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Antibiotic Susceptibility Patterns of Isolated Bacteria from Otitis Media in Children at Mohamed Aden Sheikh Children Teaching Hospital in Hargeisa, Somaliland

Saed N. Ahmed

Departments of Health Services and Public Health, Ministry of Health Development, Hargeisa, Somaliland
Email: hajar.bdr2016@gmail.com

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Abstract

Background: Otitis media (OM) is a group of inflammatory diseases of the middle ear. OM is a prevailing problem among children in Hargeisa. The antibiotic susceptibility of etiologic bacteria is not investigated in Somaliland which hinders the effective treatment of OM cases in children. **Objective:** This study aimed at determining the etiologic bacteria and its antibiotic susceptibilities in children presenting with OM to a pediatric referral hospital in Hargeisa for the period March 2013-May 2017. **Methods:** A cross-sectional retrospective study was conducted on a random sample of 270 children with OM. The laboratory used standard microbiological techniques for bacterial isolation and Kirby Bauer disk diffusion method for antibiotic susceptibility testing. Data were entered and analyzed using Epi Info 7 and any associations among the study variables tested with Chi2 test with confidence level of 95% and p value of < 0.05 was considered to be statistically significant. **Results:** The rate of bacterial isolation was 96.3%. The predominant bacterial isolate was *S. aureus* (31.48%) followed by *P. aeruginosa* (24.81%) and *P. mirabilis* (15.93%) respectively while the least prevalent isolates were coagulase negative *Staphylococcus* (1.48%), *S. pyogenes* (0.74%) and *Enterobacter* spp. (0.37%) in descending order. Age group 0 - 3, χ^2 (143,270 = 223.245, p = 0.000) showed highest bacterial isolation. There was no significant relationship between bacterial isolate and gender, χ^2 (11,270 = 9.2283, p = 0.6008). *S. aureus* showed highest sensitivity towards ciprofloxacin (85.7%), amikacin (76.5%), and gentamicin (73.8%). All isolates showed mixed resistance pattern. **Conclusion:** *S. aureus*, *P. aeruginosa* and *P. mirabilis* were the leading causative pathogens of otitis media. No association was established between isolate distribution and gender. Both the isolated gram-positive and gram-negative bacteria showed greatest sensitivity towards ciprofloxacin while the highest resistance was observed to penicillins, tetracyclines and sulfonamides. The Otitis Media among children in Hargeisa could be possibly treated, based on the antibiogram of the major associated bacteria, with topical and systemic formulations of the following antibiotic groups: fluoroquinolones, aminoglycosides and 3rd gen. cephalosporins.

Keywords

Otitis Media, Children, Etiologic Bacteria, Antibiotic Susceptibility, Treatment

1. Introduction

Otitis media is a group of inflammatory diseases of the middle ear [1]. Otitis media (OM) is a leading cause of health care visits and drugs prescription and its complications and sequelae are important causes of preventable hearing loss, particularly in developing countries [2]. Approximately 10% of children have an episode of AOM by three months of age and, by three years of age, approximately 50% to 85% of all children have experienced at least one AOM episode [3]. The two main types are acute otitis media (AOM) and otitis media with effusion (OME) [4]. Chronic suppurative otitis media (CSOM) is also another common type of otitis media. AOM is the rapid onset of signs and symptoms of inflammation in the middle ear [5]. Chronic Suppurative Otitis Media (CSOM) is a chronic inflammation of middle ear and mastoid cavity that may present with recurrent ear discharges (otorrhea) through a tympanic perforation [6]. One in four children will have an episode of AOM at some time during the first 10 years of life with a peak incidence of diagnosis occurring between the ages of three and six years [7].

AOM is characterized by irritability or feeding difficulties which may be the only indication of a septic focus whereby older children demonstrate a consistent presence of fever and otalgia, or ear tugging and hearing loss [8]. CSOM is characterized by chronic drainage from the middle ear associated with tympanic membrane (TM) perforation [9].

AOM is often caused by bacteria, but can also be caused by viruses. The bacterial species that usually cause AOM are *Streptococcus pneumonia*, *Haemophilus influenzae*, and *Moraxella catarrhalis* [1]. In CSOM, the bacteria may be aerobic (e.g., *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Proteus mirabilis*, *Klebsiella species*) or anaerobic such as *Bacteroides*, *Peptostreptococcus*, *Proprionibacterium* [10]. Viruses associated with AOM are respiratory syncytial virus (RSV), rhinoviruses, and adenoviruses [11]. However, the focus in this study will be the bacterial etiologies.

This study was guided by the quality improvement theory developed by Donabedian and Evidence-based practice (EBP) theory which has its roots in clinical epidemiology and evidence-based medicine (EBM). Donabedian defined quality care as that capable of maximizing the patient's well-being and presented quality as a multidimensional concept and proposed the structure-process-outcome model of quality of care and which has been the basis for much work in health-care quality since its original description in 1980 [12].

Donebedian's theory was used because it entails quality of healthcare which is the ultimum area in which the study's vision of improved quality of care is focused on. Evidence-based practice (EBP) is the conscientious and judicious use of current best evidence in conjunction with clinical expertise and patient values to guide health care decisions [13]. Practice guidelines are cited as potential tools for reducing the costs of health care, for enhancing quality assurance, and for improving medical education [14]. This study was also driven by this theory of EBP as the study aimed at improving the technical resources of the healthcare practitioners involved in the treatment of OM through generation of knowledge essential for developing standard treatment guideline for OM.

Antibiotic prescribing for otitis media should be guided by local data because research has shown there is a variation in etiologies among different geographical areas [15]. Likewise, the antibiotic susceptibility patterns of causative pathogens exhibit geographic variation [10]. However, antibiotic prescribing for otitis media in Somaliland is based on foreign data which cannot reflect the local etiological and antibiotic susceptibility patterns. Therefore, there was a significant research gap there for the study to fill.

