Otitis media - focusing on the developing world

1. Introduction
Otitis media literally means “inflammation of the middle ear”. Most often, it is synonymous with infections of the middle ear, however; some variants of otitis media may result from other conditions other than infection e.g. allergy, anatomical defects etc. The health-economic burden of this disorder is severe especially in Africa and other developing nations where the disease prevalence could be as high as 11% with severe economic implications. [1-4] As a consequence of the compact and complex anatomy physiology of the ear, otitis media can present with varied clinical features depending on the duration, severity and progression. Severe complications (intra cranial and extra cranial) can result from untreated or poorly treated otitis media. A sound knowledge of the anatomy and physiology of the ear is necessary for the management of this disease. Therefore, it is imperative that a brief description of these features be given prior to further discussions on this disease entity.

2. Anatomy of the ear
Development: The development of the ear commences from the 3rd week intra-uterine life (IUL) and ends at adulthood. It is a complex process that involves some overlaps and simultaneous differentiations of the various parts of the ear - inner, middle and outer ears. Gross description of middle ear cleft: The middle ear cleft synonymous with the middle ear is made of the middle ear cavity, ossicles, additus ad antrum-recess connecting the middle ear cavity with the mastoid cavity, attic-superior compartment of the cavity with tegmen tympanum as its roof, Eustachian tube –narrow air pressure equalizing tube connecting the middle ear laterally to the nasopharynx. The functions of the middle ear structures are basically for transformation, transmission and amplification of sound in hearing. This function is impaired in otitis media. However, the involvement of contiguous structures for sensorineural transmission (cochlear and VIII cranial nerve) and maintenance of balance (vestibular apparatus) could result as sequelae otitis media. Further readings on basic anatomy and physiological functions could be obtained from standard texts e.g. Scott-brown series. [5]
3. Classification of Otitis Media

Otitis media is a broad subject which could be classified according to:

1. Duration - acute otitis media and chronic otitis media
3. Otitis media with effusion and Aero-otitis media
4. Causative organism - bacterial otitis media (common) and specific otitis media
   e.g. Tubercular and syphilitic otitis media (less common).

The dynamism in the field of otology has brought about a current classification of choice by Browning et al [6] which de-emphasizes the words “suppurative” and “non-suppurative” otitis media, since it is a progression of same pathologic process. Furthermore one could lead to the other depending on the prevailing factors. Thus, otitis media could be further described as “active”, “inactive”, “healed”, but the standard classification remains acute otitis media, chronic otitis media, otitis media with effusion and specific otitis media. [6]

A brief description of the un-common types of otitis media shall be given whereas the detailed discussion shall be focused on the three commonly encountered types of otitis media namely: acute otitis media (AOM), chronic otitis media (COM) and otitis media with effusion (OME). The details of the surgical procedures, which can be found in standard ENT and Otology text books; are not included in the description.

Aero-otitis media is caused by disequilibrium in pressure equalization between the atmosphere and the middle ear cavity via the Eustachian tube. Ascending/fast descent from height or deep sea diving are common sources. Experimental models have shown that the resultant inflammation can extend beyond the middle ear cavity and the Eustachian tube to the nasopharynx and sometimes nasal cavities and paranasal sinuses. [7]

4. Acute Otitis Media (AOM)

This is an acute infection/inflammation of the middle ear mucosa which also involves the mastoid air cells most often. AOM is predominantly a childhood infection without sex preponderance [8-10]; and 75% of the few adults that have this condition are young adults below 44 years of age. [11]

**Aetiology:** This is usually associated with either bacterial or viral infections. Global reports show that *Hemophilus influenza* and *Streptococcus pneumonia* are the most prevalent organisms responsible for acute otitis media. [12-14] However, most studies (past and present) from different parts of Africa suggest a different bacteriology spectrum. Hence, *Staphylococcus aureus* and *Streptococcus pyogenes* appear to be most dominant causative organisms among Africans, usually sensitive to penicillin based antibiotics, Cephalosporins, and Quinolones. [15-17] Ruohola et al demonstrated that most cases of AOM consist of mixed infection of bacteria and virus; with about 60% of the viruses belonging to the piconavirusspp. [18]

