

## Overview on Recurrent Otitis Media in Children and its Management

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### Abstract

**Background:** Acute otitis media (AOM) is an acute middle ear inflammation that occurs from virus or bacterial infections. Acute otitis media is the most widely diagnosed condition in children in the United States and the most frequently cited cause in children for antimicrobial treatment. Recurrent acute otitis media is described as three or more episodes of acute otitis media over six months or four or more episodes in one year, dividing the episodes of acute infection by maximum resolution intervals.

**Aim:** The purpose of this review is to examine the literature on the pathophysiology, risk factors, diagnosis, management and prevention of recurrent otitis media in children.

**Conclusion:** Comprehensive analysis of the etiological factors for rAOM may be useful for treating and preventing the disease. Prophylactic antibiotics are successful in improving the public results for otitis media. Antibiotic treatment decreases the incidence of recurrence of otitis media, the duration of otitis media incidents and the overall amount of time each infant spends with otitis media. Avoidance of well-known environmental hazards such as day care, exposure to cigarette smoke and the use of pacifiers, particularly during the peak occurrence period of OM (6 - 24 months), were associated with a reduction in OM.

**Keywords:** Recurrent Otitis Media in Children; Management of Recurrent Otitis Media in Children; Prevention of Recurrent Otitis Media in Children; Recurrent Acute Otitis Media

### Introduction

Acute otitis media (AOM) is an acute middle ear inflammation that occurs from virus or bacterial infections. Acute otitis media is the most widely diagnosed condition in children in the United States and the most frequently cited cause in children for antimicrobial treatment [1]. Recurrent acute otitis media is described as three or more episodes of acute otitis media over six months or four or more episodes in one year, dividing the episodes of acute infection by maximum resolution intervals. Recurrent acute otitis media develops in around 20 to 30% of the pediatric population during the first three years of life [2].

The most common pathogens of recurrent acute otitis media are antibiotic-resistant *Streptococcus pneumoniae* and beta-lactamase-producing *Haemophilus influenzae*. After an episode of AOM, middle ear fluid is present for a few days to more than 2 months. Fluid in the middle ear causes a conductive hearing loss of about 20 - 30 dB and particularly when asymmetric, affects temporal interaural and level difference signals that compromise the localization of binaural sound [3,4].

Risk factors for AOM include young age, frequent contact with other children, which increase exposure to causative pathogens, orofacial abnormalities (such as cleft palate), household crowding, exposure to cigarette smoke, pacifier use, shorter duration of breastfeeding, prolonged bottle-feeding while lying down and a family history of otitis media [5]. Factors that contributed to invasion of bacteria or viruses include nasopharyngeal colonization, upper respiratory tract infections and dysfunction of the Eustachian tube. Children with recurrent AOM have no effusion within the middle ear cleft between attacks of acute disease [6].

Recurrent AOM has a significant negative effect on children's quality of life and causes concern for their caregivers. Behavioral research found difficulties with auditory attention control in children with OM. For speech processing and language learning, involuntary orientation to environmental events as well as selective attention-keeping is necessary [7].

Children with suspected or confirmed rAOM are sometimes referred to a department/practice in the ears, nose, and throat (ENT). The first step is diagnostic testing. It is especially important to avoid unnecessary antimicrobial treatment or surgical procedures with TT. Rated by their teachers, school-children with OM history were suggested to be less task-oriented [8]. They also likely to have viral infections alone or to have bacterial organisms that are less virulent (e.g. *Moraxella catarrhalis* and some strains of *Haemophilus influenzae* compared with *Streptococcus pneumoniae* and *Streptococcus pyogenes* (group A streptococci [GAS]) [9].

Accurate diagnosis of acute otitis media is the first step in optimal management. It is clinically diagnosed by consistent data on physical examination (otoscopy) combined with the history of the patient and with signs and symptoms present. Several diagnostic instruments are available to assist in the diagnosis of otitis media, such as a pneumatic otoscope, tympanometry, and acoustic reflectometry [10].

In episodic management, each episode is considered a new attack and is treated with antibiotics; the patient is monitored until the episode resolves. Preventative treatment involves the administration of a conjugated heptavalent pneumococcal vaccine [11]. Systemic antibiotics remain an important option, although in mild cases watchful waiting could be applied. Treatment studies in the supply of AOM, some support for the use of antibiotics in rAOM although they are not investigating children with rAOM exclusively [12].

The purpose of this review is to examine the literature on the pathophysiology, risk factors, diagnosis, management and prevention of recurrent otitis media in children.