This study was intended to help rational antibiotic prescribing, thus the fight against antibiotic resistance which is a national and global healthcare challenge. It is estimated that between 700,000 and several million people who suffer infectious diseases from resistant microbes die worldwide every year [16]. Very high rates of resistance have been observed in all WHO regions in common bacteria (for example, *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus*) that cause common health-care associated and community-acquired infections [17].

Studies conducted in different countries and regions had identified diverse bacterial pathogens of OM. A multinational study done on 917 children with OM in the US, Israel and Eastern Europe, *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella* were isolated from ear fluid cultures [18]. In Costa Rica, organisms isolated from 40 patients with CSOM in 1991 and 1992 included *Pseudomonas* spp. (41.9%), Gram-negative enterics (29%), *Staphylococcus* (9.8%), and others (9.8%) [19]. A study in Solomon Islands identified *Proteus* in 41%, *Pseudomonas* in 26%, *Klebsiella* in 16%, *Escherichia coli* in 9%, and *S. aureus* in 7% of patients who provided ear discharge samples [20].

A similar variation of etiologic bacteria of CSOM was also reported in similar studies conducted in Asia. Indian study reported that *Staphylococcus aureus* was the prevalent isolate followed by *Proteus aeruginosa* and *Pseudomonas* respectively [21]. In Nepal, identified *Staphylococcus aureus* as the most prevalent etiology followed by *Pseudomonas aeruginosa* and *Klebsiella* respectively [22].

Another study in Iraq reported that *S. aureus* and *E. coli* were the main isolates from ear cultures respectively [23].

Studies from different parts of Africa identified various bacterial pathogens as causative agents. Sudanese study observed that *Staphylococcus aureus* and *Klebsiella* with other coliforms were the commonest pathogens among investigated children 3 months to 15 years of age [24]. Nigerian study revealed that *Pseudomonas* to be the leading pathogen of OM followed by *S. aureus* and *Proteus* spp. respectively [25]. Studies in Ethiopia, [15] [26] reported that that *Proteus* spp. was the most common isolated pathogen (27.5%) followed by *S. aureus* (26.5%). A Moroccan study identified that *Streptococcus pneumonia*, *Staphylococcus*, *E. coli*, *Klebsiella* and *Proteus* as the main isolated bacteria in OM [27].

AOM may improve with antibiotics, but they are not always necessary since not all AOM is caused by bacteria [5]. Observation without use of antibacterial agents in a child with uncomplicated AOM is an option for selected children based on diagnostic certainty, age, illness severity, and assurance of follow-up [5]. For CSOM, There is no consensus agreement on its management and several treatment approaches are used including antibiotics and ear toilet (ear washing) with antiseptics such as Hydrogen Peroxide, Povide-Iodine and Normal Saline [28] and Mastoidectomy and/or tympanoplasty are frequently necessary to permanently cure CSOM [6]. A randomized clinical trial reported that toilet combined with antimicrobial treatment is more effective than aural toilet alone (OR = 0.31, 95% CL = 0.23, 0.43) and Oral antibiotics are better than aural toilet alone (OR = 0.35, 95% CL = 0.14, 0.87) [29]. Intravenous wide-spectrum antibiotic therapy in conjunction with daily suction and debridement is efficacious for the treatment of chronic suppurative otitis media without cholesteatoma compared to daily suction and debridement without antibiotics [30]. Topical ciprofloxacin drops were as effective as combined oral and topical ciprofloxacin and the addition of oral drug did not have any beneficial effect but increased cost of treatment [31]. Antibiotics will reduce the number of episodes of AOM per year from around three to around 1.5 [32]. Mastoidectomy and/or tympanoplasty are frequently necessary to permanently cure CSOM [6].

Otitis media is highly prevalent in children living in Hargeisa. However, currently no studies are available conducted in Hargeisa to investigate on the etiologic bacteria and its antibiotic susceptibility patterns to allow evidence-based treatment approaches for otitis media Therefore, this study aimed to identify the etiologic bacteria and antibiotic susceptibilities to guide local healthcare professionals and practice guidelines as well in the effective therapeutic management of otitis media in children in Hargeisa city and in Somaliland in general.

2. Methods

2.1. Study Area, Design and Population

The study was cross-sectional by design, retrospective data collected and conducted at a tertiary pediatric teaching hospital in Hargeisa, the capital city of

Somaliland. The hospital was selected because it's the largest referral pediatric hospital in the country serving in patients and outpatients from Hargeisa and those referred from other regions and districts in Somaliland as well as from neighboring Puntland and Somalia.

The study population screening criteria were all children between the age range of 0 to 14 years who presented to the hospital with ear discharge with subsequent confirmed diagnosis by hospital physician and ear swab was collected. Children with otitis media but ear swab and culture were not done were not eligible and excluded. The study participants were randomly selected from the 8017 OM cases of children less than 15 years of age who presented to the hospital with otitis media with ear discharge between 1st March 2013 to 20th May, 2017.

2.2. Sample Size and Sample Size Determination

The sample size was calculated using Yamane (1967) sample size calculation formula [33]. 95% confidence level and a margin of error (α) of 5% were considered. The formula was stated as: n = N ÷ {1 + N(e2)}, where: n = the sample size

N = the population size (No. of patients treated at the hospital with OM).

e = the acceptable sampling error at 95% confidence level and p = 0.05 are assumed

On substitution n = 8017 ÷ {1+ [8017(0.052)]} = 8017 ÷ 21.0425 = 381.

