Original Article

Pattern of *Pseudomonas aeruginosa* Infection among Northwestern Nigerians with Chronic Suppurative Otitis Media

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Abstract

Background: *Pseudomonas aeruginosa* has been particularly blamed for the deep-seated and progressive destruction of the middle ear and mastoid structure through its toxins and enzymes. Drug-resistant *P. aeruginosa* has been found to increase along with its frequency. **Aim:** This study aimed to assess the antibiotic sensitivity pattern of *P. aeruginosa* and the effectiveness of ciprofloxacin in chronically discharging ears. **Patients and Methods:** This was a retrospective review of 180 patients who were managed for chronic suppurative otitis media between January 2009 and December 2018. **Results:** Out of the 180 patients, majority 67 (37%) were in the age group 1–10 years, range of 1 month to 70 years with mean age of 18 years and standard deviation of ± 16.8 years and M: F of 1.5:1. Most have had ear discharge for more than 6 months and the majority 78 (43.4%) of the patients had bilateral disease. Central tympanic membrane perforation was the predominant finding, 81 (45.0%) with a complication rate of 21.1%. Abscess formation was the most common complication seen among the patients. *P. aeruginosa* was the most common bacterial isolate, 43 (23.9%) followed by *Staphylococcus aureus*, 39 (21.7%). In the pediatric population, *P. aeruginosa* was most sensitive to levofloxacin, as opposed to gentamicin in the adult population. Ciprofloxacin was seen to be more effective in adults than in children. Resistance to ciprofloxacin was seen more in the children than in adults. There was a significant association between gender and occurrence of the organism. **Conclusion:** *P. aeruginosa* is most sensitive to levofloxacin and gentamicin in the pediatric and adult population, respectively. Resistance to ciprofloxacin is most common among adults.

Keywords: Antibiotics, chronic suppurative otitis media, *Pseudomonas aeruginosa,* resistance, sensitivity

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Introduction

Chronic suppurative otitis media (CSOM) is a chronic inflammation (infection) of the middle ear and mastoid cavity, which presents with recurrent ear discharges or otorrhoea through a persistent tympanic membrane perforation.[1] The disease usually begins in childhood as a spontaneous tympanic membrane perforation due to an acute infection of the middle ear, known as acute otitis media, or as sequelae of less severe forms of otitis media (e.g., secretory otitis media). In general, patients with tympanic membrane perforations that continue to discharge mucoid material for periods of 6 weeks to 3 months, despite medical treatment, are recognized as CSOM cases.[2] However, the World Health Organization (WHO) definition requires only 2 weeks of otorrhoea.[3]

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Using the country prevalence rates as grouped based on the WHO regional classification, Nigeria is among the countries with high prevalence (2%–4%) of CSOM in the world.[4] Moreover, otitis media is the most common ear disease in the tropics and in Nigeria in particular.[5-7] CSOM is the most common otologic condition seen across otorhinolaryngology clinics in Nigeria.[8-10]

In CSOM, the bacteria may be aerobic (e.g., *Pseudomonas aeruginosa [P. aeruginosa], Escherichia coli, Staphylococcus*

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aureus [S. aureus], Streptococcus pyogenes, Proteus mirabilis, Klebsiella species) or anaerobic (e.g., *Bacteroides, Peptostreptococcus, Proprionibacterium*).[11-13] Among these bacteria, *P. aeruginosa* has been particularly blamed for the deep-seated and progressive destruction of middle ear and mastoid structures through its toxins and enzymes.

Medical management of CSOM involves appropriate use of antibiotics. *P. aeruginosa* is one of the common pathogenic bacteria in hospital-acquired infections and CSOM. The organism was the most frequently isolated from otorrhoea of patients, with the annual isolation rates remaining constant over time.[14-18] In Nigeria, like in other findings worldwide, the leading bacterial isolates from chronically discharging ears are *P. aeruginosa* and *S. aureus*.[8,19-21]

Because of increasing bacterial resistance to antibiotics, notable changes in previously reported sensitivity pattern have been documented.[15-18] Thus antibiogram of bacterial isolates are not static and this creates the need for effective update of antibiogram of isolates. Drug resistance of *P. aeruginosa* has been found to increase along with its frequency. Ototopical ciprofloxacin has proven effectiveness against *P. aeruginosa,*[14] however, recently, ciprofloxacin-resistant *P. aeruginosa* is on the increase. Therefore, continuous surveillance is necessary to monitor antimicrobial resistance and to guide antibacterial therapy.

