Original Research Article

Microbiology of Chronic Suppurative Otitis Media amongst Children attending a Tertiary Health Facility in north-western Nigeria.

Abstract:

Background:
Chronic suppurative otitis media (CSOM) is a global middle ear disease worst in developing nations of the world. The burden in our environment of repeated episodes of childhood CSOM otorrhoea, and the resultant difficulty in the management of these patients because of improper or inadequate treatment is quite worrisome.

Aim: The aim of this study was to prospectively analyze the aspirated middle ear exudates of paediatric patients with CSOM for both facultative aerobic bacteria and fungi, with their antimicrobial sensitivity patterns.

Materials and Methods: A total of 166 children clinically diagnosed with CSOM were enrolled in the study, of which 219 middle ear discharge samples were obtained using sterile disposable plastic Pasteur pipettes and cultured for microbial flora. Drug susceptibility testing for the isolated microbes was conducted using the Kirby‑Bauer disc diffusion method.

Results:
The ratio of facultative/aerobic bacteria to fungi was 2.1: 1, while the ratio of Gram-positive to Gram-negative aerobic bacteria was 1: 1.7. The most common causative aerobic organisms isolated were *Staphylococcus aureus* 41/202 (20.3%), *Pseudomonas aeruginosa* 30/202 (14.9%), *Klebsiella pneumonia* 23/202 (11.4%), and *Proteus mirabilis* 21/202 (10.4%). *Aspergillus species* 47/202 (23.3%) and *Candida albicans* 21/202 (10.4%) were the commonest fungal isolates. The antimicrobial profile of aerobic isolates revealed maximum sensitivity to gentamycin (91.1%), ceftriaxone (90.1%), and ciprofloxacin (85.6%); while the isolated fungi were completely sensitive to all the antifungals.

Conclusion: The main isolates were Gram-negative aerobic bacteria, though Gram-positive aerobes and fungi were also isolated. Their varying antimicrobial susceptibility brings to the fore, the therapeutic significance of these drugs in CSOM management.

Keywords: Chronic suppurative otitis media, aerobes, fungi, Sokoto

Introduction:

Most of the time emphasis on infections is always systemic, with negligible attention given to individual organs. Unfortunately, the ear is one of such individual organs receiving minimal attention but is vulnerable to a variety of infections.[1] By definition, chronic suppurative otitis media (CSOM) otherwise referred to as active chronic otitis media (active COM) is a disease condition characterized by chronic inflammatory changes of the mucoperiosteum of the middle ear cleft (Eustachian tube, tympanic cavity, and mastoid air cells) with the presence of permanent perforation of the tympanic membrane, and recurrent or persistent mucoid or mucopurulent otorrhoea.[2,3] The otorhinolaryngologists adopt more than 12 weeks (3 months) of active otorrhoea for CSOM.[3] But generally, patients with tympanic membrane perforations who continue to discharge mucoid material for periods from 6-12 weeks, despite medical treatment, are recognized as CSOM cases.[2] For urgent referrals from primary health care facilities, and to prevent complications associated with the protraction of the disease, the World Health Organization (WHO) adopted two weeks of otorrhoea for the diagnosis of CSOM.[4]

Chronic suppurative otitis media is a global middle ear disease with a serious health-economic burden, especially in developing nations of the world including Nigeria, where the disease prevalence could be very high.[5,6] The highest prevalence of the disease among children in the world ranges from 7% to 46% and is reported among the Inuits of Alaska, Canada and Greenland, American Indians, and Australian Aborigines.

Various studies world over, have examined the microbiologic spectra in middle ear infections. Unfortunately, many local studies examine commonly the bacteriology of CSOM, avoiding mycology; thus, leaving a dearth of knowledge in this regard. *Pseudomonas aeruginosa* and *Staphylococcus aureus* are the most common aerobic microbial isolates in patients with CSOM, followed by *Proteus vulgaris*, *Klebsiella pneumoniae*, and

Diphtheroids.[2,7] The anaerobes and fungi complete the spectrum of colonizing organisms responsible for this disease.[8] These bacteria and fungi may grow concurrently in a symbiotic relationship, exhibiting an increased virulence of infection.[2,9–11]

Previous studies have highlighted CSOM as one of the common otorhinolaryngological diseases among children in ORL clinics.[12,13] The World Health Organization (WHO) estimates that each year 51,000 children aged below 5 years die from complications of CSOM in developing countries.[4] Thus, the burden in our environment of repeated episodes of childhood otorrhoea from CSOM, and the resultant difficulty in the management of these patients mainly because of improper or inadequate treatment, is the rationale for this study. Since childhood CSOM with its antecedent complications like hearing loss is a common presentation in our facility, coupled with the rising frequency of fungal infections worldwide, and the evolving microbes implicated in infections, the need to study the microbial pattern of this disease in childhood cannot be overemphasized.