**Clinical features:** The clinical mode of presentation is usually systemic (generalized) and local (ear) symptoms and signs. The typical picture is a child with high grade fever (40-41°C), refusal of feeds, incessant cries and irritability. [19, 20] There is associated ear pain (otalgia) and sometimes noise in the ear (tinnitus) with difficulty in hearing (conductive hearing loss). Ear discharge is seen in well above 90% of cases [17] in some
parts of the developing world, whereas it is only about 10% [11] among the developed nations. Delay of presentation to the clinician most probably accounts for this disparity. Other clinical features, which are detected via otoscopy Figure 1, include hyperemic tympanic membrane (generalized or localized) and sometimes bulging (if there are exudates within the middle ear). Furthermore, the discharge may be mucopurulent or purulent and appears to be pulsating in synchrony with the patient’s pulse during active discharge from the point of tympanic membrane perforation on otoscopy. **Sequelae:** The inflammation may resolve following appropriate measures such as suitable antibiotics or evacuation of the exudates within the middle ear through spontaneous or guided rupture of the tympanic membrane. [9] On the other hand the disease process may progress to complications in the presence of poorly treated or untreated virulent organisms. [21] Spread of the disease beyond the confines of the middle ear can result in extracranial or intracranial complications. Acute mastoiditis (inflammation of the mastoid air cells)/coalescent mastoiditis [22], subperiosteal abscess [23], facial nerve paralysis [24], labyrinthitis and petrositis [25, 26] are examples of such extra-cranial complications. Whereas, the intracranial ones include extradural and subdural abscesses [27], meningitis [28], otitic brain abscesses [29], otitic hydrocephalus and lateral sinus thrombosis. [30, 31]

**Figure 1** shows an actively discharging ear (hyperemic TM highlighted in yellow) with a central perforation copiously discharging pus. (A video-otoscopy picture of a child taken at ENT Clinic of UCH Ibadan Nigeria, in 2006)

**Management:** Ear swab for discharging ears are taken for microcopy, culture and sensitivity test prior to commencement of broad spectrum oral and or topical antibiotics. This is usually guided by the knowledge and behavior of predominant causative agents within a given environment. Although a school of thought precludes antibiotics therapy for Acute Otitis media, since most are associated with viral infections [32-34], however the experience within the developing world has suggested that most of the cases are either mixed (bacterial + viral) or bacterial infections [18,35]. Some native cultural practices and the humid environment of the tropics encourage secondary bacterial infections. [36] A daily aural toileting of the ear is mandatory for the discharging ear. Myringotomy to evacuate the exudates in bulging TM is encouraged prior to antibiotics management. Adequate analgesia to reduce otalgia is valuable in the management of AOM. Imaging may be necessary especially in suspected cases of complications. In addition, relevant
ancillary investigations like complete blood count, urea and electrolytes should be carried out for optimization of the patient that may require surgery under anesthesia. Complications are managed accordingly. Appropriate exploratory and decompression surgeries such as mastoidectomies, facial nerve decompressions, craniotomies for intracranial abscesses evacuations, etc. under adequate antibiotic cover are usually indicated. The details of the procedures could be referred to in standard otology text books like the Scot Brown series and Ballenger.