### Pathophysiology

OM pathogenesis begins with early and dense bacterial colonization of the nasopharynx, early onset of AOM, the establishment of an acute inflammatory cycle in the middle ear resulting from continued exposure to infectious agents, including bacterial persistence in the middle ear through the formation of biofilms, viral infections and, finally, severe chronic ear disease. Infections of the upper respiratory tract may cause mucosal congestion in the Eustachian tube and nasopharynx [13]. The resultant obstruction inhibits proper operation of the Eustachian tube and affects pressure balance within the middle ear. Aspiration of nasopharyngeal pathogens can occur inside the middle ear if sustained [14]. The presence of these infections then induces inflammation and accumulation of pus within the middle ear, contributing to clinical AOM symptoms. A bulging or erythematous tympanic membrane and purulent middle ear fluid support this scientifically. It has to be distinguished from the chronic serous otitis media (CSOM), which on otoscopic inspection shows thick, amber-colored, fluid in the middle ear area and a retracted tympanic membrane [15].

### Risk factors

One of the risk factors for the onset of OM is considered a preceding or overlapping viral URTI, as well as a poly-microbial disease. Viral URTI facilitates bacterial infection replication and improves nasopharynx and ET inflammation. Upper respiratory tract infection (URTI), which involves cough, rhinorrhea, or sore throat, has been described as a significant prognostic factor for recurrent OM [16].

Snoring is pathophysiologically determined by the size of the upper airway lymphadenoid tissue size. Previous studies suggested that the risk for recurrent otitis media appeared to be related to snoring [17].

Indoor allergens and allergies to the respiratory system including allergic rhinitis lead to the development of ROM. People with allergic or atopic disorders tend to suffer more from ROM. The prevalence of atopic disorders, including allergic rhinitis, varies from 24 to 89% in ROM patients [18].

Passive smoking has been reported to be associated with increased prevalence of middle ear disease. Several studies indicate that nicotine and other smoking products may make subjects more vulnerable to ear infections and increase the risk for invasion of micro-organisms into the middle ear. Smoke exposure could impair the ET's mucociliary function, resulting in nasopharyngeal airway blockage [19].

It is believed that breast-feeding offers antimicrobial, anti-inflammatory and immunomodulatory agents that contribute to an optimal immune system. Numerous studies have reported the relative contribution of breast-feeding to the prevention of median otitis infection [20].

Other risk factors include day care attendance, orofacial abnormalities (such as cleft palate), household crowding, use of a dummy, premature birth, not being breastfed, immunodeficiency and a positive family history of otitis media. In developing countries, malnutrition, contaminated water, poor hygiene, human immunodeficiency virus infection, tuberculosis, malaria and poor access to health care increase the risk for chronicity and complications of OM [21,22].

### Signs and symptoms

Systemic symptoms, such as trouble sleeping or reduced playfulness, irritability and fever, are typical even in the absence of AOM in respiratory viral infections (e.g. influenza and respiratory syncytial virus infections) [23]. Symptoms such as ear tugging or ear pain (otalgia) may often suggest myringitis due to a respiratory infection or ET deficiency with impaired hearing, but it is mostly better in verbal kids [24]. Otolgia as a symptom should be separated from discomfort in the outer canal due to otitis externa (which normally contributes to discomfort in the tragedy movement and inflammation in the ear canal without any systemic symptoms [25].

### Diagnosis

AOM diagnosis is the cornerstone of management, yet from a clinical perspective, it is often very challenging. In individual studies, which included case history, physical examination and other tests such as tympanogram, microscopic otoscopy or insertion of tympanostomy tubes, the diagnostic criteria for recurrent otitis media were described [26]. Otitis media diagnosis should always start with a physical examination and the use of an otoscope, ideally a pneumatic otoscope [27]. The American Academy of Pediatrics recommendations note that in children with mild to extreme bulging of the tympanic membrane or recent development of otorrhea that is not secondary to otitis externa should be diagnosed as AOM. If a child has three episodes of AOM within a 6-month period, or four in 1 year, the condition is referred to as RAOM [28].

The diagnosis can also be made with moderate bulging of the tympanic membrane with otalgia or with severe tympanic membrane erythema; the condition is unlikely in the absence of a middle ear effusion (assessed with pneumatic otoscopy or tympanometry) [29].

Otoscopy is critical in making the diagnosis, with sensitivity and specificity reported at 90% and 80% respectively; this can be improved when using pneumatic otoscopy. The clinical findings are variable, including abnormal color (e.g. yellow/amber/blue), tympanic membrane retracted/concave and levels of air-fluid [30]. An audiogram (hearing tests typically showing a mild conductive hearing loss) and tympanogram (showing an immobile ear drum or a negative middle ear pressure) provide further evidence [31].

Otoscopy alone, with no pneumatic bulb, may overlook OME because the tympanic membrane may appear normal, and symptoms associated with the ear may be minimal or absent. In contrast, pneumatic otoscopy can prevent false-positive OME diagnoses caused by surface abnormalities of the tympanic membrane without MEE [32].

Tympanometry objectively measures the mobility of tympanic membrane and the function of the middle ear. It also estimates the equivalent ear canal volume, defined as the amount of air in front of the probe, normally 0.3 - 0.9 ml in children. Tympanometry has similar sensitivity compared with pneumatic otoscopy (range: 90 - 94 per cent) but lower precision (50 - 75 per cent versus 80 per cent for tympanometry and pneumatic otoscopy, respectively) [33].

