An Evidence-Based Approach To Managing Acute Otitis Media

Abstract

Acute otitis media is one of the most common pediatric illnesses; however, there is considerable controversy in its management. While most cases are treated with antibiotics, there is a growing concern regarding antibiotic overuse and subsequent drug resistance. Researchers in the Netherlands have developed a “watchful waiting” (ie, an observation approach) that has been successful in treating acute otitis media, although it has not gained widespread popularity in the United States. This review will summarize the latest research on diagnosing acute otitis media as well as different treatment regimens, including the efficacy of the watchful-waiting approach.
Case Presentations

A mother has brought her 2 children to the ED on a Saturday evening, with both complaining of ear pain. The first child, a 3-year-old girl, has been complaining of a right-sided earache for the past 2 days. Today, she had a fever of 38.4°C at home. She has been fussier than usual, but she is still active and has been eating normally. She is an otherwise healthy girl and has never been diagnosed with acute otitis media before. On otoscopic exam, the right tympanic membrane is erythematous and bulging, with decreased movement on insufflation.

The second child, the 2-year-old brother of the first patient, has been tugging on his left ear for the past day. Otherwise, he seems fine, although he has a runny nose and has sneezed several times. He has not had a fever and has no medical problems. Although he does not appear to be as sick as his sister, his mother wonders if he has caught the same bug. On his otoscopic exam, there is opacity of the tympanic membranes bilaterally, with retraction and decreased movement of the tympanic membrane with insufflation on the left.

The mother asks you if her children will need antibiotics for an infection. Both children attend daycare, and the mother is worried because other children there have had ear infections. You think:

- Do these patients have risk factors for acute otitis media?
- Is either history suggestive of a particular diagnosis?
- Is either patient’s physical examination consistent with acute otitis media?
- Are other diagnostic tests necessary?
- Should I give either of these patients a prescription for antibiotics? If so, which antibiotic should I give, and for how long a duration?
- What pain medications are appropriate for these patients?
- What complications should I be worried about?
- Can I discharge these patients safely? What precautions should I give the parents?

Introduction

Acute otitis media (AOM) is one of the most common infections diagnosed in children in the United States. It accounts for 13% of all emergency department (ED) visits and 30 million clinic visits by children, making it the second leading diagnosis in pediatric ED visits (after upper respiratory infections). In 2000, $5 billion was spent on the diagnosis and treatment of AOM. Traditional management of AOM – particularly in patients diagnosed in the ED – has included antibiotic therapy. Although a 2002 study found a decrease in the overall population-based antibiotic prescription rate for AOM, a 2007 study reported that up to 91% of ED patients received antibiotic prescriptions for AOM. Traditional antibiotic treatment for AOM has been called into question in the past several decades based on early studies that suggested a benign natural history of the disease. A meta-analysis of clinical trials from 1966 to 1992 showed that AOM spontaneously resolved without treatment in 80% of cases, and it concluded that antibiotic prescriptions may not be necessary for all patients. Although the results of these studies were later called into question based on their less-than-stringent diagnostic criteria for AOM, researchers began to turn to other models for treating AOM.

For more than 20 years, physicians in the Netherlands have been treating AOM in children with initial observation or a “watchful-waiting” approach. Initial studies demonstrated that this approach was safe, effective, and acceptable to parents. As a result of this new treatment paradigm, a national survey of Dutch general physicians found that antibiotics for children with AOM were given in 14% to 20% of diagnosed cases from 1987 to 2001; however, more-recent data indicate that antibiotic prescription rates for AOM are increasing in the Netherlands. In 2003, 1 study reported prescription rates of up to 64%, and another study reported prescription rates of 40% to 50% from 2002 to 2008 (although these numbers are still lower than their United States counterparts). Although the healthcare system in the Netherlands differs greatly from that in the United States in that many of these patients are treated by their family physicians with close follow-up, researchers began to study this treatment model in the hope that the Dutch system would be applicable to United States physicians and their patients.

The interest in a new treatment model for AOM in the United States was also fueled by the growing rate of antibiotic use and the subsequent concern for antibiotic resistance. Early studies found that, as antibiotic overuse increases, the resistance of penicillin to Streptococcus pneumoniae bacterium has been increasing (27.5% of strains in 1995 were resistant compared to 43.8% in 1997). By comparison, in the Netherlands, resistance rates of S pneumoniae strains to penicillin are very low (as low as <1%, as reported in a small study involving respiratory isolates in 89 patients). With the 2010 introduction of the new pneumococcal conjugate vaccine (PCV13), the microbiology of AOM continues to change, but antibiotic resistance remains a concern.

In an effort to decrease antibiotic prescribing and antibiotic resistance trends, and building on the successes of the watchful-waiting approach in the Netherlands, the American Academy of Family Physicians (AAFP) and the American Academy of Pediatrics (AAP) released a practice guideline in 2004 that suggested observation without antibiotics in certain cases of AOM. Although the 2004 guideline recommendations received significant publicity, adherence to them was not widespread, and data...
show that there was little difference in antibiotic prescribing rates for AOM after publication.\textsuperscript{14,15}

Since 2004, researchers have begun to scrutinize closely the clinical trials from the past several decades. Many older trials have been criticized because they utilized broad inclusion criteria, leading to inaccurate diagnosis on study entry and creating a study population not reflective of the true AOM population. Many studies included children who did not have AOM, children who often had otitis media with effusion (OME), or children who had no middle ear disease at all. They also excluded very young children, children with severe disease, children with recent antibiotic treatment, and children with recent AOM.\textsuperscript{16} Newer trials have subsequently included a very strict definition of AOM, prompting the AAP to revise their guidelines in 2013.\textsuperscript{17} These guidelines continue to recommend an observation approach, but they strongly emphasize appropriate diagnostic criteria. The literature will continue to evolve as better-designed clinical trials are conducted using these criteria. This issue of Pediatric Emergency Medicine Practice will present evidence-based recommendations for the diagnosis of AOM and will review the efficacy of different treatment modalities.

**Critical Appraisal Of The Literature**

A literature search was performed using the PubMed and Ovid MEDLINE\textsuperscript{®} databases. Searches were limited to studies in English involving human subjects. Studies were limited to clinical trials, meta-analyses, practice guidelines, randomized controlled trials (RCTs), review articles, and systematic reviews. Prospective and retrospective cohort studies were used for the epidemiology section. Search terms included: *acute otitis media*, *children*, *treatment*, and *emergency department*. This search yielded 1208 studies; however, articles related to prevention or prophylaxis of AOM, chronic otitis media (OM), myringotomy/tymanostomy tubes, or upper respiratory infections (in general) were not reviewed. The Cochrane Database of Systematic Reviews was searched for reviews using the same terms as above,\textsuperscript{7} and relevant reviews were identified. The Database of Abstracts of Reviews of Effectiveness (DARE) was searched using the terms as above and identified 8 relevant reviews. Additionally, the National Guideline Clearinghouse (www.guideline.gov) was explored, and 1 guideline was found.