Most studies of ear swabs obtained from the external auditory canals of CSOM patients including the study center had analysed majorly the bacterial isolates and their antibiotic sensitivity pattern. This study is intended to prospectively analyze the aspirated middle ear exudates of paediatric patients with CSOM for both aerobic bacteria and fungi, with their antimicrobial sensitivity patterns. Knowledge of the established flora and their susceptibility pattern to antimicrobials will guide clinicians in prescribing an empirical regimen so that a more scientifically based treatment plan for CSOM with greater efficacy and least morbidity can be provided in our society.

Materials and methods:

Study design, Study area, Study period and Study population: This was a descriptive, cross-sectional hospital-based prospective study conducted among children aged less than 18 years that attended a tertiary hospital in North-western Nigeria with a clinical diagnosis of CSOM between June 2016 and June 2018. The criteria for establishing the diagnosis of CSOM was the presence of a tympanic membrane perforation with active otorrhoea lasting for two weeks or more.[4,14]

Study sampling: Using consecutive sampling techniques, a total of 166 paediatric patients clinically diagnosed with CSOM, who had not received any antimicrobials within the preceding two weeks, were recruited.

Study procedure: The ears were first inspected, and those with dry crust or discharge on the concha were cleaned and sterilized with gauze soaked in 70% alcohol to remove contaminants. Gentle suction toileting or dry mopping was performed to clear the external auditory canal of any discharge. Otomicroscopy was done using an operating microscope with a 250mm focal length to view and locate perforation on the tympanic membrane, and aid aspiration of the middle ear exudate using sterile disposable plastic Pasteur pipettes. The exudates were expressed onto well-labeled sterile swab sticks (in Amies transport media) enclosed in airtight plastic tubing, and sent for microbiologic analysis within 30 minutes to 2 hours of collection. Bilaterally discharging ears had their samples collected separately.

Isolation of Bacteria: The middle ear discharges were inoculated on well-labeled and dried Chocolate, MacConkey, and 5% Sheep Blood agar plates using a sterilized inoculated wire loop, which was also used to streak the smear. The agar plates were incubated at 37^0c for 18-72 hours aerobically; except for the Chocolate agar that was incubated in a candle jar carbondioxide enriched atmosphere. Gram's staining was carried out to ascertain the morphology and Gram's reaction-behavior of the isolates after air drying and heat fixing the specimen. Visual examination was done for bacterial growth after 18-72 hours. Plates with no growth were discarded, and the sample was labeled sterile for bacteria. But where there were growths, discrete colonies were selected for morphology. Thereafter, various biochemical tests were carried out to identify the different species. Emergent colonies were identified according to standard bacteriological methods.[15]

Antibacterial Susceptibility Testing: Antibiotic disc susceptibility testing of commonly used antibiotics was carried out using the Kirby Bauer disk diffusion method. The diameter of the zone of inhibition was measured and interpreted as resistant or susceptible as described in Clinical and Laboratory Standards Institute (CLSI) guidelines.[16]

Isolation of Fungi: The swab sticks were streaked directly on the well-labeled Sabouraud's Dextrose Agar (SDA) plates and incubated at room temperature aerobically for 3-7 days. Following proper masking and gloving, the growths were identified based on their morphological and cultural characteristics, and a microscopic examination was done using the lactophenol blue staining technique.[17] Germ tube method was used to differentiate Candida albicans from other species of Candida.

Antifungal Susceptibility Testing: The antifungal susceptibility test was performed using common antifungal agents, according to Clinical and Laboratory Standards Institute (CLSI) guidelines, and interpreted accordingly.[16]

Ethical Considerations: Institutional ethical approval was obtained and informed consent was taken from parents/guardians of the children before enrolling in the study.

