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Research Article

EVALUATION OF MICROBIOLOGICAL PATTERN, ANTIMICROBIAL SENSITIVITY AMONG PATIENTS OF CHRONIC OTITIS MEDIA

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ABSTRACT

Objective: The objective of the present study was to determine the causative pathogen and detect their susceptibility to a panel of antibiotics among patients diagnosed with chronic otitis media (COM).

Methods: This was a single-center, hospital-based, cross-sectional, observational study involving total of 156 patients diagnosed with COM. Pus swab collected from the patient's ear was sent for culture and sensitivity.

Results: The mean and median age of the patients included in the present study was 19.1 and 20.5 years, respectively. In the present study, 133 (85.3%) participants were diagnosed with mucosal COM, and the remaining 23 (14.7%) participants had a squamosal type of COM. A positive culture/bacterial growth was seen in 139 samples (89.10%). Of the 139 samples that had bacterial growth: 93.5% had a growth of single bacteria and 6.5% of participants showed growth of more than one bacterium. In the present study, *Pseudomonas aeruginosa* was the single most common bacteria identified on bacterial culture (32.7%), followed by other Pseudomonas species (23.7%) and *Staphylococcus aureus* (18.58%). Isolated Pseudomonas specimens were most susceptible to Polymyxin B and Colistin. Isolated Staphylococcus specimens were most sensitive to Meropenem and Imipenem.

Conclusion: *P. aeruginosa* was the single most common bacteria identified on bacterial culture among patients diagnosed with COM. About one in ten (10%) isolated pseudomonas and staphylococcus specimens were multi-drug resistant.

Keywords: Chronic otitis media, Chronic otitis media, Bacteriological profile, Antibiotic sensitivity.

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INTRODUCTION

Chronic otitis media (COM) is chronic inflammation of the middle ear and mastoid cavity; persistent or recurrent ear discharge is the most prominent symptom [1,2]. In long-term COM leads to damage of middle ear ossicles permanently and causes conductive hearing loss [2,3]. In addition, COM increases the risk of permanent sensorineural hearing loss (due to damage to the inner ear) and intracranial complications [2-4]. Hearing loss caused by COM might lead to behavioral changes and delay in communicative development among young children. Intracranial complications such as brain abscesses and meningitis are the complications of COM leading to the death of patients [5,6]. Mortality due to complications of COM is typically higher than other types of OM [5,6].

COM is a widespread condition. Studies have reported that around 30% of children should have experienced at least one episode by their fifth birthday [7,8]. The average global incidence rate is about 4.8 new episodes/1,000 people (all ages)/year [9]. COM is most prevalent in low-income and middle-income countries [9]. COM is the leading cause of repeated visits to doctors by children, and among the most common reasons for antibiotics prescription or to undergo surgery [10]. Infants and young children are prone to OM including COM because their Eustachian tubes are short, floppy, horizontal, and functions poorly [11,12]. Maturation of the tube is a gradual process, which explains the sudden decrease in the incidence of COM after age 6–7 years [13]. COM generally develops in the first few years of life but can persist during adulthood. COM is usually a complication of persistent AOM, but the risk factors for COM vary in different settings. Numerous host and environmental factors influence the risk of COM [14,15]. Frequent upper respiratory tract infections and poor socioeconomic conditions are often associated with the development of COM. In developing countries, malnutrition, contaminated water, poor hygiene, overcrowding, human immunodeficiency virus infection, Tuberculosis, malaria, and poor access to health care increase the risk for chronicity and complications of COM [14,15].

COM is mainly an infectious disease, resulting from the interplay between microbial load and immune response. The pathogenesis of COM is multifactorial [9]. Bacteria or their by-products stimulate local resident cells, attracting immune-effector cells and provoking the inflammatory response largely responsible for clinical manifestations [8]. Bacterial biofilms (i.e., colonization of bacteria embedded in the extracellular matrix and adherent to a surface), which are known to protect bacteria against antibiotic treatment and the host's immune response, have been demonstrated in the middle ear of patients with COM. Typical findings on examination include thickened granular middle-ear mucosa and mucosal polyps [16].

