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REVIEW ON THE DIAGNOSIS AND ANTIBIOTIC THERAPY OF OTITIS MEDIA IN CHILDREN

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ABSTRACT
Measurement of background radiation is of great interest for it provides useful information in monitoring environmental radioactivity. The aim of the present study is to provide information and generate database on the natural background radiation dose levels of densely populated Queen Amina Hall, Ahmadu Bello University, Zaria. The radiation dose (outdoor and indoor dose rate) were measured at 29 rooms (Block 1- 4) and their compounds using RADOS survey meter held at 1m above the ground. The measured radiation dose ranged 0.13 nGyh^{-1} to 0.43 nGyh^{-1} and 0.54 nGyh^{-1} to 1.72 nGyh^{-1} ^{1} for indoor and outdoor respectively. Some of the high values recorded could be attributed due to the contribution of cosmic radiation emanating from the atmosphere as well as the geological settings of the location as there is no any artificial contributing factor within the area. The annual effective doses within the study area was found to be 0.01 mSvy^{-1} throughout which is quit below the world average value of 0.87 mSvy^{-1} for natural sources.
Keywords: Radiation dose, Annual effective dose, RADOS meter, Queen Amina

INTRODUCTION

Human Ear is a sense organ concerned with hearing and stability. Ear is made up of three parts, which include the outer, middle and inner ear (Hoberman *et al*., 2011). Otitis media (OM) is defined as the infection of the middle ear cavity. Pathogenic microorganism (e.g. bacteria, viruses and fungi), allergy, and anatomic/functional deviations of the middle ear or Eustachian tube can cause otitis media (Jawetz et al., 2007). Ear infection can be acute (acute otitis media) or chronic (chronic or suppurative otitis media). Otitis media is one of the most common childhood illnesses, particularly in children under the age of six (Marom *et al.,* 2014). A worldwide survey of 21 WHO regional areas from 2005 to present, estimated that there are 709 million new cases of OM annually (Monasta *et al.,* 2012). In 2005, global incidence was highest among children under five (61%) (Monasta *et al*. 2012).In a recent study of children under 6 years of age in Germany, Italy, Spain, Sweden, and the United Kingdom (UK), the incidence of Acute OM was 268 per 1000 people in 2007 to 2008 and 256 between 2008 and 2010 (Liese *et al.* 2014). The rates of recurrent OM decreased by 28% from 2001 to 2011 (Marom *et al.* 2014).The number of surgical procedures for OM doubled between 1978 to 1979 and 1994 to 1995, and then increased by 1.5-fold from 1987 to 2002 in Finland (Haapkyla *et al.* 2008*).* The recent decline in Acute OM may be due to the introduction of the pneumococcal conjugate vaccine, which appears to have decreased the number of individuals suffering from OM as supported by many studies (Marom *et al.* 2014).

The prevalence of otitis media in Nigerian children was estimated to be 87.8% (overall), though it was found to be 83.3% in the dry season. Additionally, some of the common microorganisms associated with the infection are *Pseudomonas aeruginosa* as the most common bacteria and subsequently *Staphylococcus aureus*, *Escherichia coli, Streptococcus pneumoniae*, *Serratia marcescens*, *Proteus mirabilis* and *Klebsiella*. Fungal agents such as *Candida spp* are among the common cause of otitis media in children (Amah *et al.,* 2015). There is increase occurrence of *M. catarrhalis* especially in the United States and in the Nordic countries, while in some countries, like Spain, *M. catarrhalis* is a rare finding. The most alarming feature in the bacteriological reports has been increasing proportion of pathogens resistant to antimicrobial agents. The proportion of beta lactamase producing strains of *H. influenza* has increased from 25 to 30% (Barkai *et al.,* 2009). The aim of this write-up is to present a review in the diagnosis and treatment of otitis media in children.

