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Full Length Research Paper

Predisposing and bacteriological features of otitis media

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Otitis media is an infectious condition that is more frequent in children. Its management is complex because the etiologies vary as the disease progresses. This study aimed to determine the predisposing factors and the bacterial etiology of otitis media. A total of 378 patients diagnosed with otitis media; comprised acute otitis media (29.4%), otitis media with effusion (32.3%) and chronic otitis media (38.4%). Bacteriological examination was done using aerobic and anaerobic culture methods. Children less than 5 years accounted for 46% of cases. Incidence was more in the rainy season (May-October). Unilateral infection which was more common (82%) was predominantly in the left ear (66.8%). Major predisposing factors to infection were age (19.8%), upper respiratory infection (14.8%), poor hygiene and unorthodox practices (14.8%), adenoid inflammation (8.5%) and trauma (6.1%). *Streptococcus pneumoniae* (38.1%), *Moraxella catarrhalis* (19.0%) and *Staphylococcus aureus* (16.7%) characterized AOM. A paradigm shift was observed in otitis media with effusion, with *S. aureus* (19.1%) and *Bacteroides ureolyticus* (14.9%) dominating the flora. Etiologies in chronic otitis media were largely mixed aerobic-anaerobic component of 68.3%; predominant flora being *Pseudomonas aeruginosa* (14.1%) and *P. magnus* (13.4%). The paradigm shift is instructive in deciding the line of antibiotic therapy to be instituted.

Key words: Acute otitis media, aerobic bacteria, anaerobic bacteria, chronic otitis media, otitis media with effusion, poly-etiology, mono-etiology.

INTRODUCTION

Otitis media is an inflammation of the middle ear which may be acute, effusing or chronic. Acute otitis media (AOM) is common in children with *Streptococcus pneumoniae*, *Haemophilus influnzae* and *Moraxella Catarrhalis* being common pathogens (Yamanaka et al., 2008). Effusion, tympanic membrane integrity and duration of the disease characterized otitis media. Although otitis media with effusion (OME) and chronic otitis media (COM) are sometimes referred as chronic otitis media with effusion (COME) (Brook et al., 2000; Brook, 2002a), their clinical presentations are different. While OME is characterized by asymptomatic middle ear effusion, "plugged ear feeling" and translucent tympanic

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Abbreviations: AOM, Acute otitis media; **COM,** chronic otitis media; **OME,** otitis media with effusion; **COME,** chronic otitis media with effusion; **URTI,** upper respiratory tract infection.

membrane with diminished mobility (Cripps and Kyd, 2003), COM on the other hand is associated with destructive outcome such as hearing defect. Incidence in Nigeria and many developing countries ranges from 2.4 to 7.3% (Afolabi et al., 2008; Kamal et al., 2004).

A number of studies have provided significant evidence on the relationship between incidence of otitis media and factors such as eustachin tube dysfunction, age (Afolabi et al., 2008), short duration of breastfeeding (Vishnu Vardhan Reddy et al., 2006) parental smoking (Murphy, 2006), upper respiratory infection (Rovers et al., 2008), genetic abnormalities (Park et al., 2004) and racial variations (Iseh and Adegbite, 2004). There is also a strong relationship between nasopharyngeal colonization and otitis media (Bogaert et al., 2004).

Management of otitis media has not received a pattern prescription because etiologies vary depending on the clinical presentation. In this study we examined the factors that predispose to otitis media and determine the etiologies of cases seen at a referral Centre in Lagos, Nigeria. This will inform appropriate therapeutic decision.

MATERIALS AND METHODS

Informed consent

The permission to carry out this study was granted by the ethical committee of Lagos State University teaching Hospital Ikeja Lagos, Nigeria. Patients who read, understood and gave written informed consent were enrolled in the study.

Patients and study center

Three hundred and seventy eight patients diagnosed with otitis media between March 2006 and November 2007 by ENT consultants were admitted into this study. Patients enrolled into the study were grouped into three clinical categories; AOM, OME and COM based on clinical examination which included review of past medical history, routine biodata, duration of disease and otoscopic examination. Exclusion criteria included patients with other ear infections such as polyp, systemic diseases and those with non-discharging ear. Inclusion criteria included patients presenting with otitis media associated with ear discharge.

