

Acute Otitis Media in Children: A Continuing Story

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Objectives After completing this article, readers should be able to:

1. Delineate the most common bacterial infection in young children.
2. Describe the value of antibiotics in acute otitis media.
3. Discuss strategies to reduce unnecessary antibiotic usage.
4. Explain the importance of The Safety-Net Antibiotic Prescription concept.

Introduction

In 1897, L. Emmett Holt published his magnum opus, *The Diseases of Infancy and Childhood*. He devoted a full chapter to acute otitis, describing much of what we still observe about this condition: its commonality and association with the winter months, the role of eustachian tube dysfunction, and its tendency to recur. He also detailed a very different illness, noting that 43% of cases were associated with measles, scarlet fever, whooping cough, or mumps, and only 29% were associated with “simple catarrh.” Approximately 20% of cases were attributed to teething. Acute otitis infections associated with colds had a benign course and resolution. In contrast, those associated with scarlet fever, diphtheria, or influenza often involved severe invasive complications and resulted in “some degree of impairment of the sense of hearing.” For treatment, he advised blood letting with leeches and the use of dry heat. If these failed to bring relief, he recommended administration of an opiate. Pain and fever lasting into a second day were to be treated with incision of the tympanic membrane. Recurrent and chronic diseases were to be referred to the surgeon.

More than 100 years later, acute otitis media (AOM) is the childhood disease diagnosed most commonly, accounting for 20% of pediatric visits. AOM results in more than 24 million office visits, accounts for most outpatient antibiotic prescriptions provided to children, and costs an estimated \$5.3 billion annually. Fifty percent of infants in the United States have their first episode before 6 months of age, and 90% experience at least one episode by the age of 2 years. The incidence is highest among children younger than 2 years of age and tapers gradually thereafter. Males account for slightly more than 50% of all cases. Additionally, recurrent and chronic AOM infections are associated with challenges in hearing and language development.

Despite the impact and frequency of this disorder, there still is controversy regarding treatment and no universally effective preventive interventions. The purpose of this article is to provide a review of AOM, emphasizing accurate diagnosis and the available evidence-based therapeutic interventions.

Etiology/Pathophysiology

AOM results from ineffective aeration of the middle ear space, caused primarily by eustachian tube dysfunction. Commonly, even in otherwise uncompromised hosts, viral upper respiratory tract infections (URIs) induce inflammation and edema of the mucosal linings and narrowing of the eustachian tube lumen. Resorption of trapped air creates a relative vacuum within the middle ear space and reverses the flow of secretions, drawing fluid from the nasopharynx into the middle ear. Bacteria multiply within this mucoid media and stimulate an inflammatory response.

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Table 1. Risk Factors for Acute Otitis Media (AOM)

- Male gender
- Atopic disease
- Immune deficiency
- Craniofacial anomalies
- Genetic tendency
- Child care attendance
- Older siblings
- Smoke exposure
- Pacifier use
- Bottle-feeding
- Onset of first AOM infection before 6 months of age

Predisposing factors for AOM include low socioeconomic status, environmental smoke exposure, child care attendance, and limited breastfeeding. Known host risk factors include allergies, craniofacial anomalies (eg, cleft palate), select genetic disorders (eg, trisomy 21), and immunodeficiency states (Table 1).

Clinical Presentation and Diagnosis

AOM often follows, by a few days, the development of a viral URI. For infants and young children, nonspecific signs of fever, irritability, poor feeding, disrupted sleep, anorexia, or malaise commonly are present in varying degrees. In the youngest children, pain may be difficult to discern, with only a sense of discomfort about the ear being reported by an observant parent. For older children, fever and otalgia, commonly disrupting sleep, often are of sudden onset and suggest the presence of middle ear infection. In some cases, obvious symptoms may be absent.

Adequate clinical examination for this condition requires visualization of the tympanic membrane (TM) and assessment of its mobility. Equipment for the examination includes a well-maintained halogen otoscope with an insufflator bulb or tympanogram, appropriately sized specula, and the availability of curettes or other equipment for cerumen removal.

Visualization of the TM necessitates a cooperative or immobilized child. Positioning the patient for the examination is particularly important. Infants may be examined best lying supine, with arms held extended above the head by a parent, thus minimizing the impact of the shoulder on head movement. If needed, an assistant can hold the legs in full extension with pressure above the knees.

Young children, who may not hold still voluntarily for the examination, may be positioned as described for



Figure 1. Normal tympanic membrane. Courtesy of David McCormick, MD, UTMB, Galveston, TX.

infants or held sitting in their parent's lap facing the examiner. A snug parental embrace around the torso and arms enables the examiner to immobilize the patient's head against the parent's chest to complete the examination.