Data Management: Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 23 and presented in simple tables.

Results:

A total of 166 paediatric patients were studied, of which 219 middle ear exudates were collected from the right (41.6%), left (26.5%), or both (31.9%) ears. The ratio of unilateral to bilateral ear discharges was 2.1:1. Patients' ages ranged from 9 months to 17 years with a mean age of 5.5 years. Those aged 1-5 years constituted 42.8%, while 4.2% comprised less than 1 year. Males accounted for 61.5% of the patients, with a male to female ratio of 1.6:1. About 15.1% of the patients, were yet to be enrolled in school, while 49.4% of them were in primary schools. Most of the patients (73.0%) were brought to the hospital by their mothers, whereas only 20.7% were brought by their fathers. The commonest presenting symptoms were otalgia (46.4%) and itchy ears (35.5%). Only 7.8% of the patients complained of fever.

Table 1: Sociodemographic characteristics of patients

SOCIO-DEMOGRAPHIC DATA	FREQUENCY (%)
Age group (years) n=166:	
< 1	7 (4.2)
1 – 5	71 (42.8)
6 – 10	43 (25.9)
11 – 15	33 (19.9)
> 15	12 (7.2)
Sex (n=166):	
Male	102 (61.5)
Female	64 (38.6)
Patient's educational level (n=166):	
Yet to be enrolled in school	25 (15.1)
Daycare	0 (0.0)
Nursery	23 (13.9)
Primary	82 (49.4)
Secondary	36 (21.7)

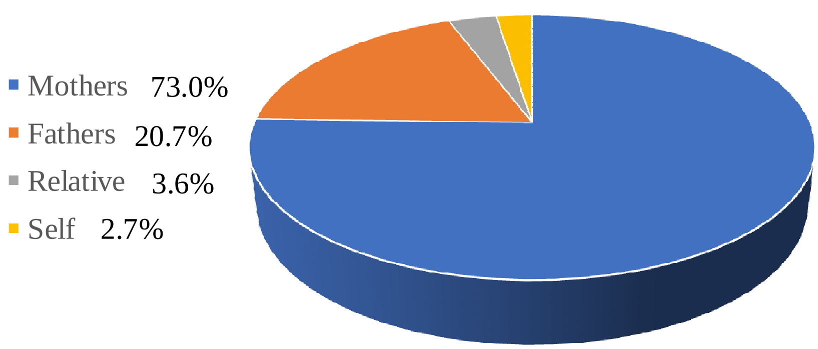


Figure 1: Caregivers that accompanied the child to the hospital.

