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ORIGINAL RESEARCH

Microbiology of chronic suppurative otitis media: A descriptive cross-sectional study

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ABSTRACT

Background: Studies on microbiologic diagnoses of CSOM differ in regard to patient age, geography, and the presence of complications such as cholesteatomas, and these inconsistencies likely impact some of the variation in reported pathogens. The study sought to determine the CSOM-causing microorganisms at Queen Elizabeth Central Hospital in Blantyre, Malawi, and establish their relationship signs and symptoms, and with the demographic pattern of the study. **Methods**: The study population comprised CSOM patients attending the ENT outpatient clinic at QECH during the study period. Inclusion criteria were all patients with actively draining CSOM who consented or whose guardians consented to participate in the study and did not meet any of the exclusion criteria. **Results**: The most common aerobes identified from the specimens were gram-negative bacteria, which included Proteus mirabilis (n= 54; 29.4%), Pseudomonas aeruginosa (n = 42; 34.8%), and Escherichia coli (n = 17; 12.8%). The gram-positive aerobes identified included Staphylococcus aureus (n = 46; 34.8%) and coagulase-negative staphylococci (n = 8; 6.0%). Other organisms were identified in small numbers. **Conclusion:** Antibiotics such as second and third generation cephalosporins and amoxicillin-clavulanic acid are no longer effective in treating chronic otitis media, due to development of bacterial resistance by majority of bacteria towards it.

INTRODUCTION

The global burden of illness from CSOM is estimated to involve about 65 to 330 million individuals with draining ears, 60% (39 to 200 million) of whom suffer from significant hearing impairment.2 Over 90% of the burden is borne by developing countries in Southeast Asia, the Western Pacific Region, and Africa.[1]

Typical pathogens reach the middle ear following insufflations of respiratory pathogens through the eustachian tubes from the nasopharynx and spread from the external ear canal inwards through a non-intact tympanic membrane.[2,3] Studies on microbiologic diagnoses of CSOM differ in regard to patient age, geography, and the presence of complications such as cholesteatomas, and these inconsistencies likely impact some of the variation in reported pathogens. A portion of the variability observed may be related to differences in sampling and processing methods.[2,4] Knowledge of the true frequency of polymicrobial infection, particularly the extent of anaerobic involvement, is limited by differences in collection and culture techniques.[5,6] Traditional swab specimen collection has been associated with contamination with normal skin flora like Staphylococcus epidermidis, diphtheroids and anaerobic organisms, such as Propionibacterium acnes.[7]

A profuse, mucoid, non-foul smelling and non-blood stained discharge points towards mucosal/safe COM.2Chronic otitis media is an inflammationand infection of the middle ear which is characterized by a persistent otorrhoea from a perforated tympanic membrane over a month.[8-10] A scanty, purulent, foul smelling, blood stained discharge associated with pain suggests a squamosal/unsafe COM. In addition, the above discharge characteristics of squamosal COM is because of the osteitic changes in the mastoid in the middle ear. Having sound knowledge of the frequency of a polymicrobial infection, in particular the extent of involvement of an anaerobe is limited due to the differences in the collection and method of culture.[11,12] A complicated CSOM was frequent before the antibiotic era. However, due to the introduction of antibiotics, clinicians have been given a tool which is used even without having an accurate causative diagnosis. Adding to this, the irrational use of antibiotics has in fact led to the emergence of the bacteriae which are multi-drug resistant strains, and hence causing disease complication.[13]

METHODS

Microbiological analyses were carried out at the QECH microbiology laboratory and University of Malawi College of Medicine's laboratory.

The study population comprised CSOM patients during the study period. Inclusion criteria were all patients with actively draining CSOM who consented or whose guardians consented to participate in the study and did not meet any of the exclusion criteria. Exclusion criteria were patients on antibiotic or antifungal treatment (ear drops or systemic) within the previous two weeks, patients with draining ears of less than two weeks duration, patients with draining ears but intact tympanic membrane (otitis externa), and patients who refused to consent to participate in the study.

Sampling method

The study utilized simple random sampling to select CSOM patients. Subjects were recruited into the study as they came to the clinic until the required number was obtained with strict application of the inclusion and exclusion criteria.

Preparation of media

Muller Hinton agar (MHA) was prepared freshly by pouring to a depth of 4 mm (25 ml medium) in flat bottomed 9 cm petri dishes on a level surface. After the preparation of media, one plate was incubated without organism for checking its sterility. Before inoculation, plates were dried, so that there were no droplets of moisture on the agar surface.