Mono or co-infections with more than one type of bacterial pathogens characterize COM [17]. Geographical location and antibiotics used to influence individual species and strain dominance. However, globally *Pseudomonas aeruginosa* and *Staphylococcus aureus* are the two most common microbial isolates in patients with COM, followed by *Proteus Vulgaris* and *Klebsiella pneumonia* [18]. Several studies from different countries, including India, Nepal, Singapore, and Nigeria, have reported that *P. aeruginosa* is the most common pathogen that causes COM, followed by *S. aureus. P. aeruginosa* can thrive well in the ear environment and is difficult to eradicate [19]. Bony necrosis and mucosal disease have been particularly implicated by *P. aeruginosa*. Biofilms of *P. aeruginosa* and *S. aureus* trigger chronic inflammation, cell proliferation, and bone resorption; and stimulate the production of inflammatory mediators by neutrophils, lymphocytes, macrophages, and monocytes, thus increasing inflammation [20]. Antibiotics and surgery have only moderate efficacy for COM, and the former have potentially serious side effects, such as increased antibiotic resistance [21]. Globally, *S. aureus* has become resistant to

several routinely prescribed frontline antibiotics. More importantly, *S. aureus* has also become resistant to several second-line (methicillin) and a few third-line antibiotics (vancomycin). The susceptibility of *P. aeruginosa* to commonly used antibiotics varies a lot [22]. Because of a high prevalence of COM and severe disabling complications, with considerable mortality, it is vital to manage the very first episode of COM with the best possible available care. Prescription of the effective antibiotic(s) (including topical preparations) shortens the natural course of the disease as well as reduces the overall cost of treatment. Toward this end, it is essential to identify the causative pathogen(s) and detect their susceptibility to a panel of available antibiotics. We also need to manage any presenting complication(s) and halt the progression of the disease. Therefore, the present study was conducted to identify the causative pathogen and identify their susceptibility to a panel of antibiotics among patients diagnosed with COM.

MATERIALS AND METHODS

Study design
This was a single-center, hospital-based, cross-sectional, observational study. Institutional Ethics Committee approval was obtained.

Study settings
The study was done at the Department of Otolaryngology, Geetanjali Medical College, Udaipur, Rajasthan, India.

Study duration
The study was conducted from February 2021 to March 2022.

Study outcomes
To identify the causative organism(s)/pathogen(s) for CSOM and to detect the susceptibility (sensitivity and resistance) pattern for various antibiotics among the causative organism(s). The identity of the causative pathogen (including subspecies, if any) was confirmed by the department of microbiology following the standard methods for isolating, culturing, and identification of the pathogen. The susceptibility of the identified pathogen to various antibiotics was based on the report of the department of microbiology.

Sample size calculation
The sample size of 156 was calculated using software Epi info TM-7 with an assumption of alpha error of 5%, i.e., confidence level 95% and beta error to be 20% i.e., power of error to be 80%. Following this, a total of 156 patients were included in this study.

Standard statistical analysis was done and a statistical package for the social sciences (IBM SPSS Statistics, version 21, Somers NY, USA) Software was used to analyze the data. Microsoft (MS) Excel and MS Word were used to obtain various types of graphs. The p-value (probability that the result is true) of <0.05 was considered statistically significant after assuming all the rules of statistical tests.

Inclusion criteria
i. Ear discharge of more than 3 weeks from all patients with chronically discharging ear (both tubo-tympanic and attico-antral disease).
ii. Patients who consented to participate in the study.

Exclusion criteria
i. Patients with a chronically discharging ear who were taking antibiotics at the time of presentation or 2 weeks before presentation.
ii. Patients with other chronic diseases are on medications. (i.e., tuberculosis, and cardiovascular diseases).
iii. Participants refused to participate in the study.

Sampling methodology
Non-probability, purposive and convivence sampling methodology was employed to recruit participants for the present study. All patients coming to the OPD and fulfilling the selection criteria were approached and recruited into the study throughout the period of participants recruitment.