Whatever the technique for immobilization, inherent cooperation or external influence, gentle traction on the external auricle in a posterior-superior direction aids in straightening the auditory canal for visualization of the TM. Careful curettage or gentle washing may be needed to remove obstructing cerumen.

In a state of health, the TM is translucent and gray, with an anterior triangular reflection of light (Fig. 1). The short process and the manubrium of the malleus are recognizable ossicular landmarks. With insufflation, a TM that is unimpeded by middle ear fluid moves easily in response to positive or negative pressure, and tympanometry results in a peaked curve.

AOM is diagnosed when a bulging, nonmobile TM is present in combination with local or systemic symptoms (Fig. 2). The color of the TM is not a defining feature of AOM because the infected middle ear may result in a TM that appears red or yellow. A bulging TM often is difficult to detect with the monocular view through the otoscope. Familiarity with the ossicular landmarks of the normal TM aids in the identification because the malleus and the umbo cannot be seen well when the TM is bulging (Fig. 3). An opaque middle ear fluid level also suggests the presence of AOM. The tympanogram in AOM describes a significantly blunted peak or is flat, suggesting limited-to-no mobility on positive or negative pressure.

Accurate diagnosis and differentiation from other concerns of the TM are crucial. Viral myringitis and otitis media with effusion (OME) may be mistaken for AOM.



Figure 2. Early acute otitis media. Courtesy of David McCormick, MD, UTMB, Galveston, TX.

Myringitis is inflammation of the TM characterized by otalgia and erythema, often with an associated viral URI. In this condition, the TM is not bulging, and its mobility is not impaired. OME is middle ear fluid, often associated with viral respiratory symptoms, diagnosed when a non-bulging, poorly mobile TM is observed (Figs. 4 and 5). The TM often is translucent, revealing a clear fluid level or bubbles in the middle ear space. Differentiation of AOM from myringitis and OME is essential to allow for logical treatment.

The definitive diagnostic test for AOM is culture of middle ear fluid obtained by tympanocentesis. In recent years, discussion in the literature has begun to encourage those who provide primary care for children to acquire this skill. Although not currently the standard of care,



Figure 3. Established acute otitis media. Courtesy of David McCormick, MD, UTMB, Galveston, TX.

diagnostic tympanocentesis performed by primary care physicians may, in future years, be a necessary skill in the evaluation of children who have recurrent or treatment-resistant AOM.

Pathogenic Organisms

Streptococcus pneumoniae, *Haemophilus influenzae*, and *Moraxella catarrhalis* remain the three leading bacterial pathogens in AOM. *S pneumoniae*, a gram-positive organism, accounts for 25% to 50% of cases of AOM and is becoming increasingly resistant to antimicrobial therapy. More than 50% of isolates are resistant to penicillin. AOM caused by *S pneumoniae* is likely to remit spontaneously in only 20% of cases. *H influenzae*, a gram-negative bacterium, accounts for 25% of cases, and 40% of isolates have developed beta-lactamase activity. Ap-

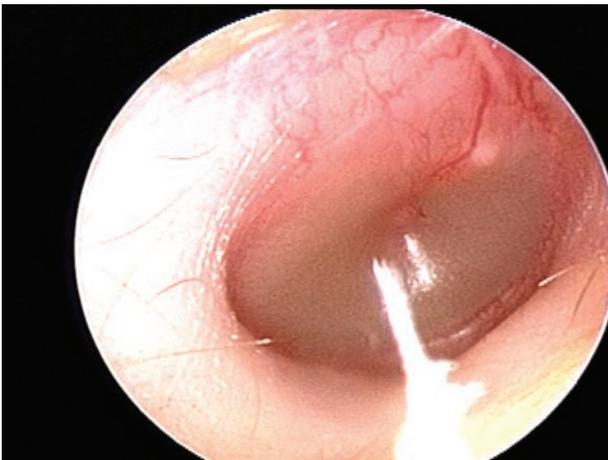


Figure 4. Serosus effusion following acute otitis media. Courtesy of David McCormick, MD, UTMB, Galveston, TX.