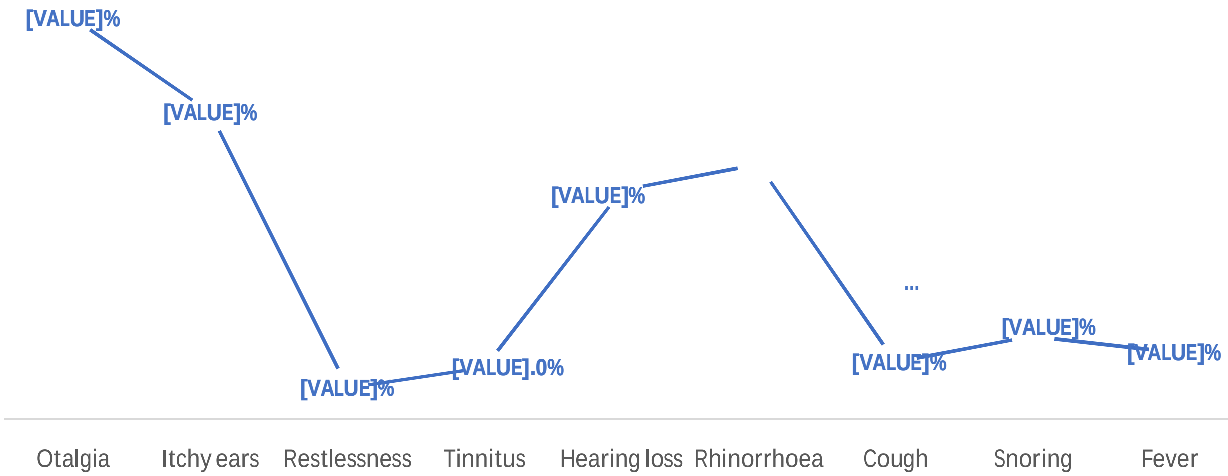


Figure 2: Presenting symptoms

Out of the 219 aspirates collected, 17 (7.8%) were sterile culturing neither bacteria nor fungi. The remaining 202 (92.2%) cultured different species of aerobic bacteria and fungi. The ratio of aerobic bacteria: fungi was 2.1:1, while the ratio of gram-positive: gram-negative aerobic bacteria was 1: 1.7. Staphylococcus species (27.3%) was the most isolated gram-positive aerobe, followed by Streptococcus species (7.9%), while Klebsiella species (19.7%), followed by Pseudomonas aeruginosa (14.9%) were the most isolated gram-negative aerobe. Aspergillus species (49.0%) and Candida albicans (21.8%) were the commonest fungal isolates.

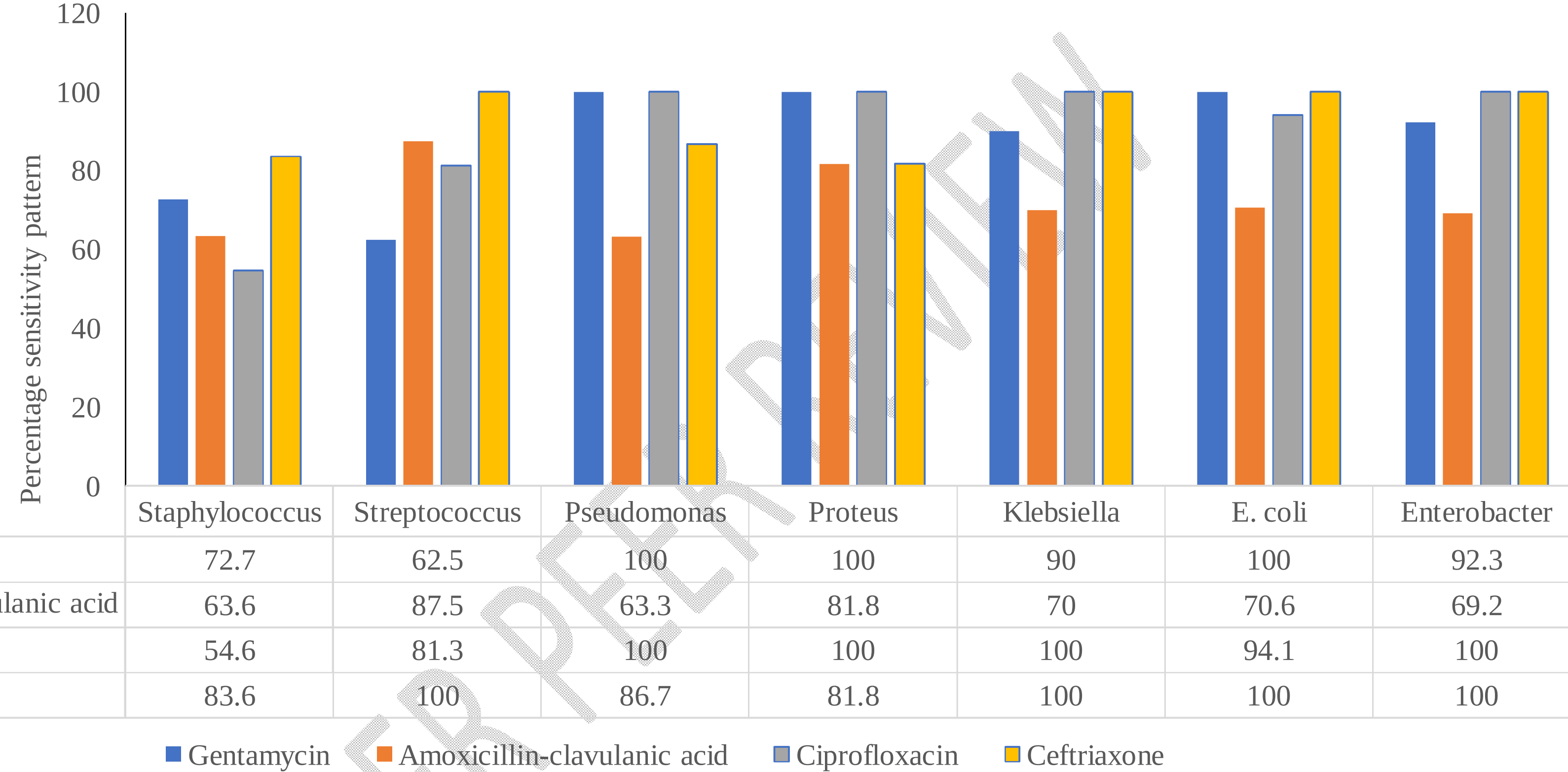
Gentamycin (91.1%), ceftriaxone (90.1%), and ciprofloxacin (85.6%) showed the highest sensitivity to the isolated aerobes, while cotrimoxazole (10.4%) and amoxicillin (5.5%) were the least; while the isolated fungi were completely susceptible to all the antifungals tested.