Specimen collection

Sterile disposable plastic pipettes (VWR) were used for collection of samples. 2 pipettes were used for each patients, one for aerobic and the other for anaerobic culture. Sample collection was done after thorough cleansing of the external auditory canal with providine-iodine solution. After sample collection, pipettes for anaerobic culture were inserted immediately into tubes containing pre-reduced thioglycollate broth (transport medium) and maintained at 25°C for not more than 2 hours before cultures were set up. While that for aerobic cultures were transported (without the transport medium) and cultured in the laboratory within 2 h of collection.

Culture

All specimens were Gram stained before inoculation unto culture media. The anaerobic specimens in thioglycollate broth were cultured unto solid and liquid media. Cooked meat medium was used as back up medium while anaerobic blood agar and selective agar plates were the solid media used. Selective media plates were prepared by incorporating standard quantities of N-S selective agar (Oxoid, SR0107B) and G-N selective agar (Oxoid, SR108B)) as directed by the manufacturers into appropriate freshly prepared brain heart infusion agar (Oxoid, CM 375B). The specimens for aerobic culture were inoculated unto blood agar, mannitol salt agar and chocolate agar. Blood agar was used as an enrichment medium for the isolation of fastidious aerobic organisms. Mannitol salt agar and chocolate agar were used for the isolation of the pathogenic *Staphylococcus* spp and *Heamophilus influenza,* respectively.

Incubation

The plates for anaerobic isolation were incubated in anaerobic jar in the presence of 90% N_2 and 10% CO_2 generated by the sachets of gas generating kit (Oxoid, BR 0038B) for 10 days. Each jar was controlled by anaerobic indicator, resazurin (Oxoid, BR 0055B). Specimens on blood and mannitol salt agar were incubated aerobically at 37°C for 24 hours while the chocolate agar plates were incubated at 37°C for 48 h in a moist carbondioxide atmosphere generated by candle extinction jar technique. A single colony of each distinct type was Gram-stained, examined microscopically and sub-cultured unto the freshly prepared blood agar plates (for aerobic culture) and brain heart infusion agar plate supplemented with 5% rabbit blood , vitamin k (1 µg/ml) and L-cysteine (2 µg/ml) for anaerobic cultures. Plates for anaerobic cultures were incubated for aero-tolerance test and isolation of pure cultures. The sub-cultured plates for aerobic culture were incubated under aerobic condition for 24 h.

Identification of isolates

API 20A system and Antibiotics impregnated disc (An-Ident discs) as described by Gresser et al. (1984) and Leigh and Simmons (1977) were used for identification of anaerobic isolates. Aerobic isolates on the other hand were identified according to methods of Cowan and Steel, (1974).

RESULTS

Children < 5 years presented with highest infection rate for all three conditions combined. Incidence was higher in the rainy season (May-October) than in the dry season (November –April). Unilateral ear infections occurred in 82% patients with involvement of the left ear in 66.8% of cases. Identified predisposing factors to otitis media were; age (19.8%), upper respiratory tract infection (14.8%), poor hygiene and unorthodox practices (14.8%), adenoid inflammation (8.5%) and trauma (6.1%) (Table 1).

A total of 78.3% cultures from AOM yielded no bacterial growth (sterile cultures). The 12.6% which were of mono-etiology comprised of just aerobic bacteria. About 35.2% and 36.1% cultures from OME were of mono and poly-etiologies respectively. All samples from COM yielded positive bacterial culture.

The ratio of anaerobes to aerobes was 1.2 : 1. AOM

Table 1. Patients demographic characteristic.

Characteristic	Percentage
Age group with highest prevalence of OM (< 5 years)	46
Male: female ratio	3:2
Incidence of OM in dry season (Nov – April)	24
Incidence of OM in rainy season (May – October)	76
Cases of first episode	18.8
Recurrent infections	82.2
Unilateral ear involvement	82; Left* 66.8; Right* 33.2
Bilateral involvement *ear involvement in unilateral infection	18
Duration of symptoms before presentation	35.6
First 3 months of infection	35.6
Between 3 – 6 months	23.7
> 6 months	40.7
Major risk factors	
Age	19.8
URTI	14.8
Poor hygiene/unorthodox practice	14.8
Adenoid inflammation	8.5
Trauma	6.1