In 2004, the AAP and the AAFP partnered with the Agency for Healthcare Research and Quality (AHRQ) and the Southern California Evidence-Based Practice Center to develop a set of clinical practice guidelines for the management of AOM.\textsuperscript{7} These guidelines were based largely on data gathered for the 2001 evidence report of AOM management published by the AHRQ.\textsuperscript{18} The issues addressed in the AAP/AAFP guidelines were: (1) the definition of AOM; (2) the natural history of AOM without antibacterial treatment; (3) the effectiveness of antibacterial agents in preventing clinical failure; and (4) the relative effectiveness of specific antibacterial regimens. Their search of the literature from 1966 to 1999 uncovered 3461 articles, and 74 studies were reviewed in full. The published clinical practice guidelines were systematic, evidence based, and peer reviewed. Subsequent to the 2004 publication of the guidelines, the AHRQ issued a 2010 update to their 2001 evidence report.\textsuperscript{19} This resource was also extensively reviewed and provided a critical analysis of the latest research addressing the following: (1) the clinical symptoms and otoscopic findings to diagnose AOM; (2) the impact of the pneumococcal heptavalent immunization (PCV7) on AOM microbial epidemiology; (3) the comparative effectiveness of different treatment options for treating uncomplicated AOM in average-risk children; (4) the comparative effectiveness of different management options for recurrent OM and persistent OM or relapse of AOM; (5) the treatment outcomes based on the following characteristics: laterality, otorrhea or perforation, severity, comorbidities, age groups, race, ethnicity, or daycare attendance; and (6) adverse effects of treatment.

In 2013, the AAP again partnered with the AHRQ and the Southern California Evidence-Based Practice Center to publish an update of the 2004 guidelines.\textsuperscript{17} The 2013 guidelines address appropriate diagnosis of AOM using a strict definition, pain management, initial observation versus antibiotic treatment, appropriate choices of antibiotics, and preventative measures. These guidelines are based largely on the 2010 AHRQ update as well as continued review of newly published literature. This source represents the most current review of the literature on AOM.

Overall, the diagnosis and treatment of AOM has been a well-studied topic. There are many large RCTs, meta-analyses, and systematic reviews addressing the management of AOM. Differences in study design (particularly diagnostic criteria for inclusion or exclusion of subjects and definitions of clinical success or failure) have made it difficult to compare different studies. The biggest flaw in the AOM literature is the lack of a strict definition of AOM for study participants. Many studies (particularly older studies prior to 2000) included subjects that did not have AOM by the current definition but had either OME or a normal variant. It is difficult to draw conclusions from these studies because a true population of AOM was not studied; however, recent studies have applied strict inclusion criteria to study participants, and this topic has been extensively discussed in the 2013 AAP guidelines as well as throughout this article.
Etiology And Pathophysiology

AOM is one of the most common diagnoses in sick children presenting to EDs. It can occur at any age, but is most prevalent in early childhood. Teele et al found that 62% of children had at least 1 episode of AOM by the age of 1 year; 83% of children had at least 1 episode of AOM by the age of 3 years.20 Ladomenou et al found that risk factors for AOM included: siblings, out-of-home daycare, ill health in pregnancy, and suboptimal breastfeeding.21

AOM begins with a precipitating event, typically a viral upper respiratory infection (URI).22 Chonnaitree et al reported that 60% of symptomatic viral URIs in young children were complicated by AOM and/or OME.23 Alper et al found similar coincidence rates of viral URI and AOM, although about 30% of new AOM cases occurred in patients without a preceding cold-like illness when rhinovirus (the most common viral isolate) was isolated.24 Viral URI results in inflammation of the nasopharynx and Eustachian tube. Edema and increased secretions obstruct the Eustachian tube and cause a negative pressure buildup in the middle ear. Children are particularly susceptible to this obstruction due to a horizontal Eustachian tube. Viruses and bacteria can secondarily infect this stagnant fluid, worsening middle ear pressure and producing the clinical findings of AOM. Viruses such as respiratory syncytial virus, rhinovirus, coronavirus, parainfluenza, adenovirus, and enterovirus have been implicated in 40% to 75% of AOM cases.25 The most common bacteria isolated from middle ear aspirates are S pneumoniae, Haemophilus influenzae (90% nontypeable strains), and Moraxella catarrhalis.13 The microbiology of AOM is complex; a study of middle ear fluid from 79 children with AOM through tympanostomy tubes isolated bacteria in 92% of cases, viruses in 70% of cases, and both bacteria and viruses in 66%, suggesting that AOM is a co-infection of bacteria and viruses.26 Live viruses and viral nucleic acids detected by polymerase chain reaction (PCR) are also implicated in AOM. The exact role of viral nucleic acids in the pathogenesis of AOM is unclear because nucleic acids of multiple viruses can be detected simultaneously and viral nucleic acids can be found in asymptomatic patients.27 It is likely that viral URI and AOM represent a spectrum of disease, but further research still needs to be done. Bacteria are still considered by many researchers to be the major pathogens in AOM.

The overall incidence of AOM has declined since the introduction of the heptavalent pneumococcal protein conjugate vaccine (PCV7) in 2000. A randomized double-blind efficacy trial found that immunization with PCV7 decreased the overall incidence of AOM by 6%.28 Studies have also shown a decrease in office visits for AOM by 20% to 40% since the introduction of PCV7.29,30 Additionally, with the introduction of PCV7 (and subsequently, PCV13), the relative incidence of the bacterial pathogens cited earlier has changed. Prior to 2000, S pneumoniae was the most common bacterium implicated in AOM, but initial studies in the PCV7 era showed a decrease in S pneumoniae and an increase in H influenzae, with H influenzae briefly surpassing S pneumoniae as the dominant otopathogen. Casey and Pichichero found a decrease in the proportion of S pneumoniae isolates (from 44% to 31%) and an increase in H influenzae isolates (42% to 57%) when comparing cohorts from 1995 to 1997 versus 2001 to 2003.31 The authors also reported an increase in the percentage of S pneumoniae that were penicillin-sensitive (58% vs 72%). Block et al similarly found that isolates of S pneumoniae decreased significantly from (48% to 31%) when comparing isolates from 1992 to 1998 versus 2000 to 2003, while nontypeable H influenzae increased from 41% to 56%.32 A 2001 RCT yielded further evidence that the incidence of S pneumoniae has decreased with PCV7; in 1662 children with AOM, 685 were positive for S pneumoniae (33% in the control group and 25% in the PCV7 group). Vaccine serotype isolates were less prevalent in the PCV7 group than in control group isolates (40% vs 60%).28 Later studies showed that the incidence of S pneumoniae was increasing again, becoming nearly identical to that of H influenzae; however, the serotypes of S pneumoniae have changed, and nearly all of the ones represented in the PCV7 vaccine have virtually disappeared and have been replaced by non-PCV7 strains.13 It should be noted that PCV7 is no longer available in the United States. It was replaced by PCV13 in 2010, and early data show a lower rate of pneumococcal AOM and reduced incidence of serotypes included in PCV13 compared to the PCV7 era.33 Knowledge of the otopathogens involved in AOM can help direct specific, targeted antibiotic therapy. A 2013 prospective study found that pathogen-specific antibiotic treatment (individualized care) reduced rates of AOM and subsequent tympanostomy tube surgery.34 The microbiology of AOM continues to evolve and is an area for continued research.

Differential Diagnosis

The differential diagnosis for ear pain is quite broad and can be separated into external (outer) ear pain, internal (middle and inner) ear pain, and referred pain from outside the ear. (See Table 1.)