However, it was not possible to reach the target 381 sample size due to the retrospective nature of the study as well as the unavailability of the ear discharge culture and sensitivity laboratory data in the hospital electronic database (medical records) and only 270 reports were found comprising of 70.8% of the target sample size which was acceptable enough to achieve external validity (sample representativeness of the target population).

2.3. Isolation and Identification of Bacteria

Secondary retrospective data were collected from the patients' medical records (electronic hospital database-Open Hospital) to isolate micro-organisms from the ear swab cultures. Ear swabs were originally collected from participants by hospital physicians and sent to Hargeisa Group Hospital Laboratory, the National Referral Hospital, for culture and sensitivity testing. The medical laboratory used standard microbiological and biochemical procedures for bacterial identification. The samples were inoculated onto blood chocolate and MaCconkey agar plates and incubated at 37˚C overnight. The gram stain was performed as well as standard biochemical tests including catalase, oxidase, urease, coagulase, and indole tests.

2.4. Antibiotic Susceptibility Testing

To determine the *in vitro* antibiotic susceptibility of the isolated bacterial species from ear discharge samples, the microbiology laboratory used disk diffusion method according to the performance standards for susceptibility testing by the Clinical Laboratory Standards Institute [34].

2.5. Data Analysis

Data were entered and analyzed using the US Centers for Disease Control and Prevention (CDC) Epi Info™ "version 7.2." software and any associations among the study variables tested with Chi2 test with confidence level of 95% and p value of < 0.05 was considered to be statistically significant.

2.6. Ethical Considerations

The ethical clearance of the study was given by the Ethical Committee of the School of Postgraduate Studies and Research of Amoud University. Moreover, official permission to conduct the study at the site and participation was obtained from the Ethical Committee and Management of Mohamed Aden Sheikh Children Teaching Hospital prior to the study commencement. Due to the retrospective nature of the study, it was not possible to obtain consent from the parents and guardians of the children who participated the study. However, the parents and guardians provided verbal consent for ear swab collection for microbiological analysis previously to the hospital though this was for medical reasons only.

3. Results

Out of the total 270 participants, 158 (58.52%) were males and 112 (41.48%) were females as presented in **Figure 1**. As described in **Figure 2**, 34.4% aged between 0 - 3 years followed by the age groups 4 - 7, 8 - 11 and 12 - 15 years constituting 29.3%, 27.8% and 8.5% respectively. The prevalence of ear samples providing positive cultures were 96.3% while in 3.7% of them, no bacterial growth was observed. The predominant bacterial isolate was *S. aureus* (31.48%) followed by *P. aeruginosa* (24.81%) and *P. mirabilis* (15.93%). The least prevalent isolates were Coagulase negative *Staphylococcus* (1.48%), *S. pyogenes* (0.74%) and *Enterobacter* spp. (0.37%) respectively as shown in **Table 1**.

The predominant bacterial isolates for females were *S. aureus* (38.39%), *P. aeruginosa* (19.64) and *P. mirabilis* (14.29) respectively while the least isolated species were CoNS, *S. pyogenes* and *S. pneumoniae* (0.89%) each as presented in **Table 2**. For male participants, the frequent bacterial isolate was *P. aeruginosa* (28.48) in contrast to the female participants followed by *S. aureus* (26.58) and *P. mirabilis* (17.9%) respectively (**Table 2**). There was no significant relationship between bacterial isolate and gender, χ^2 (11,270 = 9.2283, p = 0.6008) (**Table 3**). **Table 4** shows the distribution of isolated bacteria by age groups in which the predominant age group was (0 - 3 years). There was a significant relationship between the isolate distribution and this age group 0 - 3 (χ^2 (143,270 = 223.245, p = 0.000) as shown in **Table 5**.

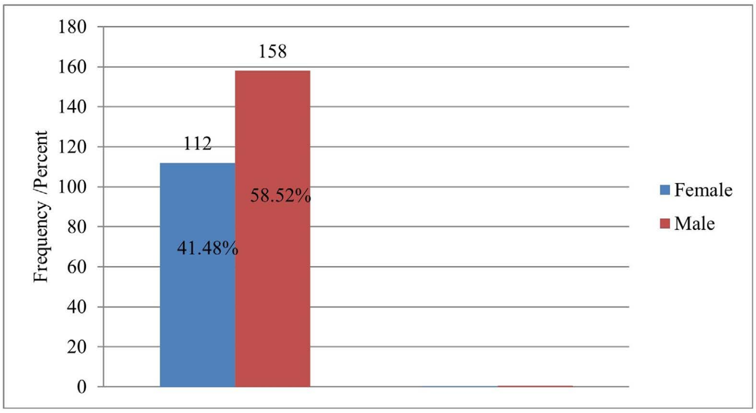

Figure 1. Sample distribution by gender.

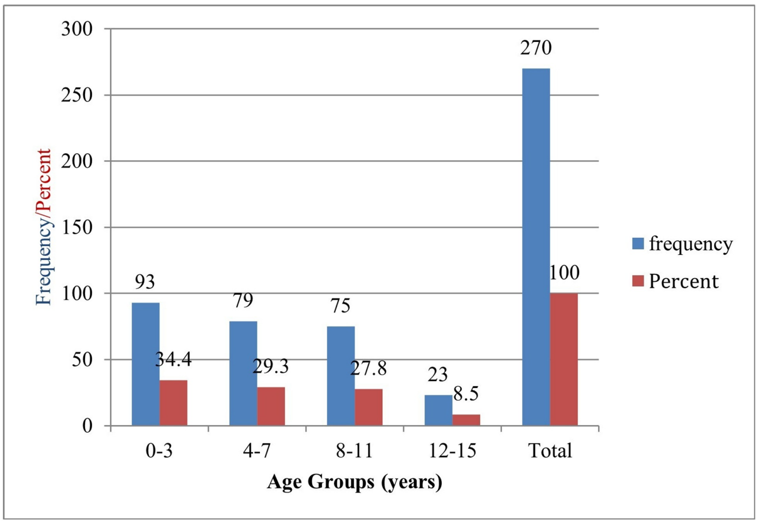

Figure 2. Sample distribution by age.