This study aims to retrospectively assess the antibiotic sensitivity pattern of *P. aeruginosa* isolates in chronically discharging ears among patients in this environment and possibly establish trend in antibiotic resistance pattern.

Patients and Methods

This is a retrospective descriptive study of patients managed for CSOM at the department of otorhinolaryngology, Aminu Kano Teaching Hospital (AKTH), Kano, Nigeria, over a 10-year period from January 2009 to December 2018, who had their ear discharge subjected to microscopy, culture, and sensitivity. Ethical approval was sought and obtained from the ethical review committee of AKTH, Kano, Nigeria.

All patients included had ear swab taken and sent to the laboratory for microscopy, culture, and sensitivity test. Patients that were excluded were those whose case records were either not found or do not have complete clinical or laboratory records. Patient's data were collected from the patient's case files and records of the department of microbiology, AKTH, Kano.

Information obtained from the case files included demographic characteristics such as age and sex, also clinical information such as presenting complaints, duration of symptoms, previous use of ototopical antibiotics, nature of ear discharge, presence or absence of complications, type of complications, and pattern of tympanic perforation. Antibiotic sensitivity was obtained from the laboratory result sheet.

Data were entered into a spreadsheet and analyzed using SPSS version 23 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were summarized as frequencies and percentages and presented as tables. Chi-square test was used to determine *P* value and to test for statistical significance, which was set at $P < 0.05$.

Results

Out of the 180 patients, majority 67 (37.2%) were in the age group 1–10 years, age range of 1 month to 70 years and a mean age of 18 years and standard deviation of ± 16.8 years with predominance of the male gender, 108 (60%) and M:F ratio of 1.5:1. The median age of occurrence was 14.0 years with interquatile range of 20.8 years [Table 1]. Most of the patients 113 (62.8%) presented with symptoms of more than 6-month duration, 113 (62.8%). Both right and left ears are affected equally, with the majority of the patients 78 (43.3%) having bilateral disease. Mucopurulent discharge 108 (60%) was the most commonly encountered among the patients, and most of them 125 (69.4%) had treatment with otic preparations [Table 2].

Otoscopy showed central tympanic membrane perforation in most of our patients, 81 (45%) [Table 3] and complication was seen in up to 38 (21.1%) of the patients [Figure 1].

P. aeruginosa is the most common bacterial isolate 43 (23.9%) in the middle ear discharge of our patients with CSOM, followed by *S. aureus*, 39 (21.7%) and *Proteus spp*, 30 (16.7%) [Table 4].

There is a statistically significant association between the gender of patients and occurrence of *P. aeruginosa* in CSOM with females more likely to have the infection ($P < 0.05$). On a similar note, a weak association was observed between age of the patients and presence of the organism in ear discharge of the assessed patients. Isolation was observed to be more likely in adults ($P > 0.059$) [Table 5].

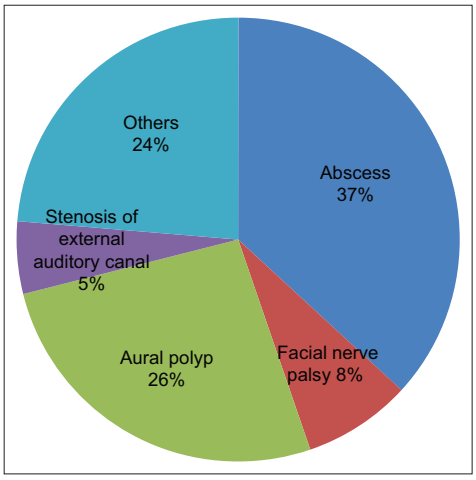

Figure 1: The pattern of complications among our patients with abscess formation being the most common (37%) followed by aural polyps (26%)

Isolated *P. aeruginosa* is seen to be most sensitive to levofloxacin followed by azithromycin and ceftriaxone in the pediatric population. However, in adults, the organism is most sensitive to gentamicin followed by ciprofloxacin. Moreover, when the sensitivities were compared in children and adults, the organism was found to be more sensitive to ciprofloxacin in adults than in children [Figure 2].