5. Otitis Media with Effusion (OME)
This is a pathological condition characterized by the accumulation of fluid (non-purulent) within the middle ear cleft with an intact tympanic membrane. Most frequently, the fluid is mucus and thick, but sometimes serous and thin in consistency. OME has also been referred to as “Glue ear” [37], “Mucoid otitis media” [38, 39], “Secretory Otitis media” [40] and “Serous otitis media”. [41]
The pathogenesis of this condition is thought to be double pronged: First, from Eustachian tube disorder; which results in poor aeration of the middle ear and poor drainage of secreted fluids.[9, 42] Secondly, it could result from hyperactivity of the middle ear gland which leads to excessive accumulation of mucus secretions.
Histological evidence has shown an increase in number of the mucus or serous –secreting cells in such situations. [8]
Just like acute otitis media, OME is predominantly a childhood problem. About 85% of cases of OME occur in children making it a rare disorder in adults. [43] In contrast however, OME has been reported to show some racial bias. It is commoner among the Caucasians especially Canadian; Australian Aboriginals and Native American children compared to Africans. [44, 45]

Aetiology: There is a variation in the aetiology in children and adults. Eustachian tube dysfunctions from adenoid enlargements, upper respiratory tract infections, congenital defects e.g. cleft lips and palates are common etiological factors in children.[46-48] Whereas, allergy, barotraumas, nasopharyngeal tumours and rhinosinusitis are associated with OME in adults.[49-51] Other factors that could be predisposing to OME include prolonged nasotracheal intubation, head and neck surgeries like maxillectomy, radiotherapy of the head and neck and immunodeficiency disorders like multiple myeloma, cystic fibrosis and HIV/AIDS.
Clinical features: Otitis media with effusion usually present with conductive hearing loss. The magnitude of hearing loss is normally mild to moderate (≤40dB). It is usually most prevalent in children below five years of age. [45] Sometimes the hearing loss may be detected accidentally through tympanometry. Pressure effects of the effusion could give rise to otalgia (ear pains). Furthermore, very early onset of OME can give rise to speech difficulties since the child requires proper hearing for speech acquisition. The otoscopic findings include intact but dull tympanic membrane lacking in the light reflex with obvious restrictions in mobility. The appearance may range from brown to yellow. The tympanic membrane may show fluid level and/or air bubbles if the effusion is serous and the TM translucent. It might appear bulgy. On the contrary the TM may exhibit certain degrees of retractions when there is a scanty viscous fluid within the middle ear.
Sequelae: Acute OME resulting from recurrent upper respiratory infections and allergy usually resolves spontaneously after few days of onset without complications. However,
if OME fails to resolve within 6 weeks, it becomes chronic with possible serious consequences. [52] As a result, atrophic tympanic membrane can result from thinning and degeneration of the fibrous layer of the TM giving rise to atelectasis of the middle ear and retraction of the tympanic membrane. Involvement of the pars tensa of the TM would result in retraction pocket formation near the attic and this predisposes to cholesteatoma formation with its subsequent dangers. Other possible complications of chronic OME include ossicular bones necrosis especially the long process of incus, tympanosclerosis (calcium laden deposits on the tympanic membrane and the ossicle with its joints) leading to fixation in movement. Stasis in the secretions in the middle ear and mastoid can also result in the formation of cholesterol granuloma. [53]

**Management:** After clinical assessment of the patient, specific audiometric investigations and imaging are necessary to confirm diagnosis. Pure Tone Audiogram (subjective test) establishes conductive hearing loss usually $\leq 40$dB, whereas Impedance Audiometry tympanometry, which is an objective test also useful in children, establishes a flat type B tympanometry curve for confirmation. X-ray mastoid (Towne’s and Owen’s views) and paranasal sinuses (occipitomental, occipitofrontal and lateral views) establish possible focus of infections from mastoiditis or paranasal sinusitis. Computerized tomographic scan where available offers better resolution although experience has shown that most patients in the developing world cannot afford this and therefore, X-rays are still relevant in this part of the world.

The principle of treatment is basically identification of the cause of the OME, evacuation of the fluid, treatment of causes and prevention of recurrence. These could be achieved via medical, surgical management or a combination of the two.