Table 1. Isolate distribution by frequency and percentage.

Isolate	Frequency	Percent (%)	Cum. Percent
CoNS	4	1.48	1.48
E. coli	15	5.56	7.04
Enterobacter spp.	1	0.37	7.41
Klebsiella pneumoniae	6	2.22	9.63
no growth	10	3.70	13.33
P. aeruginosa	67	24.81	38.15
P. vulgaris	25	9.26	47.41
P. mirabilis	43	15.93	63.33
Proteus spp.	7	2.59	65.93
S. aureus	85	31.48	97.41
S. pyogenes	2	0.74	98.15
S. pneumoniae	5	1.85	100.00
Total	270	100.00	100.00

CoNs coagulase negative *Staphylococci.*

Table 2. Isolate distribution by gender.

Gender	*CoNS*	*E. coli*	*Enterobacter spp.*	*Klebsiella pneumoniae*	*no growth*	*P. aeruginosa*	*P. vulgaris*	*P. mirabilis*	*Proteus spp.*	*S. aureus*	*S. pyogenes*	*S. pneumoniae*	Total
Female	1 (0.89)	7 (6.25)	1 (0.89)	2 (1.79)	4 (3.57)	22 (19.64)	10 (8.93)	16 (14.29)	4 (3.57)	43 (38.39)	1 (0.89)	1 (0.89)	112
Male	3 (1.9)	8 (5.06)	0 (0)	4 (2.53)	6 (3.8)	45 (28.48)	15 (9.49)	27 (17.9)	3 (1.9)	42 (26.58)	1 (0.89)	4 (0.63)	158
Total	4 (1.48)	15 (5.56)	1 (0.37)	6 (2.22)	10 (3.7)	67 (24.81)	25 (9.26)	43 (15.93)	7 (2.59)	85 (31.48)	2 (0.74)	5 (1.85)	270

CoNS Coagulase negative Staphylococcus.

Table 3. Summary of X2 test of isolate distribution by gender.

Variable	N	df	χ^2	Sig.	Decision
Isolate distribution	270	11	9.2283	0.6008	Accept H_o

Table 4. Isolate Distribution by Age.

Age	CoNS	*E. coli*	*Enterobacter spp.*	*Klebsiella pneumoniae*	*no growth*	*P. aeruginosa*	*P. vulgaris*	*P. mirabilis*	*proteus spp.*	*S. aureus*	*S. pyogenes*	*S. pneumoniae*	Total	P-Value
0 - 3	3	9	1	0	3	18	8	14	1	32	2	2	93	0.000
4 - 7	0	2	0	4	1	22	6	15	1	28	0	0	79	
8 - 11	1	2	0	2	1	20	9	13	4	20	0	3	75	
12 - 15	0	2	0	0	5	7	2	1	1	5	0	0	23	
Total	4	15	1	6	10	67	25	43	7	85	2	5	270	

Table 5. Summary of χ^2 test of isolate distribution by age and hypothesis testing.

Variable	N	df	χ^2	Sig.	Decision
Isolate distribution	270	143	223.245	0.000	Reject H_o

S. aureus, the predominant isolate, showed highest sensitivity towards the fluoroquinolone ciprofloxacin (85.7%), the aminoglycosides; amikacin (76.5%), and gentamicin (73.8%) respectively and chloramphenicol (75.6%). Highest resistance rates were observed towards the penicillins; oxacillin (94.1%), penicillin (88%), ampicillin (75%) and amoxiclav (66.7%) as well as sulfamethoxazole-trimethoprim (67.9%). *P. aeruginosa*, the second most prevalent isolated bacteria, was highly sensitive to ciprofloxacin (92.3%), followed by doxycycline (92.3%), gentamicin (87.8%) and amikacin (83.8%) respectively and highly resistant to nitrofurantoin and erythromycin (100%) both, and followed in the order of resistance by ampicillin (96.6%), amoxiclav (88.5%) and sulfamethoxazole-trimethoprim (84.8%) as illustrated in Table 6.

Overall, the most efficacious antibiotics to the total isolates were gentamicin, amikacin, ciprofloxacin and ceftriaxone while least effective drugs were

Table 6. Antibiotic susceptibility profiles of isolated bacteria.