Anatomical and Physiological Risk Factors

The middle ear is a cavity that contains the ear ossicles with the Eustachian tube placed anteriorly; the mastoid air cells posteriorly; Tympanic membrane laterally; that is between the middle and external ear, and the inner ear medially (Figure 1). Other important nearby structures are the base of the skull/brain and meninges superiorly, and the sigmoid sinus posteriorly; the nasopharynx lies behind the nasal cavities and above the soft palate. The nasopharynx is connected to the middle ear cavity by the Eustachian tubes. The nose, nasopharynx, Eustachian tubes, middle ear cavities and mastoid air cells are a continuum and covered by respiratory mucosa. The Eustachian tube regulate air and sound pressure by actively opening when swallowing, yawning or sneezing, and then by passively closing. Changes in body position affect the degree of opening and closing of the Eustachian tube. The best opening of the Eustachian tube is achieved by swallowing when in a sitting position while the worst is when in a head-down position.

The Eustachian tube also allows the secretions of the middle ear to drain into the nasopharynx with the assistance of secretory cells and the mucociliary defence system and prevents the secretions of the nasopharynx from entering the middle ear. Young children are susceptible to Acute OM because of the immaturity of the Eustachian tube (Bluestone 2008). Eustachian tube matures by the age of seven years. Thus, their eEustachian tube is shorter, more flexible and horizontal. Also craniofacial anomalies, Down syndrome and cleft palate are associated with eEustachian tube dysfunction. The nasopharyngeal dimensions have been shown to be smaller in children with OM than in healthy children (Renko *et al.* 2007).

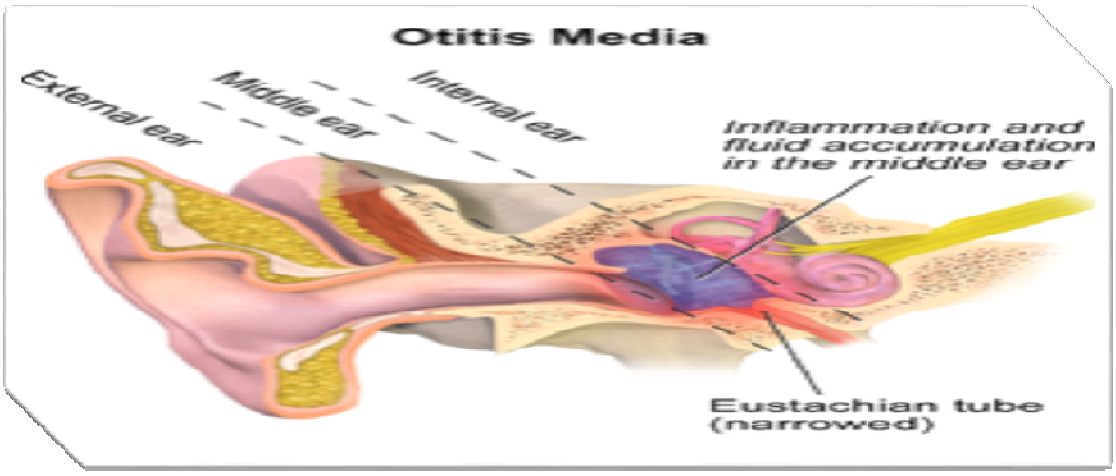

Figure 1: The structure of normal ear. Source: Little *et al., (*2002).

Breastfeeding for at least three months is protective; this effect may be associated with position maintained during breastfeeding, suckling movements, and protective factors in breast milk (Hatakka *et al.,* 2010). Children raised in low socioeconomic conditions are more likely to have otitis media. A higher incidence of otitis media was reported during the winter months (Hoffman *et al.,* 2013). Otitis media in children was realized to be associated with downs syndrome and other conditions causing craniofacial distortions. Children deficient in certain nutrients are at risk for developing otitis media. The nutrients most frequently implicated are vitamin A, zinc, and essential fatty acids (Hoffman *et al.,* 2013).

Aetiopathogenesis

The microorganisms associated with otitis media in children include bacteria, viruses and fungi. The most common bacterial pathogens isolated from middle ear discharge in children with Aacute otitis media are *Streptococcus pneumonia, Pseudomonas aeruginosa,* and *E. coli* in 26 to 39% of cases (Rutt *et al.,* 2008). Other bacteria, such as Gram-negative rods and *Staphylococcus aureus* are occasionally isolated from the middle ear discharge during the infection (Casey *et al.* 2010). *Streptococcus pneumonia (S. pneumoniae), Haemophilus influenzae (H. influenzae),* and *Moraxella catarrhalis (M. catarrhalis)* colonize the nasopharynx from early infancy and are considered part of the normal flora. An increased rate of colonization at three (3) months of age may identify a subpopulation of children that are at increased risk of OM. The prevalence of colonization with these pathogens differs by age and is highest during early childhood when over 60% of children are colonized at some point (Casey *et al.* 2010).