**Medical treatment:** The use of topical vasoconstrictors/nasal decongestants to reduce the oedema in the Eustachian tube, nasal and the middle ear mucosa and thus encourage aeration of the middle ear and the use of appropriate antibiotics to treat underlying infections are recommended. The use of anti-allergic drugs for cases of identified allergies/ atopy and relevant physical exercises e.g. jaw exercises (through gum chewing) and valsalva maneuvers to improve aeration to the middle ear are thought to be useful. However note worthy is that current evidence based researches are questioning the usefulness of vasoconstrictors and nasal decongestants in the treatment of OME. [54, 55] Surgical treatment: When conservative management is not sufficient for the resolution of the problem, then surgery is indicated. [56] First, the causative factors amenable to surgery might require specific surgical repairs or maneuvers to resolve the OME and prevent future occurrences. Examples are cleft lip/palate repairs, antrostomy and wash outs, adenoidectomy/tonsillectomies. [57-60] Secondly, in situations where the effusion is viscid or massive, myringotomy is indicated for such evacuations. Vertical incision is usually placed either on the antero-inferior or antero-superior segment of the tympanic membrane for this procedure while micro-suctioning is applied for the evacuation of the fluid and tympanostomy tube insertion for aeration. Evidence, has shown a better outcome and lesser complications in OME managed with tympanostomy tube as compared to those managed conservatively. [61]

**6. Chronic Otitis Media (COM)**

Essentially COM is a permanent abnormality on the tympanic membrane following a long standing middle ear infection emanating from previous AOM, OME or negative
pressure to the middle ear. [62] There is no generally accepted time divide between acute and chronic OME. Some authorities’ time ranges from 2 weeks to 3 months. [6, 9, 63] It may be actively discharging or not. In most texts, COM is referred to as ‘chronic suppurative otitis media’ but for reasons earlier cited this term is fast becoming obsolete. Thus ‘active’, ‘inactive’ or ‘healed’ chronic otitis media depending on the clinical disease condition are the preferred terms. Pathologically, this disease entity is further sub-divided into ‘mucosal’ and ‘squamous’ COM [62] based on the histologic features of the middle ear mucosa and the edges of the perforated TM. Furthermore, COM was previously classified as tubotympanic -‘safe’ and atticoantral - ‘unsafe’ based on the anatomical location of the TM perforation. [9] Whereas marginally located TM perforations, especially at the pars flaccida were initially regarded as ‘unsafe’ and central perforations as ‘safe’ based on their propensity towards formation of cholesteatoma, evidence based information has shown that cholesteatoma could form in either conditions thereby nullifying the previous classification.[64]

Below is Table 1 summarizing the current clinical and histological classifications of COM according to Browning. [65]

<table>
<thead>
<tr>
<th>COM classification</th>
<th>Synonyms</th>
<th>Otoscopic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active (squamous)</td>
<td>Cholesteatoma</td>
<td>Retraction of pars tensa/ flaccid, retained Squamous epithelium, debris and pus.</td>
</tr>
<tr>
<td>Active (mucosal)</td>
<td>---</td>
<td>Permanent defect of TM on pars tensa, inflamed middle ear mucosa, mucous discharge.</td>
</tr>
<tr>
<td>Inactive (Squamous)</td>
<td>Retraction</td>
<td>Retracted pars tensa/flaccid usually at postero- superior segment, with potentials of becoming active with retained debris.</td>
</tr>
<tr>
<td>Inactive (mucosal)</td>
<td>Perforation</td>
<td>Permanent perforation on pars tensa, inactive middle ear mucosa.</td>
</tr>
<tr>
<td>Healed</td>
<td>Healed perforation, tympanosclerosis</td>
<td>Thinning and/or local or generalized opacification of the pars tensa without perforation or retraction.</td>
</tr>
</tbody>
</table>

Table 1 Adapted from Browning [65]

Note: The healed COM is the desired end result following the treatment of active COM or the end result of a natural healing from AOM or COM.