Table 2. Culture results of OM samples

Culture	AOM n = 111(29.4)	OME n = 122(32.3)	COM n = 145(38.4)
Sterile cultures	87 (78.3)	35 (28.7)	0 (0)
Mono-etiology	14 (12.6)	43 (35.2)	46 (31.7)
Aerobe	14 (12.6)	20 (46.5)	17 (32.6)
Anaerobe	0 (0)	23 (53.5)	31 (67.4)
Poly-etiology	10 (9.0)	44 (36.1)	99 (68.3)

Sterile culture- cultures that yielded no bacterial growth; Mono-etiology – usually pure cultures with just one bacterial type; poly-etiology – mixed cultures with more than one bacterial type. Number in parentheses represents percentage.

yielded 85.7% aerobes and 14.3% anaerobes with *Streptococcus pneumoniae* (38.1%), *Moraxella catarrhalis* (19.0%) and *Staphylococcus aureus* (16.7%) as predominant bacteria. Bacterial flora from OME showed a transition from AOM to COM with *Staphylococcus aureus* (19.1%) and *Bacteroides ureolyticus* (14.9%) dominating the flora. COM on the other hand yielded 38.4% aerobes and 61.6% anaerobes. The etiologies in chronic otitis media were largely mixed aerobic-anaerobic component of 68.3%, predominant flora being *Pseudomonas aeruginosa* (14.1%) and *P. magnus* (13.4%) (Tables 2 and 3).

DISCUSSION

In agreement with earlier reports (Iseh and Adegbite, 2004; Akinpelu and Amusa, 2007; Gordon et al., 2004), findings from this study demonstrated that age, URTI and unorthodox approach to treatment were the major predisposing factors for otitis media infection. Age was considered a risk factor because eustachian tubes of children (less than 5 years of age) are shorter and more horizontally position than their adult counterparts. This positioning allows for reflux of commensal organisms from the nasopharynx to the sterile middle ear resulting in

Table 3. Distribution of isolates in otitis media.

Microorganism	TNS	Present in			Bilateral infection		
		AOM	OME	COM	a	b	c
Aerobes							
Pseudomonas aeruginosa	37	0	0	37	0	0	7
Proteus mirabilis	14	0	0	14	0	0	3
Klebsiella pneumoniae	9	2	0	7	1	0	0
Streptococcus pneumoniae	32	16	16	0	1	1	3
Streptococcus pyogenes	6	2	0	4	0	0	0
Moraxella catarrhalis	8	8	0	0	0	0	0
Staphylococcus aureus	66	7	27	32	10	7	2
Haemophilus influenzae	12	0	12	0	1	0	1
Escherichia coli	15	1	9	5	0	0	3
Sub-total	199 (45.1)	36 (85.7)	64 (45.4)	99(38.4)	13 (32.5)	8 (20)	19 (47.5)
Anaerobes							
Bacteroides thetaiotaomicron	22	0	0	22	0	1	3
Bacteroides ureolyticus	38	0	21	17	2	1	4
Bacteroides vulgatus	7	0	7	0	1	0	0
Clostridium perfringens	1	1	0	0	0	0	0
Eubacterium lentum	1	0	1	0	0	0	0
Fusobacterium necrophorum	6	1	0	5	0	0	1
Fusobacterium nucleatum	2	0	0	2	0	0	0
Peptostreptococcus anaerobius	13	0	0	13	1	1	0
Peptostreptococcus asaccharolyticus	20	0	16	4	1	1	2
Peptostreptococcus magnus	52	4	13	35	2	0	7
Peptostreptococcus micros	4	0	4	0	0	0	0
Porphyromonas asaccharolyticus	21	0	0	21	0	0	4
Prevotella corporis	9	0	9	0	1	0	1
Prevotella melaninogenica	42	0	6	36	2	1	5
Veillonella parvulla	4	0	0	4	0	0	0
Sub-total	242 (54.9)	6 (14.3)	77 (54.6)	159 (61.6)	10 (23.8)	5 (11.9)	27 (64.3)

TNS, Total number of isolates; a, left ear; b, right ear; c, both ear. Number in parentheses represents percentage involvement.

congestion of the tube. It has also been shown that children are prone to URTI due to their immature immune system that minimally protects them against the opportunistic organisms (Gordon et al., 2004). URTI also leads to the congestion of the eustachian tube. Similarly, poor hygiene and unorthodox approach to treatment which include introduction of unconventional ear drops and concoctions such as oil and honey into the middle ear may have initiated the proliferation of opportunistic pathogens (that have gained access to the middle ear) leading to blockage of the tube. Eustachian tube congestion usually impairs normal tube functions in terms of middle ear ventilation, cillary clearance and drainage causing ear effusion.