Informed consent
The consent form printed in patient's own preferred language was given to all the participants to read. After that, contents from the consent form were explained to all the prospective participants in their select language. Authors answered all the questions from participants about the study, procedure, risk, and data privacy to the best of their knowledge. The participants were informed and explained that they had the right to withdraw from the study at any point of time. After that, willing participants were asked to sign the consent form.

Data collection
The data were collected in a paper-based pro forma.

Source of data
There were two data sources for the present study. The first source was the face-to-face interview with the participants using the analysis proforma. The second source of the data was the clinical records, microbiological reports, and laboratory reports.

Plan and procedure
a. OPD consultation: All the patients were attended by the otolaryngologist consultant after initial registration. Appropriate laboratory and radiological investigations were conducted after the consultation.
b. Collection of Pus sample for culture and sensitivity: After obtaining informed consent, the specimen was taken using Sterile Cotton Swab for Pus Culture and Antimicrobial Sensitivity, from the site of perforation on the tympanic membrane (TM) or middle ear cavity or site of deposit in the external ear, ensuring that the cotton swab did not touch the walls of the external auditory canal (EAC). The collected cotton swab was kept in a sterile container and transported to the Department of Microbiology under optimal conditions.

Statistical analysis plan
The primary outcome was the prevalence of different causative organisms isolated from the pus samples of the participants. The other objective was to study the susceptibility to different antibiotics among the causative organisms. For analysis, the coded data were imported into Stata 17.1 version. The comparison of continuous variables between the participants in the two groups was made using a Student's *t*-test. Categorical variables were analyzed using Chi-square (χ^2) tests. A $p<0.05$ was considered statistically significant.

Funding
There was no external funding for this study. Participants were not paid any fee/incentive or given any gift to participate in the present study.

RESULTS

The mean and median age of the patients enrolled in the present study were 19.1 and 20.5 years, respectively. The minimum and maximum age was 4 and 56 years, respectively. Most of the participants were between 21 and 30 years of age. In the present study, 83 (53.2%) participants were female and the remaining 73 (46.79%) participants were male (p=0.373). Overall, only 15.38% of participants had a bilateral presentation and the remaining 84.62% of participants had unilateral involvement: the right ear was slightly more commonly involved than the left ear (Table 1). About 54% and 46% of participants had a history of similar complaints in the past in the same and the opposite ear. Further, a total of 23 (14.74%) participants had a history of complaints in both ears. About 19.87% and 14.74% of participants had a history of surgery in the past in the same and the opposite ear. Further, a total of 14 (8.97%) participants had a history of surgery in both ears.

In the present study, 133 (85.3%) participants were diagnosed with mucosal COM, and the remaining 23 (14.7%) participants had a squamosal type of COM. A positive culture/bacterial growth was seen in 139 samples (89.10%). Among patients diagnosed with a mucosal and squamosal types of COM, the culture positivity rate was 88.7%