Table 2: Microbial isolates

MICROBES	FREQUENCY (%) (N=202)	PREVALENCE (N=219)
A). Aerobic bacteria		92.2
Gram-positive		
1. *Staphylococcus aureus*	41 (20.3)	
2. *Staphylococcus epidermidis*	11 (5.5)	
3. *Staphylococcus lugdunensis*	3 (1.5)	34.7
4. *Streptococcus pneumonia*	9 (4.5)	
5. *Streptococcus pyogenes*	7 (3.5)	
6. *Corynebacterium diphtheria*	5 (2.5)	
Gram-negative		
1. *Moraxella catarrhalis*	3 (1.5)	
2. *Pseudomonas aeruginosa*	30 (14.9)	
3. *Proteus mirabilis*	21 (10.4)	
4. *Proteus vulgaris*	1 (0.5)	
5. *Escherichia coli*	17 (8.4)	57.5
6. *Enterobacter* species	13 (6.4)	
7. *Citrobacter* species	1 (0.5)	
8. *Klebsiella pneumonia*	23 (11.4)	
9. *Klebsiella oxytoca*	17 (8.4)	
B). Fungal isolates		
1. *Aspergillus niger*	36 (17.8)	
2. *Aspergillus fumigatus*	11 (5.5)	
3. *Candida albicans*	21 (10.4)	
4. *Mucor* species	12 (5.9)	43.8
5. *Penicillium* species	3 (1.5)	
6. *Cephalosporium* species	6 (3.0)	
7. *Trichosporon* species	7 (3.5)	
C). Sterile	-	7.8

Table 3: *In vitro* antibiotic sensitivity pattern of the isolated aerobes

S/No.	Isolated aerobes (n)	***In vitro* antibiotic sensitivity pattern (%)**							
		Gent	Chlr	Amx-Clav	Eryth	Cotr	Cipro	Ceftr	Amx
1.	*Staphylococcus aureus* (41)	39 (95.1)	29 (70.7)	21 (51.2)	12 (29.2)	4 (9.8)	30 (73.1)	35 (85.4)	3 (7.3)
2.	*Staphylococcus epidermidis* (11)	11 (100.0)	-	11 (100.0)	-	-	-	11 (100.0)	-
3.	*Staphylococcus lugdunensis* (3)	-	3 (100.0)	3 (100.0)	3 (100.0)	-	-	-	-
4.	*Streptococcus pneumonia* (9)	5 (55.6)	3 (33.3)	7 (77.8)	5 (55.6)	3 (33.3)	7 (77.8)	9 (100.0)	2 (22.2)
5.	*Streptococcus pyogenes* (7)	5 (71.4)	3 (42.9)	7 (100.0)	5 (71.4)	1 (14.3)	6 (85.7)	7 (100.0)	-
6.	*Corynebacterium diphtheria* (5)	4 (80.0)	1 (20.0)	1 (20.0)	1 (20.0)	1 (20.0)	5 (100.0)	3 (60.0)	-
7.	*Moraxella catarrhalis* (3)	3 (100.0)	1 (33.3)	1 (33.3)	-	-	3 (100.0)	3 (100.0)	-
8.	*Pseudomonas aeruginosa* (30)	30 (100.0)	12 (40.0)	19 (63.3)	11 (36.7)	7 (23.3)	30 (100.0)	26 (86.7)	2 (6.7)
9.	*Proteus mirabilis* (21)	21 (100.0)	13 (61.9)	17 (81.0)	5 (23.8)	2 (9.5)	21 (100.0)	18 (85.7)	-
10.	*Proteus vulgaris* (1)	1 (100.0)	-	1 (100.0)	-	-	1 (100.0)	-	-
11.	*Escherichia coli* (17)	17 (100.0)	6 (35.3)	12 (70.6)	7 (41.2)	2 (11.8)	16 (94.1)	17 (100.0)	2 (11.8)
12.	*Enterobacter* species (13)	12 (92.3)	7 (53.9)	9 (69.2)	4 (30.8)	-	13 (100.0)	13 (100.0)	-
13.	*Citrobacter* species (1)	-	-	1 (100.0)	-	-	1 (100.0)	-	-
14.	*Klebsiella pneumoniae* (23)	21 (91.3)	7 (30.4)	16 (69.6)	8 (34.8)	1 (4.4)	23 (100.0)	23 (100.0)	1 (4.4)
15.	*Klebsiella oxytoca* (17)	15 (88.2)	4 (23.5)	12 (70.6)	3 (17.7)	-	17 (100.0)	17 (100.0)	1 (5.9)
	Total (202)	184 (91.1)	89 (44.1)	138 (68.3)	64 (31.7)	21 (10.4)	173 (85.6)	182 (90.1)	11 (5.5)