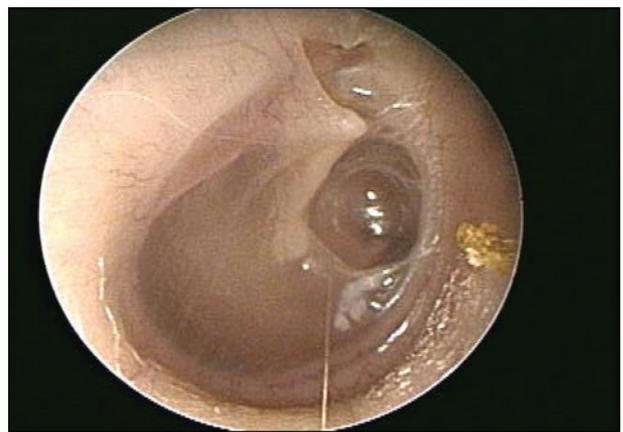


Figure 5. Retraction pocket that develops as a result of chronic effusion. Courtesy of David McCormick, MD, UTMB, Galveston, TX.

proximately 50% of AOM caused by *H influenzae* resolves spontaneously. Another gram-negative bacterium, *M catarrhalis*, causes one eighth of the cases of recognized bacterial AOM. Although nearly 100% of *M catarrhalis* have beta-lactamase activity, the spontaneous resolution rate of AOM associated with this organism is 80%.

Other bacterial pathogens account for smaller percentages of recognized cases. Nearly 20% of cases have no organism isolated. Respiratory syncytial virus, rhinoviruses, influenza A virus, parainfluenza virus type 3, and adenoviruses are commonly identified as copathogens with bacteria in AOM.

Treatment

The mainstay of treatment of AOM in the United States has been antibiotics. Amoxicillin remains the first-line drug of choice, even in this era of increased pneumococcal resistance. Amoxicillin is well tolerated at doses as high as 50 mg/kg, and dosing at this level achieves middle ear fluid antibiotic concentrations that exceed the mean inhibitory concentrations of pneumococci, even when they are relatively resistant to penicillin.

Until recently, it was recommended that AOM be treated with 10 days of antibiotics. Several studies have shown that shorter courses are acceptable in low-risk children whose disease is clinically mild. Candidates for a brief (5- to 7-day) course of antibiotics are children older than 2 years of age who have intact tympanic membranes and have not had AOM within 1 month of diagnosis. Single-dose parenteral ceftriaxone therapy is as effective as a full course of oral antibiotic therapy in uncomplicated AOM. However, the single-dose regimen is not recommended routinely as an alternative to an oral course of amoxicillin. Clinical response to antibiotic treatment usually is seen within 48 hours.

Clinicians frequently are faced with the child whose AOM does not respond to an initial course of antibiotics or relapses shortly after treatment. In these situations, a second-line oral antibiotic is an appropriate choice (Table 2). Repeated parenteral doses of ceftriaxone also have been shown to be effective in refractory cases of AOM. Three daily doses of ceftriaxone are more effective in obtaining a bacteriologic cure than is a single dose. Second-line therapy also is recommended if the clinical scenario suggests a resistant organism. When conjunctivitis is present with AOM, beta-lactamase-producing organisms such as nontypeable *H influenzae* and *M catarrhalis* are likely pathogens, and an antibiotic that is beta-lactamase-stable is appropriate. In rare cases in which AOM does not respond to a second-line antibiotic

Table 2. Second-line Antibiotics for Acute Otitis Media

Antibiotic	Dosage
Amoxicillin/clavulanic acid ES-600 suspension	90 mg/kg day divided BID
Cefprozil	30 mg/kg day divided BID
Ceftriaxone	50 mg/kg day QD × 1 to 3 doses
Cefdinir	14 mg/kg day divided BID or QD (BID dosing is approved for 5 to 10 days)

or a subsequent third-line drug, it is appropriate to consider tympanocentesis for diagnostic and therapeutic reasons.

Immediate management of AOM with antibiotics is not universal. In several countries, management consists of close clinical follow-up, with antibiotic intervention if the infection does not resolve after 48 hours. Placebo-controlled studies show that patients treated with antibiotics experience the benefit of, at most, a 1-day decrease in symptoms. Recent meta-analyses of placebo-controlled antibiotic treatment studies suggest that only 6% to 14% of children benefit from treatment. In the United States, this limited benefit, coupled with concerns about antibiotic resistance and adverse effects, has led to a growing consensus for watchful waiting as initial treatment of uncomplicated AOM.

Because AOM has been treated traditionally with antibiotics, it is not clear whether families and practitioners are willing to accept the watchful waiting approach. Studies have shown that practitioners believe that families expect antibiotics for AOM and are uncomfortable not using them to treat the disease. Parents, however, are concerned about both potential adverse effects of antibiotics and the loss of efficacy because of overuse.