		Susceptibility Patterns of Bacterial Isolates by Frequency (Percent)											
Isolate		**CN**	**AMK**	**CIP**	**SXT**	**CAF**	**T**	**DO**	**AML**	**P**	**CRO**	**E**	**AMC**
S. aureus	S	31 (73.8)	13 (76.5)	24 (85.7)	17 (32.1)	31 (75.6)	29 (58.0)	13 (72.2)	3 (25.0)	3 (12.0)	8 (57.1)	41 (68.3)	3 (33.3)
	R	11 (26.2)	4 (23.5)	4 (14.3)	36 (67.9)	10 (24.4)	21 (42.0)	5 (27.8)	9 (75.0)	22 (88.0)	6 (42.9)	19 (31.7)	6 (66.7)
P. aeruginosa	S	36 (87.8)	15 (83.3)	36 (92.3)	5 (15.2)	6 (21.4)	7 (24.1)	12 (92.3)	1 (3.4)	0 (0)	10 (58.8)	0 (0)	3 (11.5)
	R	5 (12.2)	3 (16.7)	3 (7.7)	28 (84.8)	22 (78.6)	22 (75.9)	1 (7.7)	28 (96.6)	4 (100)	7 (41.2)	1 (100)	23 (88.5)
P. mirabilis	S	17 (81.0)	5 (71.4)	23 (92.0)	13 (39.4)	5 (25.0)	2 (8.0)	0 (0.0)	5 (22.7)	0 (0.0)	17 (85.0)	0 (0.0)	6 (40.0)
	R	4 (19.0)	2 (28.6)	2 (8.0)	20 (60.6)	15 (75.0)	23 (92.0)	3 (100.0)	17 (77.3)	5 (100.0)	3 (15.0)	2 (100.0)	9 (60.0)
P. vulgaris	S	12 (70.6)	4 (80.0)	10 (90.9)	4 (28.6)	4 (25.0)	0 (0.0)	0 (0.0)	1 (12.5)	0 (0.0)	9 (90.0)	0 (0.0)	2 (16.7)
	R	5 (29.4)	1 (20.0)	1 (9.1)	10 (71.4)	12 (75.0)	15 (100.0)	4 (100.0)	7 (87.5)	2 (100.0)	1 (10.0)	1 (100.0)	10 (83.3)
CoNS	S	1 (50.0)	0 (0)	2 (100.0)	1 (100.0)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.00	0 (0.0)	1 (50.0)	1 (100.0)	0 (0.0)
	R	1 (50.0)	0 (0)	0 (0.0)	0 (0.0)	2 (100.0)	2 (66.7)	1 (100.0)	2 (100.0)	1 (100.0)	1 (50.0)	0 (0.0)	1 (100.0)
E. coli	S	3 (50.0)	5 (100.0)	9 (69.2)	2 (28.6)	2 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0)	3 (60.0)	1 (50.0)	1 (12.5)
	R	3 (50.0)	0 (0.0)	4 (30.8)	5 (71.4)	3 (60.0)	9 (100.0)	3 (100.0)	7 (100.0)	0 (0)	2 (40.0)	1 (50.0)	7 (87.5)
Enterobacter spp.	S	0 (0)	0 (0)	0 (0)	1 (100.0)	0 (0)	1 (100.0)	0 (0)	0 (0.0)	0 (0)	1 (100.0)	0 (0)	0 (0.0)
	R	0 (0)	0 (0)	0 (0)	0 (0.0)	0 (0)	0 (0.0)	0 (0)	1 (100.0)	0 (0)	0 (0.0)	0 (0)	1 (100.0)
Klebsiella pneumoniae	S	1 (50.0)	0 (0)	1 (100.0)	2 (33.3)	2 (50.0)	1 (20.0)	0 (0)	0 (100.0)	0 (0.0)	1 (100.0)	0 (0)	0 (0.0)
	R	1 (50.0)	0 (0)	0 (0.0)	4 (66.7)	2 (50.0)	4 (80.0)	0 (0)	5 (100.0)	1 (100.0)	0 (0.0)	0 (0)	5 (100.0)
Proteus spp.	S	2 (100.0)	4 (100.0)	4 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0)	4 (100.0)	0 (0.0)	1 (100.0)
	R	0 (0.0)	0 (0.0)	2 (33.3)	4 (100.0)	1 (100.0)	2 (100.0)	2 (100.0)	5 (100.0)	0 (0)	0 (0.0)	0 (0.0)	0 (0.0)
S. pyogenes	S	0 (0.0)	0 (0)	0 (0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0)	0 (0)	1 (50.0)	0 (0)	2 (100.0)	0 (0.0)
	R	1 (100.0)	0 (0)	0 (0)	2 (100.0)	1 (50.0)	1 (50.0)	0 (0)	0 (0)	1 (50.0)	0 (0)	0 (0.0)	1 (100.0)
S. pneumoniae	S	3 (100.0)	2 (100.0)	2 (100.0)	0 (0.0)	0 (0.0)	1 (33.3)	1 (50.0)	0 (0)	1 (50.0)	2 (100.0)	2 (100.0)	0 (0.0)
	R	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	2 (100.0)	2 (66.7)	1 (50.0)	0 (0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)

CoNS: coagulate negative *Staphylococci*, *AMK*: Amikacin, *AMC*: Amoxicillin clavulanic acid, *CRO*: Ceftriaxone, *CN*: *Gentamicin*; *DO*: Doxycycline, *CIP*: Ciprofloxacin, *SXT*: Trimethoprim-Sulphamethoxazole, *E*: Erythromycin, *T*: Tetracycline, *AML*: Ampicillin, *and P* Penicillin; S: sensitive, R: resistant.

tetracycline, ampicillin, penicillin, erythromycin, sulfamethoxazole-trimethoprim and amoxiclav.

4. Discussion

In this study, the culture positive samples were 96.3% which was close to that observed by [15] and higher than those reported by other researchers [35] [36]. The majority of cases in the study were under five children in line with findings of [15] [26]. This could be attributed to the anatomy of the Eustachian tube, which is horizontal, wide and short especially in children with these features enabling advantage to pathogens to mount from the nasopharynx to the middle ear cavity [37].

The most prevalent bacterial isolate in this study was *S. aureus* which is in agreement with studies [22] [38] [39] [40]. In contrast, studies [36] [41] [42] [43] [44] reported *P. aeruginosa* as the predominant bacterial isolate while [15] [26] observed *Proteus* spp. as the main bacterial isolates. In agreement with this study's findings, [45] and [46] reported *P. aeruginosa* and *S. aureus* as the most dominant causes of OM.