Since cold weather predisposes children to URTI (Gordon et al., 2004; Rover et al., 2000), it then follows that most cases of otitis media infection would be seen in rainy season than in dry season as observed in the study. Based on this observation, physician may consider taking a more conservative approach to treatment and management of otitis media during the dry months and a more aggressive approach during the wet months. Furthermore, preventive strategies for the otitis prone children should be intensified during the rainy season.

According to this study, incidence of otitis media was more in males than in females. This compares well with other studies (Akinpelu and Amusa, 2007; Iseh and Adegbite, 2004) done in Nigeria. The male preponderance in this study cannot be explained as no knowledge of anatomical difference between the ear structures of male and female children has been reported. However, Akinpelu and Amusa (2007) argued that the high incidence of male patients presenting with otitis media could be because of the active and

adventurous nature of the boys that predispose them to traumatic conditions. On the other hand, Amusa et al. (2005) who reported no difference in the prevalence of otitis media among sexes attributed that to equal enrolment of female and male patients.

The long duration (3 months to greater than 3 years) it took most patients to seek medical treatment from specialist may have contributed to the high occurrence of chronic and recurrent cases recorded in this study. Delay in treatment is dangerous because most untreated cases of AOM as well as OME become chronic, recurrent or may result to serious complications after a while (Vishnu Vardhan Reddy et al., 2006; Ryding et al., 2004; Klausen, 2000). High rate (82.0%) of unilateral otitis media was recorded. This observation is important in the management of infection because laterality of infection is strongly associated with degree of tympanic membrane inflammation and disease severity. Thus, it is reasonable for clinicians to consider bilateral ear involvement as a more severe disease than the unilateral cases. The high incidence of unilateral infection seen in this study compares well with the findings of Akinpelu et al. (2008). However, more studies should be done to elucidate the high involvement of the left ear observed in this study.

The trend of isolation of various species of aerobic and anaerobic bacteria showed that the different conditions of otitis media could be differentiated on bacteriological ground. Interestingly, there was a shift in the trend of bacterial involvement from mono to poly-etiology as infection progressed from acute to chronic form. A good number of cultures from AOM yielded no bacterial growth. In addition, aerobic and anaerobic bacteria were rarely recovered from AOM suggesting that bacteria may not have significant role to play in disease process. Thus, treatment of AOM with antibiotics should be based on severity of infection since most children with non severe AOM recover without antibiotic therapy. This approach has been shown to reduce the carriage rate of antibiotic resistant bacteria (McCormick et al., 2005; Brook et al., 2003).

The high proportion of sterile cultures recorded for AOM, suggested that virus might have a significant role in the disease process as reported by Heikkinen and Chonmaitree (2003). It could be that children whose ear effusion yielded no bacterial growth had virus rather than bacteria as the causative agents of infection. In such patients, antibiotic therapy may not be beneficial. The predominant pathogens in AOM, OME and COM were *S.pneumoniae, B. ureolyticus* and *P. aeruginosa* respectively. These are commensals of the nasopharynx that may have gained entrance into the middle ear. This underlines the role of nasopharyngeal microflora in otitis media infection as reported by Kononen et al. (2003). The paradigm shift in the number and variety of anaerobes in OME and COM showed that progression of infection from acute to chronic stage created anaerobiosis which offered favorable microenvironment for the growth and proliferation of anaerobic pathogens.

There was strong evidence that mixed aerobic-anaerobic cultures characterized chronic infection suggesting a potential synergy between anaerobic and aerobic bacteria. It has been previously reported that poly-microbial infections are more pathogenic than those involving single organism (Brook, 2002b). Thus for better management of otitis media, clinical classification of infection as well as drug susceptibility testing of the organisms recovered from chronic cases are essential for making the right decision of antimicrobial that will effectively eradicate the pathogens. In addition, educating parents and guardians (of the otitis prone children) on the possible risk factors of the disease may be a preventive strategy that might reduce disease occurrences

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