Emergency clinicians must often differentiate AOM from OME. OME is the presence of a middle ear effusion without acute signs of infection. OME is more common than AOM, and 90% of children will experience an episode of OME before the age of 5 years.35 Faden et al reported a 2:1 ratio of OME to AOM in children with URI presenting with symp-
toms suggestive of middle ear infection; therefore, emergency clinicians will see and diagnose more cases of OME than AOM.\textsuperscript{36}

Diagnosis can be difficult because OME shares many of the same symptoms as AOM (eg, ear pain or ear pulling), although many cases can be asymptomatic. Additionally, OME may precede or follow an episode of AOM. However, a key difference is that the signs and symptoms of AOM are acute. In fact, clinical history is not part of the diagnosis of OME; it is based solely on pneumatic otoscopy and can be confirmed with tympanometry.\textsuperscript{37} The differentiation between AOM and OME is important because the treatment and consequences are very different. Antibiotics are not recommended for routine OME.\textsuperscript{37} OME is also more likely to persist; a systematic literature review and meta-analysis found that 73\% of OME cases that occurred after an AOM episode resolved spontaneously by 3 months, while only 28\% resolved if there was no known triggering AOM episode.\textsuperscript{38} This chronicity is important, as persistent middle ear effusion can cause hearing loss and impaired speech development, requiring definitive surgical management.\textsuperscript{39}

**Prehospital Care**

There is little role for prehospital care in the management of AOM. Most children appear well and do not require urgent resuscitation or medications, although they do benefit from analgesia. (See the "Pain Control" section on page 12.) Furthermore, diagnosis of AOM cannot take place without otoscopy, which requires a hospital- or office-based setting.

**Emergency Department Evaluation**

**History**

Children with AOM can present with many clinical symptoms (eg, fever, irritability, headache, ear-pulling, anorexia, vomiting, and otalgia). These symptoms are nonspecific, and there are few good clinical predictors of AOM. Although many believe that most children with AOM will have fever, this has not been found to be true in the literature. In their prospective study of 671 children, Schwartz et al reported an incidence of fever of 23\%.\textsuperscript{40} Studies have found that otalgia is the best predictor of AOM. A 2003 systematic review analyzed 6 studies that looked at the accuracy of history and physical findings in diagnosing AOM.\textsuperscript{41} The authors found that, of all the symptoms noted previously, only otalgia was mildly predictive of AOM (positive likelihood ratio [+LR], 3.0-3.7). In 1 of the studies reviewed, ear-pulling also seemed to suggest a diagnosis of AOM (+LR, 3.3).\textsuperscript{42} The presence of concurrent URI, fever, cough, rhinitis, sore throat, excessive crying, poor appetite, and vomiting were not helpful in the diagnosis of AOM (+LR of approximately 1).\textsuperscript{41}

In the literature, parental suspicion based on a child’s symptoms is not a consistent predictor of AOM. A 2010 prospective study of 469 children found that parental suspicion of AOM was correct in 51\% of all children, 48\% of children without a prior episode of AOM, and 52\% of children with a prior episode.\textsuperscript{43} On the other hand, a 1998 prospective study of 857 children concluded that parents were able to predict AOM fairly well, with a sensitivity of 70\% and specificity of 80\%.\textsuperscript{44}

**Clinical Practice Pearl**

Clinical history is often not helpful in predicting AOM. Symptoms of AOM are indistinguishable from those of URI, and are, therefore, unreliable in convincing the emergency clinician of a diagnosis of AOM. Although otalgia is the best predictor of AOM, most children with AOM are aged < 2 years and often cannot say whether they have ear pain or not.

**Physical Examination: Basic Principles**

Without predictive clinical symptoms for AOM, the emergency clinician must rely heavily on the otoscopic examination. This can often be difficult in children who are noncompliant with examination. One helpful technique is to have the child sit in the parent’s lap and have the parent hold the child’s head in place. Infants can be placed on the examining table with the parent holding the head to one side. Once the child is in place, the external ear should be examined for any erythema, lacerations,

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<th>Table 1. Differential Diagnosis Of Ear Pain</th>
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<tr>
<td><strong>External Pain</strong></td>
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<td>• Otitis externa</td>
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<td>• Malignant otitis externa</td>
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<td>• Contact dermatitis</td>
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<td>• Foreign body</td>
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<td>• Cerumen impaction</td>
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<td>• Tumor</td>
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<tr>
<td><strong>Internal Pain</strong></td>
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<tr>
<td>• Acute otitis media</td>
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<td>• Otitis media with effusion</td>
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<tr>
<td>• Cholesteatoma</td>
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<tr>
<td>• Typanic membrane perforation</td>
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<td>• Traumatic disruption of the ossicles of the inner ear</td>
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<td>• Hemotympanum</td>
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<td>• Basilar skull fracture</td>
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<tr>
<td><strong>Secondary Otitalgia</strong></td>
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<tr>
<td>• Auricular lymphadenopathy</td>
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<td>• Parotitis</td>
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<tr>
<td>• Temporomandibular joint syndrome</td>
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<tr>
<td>• Bell palsy</td>
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<tr>
<td>• Oropharyngeal infections</td>
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<tr>
<td>• Sinusitis</td>
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<td>• Cervical spine injury</td>
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swelling, or bruising. The mastoid bone should be palpated for tenderness. The emergency clinician should pull on the tragus and assess for tenderness. Next, the internal ear canal can be examined with an otoscope. Any redness, swelling, discharge, or masses should be noted. Cerumen should be removed in order to get a complete view of the tympanic membrane (TM). The TM should be examined for color, opacification, position, and mobility. The normal TM is translucent and pearly gray in color, and landmarks (the pars flaccida, the malleus, and the light reflex) should be clearly visualized. Ideally, a pneumatic otoscope should be used to test mobility. The pneumatic otoscope contains a rubber tube and insufflator bulb. It is inserted into the ear, creating an airtight seal between the external auditory canal and speculum (a 4-mm speculum is appropriate for most children). Once the seal is created, the insufflator bulb can be compressed. Compression of the insufflator bulb creates a positive pressure in the middle ear cavity, causing the TM to move backwards, away from the observer. Subsequent release of the bulb creates a negative pressure in the middle ear cavity, and the TM should move toward the observer. Impaired mobility can be seen in both AOM and OME. A bulging TM is seen with AOM, and an immobile or retracted TM is associated with OME. When pressure in the middle ear cavity is increased due to middle ear effusion, the TM may be retracted and unable to move back towards the observer (although there may be some mobility with negative pressure). In general, when a middle ear effusion is present, there will be decreased mobility of the TM in either direction when positive and negative pressures are generated inside the middle ear cavity via the insufflator bulb.45-49

Inadequate examination can occur when the external auditory canal cannot be completely cleared of cerumen, the ear canal is too narrow, an adequate seal between the otoscope and ear canal cannot be maintained, the child is uncooperative with the examination, or the clinician is inexperienced in performing the examination. It is important for the emergency clinician to be well trained in otoscopic findings and recognize when limitations in the examination occur.