The resistance pattern of *P. aeruginosa* to the tested antimicrobial agents showed that the highest resistance was to augmentin followed by tetracycline among the adults. In the pediatric population, the organism is most resistant to erythromycin followed by the trio of augmentin, ciprofloxacin, and ofloxacin. In addition, the resistance to ciprofloxacin is seen more in children than in adults [Figure 3].

Table 1: Age and sex distribution of the study population

Age group (years)	Male	Female	Total (%)
<1	9	4	13 (7.2)
1-10	44	23	67 (37.2)
11-20	29	16	45 (25.0)
21-30	10	17	27 (15.0)
31-40	5	4	9 (5.0)
41-50	3	3	6 (3.3)
51-60	4	2	6 (3.3)
61-70	4	3	7 (3.9)
Total (%)	108 (60.0)	72 (40.0)	180 (100)

Median=14.0 years, IQR=20-8, Range=1-70 years, Male: Female=1.5:1.
IQR: Interquartile range

Table 2: Clinical characteristics of the study population

Variable	Number of patients, *n* (%)
Duration of presenting complaint (months)	
1-3	34 (18.9)
4-6	33 (18.3)
>6	113 (62.8)
Total (%)	180 (100)
Side of disease	
Right	51 (28.3)
Left	51 (28.3)
Both	78 (43.3)
Total (%)	180 (100)
Nature of discharge	
Mucopurulent	108 (60)
Mucoid	54 (30)
Blood stained	18 (10)
Total (%)	180 (100)
History of ear drop use	
Yes	125 (69.4)
No	46 (25.6)
Cannot remember	9 (5)
Total (%)	180 (100)

Table 3: Distribution of nature of tympanic membrane perforation

Variable	Number of patients, *n* (%)
Pattern of tympanic membrane perforation	
Total (%)	23 (12.8)
Subtotal	53 (29.4)
Marginal	22 (12.2)
Central	81 (45)
Multiple	1 (0.6)
Total	180 (100)

Complication rate=21.1%

Discussion

CSOM in both children and adults is a common problem, especially in resource-constrained countries. This current retrospective review showed that the majority of our patients are in the age group of 1–10 years with a mean age of 18 years. This is similar to findings from reviews in Nigeria and Ethiopia.[22-24] However, on the contrary, data from South Korea, Japan, and china revealed a higher mean age of occurrence ranging from 32 to 51.7 years.[15,25-27] Risk factors that predispose to the occurrence of CSOM are prevalent in densely populated or resource-constrained societies who commonly have a large population of the young and low vaccination coverage.

The male gender is more commonly afflicted by the disease in our environment as is also seen in other communities.[23-29] However, some authors reported predominance of the female gender.[15] Long duration of symptoms beyond 6 months is common among our patients as was similarly reported by Madana *et al*.[17] Bilateral affectation is a more common occurrence among our patients as was previously reported by Wasihun and Zemene[24] Hiremath *et al*.[29] However, to the contrary, Orji and Dike in Nigeria[22] and Afolabi *et al*. in Nigeria[23] reported unilateral disease as more common. This may be due to differences in sample size in the studies. In Ethiopia, Wasihun and Zemene[24] reported that most of their patients presented with mucopurulent ear discharge in agreement with what we found in this review. Some studies in India[29] reported tubotympanic disease as the most common form of CSOM in agreement with the findings of this study. However, in India, Madana *et al*. reviewed children who had mastoid surgery and found only 3% having central perforation,

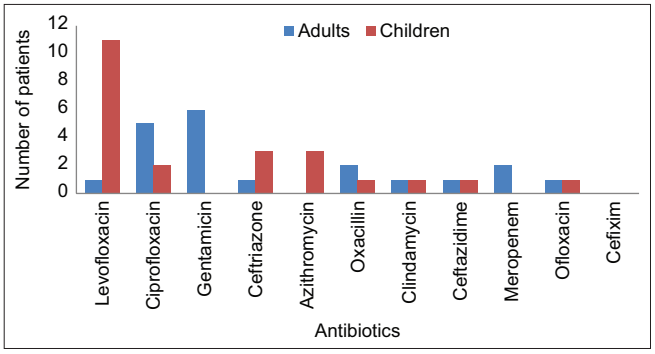

Figure 2: Antibiotic sensitivity pattern of *Pseudomonas aeruginosa*

Table 4: Distribution bacterial isolates among patients with chronic suppurative otitis media