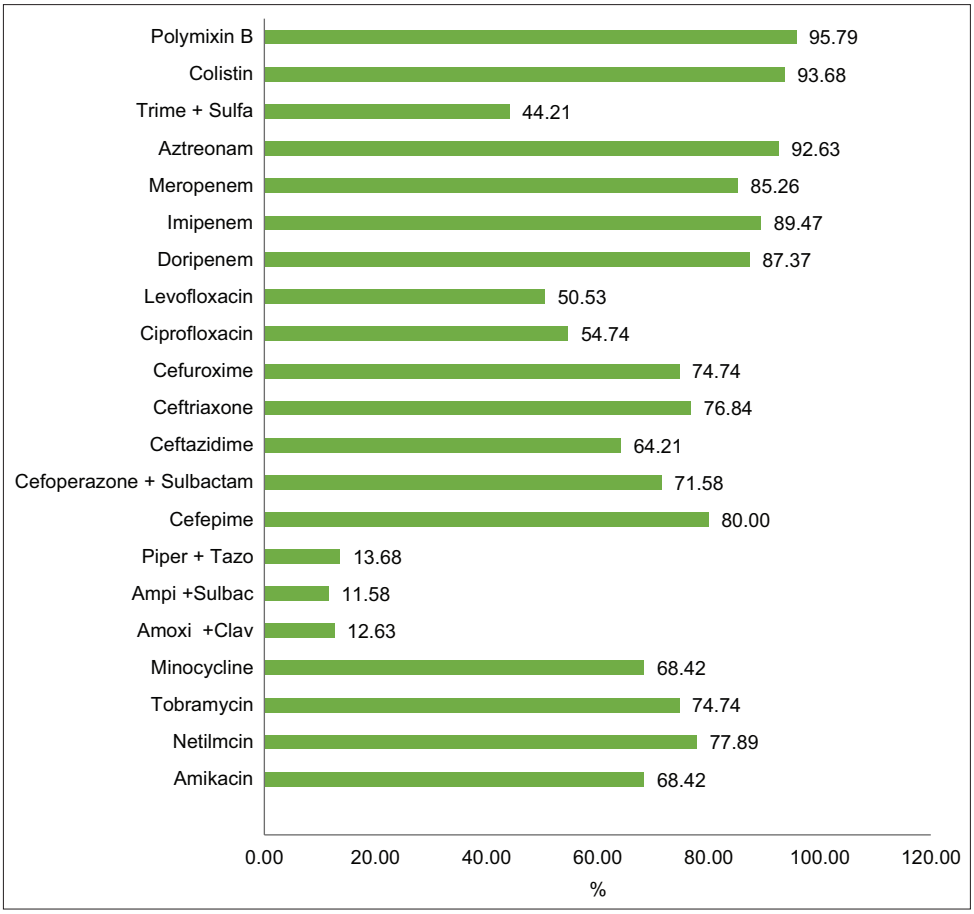

Fig. 1: Antibiotic sensitivity of Pseudomonas spp.

and 91.4%, respectively. Of the 139 samples that had bacterial growth: 93.5% had a growth of single bacteria and 6.5% of participants showed growth of more than one bacterium (Table 2). Among participants diagnosed to have mucosal and squamosal COM, 4.2% and 19.0% participants had mixed growth, respectively (*p =0.041).

In the present study, *P. aeruginosa* was the single most common bacteria identified on bacterial culture (32.7%), followed by other Pseudomonas species (23.7%), *S. aureus* (18.58%) (Table 3). There was one case each of *Burkholderia* and Achromobacter on the culture.

In the present study, the isolated specimens of Pseudomonas were most sensitive to Polymyxin B (95.79%) and most resistant to Ampicillin+Sulbactam (88.42%) (Fig. 1). The isolated specimens of *S. aureus* were most sensitive to Clindamycin and Meropenem (82.76%) and most resistant to Levofloxacin and Trimethoprim+Sulfamethoxazole (68.97%) (Fig. 2). Finally, the isolated specimens of *Escherichia coli* were most sensitive to Meropenem and Polymyxin B (93.33%) and most resistant to ceftazidime, azithromycin, and Ampicillin+Sulbactam (40.0%) (Fig. 3).

Table 1: Descriptive characteristics of the participants (n=156)

Variables	n	%
Age group		
≥10	33	21.15
11–20	45	28.85
21–30	64	41.03
>30	14	8.97
Gender		
Female	83	53.21
Male	73	46.79
Anatomical side		
Left	63	40.38
Right	69	44.23
Bilateral	24	15.38

DISCUSSION

The persistent inflammation of the middle ear cleft that lasts for more than 3 months and is accompanied by the perforation of the tympanic membrane is referred to as COM [23]. It is possible that chronic inflammation will manifest itself in a variety of ways across different population groups (age, gender, etc.). In some patients of COM, there is merely a perforation of the tympanic membrane and there is no loss of the ossicles or the bony structures. However, in certain individuals, in addition to perforation of the tympanic membrane, there is also the erosion of, or even complete destruction of, the ossicles. This may or may not be followed by the development of the keratinized epithelium in the middle ear, which is known as cholesteatoma. Cholesteatoma is a lytic process and is typically accompanied by ossicular and bony erosions [24]. There are many inflammatory disorders affecting the middle ear that behave in different ways, and the surgery that must be performed to treat each of these illnesses is distinct from one another.