There was no significant association between bacterial isolate and gender in this study (χ^2 (11,270 = 9.2283, p = 0.6008), χ^{c2} = 19.675 > χ^{o2} = 9.2283) as reported by [43] [47]. On the contrary, others have found that there was an association between gender and otitis media [15] [48] [49] [50]. In addition, a significant relationship was found between number of isolates and age group (0 - 3) (p = 0.000). This is in close agreement with a study done in Ethiopia which reported the highest bacterial isolates found in age group 0 - 5 (p = 0.02) [40]. Similar result was observed by other studies in Ethiopia [15] and [26].

In the present study, the antibiotic susceptibility patterns of bacterial isolates varied among different antibiotics tested. *S. aureus*, the most prevalent isolate, was 85.7% sensitive to ciprofloxacin, the drug exhibited most effective antibacterial activity which is in agreement with the report of [44] and in contrast to that of [15] [40] and [42]. *S. aureus* was sensitive to gentamicin (73.8%) in this study as reported also by [15] [35] [36] [38] and [39] demonstrated high resistance to penicillin (88%), ampicillin (75%) and amoxiclav (66.7%). This pattern of *S. aureus* resistance pattern correlates with the findings of [27]. In this study, 31.7% of the *S. aureus* isolates were resistant to erythromycin which is very close to the findings of [15] and [40] which observed 39% and 31.5% of the isolates being resistant respectively.

P. aeruginosa, the second most prevalent isolated bacteria, was highly sensitive to ciprofloxacin (92.3%). Similar finding has been reported by [36] [44]. Contrastingly, less *P. aeruginosa* sensitivity pattern to ciprofloxacin had been reported by [27] [35] [40]. Proteus mirabilis showed multiple drug resistant patterns with 100% resistance to doxycycline, penicillin and erythromycin as similarly observed by [36] [40].

The most efficacious antibiotics to the total isolates were gentamicin, amikacin, ciprofloxacin. This agreed with the results of [40]. The two proteus species were the most resistant bacteria to many antibiotics tested. All isolates showed highest resistance rates to tetracyclines, ampicillin, penicillin, erythromycin and amoxiclav.

5. Conclusion

S. aureus, *P. aeruginosa* and *Proteus mirabilis* were the leading causative pathogens of otitis media. No association was established between isolate distribution and gender. Both the isolated gram positive and gram negative bacteria showed greatest sensitivity towards ciprofloxacin while the highest resistance was observed to penicillins, tetracyclines and sulfonamides. *S. aureus*, *P. aeruginosa* and *P. mirabilis* remain the major etiologic bacteria of OM among children in Hargeisa which could effectively be treated with topical and systemic flouroquinolones, aminoglycosides and 3rd gen. cephalosporins.

6. Limitations

It was not possible to reach the target 381 sample sizes due to the retrospective nature of the study as well as the unavailability of the ear discharge culture and sensitivity laboratory data in the hospital electronic database (medical records) and only 270 reports were found comprising of 70.8% of the target sample size.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Qureishi, A., Lee, Y., Belfield, K., Birchall, J.P. and Daniel, M. (2014) Update on Otitis Media—Prevention and Treatment. *Infection and Drug Resistance*, **7**, 15-24. https://doi.org/10.2147/IDR.S39637

[2] Monasta, L., *et al.* (2012) Burden of Disease Caused by Otitis Media: Systematic Review and Global Estimates. *PLOS ONE*, **7**, e36226. https://doi.org/10.1371/journal.pone.0036226

[3] Teele, D.W., Klein, J.O. and Rosner, B. (1989) Epidemiology of Otitis Media during the First Seven Years of Life in Children in Greater Boston: A Prospective, Cohort Study. *The Journal of Infectious Diseases*, **160**, 83-94. https://doi.org/10.1093/infdis/160.1.83

[4] Centers for Disease Control and Prevention (2017) CDC—Get Smart: Otitis Media (Fluid in the Middle Ear). https://web.archive.org/web/20150219034155/http://www.cdc.gov/getsmart/antibiotic-use/uri/ear-infection.html

[5] American Academy of Pediatrics and American Academy of Family Physicians Clinical Practice Guideline Subcommittee on Management of Acute Otitis Media Diagnosis and Management of Acute Otitis Media. 2004. http://pediatrics.aappublications.org

[6] World Health Organization (2004) Chronic Suppurative Otitis Media: Burden of Illness and Management Options.

[7] Scottish Intercollegiate Guideline Network (2003) Diagnosis and Management of Childhood Otitis Media in Primary Care. 66th Edition, SIGN. https://www.sign.ac.uk/our-guidelines/diagnosis-and-management-of-childhood-otitis-media-in-primary-care/

[8] Donaldson, J.D. (2017) Acute Otitis Media: Practice Essentials, Background, Anatomy. Medscape. https://emedicine.medscape.com/article/859316-overview

[9] Bluestone, C.D. (1998) 1 412 6926074. 1 Presented at the World Health Organization & CIBA Foundation Joint Workshop on Prevention of Hearing Impairment from Cronic Otitis Media.

[10] Brook, I. and Frazier, E.H. (1996) Microbial Dynamics of Persistent Purulent Otitis Media in Children. *The Journal of Pediatrics*, **128**, 237-240.