	Staphylococcus	Streptococcus	Pseudomonas	Proteus	Klebsiella	E. coli	Enterobacter
Gentamycin	72.7	62.5	100	100	90	100	92.3
Amoxicillin-clavulanic acid	63.6	87.5	63.3	81.8	70	70.6	69.2
Ciprofloxacin	54.6	81.3	100	100	100	94.1	100
Ceftriaxone	83.6	100	86.7	81.8	100	100	100

Figure 3: Sensitivity pattern of the major isolated aerobes

DISCUSSION

Chronic suppurative otitis media is a common problem faced not only by the Otorhinolaryngologist but also by General medicine practitioners, Family physicians, and Paediatricians.[18] Despite advances in public health and medical care, CSOM is still prevalent around the world. The disease can have irreversible untoward complications if poorly or lately treated, and thus an early bacteriological and mycological diagnosis with prompt treatment using appropriate antimicrobials is essential in combating it. Unfortunately, the susceptibility of CSOM-causing microbes to antimicrobials changes considerably from time to time and is worsened by the misuse of antibiotics. This tends to create multidrug resistance among the microbes, thereby making management even more difficult.[19]

CSOM was commonest among children aged 1 – 5 years (42.8%) in our study. These findings were similar to those reported in other studies, and further, emphasize CSOM as a disease of childhood.[11,13] This study revealed the prevalence of unilateral over bilateral ear discharges in a ratio of 2.1: 1. Similarly, other studies in the south-western and south-eastern regions of Nigeria observed the prevalence of unilateral ear discharge over the bilateral.[11,20] This is important in the management of patients because there is a strong association between bilateral infection and disease severity.[21] It is only reasonable to consider bilateral ear involvement as a more severe disease that requires more attentive and specific management protocol, than unilateral. Outside otorrhoea which was present in all the patients, otalgia (46.4%), itchy ears (35.5%), rhinorrhea (29.5%), and hearing loss (26.5%) were the most common presenting symptoms. Haider and Iseh *et al* noted otalgia, itching, and hearing loss as the commonest presenting symptoms in CSOM. [13,22]

Samples in this study were processed to recover aerobic bacteria and fungi. With regard to the morphotypes, this study yielded more mono-aerobic bacterial cultures (48.4%). Poly-microbial cultures involving aerobes and fungi accounted for 43.8%; while only 7.8% of the cultures were sterile with neither bacterial nor fungal growths. In India, Yousuf *et al* reported 12.0% sterile cultures, 62.8% mono-microbial, and 25.2% poly-microbial cultures, while Pokharnikar *et al* reported 11.67% of sterile cultures and only 2.5% of poly-microbial culture.[23,24] These dissimilarities in the results may be attributed to differences in the patient population studied and geographical variations. The role of prior empirical antibiotics in sterile cultures of actively discharging CSOM has been reiterated; invariably making treatment of CSOM.[11]