Cerumen impaction is a common problem in children; however, its management can be difficult in the ED due to time constraints. If there is cerumen obstructing the view of the TM, the emergency clinician should attempt to remove it. There are many different methods of cerumen removal, but few well-designed RCTs have addressed the optimal approach. A 2002 review article recommended docusate sodium 15 minutes prior to irrigation as the most effective method for cerumen removal in a single visit. Triethanolamine (Cerumenex) and olive oil can also be used, but it may be less effective.50 In general, irrigation is the preferred technique, as the patient does not need to be entirely still during the procedure. Irrigation is contraindicated if TM perforation is suspected. Manual extraction is another technique, and it may be helpful if there is large, hardened cerumen present. It is often quicker, but it can be more painful, and patients must remain still during the procedure because there is a risk of damage to the canal or TM with sudden movements.51

Otoscopic Findings

There are several otoscopic findings that are predictive of AOM. Karma et al looked prospectively at otoscopic findings of 2911 children aged 6 months to 2 years to develop the accuracy of signs of middle ear effusion in AOM.49 Half of the children in the study were examined by an otolaryngologist and the other half by a pediatrician. Redness of the TM was seen in 18% and 27% of visits, and it predicted AOM 51% to 60% of the time. However, a distinctively, strongly, or moderately red TM or hemorrhagic TM did correlate with AOM; a slightly red TM did not. Cloudiness of the TM was seen in 81% and 67% of visits, with a high sensitivity (74%) and specificity (93%). Impaired mobility had the highest sensitivity and specificity (95% and 85%, respectively), but it was especially predictive of AOM when the TM was also bulging (97% specificity). The authors concluded that a cloudy, bulging TM with impaired mobility was most predictive of AOM.49 A 2003 systematic review analyzed 4 studies (including the Karma et al study) to develop LRs for signs of AOM.41 The authors reported that a cloudy TM (+LR, 34), bulging TM (+LR, 51), or distinctly immobile TM on pneumatic otoscopy (+LR, 51) are the most useful signs for predicting AOM. A distinctively red TM (+LR, 8.4) was also somewhat predictive of AOM, while a retracted TM or slightly immobile TM was not helpful in predicting AOM. The authors did point out that these studies contained bias; all 4 relied on a clinical diagnosis of AOM without tympanocentesis, and 2 of the studies contained spectrum bias (where the sample of children used in the study was not representative of the population as a whole).

In 2012, Shaikh et al prospectively reviewed otoscopy findings in 263 children to develop an algorithm for diagnosis of AOM.52 The authors reported that a bulging TM was the most specific finding to predict AOM; 92% of children with AOM had a bulging TM in this study. Normal TM mobility was seen in 0% of patients. Redness of the TM was nonspecific; only 30% of patients with AOM had redness. Redness without a bulging TM was seen in < 1% of patients with AOM. The authors concluded that bulging of the TM should be used to define AOM.

The major difficulty emergency clinicians face is differentiating between AOM and OME. (See
Middle ear effusion without associated signs/symptoms of middle ear inflammation (TM effusion) may precede or follow an episode of AOM. Presence of middle ear effusion plus recent onset of ear pain or intense erythema of the TM (Grade B recommendation), or (2) mild bulging of the TM or new onset of otorrhea (Grade B recommendation), or (3) cultures of ear drainage (only for patients with serious infections, with recurrent infections, or who are immunocompromised)

Tympanocentesis may be performed to obtain middle ear fluid. This procedure utilizes an operating otoscope, through which a needle is passed to penetrate the TM and withdraw fluid. This allows the middle ear fluid to be sampled for particular pathogens to guide antibiotic treatment. Tympanocentesis was used frequently in the past for diagnosis of AOM, but it is now reserved for severe or recurrent cases and is rarely performed in the ED setting. It does have a role in detecting pathogens in patients with recurrent or persistent AOM; these patients should be referred to a specialist.

Two adjunctive studies can be used to measure the mobility of the TM and to detect the presence of middle ear effusion. Tympanometry involves a tympanometer, an instrument that is inserted into the ear and forms a seal, which then generates a sound wave that causes vibration of the middle ear. Sound waves are reflected off the TM and measured by the tympanometer, giving a reading that reflects the mobility of the TM. Acoustic reflectometry is a similar test, although a seal is not required. These instruments are used to detect a middle ear effusion, which will alter the sound waves reflected off the TM; however, the use of either of these tests in the diagnosis of AOM is limited. A 2012 study compared acoustic reflectometry with pneumatic otoscopy in symptomatic and asymptomatic children and found that acoustic reflectometry was able to detect obvious effusion from no effusion at symptomatic visits, but it was not able to detect the difference between AOM and OME in the majority of cases.

Table 2.) This is best accomplished by pneumatic otoscopy. A prospective study of 783 patients found that 96% of patients with AOM had a bulging TM compared to 0% of patients with OME. Opacification of the TM best differentiated OME from no effusion present.

<table>
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<th>What's New In The 2013 AAP Guidelines</th>
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| The 2013 AAP guidelines stress accurate diagnosis above all, as this will better stratify the patients who may require treatment. The earlier 2004 AAP/AAPF guidelines required 3 components for diagnosis of AOM: (1) acute onset of symptoms, (2) presence of middle ear effusion, and (3) signs of middle ear inflammation. This was criticized for not being a strict enough definition, allowing some cases of OME to be labeled as AOM. Furthermore, the 2004 guidelines suggested that clinicians give antibiotics to children aged 6 to 24 months with “certain diagnosis,” while young children with “uncertain diagnosis” could be treated with a watchful-waiting approach. This use of “uncertain diagnosis” may have prompted emergency clinicians to diagnose AOM without adequate visualization of the TM. The AAP subsequently updated their guidelines with the following diagnostic criteria: (1) moderate-to-severe bulging of the TM or new onset of otorrhea (Grade B recommendation), or (2) mild bulging of the TM plus recent onset of ear pain or intense erythema of the TM (Grade C recommendation). They also stated that AOM should not be diagnosed in patients without evidence of middle ear effusion on pneumatic otoscopy and/or tympanometry (Grade B recommendation). These recommendations essentially require emergency clinicians to perform an appropriate examination (including pneumatic otoscopy) and be able to identify a bulging TM and signs of middle ear effusion.

Diagnostic Studies

Routine diagnostic studies are not needed for most cases of uncomplicated AOM. If more serious disease is present or alternate diagnoses are more likely, studies may include the following: (1) head computed tomography (CT) (to exclude basilar skull fracture, mastoiditis, or malignant otitis externa); (2) complete blood count (only for more serious infections); and (3) cultures of ear drainage (only for patients with serious infections, with recurrent infections, or who are immunocompromised).

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
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<td>AOM</td>
<td>Acute onset of signs and symptoms</td>
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<td></td>
<td>Presence of middle ear effusion</td>
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<td></td>
<td>Signs and symptoms of middle ear inflammation (TM bulging, otorrhea, erythema of the TM)</td>
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<td>OME</td>
<td>Middle ear effusion without associated signs/symptoms of inflammation</td>
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Abbreviations: AOM, acute otitis media; OME, otitis media with effusion; TM, tympanic membrane.

Treatment

The treatment of AOM has been the subject of controversy over the past 10 to 20 years. Controversies include whether or not a patient needs antibiotics, which antibiotic to use, the length of treatment, and the risks of treatment.
Antibiotics Versus Placebo

There have been numerous RCTs analyzing the effectiveness of treatment of AOM with antibiotics versus placebo; however, many of these early trials were flawed. Few studies included bulging TM as a diagnostic criterion despite the evidence that a bulging TM is the best predictor of AOM and should be considered part of its diagnosis. Many of the study participants did not have AOM, but rather OME, a disease entity that does not require antibiotic treatment. Additionally, many studies excluded children under age 2 (the majority of the AOM population), children with severe disease, children with fever or bulging TM, children with recent AOM or recent antibiotic use, and children with perforation of the TM. It is, therefore, difficult to compare different studies that utilized different inclusion and exclusion criteria as well as different clinical endpoints (some relied on resolution of otoscopic findings, others on relief of clinical symptoms), and it is impossible to draw conclusions on the effects of antibiotic therapy of AOM using a population with mild disease or even no disease. Nonetheless, this issue will summarize the findings of the earlier research as well as what newer studies have found.