[11] Murphy, T.F., *et al.* (2013) Panel 5: Microbiology and Immunology Panel. *Otolaryngology—Head and Neck Surgery* (*United States*), **148**, E64-E89. https://doi.org/10.1177/0194599812459636

[12] Donabedian, A. (1988) The Quality of Care. How Can It Be Assessed? *JAMA*, **260**, 1743-1748. https://doi.org/10.1001/jama.260.12.1743

[13] Cook, D. (1998) Evidence-Based Critical Care Medicine: A Potential Tool for Change. *New Horizons*, **6**, 20-25. https://pubmed.ncbi.nlm.nih.gov/9508254/

[14] Wolf, S.H. (1992) Practice Guidelines, a New Reality in Medicine. II. Methods of Developing Guidelines. *Archives of Internal Medicine*, **152**, 946-952. https://pubmed.ncbi.nlm.nih.gov/1580720 https://doi.org/10.1001/archinte.1992.00400170036007

[15] Muluye, D., Wondimeneh, Y., Ferede, G., Moges, F. and Nega, T. (2013) Bacterial Isolates and Drug Susceptibility Patterns of Ear Discharge from Patients with Ear Infection at Gondar University Hospital, Northwest Ethiopia. *BMC Ear, Nose and Throat Disorders*, **13**, Article No. 10. https://doi.org/10.1186/1472-6815-13-10

[16] O'Neill, J. (2016) Tackling Drug-Resistant Infections Globally: Final Report and Recommendations: The Review on Antimicrobial Resistance.

[17] World Health Organization (2014) WHO_HSE_PED_AIP_2014.2_eng. Geneva.

[18] Jacobs, M.R., Dagan, R., Appelbaum, P.C. and Burch, D.J. (1998) Prevalence of Antimicrobial-Resistant Pathogens in Middle Ear Fluid: Multinational Study of 917 Children with Acute Otitis Media. *Antimicrobial Agents and Chemotherapy*, **42**, 589-595. https://doi.org/10.1128/AAC.42.3.589

[19] Arguedas, A.G., Herrera, J.F., Faingezicht, I. and Mohs, E. (1993) Ceftazidime for Therapy of Children with Chronic Suppurative Otitis Media without Cholesteatoma. *The Pediatric Infectious Disease Journal*, **12**, 246-248. https://doi.org/10.1097/00006454-199303000-00016

[20] Eason, R.J., Harding, E., Nicholson, R., Pada, J. and Gathercole, J. (1986) Chronic Suppurative Otitis Media in the Solomon Islands: A Prospective, Microbiological, Audiometric and Therapeutic Survey. *New Zealand Medical Journal*, **99**, 812-815. https://pubmed.ncbi.nlm.nih.gov/3466089

[21] Singh, A.H., Basu, R. and Venkatesh, A. (2012) Aerobic Bacteriology of Chronic Suppurative Otitis Media in Rajahmundry, Andhra Pradesh, India. *Biology and Medicine*, **4**, 73-79. https://www.researchgate.net/publication/289614540_Aerobic_bacteriology_of_chronic_suppurative_otitis_media_in_Rajahmundry_Andhra_Pradesh_India

[22] Shrestha, B., Amatya, R., Shrestha, I. and Ghosh, I. (2011) Microbiological Profile of Chronic Supurative Otitis Media. *Nepalese Journal of ENT Head and Neck Surgery*, **2**, 6-7. https://doi.org/10.3126/njenthns.v2i2.6793

[23] Al-Marzoqi, A.H., Al-Janabi, S.O., Hussein, H.J., Mohammad, Z., Taee, A. and Yheea, S.K. (2013) Otitis Media; Etiology and Antibiotics Susceptibility among Children under Ten Years Old in Hillah City, Iraq. *Journal of Natural Sciences Research*, **3**, 1-7. https://iiste.org/Journals/index.php/JNSR/article/view/4879

[24] Hussain, M.A., Ali, E.M. and Ahmed, H.S. (1991) Otitis Media in Sudanese Children: Presentation and Bacteriology. *East African Medical Journal*, **68**, 679-685.

[25] Ejiofor, S.O., Edeh, A.D., Ezeudu, C.E., Gugu, T.H. and Oli, A.N. (2016) Multi-Drug Resistant Acute Otitis Media amongst Children Attending Out-Patient Clinic in Chukwuemeka Odumegwu Ojukwu University Teaching Hospital, Awka, South-East Nigeria. *Advances in Microbiology*, **6**, 495-501. https://doi.org/10.4236/aim.2016.67049

[26] Abera, B. and Kibret, M. (2011) Bacteriology and Antimicrobial Susceptibility of Otitis Media at Dessie Regional Health Research Laboratory, Ethiopia. *Ethiopian Journal of Health Development*, **25**, 161-167.

[27] Es-Said, I., Mahdoufi, R., Yagoubi, M. and Zouhdi, M. (2014) Isolation and Antibiotic Susceptibility of Bacteria from Otitis Media Infections in Children in Rabat Morocco. *Journal of Biology, Agriculture and Healthcare*, **4**, 153-159. https://www.iiste.org

[28] Ludman, H. (1980) Discharge from the Ear: Otitis Externa and Acute Otitis Media. *British Medical Journal*, **281**, 1616-1617. https://doi.org/10.1136/bmj.281.6255.1616

[29] Rotimi, V.O., Olabiyi, D.A., Banjo, T.O. and Okeowo, P.A. (1990) Randomised Comparative Efficacy of Clindamycin, Metronidazole, and Lincomycin, plus Gentamicin in Chronic Suppurative Otitis Media. *West African Journal of Medicine*, **9**, 89-97. https://europepmc.org/article/med/2268574

[30] Fliss, D.M., Dagan, R., Houri, Z. and Leiberman, A. (1990) Medical Management of Chronic Suppurative Otitis Media without Cholesteatoma in Children. *The Journal of Pediatrics*, **116**, 991-996. https://doi.org/10.1016/S0022-3476(05)80666-3

[31] Onali, M.A., Bareeqa, S.B., Zia, S., Ahmed, S.I., Owais, A. and Ahmad, A.N. (2018) Efficacy of Empirical Therapy with Combined Ciprofloxacin versus Topical Drops Alone in Patients with Tubotympanic Chronic Suppurative Otitis Media: A Randomized Double-Blind Controlled Trial. *Clinical Medicine Insights: Ear, Nose and Throat*, **11**. https://doi.org/10.1177/1179550617751907

[32] Leach, A.J. and Morris, P.S. (2006) Antibiotics for the Prevention of Acute and Chronic Suppurative Otitis Media in Children. *Cochrane Database of Systematic Reviews*, No. 4, CD004401. https://doi.org/10.1002/14651858.CD004401.pub2

[33] Yamane, T. (1967) Statistics: An Introductory Analysis. 2nd Edition, Harper and Row, New York. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=1440506

[34] Weinstein, M.P. and Clinical and Laboratory Standards Institute (2020) Performance Standards for Antimicrobial Susceptibility Testing. 20th Edition, 1-332.

