-female ratio of 1.35:1. The higher prevalence among males may be due to their increased participation in outdoor activities, which exposes those contaminated environments. This finding is consistent with research conducted by Garima et al [3], Vikas Jain et al [4], and Monica Edwin et al [5]. Conversely, studies by Rashid M [10] and Mst. Romena Khatun et al [11] have reported a predominance of females over males.

In our study, the maximum number of cases were observed in the age group of 21-30 years, accounting for 24 cases (30%), followed by the 31-40 years age group, with 18 cases (22.5%). This trend mirrors the findings reported in studies by various authors [3, 5, 10]. The higher incidence in younger adults may be linked to anatomical factors like the shorter and broader eustachian tube, which is more conducive to infections. Furthermore, the active engagement of young adults in outdoor activities can create environments favourable for microbial growth, thereby increasing susceptibility to ear infections.

In our study, 9 out of 80 specimens (11.2%) were sterile, while 71 samples (88.8%) showed monomicrobial growth. This finding aligns with previous observations by Kalpana and Neeta [2], Kumar D et al [7]. In contrast, Rana et al [8] reported monomicrobial growth in 98 samples (68.1%), with 46 samples (31.9%) showing polymicrobial growth. Similarly, Sonam Rathi et al [9] documented monomicrobial isolates in 108 cases (90%) and polymicrobial growth in 11 cases (9.1%).

In our study, Gram-negative organisms were more frequently isolated (55%) compared to Gram-positive organisms (33.8%). Among the isolated species, Pseudomonas aeruginosa (43.8%) was the most commonly isolated species, followed by Staphylococcus aureus (30%), Klebsiella spp. (5%), Acinetobacter spp. (3.7%), Coagulase-negative Staphylococci (3.8%), and Escherichia coli (2.5%). These findings align with those reported by various authors [3-6,8,10,11]. On the contrary, studies by Smitha N R et al [2], Kumar D et al [7], and Sonam Rathi et al [9], have reported Staphylococcus aureus as a frequently isolated species, followed by Pseudomonas aeruginosa. This variation may arise from differences in geographical locations and the diversity of populations included in the studies. Recent research by Garg A et al, 2022 and Kawatra R et al, 2023; further supports this pattern, indicating that either Pseudomonas aeruginosa or Staphylococcus aureus predominates in cases of CSOM.

Gram-negative aerobes predominate in CSOM, suggesting an unlikely origin from the nasopharynx, where these organisms are typically absent. The increased isolation rate of Pseudomonas aeruginosa carries significant implications, given its role as a common cause of hospital-acquired infections and its increasing resistance to potent antibiotics. Pseudomonas, thriving in the warm and humid external auditory meatus of CSOM patients, poses challenges in eradication and is frequently associated with intra- and extra cranial complications through biofilm formation, toxin production, and enzyme activity. The frequent isolation of faecal bacteria like E. coli and Klebsiella indicates a increased risk of infection among individuals living in conditions with poor hygiene. Staphylococcus aureus prevalence in CSOM is associated with its high carriage of resistant strains in the external auditory canal and upper respiratory tract. Coagulase-negative Staphylococci (CONS), are opportunistic pathogens, that invade the middle ear especially during periods of immunocompromise [3,8].

In our research, Pseudomonas aeruginosa demonstrated varying susceptibility to different antibiotics. Meropenem showed the highest effectiveness with complete susceptibility (100%), followed by Ciprofloxacin (91.4%), Gentamicin (91.4%), Amikacin (82.9%), and Piperacillin-Tazobactam (54.3%). Notably, the bacteria exhibited complete resistance to ceftazidime. Our findings align closely with those of Garg A et al,2022 [14], who reported similar susceptibility patterns in Pseudomonas spp., including high sensitivity to Meropenem (93.4%), Amikacin (92.39%), Gentamicin (90.48%), and Ciprofloxacin (80.96%). Another study from 2018 reported 46.15% of Pseudomonas isolates were sensitive to Amikacin, 30.76% to Gentamicin, and 34.61% to Ciprofloxacin [9].

In the present study, Klebsiella spp. and Escherichia coli exhibited complete susceptibility (100%) to Amikacin, Gentamicin, Piperacillin-Tazobactam, and Meropenem. Ciprofloxacin showed sensitivity rates of 75% for Klebsiella spp. and 100% resistance for Escherichia coli. Both strains of Enterobacteriaceae were (100%) resistant to ceftriaxone. According to a study by Monica Edwin et al.[5], Piperacillin-Tazobactam and Meropenem demonstrated 100% sensitivity for Escherichia coli and Klebsiella spp., while Amikacin ranged from 86%-100%, Gentamicin from 75%-100%, Ciprofloxacin 29% to 100%, and Ceftriaxone showed 75% sensitivity.

This variation in antibiogram pattern may be due to variation in study population and geographical region. This shift in the antibiogram profile of Gram negative isolates from resistant to being more susceptible to aminoglycosides and fluoroquinolones indicates adaptability to the environment, genetic remodelling, improved infection control measures, changes in bacterial population dynamics, introduction of new antibiotics.

In addition, reduced use of antibiotics can lead to decreased selection pressure, allowing susceptible strains to predominate. Topical quinolones are seen as promising options for treating chronic suppurative otitis media (CSOM). They work by inhibiting bacterial DNA gyrase or topoisomerase-II, which hinders DNA replication and transcription. However, vigilant monitoring of topical quinolone use is essential to mitigate the risk of secondary fungal infections that may lead to otitis externa. In our study Staphylococcus aureus, showed highest susceptibility to Vancomycin (100%), which is in accordance with various studies [6,7,13,14]. Resistance to commonly used macrolides was notably high at 58.3%, while aminoglycosides showed resistance in 37.5% of cases. This could be attributed to the practice of conducting sensitivity testing only after initial antibiotics fail. To prevent the emergence of resistant strains, it is imperative to avoid unnecessary use of these antimicrobials.

Limitation of the study

Anaerobic bacteria in CSOM were not evaluated. Therefore, further studies are recommended to address these limitations.

Conclusion

Chronic suppurative otitis media (CSOM) represents a notable public health issue worldwide, particularly affecting areas with restricted healthcare availability and resources. This study was conducted to identify common etiological agents of CSOM and their antibiotic sensitivity profile. Pseudomonas aeruginosa and Staphylococcus aureus are most common pathogens isolated in CSOM. Pseudomonas aeruginosa was most susceptible to Meropenem, Ciprofloxacin and Gentamicin. Staphylococcus aureus was 100% susceptible to Vancomycin. Knowledge of the predominant organisms implicated in CSOM and their antibiotic susceptibility profiles is essential for establishing effective antibiotic policies and initiating empirical therapy in advance of receiving culture and sensitivity reports. The alarming upward trend in multi-drug resistant organisms emphasizes the critical need for continuous and stringent surveillance of resistant bacteria, thereby advocating against the indiscriminate use of antibiotics. In addition, having insight of risk factors, seasonal changes, and the local antibiotic susceptibility policy helps in achieving optimal outcomes in the medical management of CSOM.

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