The 2010 AHRQ evidence report pooled the results of studies conducted from 1967 to 2005 and reported a rate difference for clinical success by day 14 between amoxicillin and placebo of 12% in favor of amoxicillin, and a number needed to treat (NNT) of 9 for a clinical success. During the time period of 1980 to 2004, clinical investigators summarized that antibiotics did not afford much benefit compared to placebo, and the high rate of resolution among the placebo group led to the conclusion that most cases of AOM resolved spontaneously without treatment.

In 2011, 2 RCTs comparing the effectiveness of antibiotic therapy versus placebo that used stringent criteria for diagnosis of AOM were published. In the first study, Tahtinen et al studied 319 children with AOM (aged 6 months to 3 years) who were randomized to amoxicillin-clavulanate (40/5.7 mg/kg/day) versus placebo for 7 days. Study participants were required to have at least 2 of the following findings on pneumatic otoscopy: bulging TM, impaired mobility, abnormal color or opacity, or air-fluid interfaces. Second, they were required to have findings of acute TM inflammation, eg, erythematous streaks, patches, or increased vascularity over a full, bulging, or yellow TM. Third, they were required to have acute symptoms (eg, fever, otalgia, or respiratory symptoms). The primary outcome of the study was time to treatment failure, which included 6 components: (1) no improvement in overall condition by day 3 (assessed by the parent); (2) worsening of condition at any time (assessed by the parent); (3) no improvement in otoscopic signs by day 8; (4) perforation of the TM; (5) severe infection (ie, pneumonia or mastoiditis) requiring systemic antibiotics; or (6) any reason for stopping the study drug at any time (eg, an adverse event or nonadherence to therapy). At any time, the physician could switch from the study drug to rescue treatment if the child’s overall condition or otoscopic findings warranted. The time to initiation of rescue treatment was used as a secondary outcome.

The authors reported treatment failure in 18.6% of children treated with amoxicillin-clavulanate versus 44.9% in the placebo group (a rate difference of 26.3% with a NNT of 3.8, P < 0.001). The authors noted that the difference between the 2 groups occurred early; by day 3, the treatment failure rate was 13.7% in the amoxicillin-clavulanate group and 25.3% in the placebo group. Rescue treatment was required in 6.8% of all the children in the amoxicillin-clavulanate group and 33.5% of the placebo group. Contralateral AOM occurred in 8.2% of the amoxicillin-clavulanate group and 18.6% of the placebo group. Overall condition and otoscopic signs by day 8 were significantly better in the amoxicillin-clavulanate group versus the placebo group. The authors concluded that antibiotic therapy was superior to placebo in treatment of AOM, and this difference was detected early in the course of treatment.

Hoberman et al studied 291 children aged 6 to 23 months who were randomized to amoxicillin-clavulanate (90/6.4 mg/kg/day) versus placebo for 10 days. Study participants were required to have AOM diagnosed by the following 3 criteria: (1) acute onset (< 24 h) of symptoms that parents rated at least a 3 on the Acute Otitis Media Severity of Symptoms (AOM-SOS) scale (the AOM-SOS scale contains 7 items that are scored from 0-2, with higher scores representing increasing intensity: tugging of ears, crying, irritability, difficulty sleeping, diminished activity, diminished appetite, and fever); (2) presence of middle ear effusion; and (3) moderate or marked bulging of the TM or slight bulging plus otalgia or marked erythema of the TM. Children were excluded if they had another acute illness (eg, pneumonia), had received a dose of an antibiotic in the last 96 hours, had otalgia for > 48 hours, or had perforation of the TM.

The authors defined clinical failure at day 4 to 5 as a lack of improvement in symptoms and/or worsening of signs on otoscopy. Clinical failure at day 10 to 12 was defined as a failure to achieve complete resolution of symptoms and otoscopic findings (except for persistence of middle ear effusion). Children who met criteria for clinical failure were treated with amoxicillin (90 mg/kg/day) and cefixime (8 mg/kg/day) for 10 days. The primary outcomes of the study were time to resolution of symptoms and symptom burden over time. The authors reported that the time to initial resolution of symptoms (the first recording of an AOM-SOS scale score of 0 or 1)
in the amoxicillin-clavulanate group was by day 2 in 35% of children, by day 4 in 61%, and by day 7 in 80%. Among the placebo group, the corresponding results were 28%, 54%, and 74%. Sustained resolution of symptoms (defined as 2 successive readings of 0 or 1 on the AOM-SOS scale) was achieved by the amoxicillin-clavulanate group in 20% by day 2, 41% by day 4, and 67% by day 7; the corresponding values for the placebo group were 14%, 36%, and 53% (P = 0.04 for the overall comparison). The average symptom scores were lower in the amoxicillin-clavulanate group at all time periods measured. Clinical failure was reduced in the amoxicillin-clavulanate group as well: 4% versus 23% at day 4 to 5 and 16% versus 51% at day 10 to 12 (NNT = 2.9 at day 4-5, NNT = 3 at day 10-12). Clinical failure occurred at the same rate in both groups regardless of disease severity. The authors concluded that children aged < 2 years with AOM (using strict diagnostic criteria) benefited from amoxicillin-clavulanate regardless of clinical severity.

**Antibiotics Versus Placebo: The Bottom Line**

There is variation in the literature on AOM regarding the effectiveness of antibiotics versus placebo. Earlier literature, including extensive systematic reviews, consistently found good outcomes in the placebo group of RCTs. However, these studies used less-strict and, occasionally, vague diagnostic criteria for AOM, allowing the inclusion of patients with OME, URI, or no disease. Recent literature that applies strict diagnostic criteria, requiring bulging of the TM and evidence of middle ear effusion on pneumatic otoscopy, has shown a larger benefit of antibiotic therapy in children with certain diagnosis.

**Initial Antibiotics Versus A Watchful-Waiting Approach**

Based on the conclusions of early literature supporting a benign natural history of AOM, observation emerged as a potential treatment option. Physicians in the Netherlands were the first to recommend initial observation or a watchful-waiting approach for treatment of AOM. A series of national guidelines was published by the Dutch College of General Practitioners in 1990 (and revised in 1999) that recommended 72 hours of observation for all children aged > 6 months with AOM, recommending antibiotics only if there was failure to improve after this waiting period. In 2000, national guidelines in Sweden were released, and the United States followed in 2004. Again, these guidelines were based on flawed literature that did not use strict diagnostic criteria for inclusion subjects.

Several recent prospective studies and RCTs have attempted to address the question of initial observation or watchful waiting as an option in AOM. In some cases, studies looked at the efficacy of a “wait-and-see” prescription, in which parents were given a prescription for antibiotics at the initial visit but instructed not to fill it unless the child’s condition worsened or was unimproved in 48 to 72 hours.

In 2003, Siegel et al looked at the feasibility of a safety-net antibiotic prescription (SNAP) method based on a model used in England. The SNAP method is a wait-and-see prescription as described above. This prospective study looked at 194 children with AOM aged 1 to 12 years. Diagnosis of AOM required: (1) a bulging or pustular TM on otoscopy, or (2) a red TM with decreased mobility by pneumatic otoscopy or tympanometry. The authors found that 69% of study participants did not fill the SNAP. In a follow-up telephone interview with parents at days 5 to 10, 78% said that pain medication alone was effective in symptom control and 63% said they would be willing to treat future AOM episodes without antibiotics.