In the present study, out of 156 analyzed samples, a positive culture/bacterial growth was seen in 139 samples (89.10%). Among patients diagnosed to have the mucosal and squamosal type of COM, the culture positivity rate was 88.7% and 91.4%, respectively. Out of the 139 samples that had bacterial growth: 93.5% had a growth of single bacteria and 6.5% of participants showed growth of more than one bacterium. Among participants diagnosed to have mucosal and

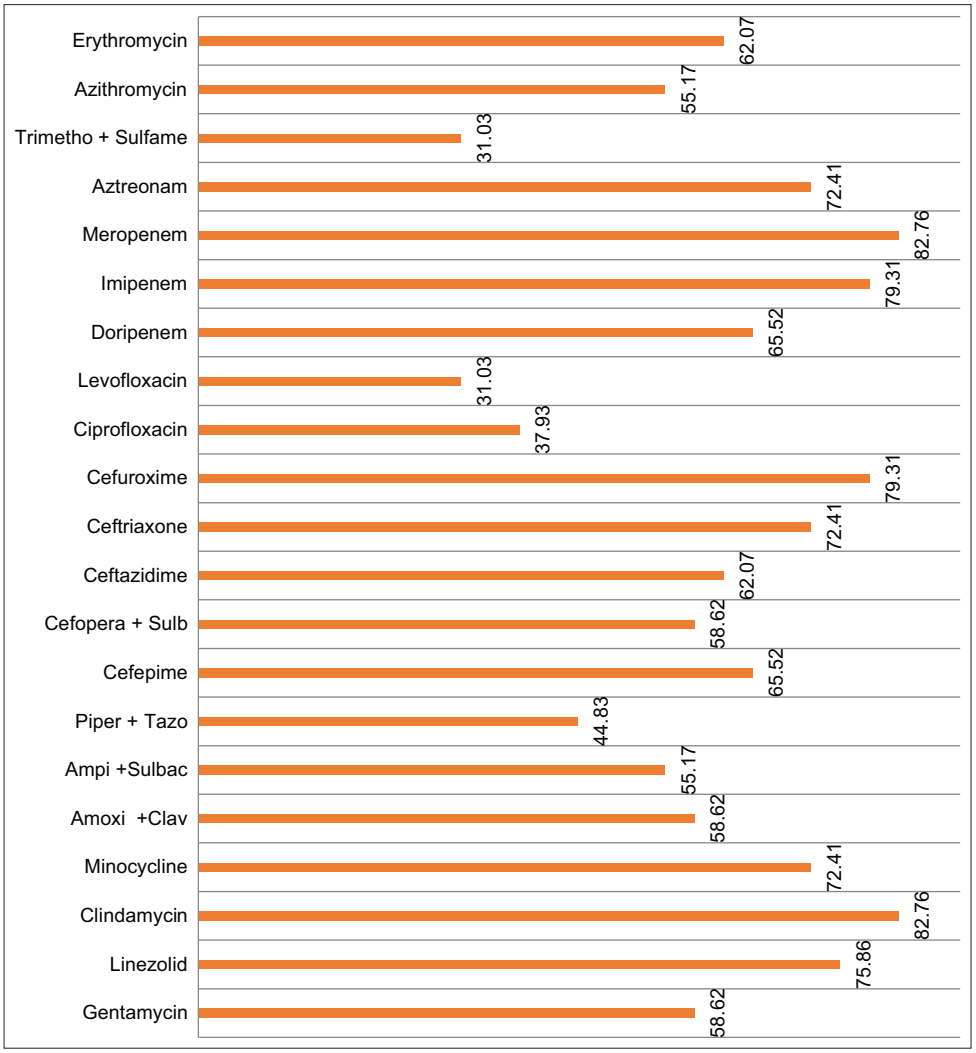

Fig. 2: Antibiotic sensitivity - *Staphylococcus aureus*

Table 2: Outcome of bacterial culture (n=156)