The most commonly verified virus in Acute OM is respiratory syncytial virus. Other important agents are rhinovirus, influenza virus and adenoviruses, along with enterovirus and parainfluenza virus (Coker *et al.* 1983). Otitis media caused by viral agents occurs most frequently following viral upper respiratory tract infection, leading to nasopharyngeal and Eustachian tube inflammation, negative middle ear pressure and the movement of secretions from the nasopharynx into the middle ear (Chonmaitree *et al.* 2008). Viral infection of the nasopharynx creates an environment that promotes bacterial attachment and colonization, adhesion to cells, and invasion of the middle ear (Murphy *et al.* 2013). Human rhinovirus, parainfluenza viruses, adenovirus and respiratory syncytial virus were detected significantly more often in the nasopharynx of children with a history of recurrent Acute OM compared to healthy children (Wiertsema *et al.* 2011).

Some of the fungi associated with otitis media in children are *Aspergillus niger, A. flavus, A. fumigates, Candida albicans, Penicillium spp, Cephalosporium spp, Alternaria alternate* (Rutt *et al.,* 2008).

Clinical Features

The incubation period of bacterial otitis media can be short from five to seven (5-7) days or long for up to 21 days. Signs & symptoms may develop within two days (Hoberman *et al.* 2011). The clinical features are irritability, difficulty in sleeping, tugging or pulling at one or both ears, fever, Otalgia, Otorrhea (ear discharge) and Headache (Laine *et al.,* 2010).

Complications

The complication of acute or chronic otitis media is of two types:

i. The intracranial complication and,
ii. The extracranial complication.

Intracranial complications include the following:

Brain abscess: characterised by fever, headache and convulsions.
Meningitis: fever, Meningismus.
Sigmoid sinus thrombosis: spiking fever, otitis media, oedema and tenderness over mastoid bone, headacheq.
Extracranial complications includes the following:
Labyrinthitis: inflammation of kinetic labyrinth characterized by fever, nystagmus, and vertigo, which may occur secondary to suppurative otitis media.
Mastoiditis: it is the inflammation of mastoid bone with subperiosteal abscess: fever, fluctuance overlying the mastoid area, lateral displacement of pinna (Lieberthal *et al.* 2013).
Petrositis: retro-orbital pain, Otorrhea and fever (Dubey *et al.* 2007).

Diagnosis of Otitis Media

Otitis media is diagnosed by clinical and laboratory approaches.

Clinical Diagnosis

Clinical diagnosis involves the use of clinical features discussed earlier and Otoscopy, which is the examination of the infected ear using an instrument known as otoscope.

An auroscope/otoscope is an instrument that is used for examination of tympanic membrane that is not obstructed by cerumen (Figure 2). It is used in cases of suspected acute otitis media to avoid over diagnosing "red ears". The appearance of the eardrum in acute otitis media is hyperaemic (reddish), bulging and finally perforation and discharge from the ear. The discharge may be serous, serosanguineous or mucopurulent (Figures 3a and 3b). Crying or attempts to remove cerumen can cause erythema of the eardrum; therefore erythema of the tympanic membrane alone should not be the sole basis for the diagnosis of acute otitis media. In otitis media with effusion, Otoscopic findings include visualization of air-fluid levels and clear or amber middle ear fluid (Lieberthal *et al.* 2013). In cases of chronic suppurative otitis media, visualization of the tympanic membrane will reveal a perforation. In addition, polyps and discharge crusts may also be evident. It may be necessary in some children to examine the ears under general anaesthesia to make a proper assessment.

Figure 2: The instrument for ear examination (otoscope). Source: Lieberthal *et al.* (2013).