In 2005, McCormick et al conducted a RCT of 223 children aged 6 months to 12 years who were randomized to initial antibiotics (amoxicillin 90 mg/kg/day) or observation (symptom management only). Inclusion criteria included: (1) symptoms of AOM; (2) otoscopic evidence of AOM, including middle ear effusion; and (3) nonsevere AOM. In the watchful-waiting group, 66% of children completed the study without requiring antibiotics. The authors found that the antibiotic-treated group had faster improvement in symptom scores and better otoscopic scores at day 12. There was a 16% rate difference in clinical success by day 12, but by day 30 there was no difference in failure rates or recurrence between groups. There was no difference in parental satisfaction, office/ED visits, or missed work/school days between groups. The authors concluded that initial observation was an acceptable approach for some children.

In 2006, Spiro et al randomized 283 children to initial antibiotics or a wait-and-see prescription (WASP). This study occurred in an ED setting, and all study patients received a prescription, although the WASP group was told not to fill it unless the child was not better (or was worse) in 48 hours. This study did not apply strict inclusion criteria; diagnosis of AOM was made at the discretion of the physician. The authors found that 62% of patients in the WASP group did not fill the prescription. They also observed that there was no statistically significant difference between groups in fever or otalgia at days 4 to 6 and 11 to 14. Although this study is flawed, it is one of the few that specifically looks at the credibility of a waitful-waiting approach in the ED.

A 2009 prospective study by Fischer et al also looked at the use of an observation option for AOM in the ED. Although the authors called this an observation study, it is more similar to the WASP/SNAP models described earlier, as parents were given an...
antibiotic prescription at the initial ED visit.\textsuperscript{73} Again, this study did not require a bulging TM for inclusion. The study enrolled 144 children aged > 2 years. Parents were given an antibiotic prescription and instructed not to fill it unless the child was worse or not better in 48 to 72 hours. In a follow-up telephone interview with parents, 73\% of subjects were treated successfully without antibiotics. Of those who did fill the antibiotic prescription, 81\% cited persistent otalgia as the main reason.

In 2012, Tahtinen et al looked at the effect of delayed antibiotic therapy.\textsuperscript{74} In this clinical trial, 161 children received immediate antibiotic therapy and 53 children were placebo recipients from another RCT who were given antibiotic therapy after a watchful-waiting period. The median watchful-waiting period was 48 hours. The authors found that both groups had improvement during antibiotic treatment (91\% and 96\% in the delayed and immediate treatment groups, respectively). However, delayed antibiotic therapy was associated with prolonged resolution of fever, ear pain, poor appetite, and decreased activity. This new approach appears to be feasible but perhaps not as advantageous as a watchful-waiting approach.

A major concern regarding a watchful-waiting approach—especially in the ED—comes from physicians. There is the belief that most parents will not be satisfied with delayed antibiotics for the treatment of their child’s AOM or that they may not listen to the emergency clinician’s instructions and will fill the prescription right away; however, most studies have not shown this to be true. A RCT in a New York City pediatric ED with 232 children aged 2 to 12 years found that patient satisfaction after treatment for AOM was 91\% for delayed antibiotics versus 95\% for immediate antibiotics. Only 19\% of patients in the delayed antibiotics group ended up filling the prescription.\textsuperscript{75} In the prospective study of 144 children by Fischer et al, they reported that 78\% of parents said that pain medications alone were effective in treating AOM and 63\% of parents said they would treat future AOM episodes without antibiotics. This study also identified that a predictor of whether parents would fill an antibiotic prescription was whether the child had had previous episodes of AOM. In children with more than 2 previous episodes, 83.9\% of parents filled the antibiotic prescription, compared to 65.3\% of parents of children with 1 or no prior episodes.\textsuperscript{76} Overall, despite popular belief, a wait-and-see approach is acceptable to parents.

Since the publication of the 2004 AAP/AAFP guidelines endorsing observation for AOM, attitudes towards a watchful-waiting approach have not changed very much. Vernacchio et al surveyed primary care physicians in 2006 to compare their practices before and after publication of the guidelines. The authors found that 83\% considered observation to be a reasonable option (decreased from 88\% in 2004) and utilized it in an average of 15\% of AOM cases. Common physician-identified barriers included parental reluctance (84\%) and the cost and difficulty of follow-up in children who did not improve (31\%).\textsuperscript{14} Coco et al also reported that rates of antibiotic prescription did not change significantly after the publication of the 2004 guidelines. They found that predictors of no antibiotic prescribing included the absence of pain, the absence of fever, and the receipt of an analgesic prescription.\textsuperscript{15} A survey of Italian pediatricians and otolaryngologists found that a positive attitude about the 2004 guidelines was associated with AOM medical education during postresidency and use of appropriate diagnostic methods.\textsuperscript{76} Overall, studies suggest that watchful waiting with appropriate pain control is acceptable to parents and patients, but physicians continue to be reluctant to adhere to this approach based on perceived parental disapproval, lack of proper education, and inadequate patient follow-up.

**Initial Choice Of Antibiotic**

Initial choice of antibiotic is based on antibiotic susceptibility of the major AOM pathogens: \textit{S pneumoniae} and \textit{H influenzae}. Ideally, tympanocentesis is performed to isolate pathogens from the middle ear of children with AOM diagnosed using strict criteria, and subsequent antibiotic susceptibility testing is performed on pathogens. It is difficult for new studies to meet these criteria because children with uncomplicated AOM rarely undergo tympanocentesis; this procedure tends to be performed on children with recurrent or persistent AOM who are more likely to have resistant pathogens. In the post-PCV7 era, the dominant strains of \textit{S pneumoniae} continue to evolve and resistant pathogens emerge.\textsuperscript{77}

A 2009 study of respiratory isolates from children looked at susceptibilities of \textit{S pneumoniae} and \textit{H influenzae} to multiple antibiotics.\textsuperscript{78} The authors found that 86\% of \textit{S pneumoniae} strains were penicillin sensitive. The most active drugs against \textit{S pneumoniae} were ceftriaxone (95\% susceptible), amoxicillin (89\% susceptible to high-dose; 74\% to standard dose), and clindamycin (85\% susceptible). Azithromycin and cephalosporins had similar susceptibility, around 50\% to 70\%. For \textit{H influenzae}, although many strains were beta-lactamase producers, there were many drugs with good activity against the pathogen. Third-generation cephalosporins had the highest susceptibility (~100\%), followed by high-dose amoxicillin-clavulinate (100\%, but this dropped to 85\% at standard-dose), cefuroxime (78\% in beta-lactamase producers and 95\% in nonproducers), and cefdinir (84\% in beta-lactamase producers and 100\% in nonproducers). Standard-dose amoxicillin had 58\% susceptibility, essentially equivalent
to high-dose amoxicillin. Azithromycin was not active against *H influenzae*, with 0% susceptibility. In 2013, preliminary data suggest that 70% of United States otopathogens are resistant to amoxicillin and azithromycin. Based on the in vitro models currently available, third-generation cephalosporins, amoxicillin, and amoxicillin-clavulanate are reasonable choices for initial antibiotic therapy, whereas azithromycin would be inappropriate, given that it has no activity against *H influenzae*.