A trend towards Gram-negative aerobes (Gram-positive to Gram-negative ratio of 1:1.7) was noted. This suggests that CSOM infection in our study is more Gram-negative than Gram-positive aerobes. Yousuf *et al* highlighted a Gram-positive to Gram-negative ratio of 1.08:1.[23] Our study revealed that active CSOM infection in Sokoto children population was mainly caused by the following aerobes: *Staphylococcus aureus* 41/202 (20.3%), *Pseudomonas aeruginosa* 30/202 (14.9%), *Klebsiella pneumonia* 23/202 (11.4%), *Proteus mirabilis* 21/202 (10.4%), *Escherichia coli* 17/202 (8.4%) and *Klebsiella oxytoca* 17/202 (8.4%). Similarly, *Pseudomonas aeruginosa, Staphylococcus aureus, Proteus* species, *Klebsiella* species, and *Diphtheroids* are the most reported aerobic bacteria isolates in CSOM globally, even by the World Health Organisation.[2,4,24] Shrivastava *et al* in their study, isolated a comparable number of *Staphylococcus aureus* (29.24%) and *Pseudomonas aeruginosa* (28.30%) as the first and second most isolated aerobic bacteria.[25] Isolation of coliforms bacteria such as *Klebsiella* species and *Escherichia coli* in this study was similar to those in India.[23,24] An earlier study in this same center had cultured an equal number of *Pseudomonas aeruginosa* and *Staphylococcus aureus* as the main isolates with very few *Proteus* species.[13] Interestingly, a study in South Africa and south-western Nigeria, cultured *Haemophilus influenzae* as an isolate in CSOM.[26,27] Many have argued that the bacteria isolated from chronically discharging middle ears are secondary invaders of mucosa that is inflamed due to other factors rather than they are the primary cause of the disease because in CSOM the middle ear environment is thought to be more tolerant to unusual organisms.[3] This view is strengthened by the fact that *Pseudomonas* and *Proteus* which are common inhabitants of even healthy external auditory canals were isolated in this study. *Pseudomonas aeruginosa* is a unique microbe because it survives competition with other pathogens due to its minimal nutritional requirements and its arsenal of antibacterials like pyocyanin and bacteriocin.[25] In local infections like CSOM, the organism can create a secure environment for itself through the necrotizing activities of its extracellular enzymes.[28] A combination of the physical characteristics of the niche, a damaged epithelium, interrupted circulation, devitalized tissue and opportunistic nature protects it from normal host defense mechanisms, and antibiotic agents, causing it to flourish in the external auditory canal. *Staphylococcus aureus* is ubiquitous with highly resistant strains; thus a likely reason for its high prevalence in our study.[9] The isolation of fecal bacteria like *Escherichia coli* and *Klebsiella* species, and water bacteria like *Pseudomonas aeruginosa* may indicate that children in this study area are at risk of infection due to poor hygiene conditions; a reflection of their low socio-economic status.

The prevalence of fungi in our study was 43.8%. Ibekwe *et al* and Prakash *et al* had 25.0% and 12.25% respectively of fungal isolates in their studies.[8,29] Interestingly, opportunistic fungal infections have gained greater importance in human medicine, possibly because of the increasing number of immunocompromised patients; even though they can also produce infection in immunocompetent hosts.[30–32] The fungi isolated from actively discharging CSOM of Sokoto children population included *Aspergillus niger* (17.8%), *Candida albicans* (10.4%), and *Aspergillus fumigatus* (5.5%). These findings further reiterate the role of fungal infections in CSOM. Some have postulated that the prolonged use of topical broad-spectrum antibiotics may lead to the suppression of bacterial flora and the subsequent emergence of opportunistic fungal flora in the oral cavity, gastrointestinal tract, vaginal tract, and even in the middle ear.[9,33] This occurs following the entry of fungal spores from the external environment into the moist and alkaline medium of middle ear discharge, which finally leads to the development of mycotic otitis media causing intractable otorrhoea.[33] In CSOM, the development of otalgia, itching, and the presence of hyphae indicate the presence of fungi.[8]