Outcomes	n	%
Mucosal	133	85.3
Squamosal (unsafe)	23	14.7
Culture		
Negative	17	10.90
Positive	139	89.10
Total	156	100.00
Type of COM	Mucosal	Squamosal
Negative	15 (11.3%)	2 (8.6%)
Positive	118 (88.7%)	21 (91.4)
Nature of growth (n=139)		
Single	113 (95.8)	17 (81.0)
Mixed	5 (4.2)	4 (19.0)

COM: Chronic otitis media

Table 3: Type of COM and the causative organism (n=156)

Bacteria	Mucosal (n=133)	Squamosal (n=23)
No growth	15 (11.3)	2 (8.6)
Pseudomonas aeruginosa	46 (34.6)	11 (47.8)
Pseudomonas spp.	35 (26.3)	2 (8.6)
Escherichia coli	13 (9.7)	2 (8.6)
Staphylococcus aureus	22 (16.5)	6 (26.1)
Others	2 (1.5)	0
Total	133	23

COM: Chronic otitis media

squamosal COM 4.2% and 19.0% participants had mixed growth, respectively.

Khanna *et al.*, [25] reported a culture positivity of 78% and Chirwa *et al.*, [26] reported a culture positivity rate of 82%. Deb and Ray reported that out of the 100 swabs collected from COM patients, 53 yielded positive cultures, for different aerobic bacteria and 47 were culture negative. Kombade *et al.*, reported that out of 153 samples cultured, bacterial growth was obtained in 126 (82.4%) and 27 (17.6%) showed no growth [27]. Draman *et al.*, reported that 69.2% of the isolated organisms were monomicrobial, 14.3% were polymicrobial, and only 6.6% were mixed growth of more than three microorganisms [28]. Kombade *et al.*, reported that out of 109 total isolates, monomicrobial growth was seen in 90.8% of samples and 9.2% with polymicrobial growth [27]. Kumar *et al.*, conducted a study among patients with unsafe COM, they reported that 5.72% of the ears showed a sterile culture after 72 h, while 94.28% of the ears showed growth [29].

In the present study, *P. aeruginosa* was the single most common bacteria identified on bacterial culture (32.7%), followed by other Pseudomonas species (23.7%), *S. aureus* (18.58%). There was one case each showing growth of *Burkholderia* and Achrimaxis on the culture. No fungi was isolated from any samples in the present study. Overall, the