In clinical trials, the superiority of a particular antibiotic is less clear. The 2010 AHRQ evidence report pooled data from clinically similar RCTs from 1988 to 2005 to investigate the effects of different antibiotic regimens. The report looked at 4 RCTs comparing amoxicillin versus ceftriaxone (single dose), 5 RCTs comparing amoxicillin-clavulanate versus ceftriaxone (single dose), and additional regimens. The authors did acknowledge that this conclusion did not apply to children aged < 2 years, who may benefit from longer treatment durations. A 2000 meta-analysis found that there was no difference when comparing treatment failures with short-term courses of ceftriaxone or azithromycin (< 7 days) versus long-term courses; however, there was an increased rate of adverse gastrointestinal events with 7 days or more of treatment. Pichichero and Cohen reviewed 27 clinical trials involving 6932 patients and concluded that there was no difference in efficacy of a shortened course of antibiotics (3-5 days) versus 10 days of antibiotics in terms of signs/symptoms, relapse, or reinfection, with a risk difference of 6% (95% confidence interval [CI], 2%-10%) at 8 to 19 days and a NNT of 17. The 2010 Cochrane review of 49 trials found the rate of treatment failure at 1 month after initiation of therapy to be 21% with short-course treatment and 18% with long-course treatment, which is an absolute difference of 3%. There were no differences when comparing treatment failures with short-term courses of ceftriaxone or azithromycin (< 7 days) versus long-term courses; however, there was an increased rate of adverse gastrointestinal events with 7 days or more of treatment.

### What's New In The 2013 Guidelines

High-dose amoxicillin (80-90 mg/kg/day in 2 divided doses) remains the first-line antibiotic recommended by the 2013 AAP guidelines for its effectiveness against common AOM pathogens, safety, low cost, acceptable taste, and narrow microbiologic spectrum. High-dose amoxicillin-clavulanate (90/6.4 mg/kg/day in 2 divided doses) is also considered to be the first-line treatment in patients who have received amoxicillin in the last 30 days or those with concurrent conjunctivitis (in which *H influenzae* is the likely otopathogen). Alternative antibiotics in patients with penicillin allergy include several second- or third-generation cephalosporins: cefdinir (14 mg/kg/day in 1 or 2 doses), cefuroxime (30 mg/kg/day in 2 divided doses), cefpodoxime (10 mg/kg/day in 2 divided doses), and ceftriaxone (50 mg/kg administered intramuscularly or intravenously for 1 or 3 days).

### Duration Of Therapy

There is no well-defined duration of therapy for AOM. Standard treatment is 10 days, based on the treatment duration for streptococcal pharyngitis, but there is no evidence-based support for this duration in AOM. The United Kingdom, Sweden, and other countries recommend 5 days of initial antibiotic therapy. Studies have looked to determine whether a shorter course of therapy may be more appropriate. A 2000 meta-analysis found that there was no difference between 5 versus 10 days of antibiotics in terms of signs/symptoms, relapse, or reinfection, with a risk difference of 6% (95% confidence interval [CI], 2%-10%) at 8 to 19 days and a NNT of 17. The 2010 Cochrane review of 49 trials found the rate of treatment failure at 1 month after initiation of therapy to be 21% with short-course treatment and 18% with long-course treatment, which is an absolute difference of 3%. There were no differences when comparing treatment failures with short-term courses of ceftriaxone or azithromycin (< 7 days) versus long-term courses; however, there was an increased rate of adverse gastrointestinal events with 7 days or more of treatment. Pichichero and Cohen reviewed 27 clinical trials involving 6932 patients and concluded that there was no difference in efficacy of a shortened course of antibiotics (3-5 days) versus 10 days of antibiotics for penicillins, macrolides, or cephalosporins. The authors did acknowledge that this conclusion did not apply to children aged < 2 years, who may benefit from longer treatment durations. Based on these studies, the 2013 AAP guidelines recommend 10 days of treatment for children aged < 2 years or those with severe symptoms. A 5- to 7-day course of treatment may be adequate for older children with mild to moderate AOM.

### Antibiotic Dosing

The dosing of amoxicillin is based on studies that looked at the concentration of the antibiotic in the middle ear fluid and subsequent activity against strains of *S pneumoniae*. Based on their studies, Seikel et al estimated that high-dose amoxicillin (80-90 mg/kg/day in 2 divided doses) would be effective for two-thirds of intermediate-resistant strains and one-third of resistant strains causing AOM. Although bacteriologic failure is not the same as clinical failure, studies have shown that they correlate well, with approximately an 86% agreement. Therefore, based on current resistance patterns, dosing amoxicillin at 80 to 90 mg/kg/day is considered appropriate. A 2001 prospective study concluded that high-dose amoxicillin/clavulanate (90/6.4 mg/kg/day) was highly efficacious in children with AOM, on the basis of bacteriologic outcome on days 4 to 6 and clinical outcome on days 12 to 15. This regimen was also very effective in those most likely to fail treatment, such as children aged < 2 years and those with infections caused by penicillin-resistant *S pneumoniae*. The dosing of amoxicillin or amoxicillin-clavulanate is often split into 2 divided doses, as this has been associated with less diarrhea. It is
also important to note that higher dosing of antibiotics does not prevent bacterial resistance but only promotes it. Regimens should, therefore, attempt to use the lowest dose possible that is clinically effective and reduce a patient’s overall exposure to antibiotics through duration of therapy.

Dosing absorption may play a role in cases of clinical failure. Pichichero and Reed reviewed studies that evaluated amoxicillin intestinal absorption, serum concentrations, and/or middle ear fluid concentrations. The authors detected substantial differences between patients in serum and middle ear fluid concentrations of amoxicillin after oral administration. They found that 15% to 35% of children had no detectable amoxicillin in middle ear fluid, which may help to explain certain AOM treatment failures.106

**Persistent Acute Otitis Media**

When patients return to the ED within 48 to 72 hours due to nonimprovement of their condition, the emergency clinician should reassess these patients and consider whether this is due to a wrong diagnosis, antibiotic failure, or observation failure. The 2013 AAP guidelines recommend that the physician consider changing the antibiotic in patients with persistent, severe symptoms and unimproved otoscopic findings after initial treatment. Patients who have failed amoxicillin should be started on amoxicillin-clavulanate 90/6.4 mg/kg/day.17 These recommendations were based in part on a study by Dagan et al, which found that a regimen of high-dose amoxicillin-clavulanate was effective in treating 91% of infections caused by penicillin-resistant *S pneumoniae* and 94% of infections caused by *H influenzae*. Infections caused by these pathogens may be responsible for some cases of persistent AOM, and the authors postulated that high-dose amoxicillin-clavulanate was a good choice for second-line treatment in patients who have failed amoxicillin therapy.106 The 2013 AAP guidelines also recommend parenteral ceftriaxone (50 mg/kg) as a first-line therapy for persistent AOM. It can be used in patients who were initially given amoxicillin, amoxicillin-clavulanate, or oral cephalosporin therapy.17 A prospective study of 109 patients found that 3 days of ceftriaxone therapy was effective for the treatment of nonresponsive AOM caused by penicillin-resistant *S pneumoniae*, and it was significantly superior to a 1-time dose of ceftriaxone.109

There are other alternatives that emergency clinicians can consider for treatment failure. Several RCTs have compared other regimens to amoxicillin-clavulanate for the treatment of persistent AOM, including gatifloxacin, levofloxacin, and azithromycin,110-115 and another compared cefaclor versus cefuroxime.114 None of these studies demonstrated an obvious advantage of any particular regimen. Clindamycin has also been suggested as an alternate therapy in persistent AOM due to its activity against penicillin-resistant *S pneumoniae* in in vitro studies.78 It is reasonable to use amoxicillin-clavulanate as a first-line agent for persistent or recurrent AOM, although there are other agents to choose from. It should be noted that although erythromycin-sulfisoxazole and sulfamethoxazole-trimethoprim are recommended as alternatives to first-line therapy in patients with amoxicillin allergies, they should not be used in patients with persistent AOM, based on the resistance of *S pneumoniae* to these agents.11,115

If AOM continues to persist after rescue therapy, this is beyond the scope of the emergency clinician. The patient should be referred to an ear, nose, and throat specialist to undergo tympanocentesis with gram stain, culture, and antibiotic sensitivities to find the optimal therapy.17 Persistence of middle ear effusion after AOM is common and does not require a change in antibiotic therapy. A 2003 systematic review found that 60% to 70% of children have middle ear effusion 2 weeks after an episode of AOM, 40% at 1 month, and 10% to 25% after 3 months.38 Although OME does need to be followed over the long term, the emergency clinician will not need to alter management of the patient in the ED.