Recently, Cates, a family practitioner in the United Kingdom, described the concept of a Safety-Net Antibiotic Prescription (SNAP) for AOM (see Suggested Reading). Cates' practice made it a policy to offer families a SNAP for relatively well children who had AOM. Children were prescribed pain control medication, and parents were provided information on the medical reasons behind this strategy. It was suggested that parents allow the infection 1 to 2 days to resolve prior to beginning the antibiotic. If symptoms persisted or worsened, they were to fill the prescription and begin active treatment. With this strategy, the Cates group lowered overall antibiotic

Table 3. Exclusion Criteria for Safety-Net Antibiotic Prescription (SNAP)

1. Temperature on physical examination or by history of $>101.5^{\circ}\text{F}$ (38.2°C) by any method within the past 48 h
2. Symptoms suggestive of AOM for >48 h
3. Toxic-appearing child
4. Tympanic membrane of the infected ear not intact
5. The presence of a chronic condition that may impede the child's immunity or ability to clear the infection, as judged by the examining clinician
6. Another episode of AOM within the past 3 mo
7. Signs of impending perforation in the infected ear, as judged by the examining clinician
8. Coexisting bacterial infection
9. Family probably unable to seek medical care if the child's clinical status worsens (eg, the family does not have reliable transportation), as judged by the examining clinician
10. The child's parent/guardian cannot gain an acceptable understanding of the protocol (according to the parent/guardian or the clinician)

use by 32% compared with a 12% reduction in a control group.

The Cincinnati Pediatric Research Group (CPRG) tested a similar SNAP protocol within a research network of pediatric practices. Exclusion criteria for using a SNAP are summarized in Table 3. Families in this study filled the SNAP only 32% of the time within the first 5 days of infection, and 62% of parents said they would be willing to have AOM treated again in their child with observation and pain control.

The Cates and CPRG studies do not clarify the percentage of AOM cases for which SNAP may be appropriate. It is unknown how the timing of a preceding episode of AOM should affect the decision to consider using the SNAP technique. Recent data suggest that it is safe to use watchful waiting for children as young as 1 year of age, but several experts recommend routine use of antibiotics until 2 years of age. Clearly, further studies are needed to compare the clinical outcomes of the SNAP technique with those of traditional antibiotic use.

Other strategies should be pursued to increase the appropriateness of antibiotic use in AOM. Garbutt and associates demonstrated that pediatricians routinely overdiagnose AOM and use minimal Centers for Disease Control and Prevention criteria only 38% of the time (see Suggested Reading). More accurate diagnosis and

shorter courses of therapy could lower the inappropriate use of antibiotics in this disease significantly.

Because pain is the primary reason that parents bring their children to the pediatrician for evaluation, addressing analgesia is critical. Oral analgesics or topical numbing drops (for children who have intact TMs) typically provide good pain control. Decongestants or antihistamines have not been shown to add value in the treatment of AOM or of the serous effusion that follows an acute infection.

Prevention

In February 2000, the heptavalent pneumococcal vaccine was approved for universal use in children younger than 2 years of age and in children ages 2 to 5 years who are at higher risk for pneumococcal disease. Preliminary studies have shown an appreciable drop in the incidence of AOM related to the use of this vaccine. The benefit appears to be strongest in children older than 2 years of age who have experienced at least one episode of AOM.

Although most children suffer at least one episode of AOM, several groups of children are at increased risk (Table 1). Because AOM often is a complication of URI and eustachian tube dysfunction, it is not unexpected that children attending child care experience more AOM. Smoke exposure is a major risk factor, and reducing the exposure of children to tobacco smoke limits the development of recurrent AOM. Decreasing pacifier use, discouraging the propping of bottles during feeding, and encouraging early weaning for infants who are bottle-fed also may have a positive impact.

Otitis-prone children commonly have received daily doses of antibiotic for prophylaxis against recurrent infection. With growing concerns over the development of pneumococcal antibiotic resistance and limited evidence to suggest benefit, this practice has fallen from favor.

Complications

The TM is perforated in 5% of AOM cases and represents the most common complication of the infection. In this situation, topical antibiotic drops often are recommended as an adjunct to an oral agent, although there are no convincing data to confirm the benefit of this practice. If a perforation is documented, the child should be followed to evaluate whether the drainage has stopped and the perforation has sealed. Persistent drainage or prolonged perforation of the TM is an indication for consultation with an otolaryngologist.

Although OME is present in virtually all children after successful treatment of AOM, it may persist for a variable length of time. Prolonged OME increases the risk for

language delay due to partial hearing loss. The clinical guideline for AOM treatment at our institution recommends a formal hearing evaluation for children who have OME that persists for more than 3 months and for children who have four or more episodes of AOM in 6 months or five or more episodes in 12 months. A speech therapy evaluation should be considered for children who have documented hearing loss.