COM is commoner in the developing countries, where prevalence were as high as 6-11.1% across the various age groups [1, 66-68], than in the developed countries. Several researchers have shown that people of lower socioeconomic class are affected more than the upper divide. [2, 69] It affects all age groups with preponderance in adults, but no sex discrimination. Seasonal variations with the disease progression have been recorded in both the tropical and temperate regions. In the West African sub-region it has been noted that some inactive COM become active during the rainy seasons. [36] Similar observations were also made in America and Europe during the winter seasons. [70]

Aetiology: Chronic otitis media could be a seqellae to AOM and OME following poorly managed cases. Environmental factor and state of hygiene has been identified as a predisposing factor toward developing COM as seen in AOM. It was also found that the
prevalence of COM tend to be significantly more in patients suffering from gastroesophageal diseases (GERD). [71] In addition, more patients with craniofacial abnormalities e.g. cleft lips/palates, velopalatine muscle incompetence tend to be more predisposed. [58] Genetic/racial link is suggested to explain the difference in preponderance of this disease among certain group of people with fairly similar living conditions. [72, 73] Furthermore strong, autoimmune and immunodeficiency states are also suggested to be predisposing factors towards development of COM. The bacteriological causative agents most commonly associated with COM include *Pseudomonas aeruginosa*, proteus spp, *E. coli* and *Staphylococcus aureus*. [15, 16] Common anerobes include *Peptostreptococcus* spp, *Prevotella melaninogenica* and *B. fragilis*. [74]

**Clinical features:** The clinical features of typical uncomplicated COM are not as common as in the case of AOM. The patient is usually afebrile, with a history of prolonged or recurrent ear discharge in active COM with varying characteristic features of the otorrhoea. Copious mucopurulent otorrhoea is usually a feature of active mucosal COM; whereas scanty foul smelling and sometimes sanguineous varieties are seen in active squamous COM (cholesteatoma). [75] This may be unilateral or bilateral. Otalgia is not a common feature except in complicated conditions. Hearing loss, of conductive type; and sometimes mixed (conductive and sensorineural) is also a common feature of COM. [76,77] Otoscopic examinations **Figures 2a & 2b** usually show TM perforations of varying features – locations, sizes, shapes, dryness or wetness. [36] Aural polyp, a coalition of exuberant granulation tissues formed following chronic irritation of the middle ear mucosa, could be present. It sometimes occludes the entire perforation on the TM and prolapses into the external auditory canal. Again, retraction pockets and neo-membranes (dimeric tympanic membrane lacking in the middle fibrous layer) can be prominent features of the healed COM. Clinical features of complications may also be seen as enumerated below.

**Figure 2a**

![Image](Image)

**Active mucosal COM with a large perforation exposing the middle ear mucosa and its mucopurulent discharge.**

**Figure 2b**

![Image](Image)

**Inactive mucosal COM with kidney shaped dry perforation.**

Video-otoscopic pictures taken in the ISTH ENT clinic, Irrua Nigeria 2008)
Sequelae: Active COM can become inactive or healed COM and vice versa depending on prevailing circumstances and level of interventions. However, it could progress to severe and some times life threatening complications which are broadly classified as, ‘extra-cranial’ and ‘intra-cranial’ respectively. [78]

The extra-cranial complications are further sub-divided into extra temporal and intra temporal. The extra-temporal complications include Luc’s (temporalis region), Citelli (sub-periosteal), Bezold’s (sternocleidomastoid) abscesses. These are abscesses formed through the tracking of pus via the middle ear through natural anatomical channels of the head and neck to accumulate at the above designated sites. The intratemporal components of the extra-cranial complications include: mastoiditis, petrositis, facial paralysis and labyrinthitis. The intracranial complications are similar to those of the AOM as earlier enumerated with otitic hydrocephalus as the least common intracranial complication. [79]

Management: Akin to the diagnosis of AOM, appropriate ear swab should be taken for microscopy, culture and sensitivity tests. Micro pipette technique of deeply seated otorrhoea within the middle ear cavity en-route the perforation on the TM in active COM is method of choice to avoid contaminants. This is a useful guide to the identification of causative agent and appropriate choice of antibiotics. Appropriate views of radiological imaging (X-rays, CT-scan) [80, 81] as in AOM is essential for the grading of the degree of disease and to provide guidance during surgeries where indicated. Audiological investigations (Pure Tone Audiogram, Speech Audiometry) to assess the types and levels of hearing losses is imperative as this serves as a predictor to the mode of rehabilitation and management of choice.