Overall, the aerobes isolated from the actively discharging CSOM of Sokoto children population were sensitive to gentamycin (91.1%), ceftriaxone (90.1%), and ciprofloxacin (85.6%). Earlier studies in Nigeria, Iran, and India where similar organisms were isolated, reported high in *vitro* sensitivity to aminoglycoside and fluoroquinolones.[11,13,29,34] Regarding individual aerobe susceptibility to antimicrobials, *Pseudomonas* had all isolates completely sensitive to aminoglycoside and fluoroquinolone, with 86.7% and 63.3% sensitivity to cephalosporin and amoxicillin-clavulanic acid respectively. A study in India by Srivastava et al also reported a similar antibiotic sensitivity pattern with *Pseudomonas*.[35] *Klebsiella species* in our study displayed complete sensitivity to fluoroquinolone and cephalosporine, with 90.0% and 70.0% sensitivity to aminoglycoside and amoxicillin-clavulanic acid. *Staphylococcus* did not show complete sensitivity to any antibiotic. Even amoxicillin-clavulanic acid, which enjoys high patronage in this study area, being the most often prescribed empirical antibiotic in otitis media did not express good *in vitro* sensitivity when compared with gentamycin, ceftriaxone, and ciprofloxacin. The isolated fungi showed complete *in vitro* sensitivity to clotrimazole, nystatin, fluconazole, griseofulvin, ketoconazole, and terbinafine. This goes to illustrate that variations in the degree of susceptibility of microbes to antimicrobials occur, and emphasizes the need for local studies in this respect to guide the rational use of the existing antibiotics. Some isolates displayed multidrug resistance which reflects the degree of misuse of antibiotics in this study area. Resistance of pathogenic organisms to over-the-counter antibiotics from recurrent use has become a worldwide problem with serious consequences for the treatment of diseases including CSOM.[36] In this study, many aerobes showed some form of resistance to the antibiotics tested, especially amoxicillin and cotrimoxazole, further buttressing the multidrug resistance phenomenon. The anaerobes displayed minimal multidrug resistance when compared with the aerobes.

Beta-lactams (penicillins, cephalosporins, etc) are by far the most widely used and efficacious of all antibiotics.[9] Over the past few decades, widespread resistance because of the production of beta-lactamase enzyme has evolved among the most common pathogens to these drugs. The beta-lactamase-producing bacteria isolated in this study were *Staphylococcus, Proteus, Pseudomonas aeruginosa*, *Streptococcus, Klebsiella, Citrobacter*, and *Escherichia coli.* These isolates expressed either partial or complete resistance to amoxicillin or ceftriaxone, both of which are beta-lactams. Even though clavulanic acid is a weak broad-spectrum antibiotic, its addition at low concentrations to these beta-lactamase-labile penicillins has demonstrated marked improvement in their activity. Thus, the concept behind amoxicillin-clavulanic acid. These beta-lactamase-producing bacteria, though demonstrated better susceptibility to amoxicillin-clavulanic acid than to only amoxicillin in this study, only a few of the regular bacteria isolated in this study showed complete (100.0%) *in vitro* sensitivity to the drug. This finding may support the concluding statements of Reading *et al*, who noted that the improvement of the activity of beta-lactams by clavulanic acid is very marked for strains of bacteria that owe their resistance to the production of beta-lactamase, but only occurs where this enzyme is readily inhibited by the acid.[37] From this statement, therefore, it is possible that the clavulanic acid in the amoxicillin-clavulanic acid does not readily inhibit all the beta-lactamases produced by the different bacteria strains isolated in this study area, which likely explains this pattern of sensitivity to amoxicillin-clavulanic acid.

Conclusion:

Aerobic bacteria and fungi were identified in this study to cause CSOM. The main isolates were Gram-negative aerobic bacteria. The bacteria *in vitro* antibiotic sensitivity patterns from this study were gentamycin, ceftriaxone, and ciprofloxacin all exhibiting good gram-negative coverage. The isolated fungi were completely susceptible to all the *in vitro* antifungals tested. This brings to the fore, the role of antimicrobials in the management of CSOM. As first-line drugs in children with CSOM, systemic cephalosporins, ad-hoc ototopic constitution of ceftriaxone, or ototopic fluoroquinolones may be used. In cases of recalcitrant suppuration, mycotic otorrhoea should be suspected and daily aural wick dressing with any of the antifungals studied can be added to the treatment plan.

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