### Management

Symptoms relieve and recurrence reduction are targets for AOM treatment. Currently, there are three main treatment modalities for recurrent otitis media: prophylactic antibiotics, adenoidectomy and tympanostomy tube insertion [34]. In children patients who are not allergic to penicillin, the antibiotic of choice is high-dose amoxicillin for ten days when a bacterial etiology is suspected. Because of its high concentration in the middle ear, amoxicillin has a good efficacy in the treatment otitis media [35]. The American Academy of Pediatrics (AAP) suggests azithromycin as a single dose of 10 mg/kg or clarithromycin (15 mg/kg a day in 2 separated doses) in cases with penicillin allergies [36]. Cefdinir (14 mg/kg daily in 1 or 2 doses), cefpodoxime (10 mg/kg daily, once daily), or cefuroxime (30 mg/kg daily in 2 doses) can also be used as alternatives for patients with penicillin allergies. Ceftriaxone (50 mg/kg a day) for three consecutive days either intravenously or intramuscularly is used for children who vomit or if there are conditions where oral antibiotics cannot be given [37].

Symptoms should improve within 1 - 2 days and resolve within 2 - 3 days of the start of antibiotics. If after two days the symptoms have not improved, the antibiotic will be modified to one that targets all penicillin-resistant *S. pneumoniae* and beta-lactamase-producing bacteria - amoxicillin/clavulanate or ceftriaxone parenteral [38].

High-dose amoxicillin therapy fail if the pathogen is a  $\beta$ -lactamase-producing pathogen, such as *Haemophilus influenzae* and if the pathogen is penicillin-nonsusceptible *Streptococcus pneumoniae*, use of  $\beta$ -lactamase-stable drugs such as cefuroxime axetil may fail [39].

Due to the cost and side effects, the administration of high-dose amoxicillin with clavulanic acid is not often an effective option, and newer drugs, such as gatifloxacin, are not approved as suitable medicines for daily use in children with AOM but can play a role in the diagnosis of chronic or non-responsive otitis media [40].

Recurrent antibiotic-requiring infections are clinical evidence of Eustachian tube dysfunction and placement of the tympanostomy tube allows middle ear space ventilation and normal hearing maintenance [41].

Pain control can be accomplished by administrating non-steroidal anti-inflammatory medications (NSAIDs), such as acetaminophen. Analgesics are especially important at bedtime as disturbed sleep is one of the most common symptoms that motivates parents to seek care. It has been demonstrated that ibuprofen and acetaminophen are successful [27].

Surgical placement of tympanostomy tubes is recommended for children with recurrent AOM. Tympanostomy tubes usually last 6 to 12 months; once extruded, there is no evidence of ongoing benefit [42].

### Prevention

The rAOM syndrome implies that the individuals affected are suffering from repeated infections of bacterial origin in the middle ear. So, prophylactic antibiotics may be used against rAOM. The effectiveness of antibiotics as a treatment and as a prophylaxis should be examined. Early studies on young children with rAOM have shown that antibiotics can provide protection against OM recurrence and the frequency of AOM episodes, with amoxicillin appearing as the drug of choice [43].

Given that AOM is usually caused by symptomatic viral URTI, viral URTI avoidance may affect the occurrence of AOM. To date, influenza virus has been the only vaccines available against viral respiratory infection [44]. Pneumococcal conjugated vaccines with protein D from Hi as carrier protein have caught special attention regarding rAOM, since there is a high representation of Hi as a causative agent. During 'flu' seasons, trivalent influenza vaccines (protecting against three strains of the influenza virus), both inactivated influenza vaccines and live attenuated influenza vaccines, have been shown to reduce AOM [45].

Exclusive breastfeeding before the age of at least three months decreases the occurrence of AOM, and this effect continues for four to 12 months after breastfeeding has stopped. This decrease is likely to be secondary to immunoglobulins and other in breast milk components that improve the immunity of infants against pathogens [46].

Limiting daycare exposure for very young children decreases the risk of infection with the upper respiratory tract and thus with AOM. The risk is associated with the number of encounters with other children regardless of the total number of children studying at the school, so the risk is greatest in the first year of life. Pacifier use and smoking should also be limited [47,48].

### Conclusion

Comprehensive analysis of the etiological factors for rAOM may be useful for treating and preventing the disease. Prophylactic antibiotics are successful in improving the public results for otitis media. Antibiotic treatment decreases the incidence of recurrence of otitis media, the duration of otitis media incidents and the overall amount of time each infant spends with otitis media. Avoidance of well-known environmental hazards such as day care, exposure to cigarette smoke and the use of pacifiers, particularly during the peak occurrence period of OM (6 - 24 months), were associated with a reduction in OM.

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