The principles of management entail eradication of disease and restoration of function to as near normal as possible. Here, treatment could be, medical, surgical or both. Active mucosal COM could be managed via aural toileting and appropriate antibiotics (topical and systemic), nasal decongestants and Vitamin supplements (Vitamins C and A) to enhance healing.[82-84] Once total disease eradication and dryness is achieved, the level of function loss is assessed to decide whether there is need for further surgical intervention (e.g. myringoplasty and tympanoplasties) or not. An argument among otologists, on whether or not total dryness should be achieved before reconstructive surgeries are embarked upon, is prominent in the literatures. [85-89]

However, experience has shown that dry ears prior to reconstruction is better favored in our environment (developing countries) considering limiting environmental factors (like limited manpower and resources) and severe cost of failures in such reconstructions. Healed COM, (i.e. dry ear with a permanent central perforation), needs no further active intervention, other than a regular review of the patient.

However, medical intervention alone in Active Squamous COM (chronic ear discharge usually foul smelling and scanty, with marginal TM perforation and other otoscopic findings as in Table 1 above) is insufficient. An aggressive management and total excision of the squamous tissues within the middle ear is mandatory in order to prevent severe sequelae of cholesteatoma formation. [89] Such situations require a surgical intervention based on the extent of disease and the state of the patient. Thus, canal wall down and canal wall-up procedures; in addition to mastoidectomies of various classes necessary to ensure total exenteration of infected mastoid cells and eradication of the
diseased tissues have been described in the past. Over time, further modifications ranging from radical, through modified to selective interventions have been developed in order to conserve functions of hearing while at the same time ensuring a total eradication of disease. The details of these procedures could be read in standard operating otology text books.

7. Specific Otitis Media
Tuberculous otitis media is uncommon. However, following global re-emergence of tuberculosis the trend may be on the rise again. [90] The first documentation of the clinical features of this disease was made in 1853 whereas the first isolation of the organism (*Mycobacterium tuberculosis*) from ear discharge was in 1883. [91,92] It is usually characterized by painless ear discharge on a multi-perforated tympanic membrane and affects all age groups especially children and young adults (84% of cases).[93, 94] Diagnosis is confirmed by isolation of the organism from the otorrhoea and treatment is with anti-tuberculous therapy.

Syphilitic otitis media is caused by a spirochete which affects both the cochlear and semicircular canal. Therefore it is usually characterized by severe Sensorineural hearing loss and vertigo. [95] Diagnosis is made through a dark field microscopic examination of the ear discharge. The treatment is with anti-syphilitic drugs (Penicillin G, Aminoglycosides or Azithromycin). [96]

8. Conclusion
Otitis media is prevalent the world over with potentially severe complications if inadequately managed especially in the developing countries. It is of note that in the developing countries poverty, ignorance, dearth of specialists and limited access to medical care amongst others conspire to worsen the course of otitis media. Thus hearing loss with risks of developing behavioral, speech, language and cognitive problems are not uncommon complications of otitis media in the developing countries.

9. Recommendations
Otitis media (various classes) are common diseases that affect all age groups and races. There is preponderance of the acute variety among children and the younger age group and this responds well to early conservative management. However, chronic otitis media is more recalcitrant to management and prone to severe and often life threatening complications. Therefore, we recommend that all cases of chronic Otitis media, persistent/recurrent acute otitis media, Otitis media with effusion and specific otitis media be referred to the otorhinolaryngologist for prompt management.

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