Inoculum preparation

The organisms were sub-cultured one day prior to test. A 0.5 McFarland turbidity standard was used to prepare the inoculum in the study. The inoculum was made by suspending a colony in peptone water and matching the turbidity with a 0.5 McFarland standard. With the help of a sterile swab test organisms were inoculated into MHA.

Data management

All data collected in the study were sorted, coded, and entered in a computer using SPSS version 20 software. Data were cross-checked against the data files for any inconsistencies or obvious data entry errors. The laboratory request form was also checked for the desired test. The data entry and editing was done throughout the study process.The demographic details, characteristics, and particulars of the subjects, in terms of predictability and determination of risk of CSOM, were analyzed using the Chi-square test. Cross tabulations were done to establish relationships between variables and Chi-square tests were used to test association. Data from bacterial isolation were analyzed using qualitative methods.

RESULTS

There were 84 males (58.3%) and 60 females (41.6%). The mean age was 18.7 years where 84 (58.3%) were aged below 18 years and 60 (41.6%) were aged 18 years and above. The range of the ages was 2 to 64 years, and the median age was 14 years.

There was an equal number (n = 62; 46.9%) of mixed and pure cultures, while 3 (2.2%) specimens produced no growth. On Gram staining, gram-negative bacteria accounted for 94 specimens (73.2%) and gram-positive bacteria were found in 42 specimens (28.3%). Bacterial findings were categorized into aerobes and anaerobes. The most common aerobes identified from the specimens were gram-negative bacteria, which included Proteus mirabilis (n= 54; 29.4%), Pseudomonas aeruginosa (n = 42; 34.8%), and Escherichia coli (n = 17; 12.8%). The gram-positive aerobes identified included Staphylococcus aureus (n = 46; 34.8%) and coagulase-negative staphylococci (n = 8; 6.0%). Other organisms were identified in small numbers (Table 1).

Table1: Aerobes isolated

Species		
Staphylococcus aureus	**46**	**34.8%**
Coagulase-negative staphylococci	**8**	**6.0%**
Streptococcus pyogenes	**5**	**3.7%**
Streptococcus pneumoniae	**3**	**2.2%**
Total	**62**	**46.9%**
Gram-negative aerobes		
Proteus mirabilis	**48**	**36.3%**
Pseudomonas aeruginosa	**36**	**27.2%**
Escherichia coli	**17**	**12.8%**
Klebsiella pneumoniae	**7**	**5.3%**
Proteus vulgaris	**7**	**5.3%**
***Diptheroides* spp.**	**5**	**3.7%**
Enterobacter cloacae	**4**	**3.0%**
Morganella morganii	**2**	**1.5%**
Raultella ornithinolytica	**2**	**1.5%**
Coliforms	**2**	**1.5%**

Enterobacter cloacae	**2**	**1.5%**
Total	**132**	**68.0%**

Anaerobes were isolated from 49 (34.0%) of the specimens. The most common anaerobes identified were Bacteroides spp. in 22 specimens (15.2%), Peptostreptococcus spp. in 16 (11.1%), and Clostridium spp. in 8 (5.5%) (Table 2).

Table 2: Anaerobes isolated

Species	Frequency	Percent
***Bacteroides* spp.**	**22**	**15.2%**
***Peptostreptococcus* spp.**	**16**	**11.1%**
***Clostridium* spp.**	**8**	**5.5%**
Prevotella melaninogenica	**3**	**2.0%**
Total	**49**	**34.0%**

The chi-square test was used to determine the relationship between the different CSOM-causing microorganisms and symptoms and signs. Some CSOM-causing microorganisms were—significantly more so than the others ($p < 0.05$)— characteristically associated with each of the following clinical features: quantity of pus drainage, mode of onset, otalgia, hearing loss, location of tympanic membrane perforation and mucosal appearance (Table 3, Table 4).

Table 3: Associations between CSOM-causing microorganisms and clinical features

Clinical feature	Wald chi-square	df	p-value
Otorrhoea	0.047	3	**0.832**
Type of discharge	1.028	3	**0.597**
Quantity of discharge	13.207	3	**0.003**
Type of odour	0.683	2	**0.408**
Mode of onset	14.564	5	**0.009**
Presence of otalgia	6.053	2	**0.026**
Presence of hearing loss	11.627	2	**0.001**
Character of pus discharged	9.517	5	**0.075**
Location of TM perforation	39.278	4	**0.000**
Mucosal appearance	36.444	3	**0.000**
Granulation tissue	0.479	1	**0.488**
TM = tympanic membrane			

Table 4: Most common organisms associated with specific clinical features of CSOM

Clinical feature	Most common organism
Continuous pus drainage	***P. mirabilis***
Recurrent pus discharge	***S. aureus***
Otalgia	***P. mirabilis***
Persistent hearing loss	***S. aureus***
Central perforation	***P. mirabilis***
Marginal perforation	***Aspergillus* spp.**