Tympanostomy tubes are inserted most commonly for recurrent or chronic otitis media despite a lack of data showing long-term speech or hearing benefits from the procedure. Regardless, strong consensus suggests that tympanostomy tubes seem a reasonable option for children who have experienced at least four episodes of AOM in a 6- to 12-month period or who have OME that persists bilaterally for 3 months or unilaterally for 6 months. Tympanostomy tubes are inserted at a rate of about 25 for every 1,000 episodes of AOM.

Mastoiditis, although rare, is the most common serious complication of AOM and presents with fever, mastoid surface tenderness, and anterior displacement of the external ear. Almost all children who have AOM develop mastoid air cell inflammation and fluid, although clinical mastoiditis develops in only about 1 in 500 to 1,000 children. Approximately 50% of children who suffer mastoiditis are being treated with antibiotics at the time of diagnosis. Although it is not clear whether early initiation of antibiotics helps to prevent the development of mastoiditis, the incidence of this complication is about half as common in the United States as in countries where watchful waiting more commonly is employed. Other serious, but less common complications of AOM include bacteremia, meningitis, and cerebral abscess. One potential benefit of the SNAP technique is that antibiotics can be instituted without delay in children who do not respond to watchful waiting, which may decrease the chances of complications such as mastoiditis and perforation. Further studies are needed to test this hypothesis.

Conclusion

AOM remains the most common bacterial infection in childhood. Because the benefit from antibiotics is limited and concern about resistance is increasing, routine antibiotic treatment of all cases of AOM is being questioned. The SNAP technique may be a useful tool to reduce unnecessary antibiotic exposure while allowing for antibiotics to be available for children who do not respond to watchful waiting. Children who have persistent OME and recurrent infection are potential candidates for tympanostomy tubes.

Suggested Reading

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PIR Quiz

Quiz also available online at www.pedsinreview.org.

1. Which of the following statements regarding otitis media is true?
 - A. Antihistamines play an important role in reducing the symptoms of otitis media.
 - B. Breastfed infants have a higher risk of otitis media than do formula-fed infants.
 - C. Children who have craniofacial anomalies have an increased risk of otitis media.
 - D. Otitis media caused by *S pneumoniae* usually remits spontaneously without antibiotics.
 - E. Otitis media occurs rarely in infants younger than 6 months of age.
2. You are evaluating a 2-year-old girl who complains of ear pain. Her temperature is 100°F (37.4°C). Physical examination reveals an alert, nontoxic child who has nasal congestion. Her tympanic membranes are erythematous, with normal landmarks and positive movement on insufflation. A tympanogram shows a peaked curve. The rest of the findings on her physical examination are normal. Of the following, the *most* accurate diagnosis is:
 - A. Acute otitis media.
 - B. Acute otitis media with effusion.
 - C. Chronic otitis media with effusion.
 - D. Myringitis.
 - E. Otitis externa.
3. Of the following, the *best* management plan for the patient described in the previous question is:
 - A. A single dose of intramuscular ceftriaxone.
 - B. Oral amoxicillin.
 - C. Oral amoxicillin/clavulanic acid.
 - D. Oral analgesics.
 - E. Oral antihistamines.
4. You are evaluating a 2-year-old boy who has a 1-day history of ear pain and low-grade fever. According to his chart, he was treated for otitis media by your partner last month. The child is playful but complains of right ear pain when asked. His temperature is 100.8°F (37.8°C). Physical examination reveals an intact, erythematous, bulging tympanic membrane on the right. Movement on insufflation is minimal. You diagnose otitis media and consider using the Safety-Net Antibiotic Plan (SNAP) protocol. Of the following, the characteristic of this child's ear infection that makes the SNAP technique an unacceptable option is:
 - A. Age of 2 years.
 - B. Bulging tympanic membrane with no movement on insufflation.
 - C. History of otitis media 1 month ago.
 - D. Intact tympanic membrane.
 - E. Symptoms of 1 day's duration.
5. A 1-year-old girl comes to your office with "pink eye." Her temperature is 101.5°F (38.2°C), and she appears well. Physical examination reveals left scleral injection with clear eye discharge and a left tympanic membrane that is erythematous and bulging and does not move on insufflation. Of the following, the *most* appropriate management plan for this girl is:
 - A. Oral amoxicillin.
 - B. Oral amoxicillin/clavulanic acid.
 - C. Oral analgesics only.
 - D. Parenteral penicillin.
 - E. Topical antibiotic drops.