[35] Raghu Kumar, K., Navya, S., Basavarajappa, K., Professor, A. and Kumar, R.K. (2014) A Study of Bacterial Profile and Antibiotic Susceptibility Pattern of Chronic Suppurative Otitis Media among Patients Attending a Tertiary Care Centre, Davangere. *Scholars Journal of Applied Medical Sciences*, **2**, 1606-1612. https://saspublishers.com/article/7166/

[36] Ogbogu, P.I., Eghafona, N.O. and Ogbogu, M.I. (2013) Microbiology of Otitis Media among Children Attending a Tertiary Hospital in Benin City, Nigeria. *Journal of Public Health and Epidemiology Full Length Research Paper*, **5**, 280-284.

[37] Bluestone, C.D. (1998) Epidemiology and Pathogenesis of Chronic Suppurative Otitis Media: Implications for Prevention and Treatment. *International Journal of Pediatric Otorhinolaryngology*, **42**, 207-223. https://doi.org/10.1016/S0165-5876(97)00147-X

[38] Mohammad, A. (2010) Etiology and Antimicrobial Susceptibility Pattern of Otitis Media in Children at Princess Rhamah Hospital in Jordan. *The New Iraqi Journal of Medicine*, **6**, 27-30.

[39] Singh, A.H., Basu, R. and Venkatesh, A. (2012) Aerobic Bacteriology of Chronic Suppurative Otitis Media in Rajahmundry, Andhra Pradesh, India. *Biology and Medicine*, **4**, 73-79. https://www.biolmedonline.com

[40] Wasihun, A.G. and Zemene, Y. (2015) Bacterial Profile and Antimicrobial Suscepti-

bility Patterns of Otitis Media in Ayder Teaching and Referral Hospital, Mekelle University, Northern Ethiopia. *Springerplus*, **4**, Article No. 701. https://doi.org/10.1186/s40064-015-1471-z

[41] Afolabi, O.A., Salaudeen, A.G., Ologe, F.E., Nwabuisi, C. and Nwawolo, C.C. (2012) Pattern of Bacterial Isolates in the Middle Ear Discharge of Patients with Chronic Suppurative Otitis Media in a Tertiary Hospital in North Central Nigeria. *African Health Sciences*, **12**, 362-368. https://doi.org/10.4314/ahs.v12i3.18

[42] Alsaimary, I.E., Alabbasi, A.M. and Najim, J.M. (2010) Antibiotics Susceptibility of Bacterial Pathogens Associated with Otitis Media. *Journal of Bacteriology Research*, **2**, 41-50. http://www.academicjournals.org/JBR

[43] Hailu, D., Mekonnen, D., Derbie, A., Mulu, W. and Abera, B. (2016) Pathogenic Bacteria Profile and Antimicrobial Susceptibility Patterns of Ear Infection at Bahir Dar Regional Health Research Laboratory Center, Ethiopia. *SpringerPlus*, **5**, Article No. 466. https://doi.org/10.1186/s40064-016-2123-7

[44] Mozafari Nia, K., Sepehri, G., Khatmi, H. and Shakibaie, M. (2011) Isolation and Antimicrobial Susceptibility of Bacteria from Chronic Suppurative Otitis Media Patients in Kerman, Iran. *Iranian Red Crescent Medical Journal*, **13**, 891-894.

[45] Iseh, K.R. and Adegbite, T. (2004) Pattern and Bacteriology of Acute Suppurative Otitis Media in Sokoto, Nigeria. *Annals of African Medicine*, **3**, 164-166.

[46] Weckwerth, P.H., *et al.* (2009) Chronic Suppurative Otitis Media in Cleft Palate: Microorganism Etiology and Susceptibilities. *Cleft Palate-Craniofacial Journal*, **46**, 461-467. https://doi.org/10.1597/08-144.1

[47] Osazuwa, F., *et al.* (2011) Etiologic Agents of Otitis Media in Benin City, Nigeria. *North American Journal of Medicine and Science*, **3**, 95-98. https://doi.org/10.4297/najms.2011.395

[48] Egbe, C., Mordi, R., Omoregie, R. and Enabulele, O. (2010) Prevalence of Otitis Media in Okada Community, Edo State, Nigeria. *Macedonian Journal of Medical Sciences*, **3**, 299-302. https://doi.org/10.3889/MJMS.1857-5773.2010.0110

[49] Kero, P. and Piekkala, P. (1987) Factors Affecting the Occurrence of Acute Otitis Media during the First Year of Life. *Acta Paediatrica*, **76**, 618-623. https://doi.org/10.1111/j.1651-2227.1987.tb10531.x

[50] Santoshi Kumari, M., Madhavi, J., Bala Krishna, N., Raja Meghanadh, K. and Jyothy, A. (2016) Prevalence and Associated Risk Factors of Otitis Media and Its Subtypes in South Indian Population. *Egyptian Journal of Ear, Nose, Throat and Allied Sciences*, **17**, 57-62. https://doi.org/10.1016/j.ejenta.2016.04.001