DISCUSSION

This is similar to studies reported by others in India and Pakistan.[14,15] There are several reasons to explain this observation. The eustachian tubes in children are shorter, narrower, and more horizontal than in adults, and frequent upper respiratory tract infections are more common in children.[16] However, these findings differ from the findings of another study from Singapore, which showed that the disease was more prevalent in the age group of 31 to 40 years.[17] In our study, males were more affected than females, and this is similar to findings reported from Ethiopia.[18]

Otorrhoea was observed in the left ear in 61 cases (51.7%), and in the right ear in 57 cases (48.3%). There were 7 bilateral cases. This is comparable with results from a local study and a study from Nigeria.[19] Patients in our study, who had bilateral disease, exhibited no differences in terms of CSOM-causing microorganisms between the right and left ears. However, in one study conducted in South Africa, 44.4% of patients with bilateral disease showed differences in the distribution of bacteria, indicating that separate pus specimens need to be taken in bilateral disease.[20] The commonest mode of onset was acute ear pain, which was reported by nearly three-quarters of the patients. Otalgia was present in 111 ears (94.1%), which was higher compared to a study in Iraq, where the prevalence of otalgia was 41.7%.[21]

The pus drainage was mainly purulent and foul smelling in 90 ears (76.2%) and mucopurulent and odourless in 28 ears (23.8%). This is similar to a study in Bangladesh, where aural drainage was mucoid or mucopurulent in 80 (80%) of patients with tubotympanic CSOM and foul smelling, scanty ear drainage was present in 88 (88%) of patients with atticoantral CSOM.[22] Findings in a study done in Iraq indicated that pus drainage was foul smelling in 30 ears (25%), which was different from this study. The difference can be attributed to variation in population characteristics and geographical location.

In our study, the isolates obtained in the culture were subjected to antimicrobial sensitivity testing to infer the sensitivity and resistance of the isolated flora towards the various antibiotics. The results obtained are as follows: Pseudomonas aeroginosa, which was the most common isolate obtained, was sensitive to polymyxin B, Ofloxacin, piperacillin-tazobactam, ticarcillin, and colistin, Whereas it was resistant to most of the antibiotics such as gentamycin, amikacin, ciprofloxacin, cefotaxime, cefoxitin, meropenem, amoxicillin-clavulanic acid, and levofloxacin. In a similar study done by Kumar et al, the Pseudomonas aeroginosa strains were sensitive to ticarcillin, and colistin, whereas there was reduced sensitivity to cefepime, amikacin, ciprofloxacin, and gentamycin.[23] Where as in a similar study done by Deb et al, pseudomonas was the most common gram negative isolate but was sensitive to ciprofloxacin.[24] Compared to these studies, our study shows a variation where there is resistance noted for gentamycin, amikacin, ciprofloxacin, cefotaxime, cefoxitin. This could be possibly due to the emergence of antibiotic resistance strains of Pseudomonas aeroginosa, which emphasizes on the limited use of antibiotics to be done.

In this study, fungal isolates were identified in 21 (17.8%) of the sampled specimens, and Aspergillus spp. were the commonest, followed by Candida spp.; this is comparable with results published elsewhere.[25] Fungal infections of the middle ear are common as fungi thrive well in moist ears.[26] The most commonly isolated fungi in CSOM are Candida and Aspergillus.[27]

This study showed statistically significant characteristic associations of some CSOM-causing microorganisms with specific aspects of the CSOM symptomatology, which is contrary to a study where bacteriological findings had no significant effect on symptoms and signs.[28]

One limitation for this study was that antibiotic susceptibility testing was not done. We recommend that future studies evaluate the drug sensitivities of local microorganisms that cause CSOM and subsequently identify changes in bacteriological profile and, possibly, the emergence of multidrug-resistant strains resulting from indiscriminate use of antibacterial agents.

CONCLUSION

Our study has demonstrated that chronic otitis media can affect wide range of age groups, with adolescents being mostly involved. Pseudomonas aeroginosa, and Proteus mirabilis are the main isolated bacteriae in chronic otitis media, whether it be mucosal, or squamosal COM. Klebsiella pneumoniae plays an additional role in predominantly squamosal COM. Antibiotics such as second and third generation cephalosporins and amoxicillin-clavulanic acid are no longer effective in treating chronic otitis media, due to development of bacterial resistance by majority of bacteria towards it. Sending a swab from the middle ear for culture and sensitivity is of utmost importance, since it gives accurate sensitivity of the isolated bacteria towards a specific antibiotic group, thereby preventing further development of bacterial resistance.

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