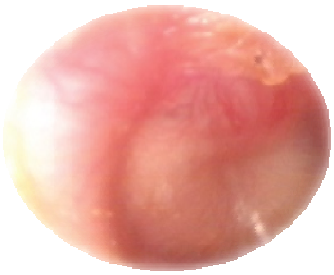

Figure 3a: Bulging tympanic membrane
Source: Little *et al., (*2002).

figure 3b: Perforated tympanic membrane

Laboratory Diagnosis

The laboratory diagnosis of otitis media is carried out after immediate collection of ear discharge from the infected ear-using swab sticks (a stick with a cotton wool at its summit) at the microbiology laboratory. Isolation of bacteria associated with otitis media is done by culture method, using media such as MacConkey agar, blood agar and mannitol salt agar. The isolates are incubated aerobically at 37^{0}C for 24 hours. Bacterial species are identified according to standard microbiological methods such as biochemical tests (catalase, oxidase, urease and motility). The presence of colonies in the isolated media indicate the presence of bacteria. Gram staining is performed to know whether the bacteria is Gram positive or Negative. Additionally, Biochemical tests and sensitivity testing are carried out to characterize the bacteria and identify the better antibiotics for the effective treatment of otitis media (Cheesbrough, 2006).

Ttreatment of Otitis Media

The increased patterns of bacterial resistance mandate an evidence-based approach to pharmacotherapy of otitis media. The recommended treatment duration for uncomplicated Acute OM is 5 - 7 days.

Amoxicillin has been the first line antibiotic for treating otitis media even though, there may be a high prevalence of drug-resistant Streptococcus pneumoniae, because of resistance to β-lactam antibiotics, such as amoxicillin, which develops as a stepwise process. Amoxicillin-clavulanic acid combination is an appropriate choice as a second-line antibiotic if a child is not responding to treatment with amoxicillin after 72 hours (Tähtinen *et al.* 2011). Similarly, Quinolones such as ciprofloxacin and ofloxacin among others were found to be effective in the treatment of Otitis media (Bailey and Parvataneni, 2000). If the patient is allergic to the penicillins, other antibiotics (e.g. ciprofloxacin otic drop and cefuroxime oral are useful alternatives. A child that remains symptomatic for more than three days while on a second-line agent may require tympanocentesis to identify the causative pathogen. In case resistant *pneumococcus spp* is found or if sample of ear discharge is not obtainable, clindamycin or intramuscular ceftriaxone appears to be best third-line drug. Recent studies have shown that short courses (2 - 3 days of antibiotic) at high doses are equally effective in terms of resolution of clinical features (Tähtinen *et al.* 2011). The side effects of antibiotics such as penicillins that may company a treatment option should be considered before giving any prescription.

Prevention and Control

i. Exclusive breastfeeding for the first six months is associated with great protection against otitis media in children.
ii. Pneumococcal conjugate vaccines (PCV) in early infancy, decreases the risk of acute otitis media in healthy infants (Lieberthal *et al.* 2013).
iii. Early diagnosis and treatment will help to prevent complications following acute otitis media.

CONCLUSION

This review highlighted the diagnostic methods and various antibiotic therapies for otitis media. Early diagnosis and treatment of otitis media is very important to prevent the subsequent debilitating complications among the affected children. Appropriate diagnosis will certainly help in choosing appropriate antibiotic for effective treatment of otitis media in children. Empirical antibiotic therapy with amoxicillin, amoxicillin-clavulanic acid, ciprofloxacin etc. for at least 72 hours at adequate dose before the result of culture is effective for the resolution of sign and symptoms of disease. Mothers are encouraged to bring their children to the hospital whenever otitis media is suspected for proper evaluation and treatment.

RECOMMENDATIONS

- Any suspected case of otitis media should be diagnosed and treated early to prevent development of complications.
- Empirical antibiotic therapy should be considered in children with otitis media after collection of ear discharge sample before result of culture is ready.
- Culture and sensitivity must be carried out to know the most suitable antibiotic for treatment especially if the patient is not responding to empiric antibiotic therapy.
- Mothers are discouraged from using cotton buds or any other material to remove ear discharge/wax from the ears of their children.

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