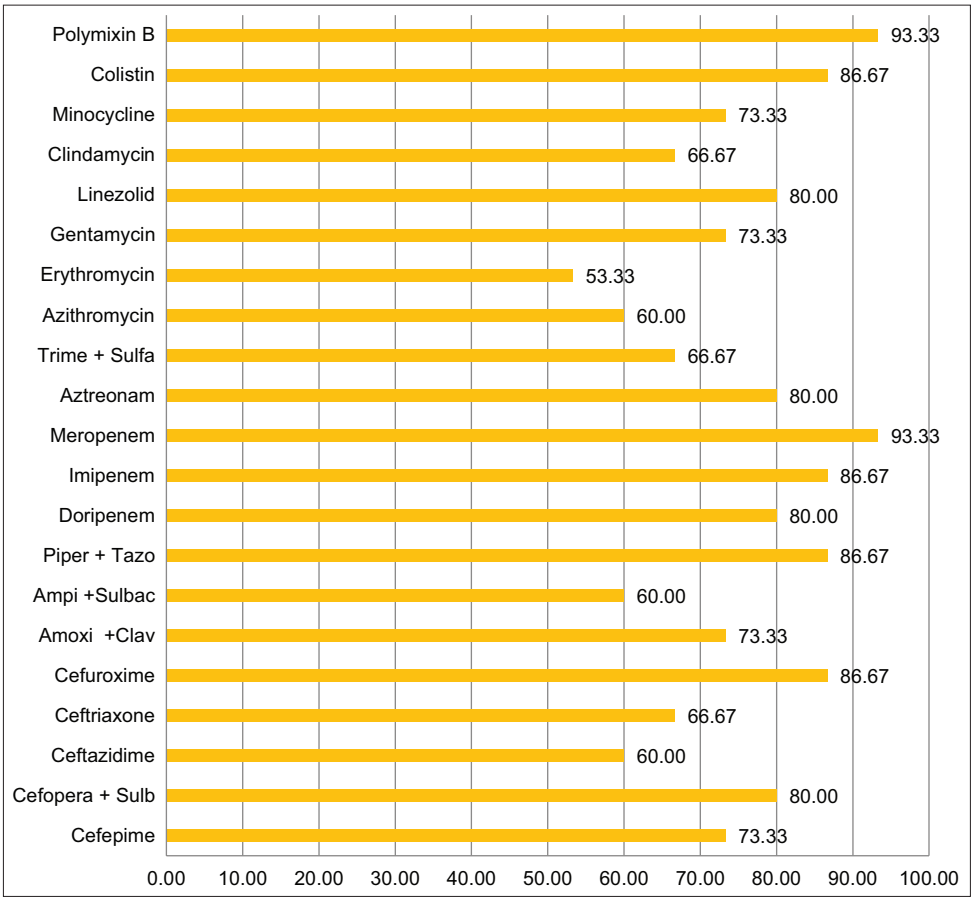

Fig. 3: Antibiotic sensitivity - *Escherichia coli*

gram-negative bacteria were more commonly isolated in comparison to Gram-positive bacteria. Similar to our findings, Kombade *et al.*, also reported that Gram-negative bacteria (69.2%) exceeded Gram-positive bacteria (30.8%) [27].

The findings of the present study are very similar to several other studies conducted across the world in which the commonest organisms implicated in COM were *P. aeruginosa*, *S. aureus*, proteus, and other enteric bacteria. Wintermeyer and Nahata (1994) [30] conducted a review of studies of microorganisms implicated in COM and reported that in children, as in adults, the most commonly isolated organism is *P. aeruginosa*. Similar to our study, Deb and Ray did not find any fungal isolates from the samples [31]. Similar to our study, Deb and Ray also reported that the commonest bacteria isolated were *P. aeruginosa* followed by *S. aureus*, *E. coli,* and proteus [31]. Kumar *et al.*, reported that the most common bacterial isolates were *P. aeruginosa* (46.08%), *S. aureus* (33.19%), Proteus species (6.25%), Coagulase negative *S. aureus* (5.2%), *E. coli* (3.47%), Klebsiella (2.60%), and Citrobacter species (1.73%) which is similar to studies performed by Mansoor *et al.* (2009) [32], Argeudas *et al.* (1994) [33] and Kenna *et al.* (1986) [34]. Draman *et al.*, also reported that the most common microorganism isolated in their study was *P. aeruginosa* (32.6%), followed by *S. aureus* (16.9%) [28]. Kumar *et al.*, reported that among patients with unsafe COM - Pseudomonas, Klebsiella, Staphylococcus, Proteus, and *E. coli* were the three most common bacteria [28]. But in contrast, Loy *et al.* (2002) and Agarwal A *et al.*, reported *S. aureus* as the major causative agent [35].

Among participants diagnosed to have mucosal and squamosal COM 4.2% and 19.0% participants had mixed growth, respectively (**p=0.041).

CONCLUSION

Overall, only one in six patients (15.38%) had a bilateral presentation and the remaining 84.62% of participants had unilateral involvement. Overall, only one in six patients (14.7%) had a squamosal type of COM. and remaining 85.3% patients were diagnosed with mucosal COM. A positive culture/bacterial growth was seen in 89.10% of cases. Multi-bacterial growth on culture was significantly more common among participants diagnosed to have squamosal COM (19.0%) in comparison to those who had mucosal type of COM (4.2%), respectively. *P. aeruginosa* was the single most common bacteria identified on bacterial culture, followed by other Pseudomonas species (23.7%), and *S. aureus* (18.58%). Isolated Pseudomonas specimens were most sensitive to Polymyxin B and Colistin. Isolated Staphylococcus specimens were most sensitive to Meropenem and Imipenem. Isolated *E. coli* were most sensitive to Polymyxin B, Colistin, and Cefuroxime.

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AUTHORS' CONTRIBUTION

All the authors have contributed equally.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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