Organism	Number, *n* (%)
Pseudomonas	43 (23.9)
Staphylococcus aureus	39 (21.7)
Proteus spp.	30 (16.7)
Klebsiella	28 (15.6)
Streptococcus spp.	15 (8.3)
Others	25 (13.9)
Total	180 (100)

Table 5: Factors associated with occurrence of *Pseudomonas aeruginosa* in patients with chronic suppurative otitis media

Factor	Pseudomonas	Other organism	χ^2	*P*
Age (years)				
<18	20	23	3.575	0.059
≥18	86	51		
Gender				
Male	20	88	4.283	0.038
Female	23	49		
Tympanic membrane perforation				
Attico antral disease	7	15	0.867	0.352
Tubotympanic	36	122		
Complication				
Yes	6	32	0.089	0.762
No	13	59		

majority had atticoantral disease.[17] Complications were seen in 21.1% of our subjects in contrast to 44% reported by Madana *et al*. in India.[17] Although their review was among children who underwent mastoid surgery.

Occurrence of *P. aeruginosa* varies widely in studies across the world with prevalence ranging from 2.7% to 44%.[15,17,27-29] The predominant bacterial isolate in the middle ear discharge of our patients was *P. aeruginosa* as similarly reported by several other authors.[15,17,22,23,29] However, some studies revealed contrasting findings.[24,25,27,28] *P. aeruginosa* was seen in our study to be most sensitive to levofloxacin in the pediatric population, in contrast to findings by Madana *et al*.[17] and Lee *et al*.[25] who reported ceftazidime and cephalothin, respectively, as most active on the organism. On the other hand, gentamicin was seen among our adult patients to be most effective against *P. aeruginosa* isolates as similarly reported by Orji and Dike in Nigeria.[22]

In general, ciprofloxacin that is commonly used in most otorhinolaryngological clinics across Nigeria as topical agent for the treatment of CSOM was not seen to be particularly effective against *P. aeruginosa,* especially in children from the findings of our study. This is comparable to the findings of other studies worldwide.[15,24,25,27] *P. aeruginosa* isolates

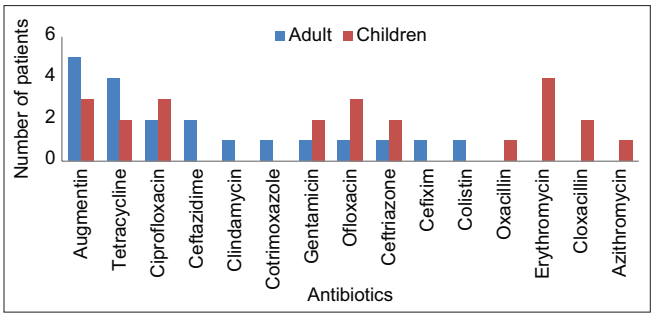

Figure 3: Antibiotic resistance pattern of *Pseudomonas aeruginosa*

from the ears of our patients showed high level of resistance to amoxycillin-clavulanic acid as similarly reported in some other studies.[22,24]

Our study revealed some relationship between gender and to some extent age and occurrence of *P. aeruginosa* in patients with CSOM. This is similar to findings by Ayaz *et al*.[30] in Pakistan where they found children <10 years to be affected the most with *P. aeruginosa* being the predominant organism. The same study, however, found in contrast, the male gender being infected more as compared to females.

The retrospective nature of this review and the scope of the antibiotics tested for sensitivity were limitations in this study.

Conclusion

P. aeruginosa is the most common isolate in our patients with CSOM and its occurrence is statistically associated with gender and to some extent the age of patients. *P. aeruginosa* is most sensitive to levofloxacin and gentamicin in the pediatric and adult population, respectively. Resistance to ciprofloxacin is most common among adults.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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