**Pain Control**

Pain management is the cornerstone of treatment for AOM. Management of pain in children with AOM should always be addressed, regardless of the decision to treat with antibiotics. Many of the studies discussed in this issue ensured adequate pain control in all treatment arms so as not to bias the results. Additionally, as discussed earlier, treatment of pain alone has been found to be satisfactory to patients and parents.79

**Acetaminophen And Ibuprofen**

There are few studies that look at the use of acetaminophen or ibuprofen specifically in children with AOM. A 1996 RCT looked at the efficacy of acetaminophen 10 mg/kg 3 times a day, ibuprofen 10 mg/kg 3 times a day, and placebo in the treatment of AOM in 219 children. After 2 days of treatment, there was no difference in the appearance of the TM in either of the groups. Children treated with ibuprofen had less pain compared to placebo (7% vs 25%), while there were no statistically significant differences between the acetaminophen and placebo groups.116 A 2004 meta-analysis analyzed 17 RCTs to look at the effectiveness of single-dose acetaminophen versus single-dose ibuprofen in the treating pain and/or fever (from any cause) in children. This study found that ibuprofen and acetaminophen were equally effective in relieving pain (risk ratio [RR] of 1.14 at 2 h with a 95% CI, 0.82-1.58, where a RR = 1 indicates equal effectiveness at achieving 50%
of maximum pain relief and > 1 indicates superiority of ibuprofen over acetaminophen), and ibuprofen reduced fever more than acetaminophen at 2, 4, and 6 hours posttreatment (effect size of 0.19 at 2 h [95% CI, 0.05-0.33], 0.31 at 4 hours [95% CI, 0.19-0.44], and 0.33 at 6 hours [95% CI, 0.19-0.47], where an effect size of 0 indicates equal effectiveness in reducing fever and > 0 indicates superiority of ibuprofen over acetaminophen). This meta-analysis recommended dosing of 5 to 10 mg/kg of ibuprofen and 10 to 15 mg/kg of acetaminophen. In summary, either acetaminophen or ibuprofen is reasonable for controlling pain and/or fever in children, although ibuprofen may be slightly more effective.

**Topical Agents (Antipyrine Solution, Lignocaine, Naturopathic Solution)**

A 1997 RCT of 54 children aged 5 to 19 compared the effectiveness of solution of an antipyrine, benzocaine, and glycerin solution versus placebo in reducing ear pain. The authors reported that more children in the antipyrine solution group compared to placebo (96% vs 70%) experienced a 25% reduction in pain 30 minutes after application. A 2008 RCT of 63 children aged 3 to 17 years compared topical aqueous 2% lignocaine drops with placebo and found that children who received lignocaine were more likely to have a 50% reduction in pain scores at 10 minutes (RR, 2.06; 95% CI, 1.03-4.11) and 30 minutes (RR, 1.44; 95% CI, 1.07-1.93). A 2001 randomized trial of 103 children aged 6 to 18 years found that a naturopathic ear drop formulation called Otikon Otic was as effective as anesthetic ear drops. A 2009 systematic review studied 5 RCTs involving 2695 patients (updated in 2011, but no new studies were identified) reviewed 15 RCTs involving 2695 patients and reported a small statistical benefit from decongestant-antihistamine therapy with a lower rate of persistent AOM at 2 weeks (fixed RR, 0.76; 95% CI, 0.60 to 0.96; NNT = 10). However, they also reported no benefit in early cure rates, symptom resolution, prevention of surgery, or other complications in patients treated with decongestants, antihistamines, or both. Furthermore, there was a 5- to 8-fold increase in side effects in those receiving treatment. The authors concluded that the slight benefit in reducing AOM persistence with combination therapy was not clinically significant and may be due to study design bias, and given the lack of other benefits plus the risk of side effects, they did not recommend the routine use of decongestants or antihistamines in AOM. A 2003 RCT found that children who received antihistamines actually had a longer duration of middle ear effusion compared to nontreated patients (median duration 73 days vs 23-36 days). The authors recommended avoiding antihistamines in the treatment of AOM.

**Narcotic Analgesics**

There have been no studies on the use of narcotic analgesic agents in AOM. These agents have more serious side effects (lethargy, constipation, nausea/vomiting, and respiratory depression) compared to the other medications discussed earlier. They should be used sparingly in children whose pain is severe and resistant to standard therapies. The physician must weigh the risks and benefits of narcotic analgesia in patients with severe otalgia.

**Other Remedies**

Home remedies, cold/heat application, oil drops, and distraction have been proposed for AOM, but there are no RCTs on these agents. Tymanocentesis may also be performed to drain fluid from the middle ear and relieve pressure, but this is an invasive procedure and should only be performed in patients with severe pain resistant to standard forms of pain control.

**Pain Control: The Bottom Line**

Acetaminophen and ibuprofen are first-line medications for pain relief in AOM, with ibuprofen having a slight advantage, particularly in children with fever. Topical agents are considered to be a suitable second-line choice (particularly for short-term relief) in older children. Narcotics may be effective at treating pain, but they should be used with caution due to their risk profile.

**Decongestants And Antihistamines**

There is no role for the use of decongestants or antihistamines in the treatment of AOM. It has been thought that these agents may decrease symptoms or improve middle ear effusion, but this has not been shown in clinical studies. A 2007 meta-analysis (updated in 2011, but no new studies were identified) reviewed 15 RCTs involving 2695 patients and reported a small statistical benefit from decongestant-antihistamine therapy with a lower rate of persistent AOM at 2 weeks (fixed RR, 0.76; 95% CI, 0.60 to 0.96; NNT = 10). However, they also reported no benefit in early cure rates, symptom resolution, prevention of surgery, or other complications in patients treated with decongestants, antihistamines, or both. Furthermore, there was a 5- to 8-fold increase in side effects in those receiving treatment. The authors concluded that the slight benefit in reducing AOM persistence with combination therapy was not clinically significant and may be due to study design bias, and given the lack of other benefits plus the risk of side effects, they did not recommend the routine use of decongestants or antihistamines in AOM. A 2003 RCT found that children who received antihistamines actually had a longer duration of middle ear effusion compared to nontreated patients (median duration 73 days vs 23-36 days). The authors recommended avoiding antihistamines in the treatment of AOM.

**Effect Of Age On Treatment**

Multiple studies suggest that there is a difference in clinical response to AOM in children aged < 2 years compared to older children. Early studies demonstrated that younger children tended to have higher rates of clinical failure. Children aged < 1 year were also more likely to have treatment failure than older children. The 2010 AHRQ evidence report concluded that children aged > 2 years had better outcomes compared to children aged < 2 years, regardless of whether they received antibiotics. The authors compared the clinical success in patients aged > 2 years treated with amoxicillin or ampicillin in 3 trials and patients aged < 2 years.
Clinical Pathway For Suspected Acute Otitis Media In Pediatric Patients

Child presents with ear pain, fever, or concerns for AOM

Consider alternate diagnosis

Signs of middle ear effusion on pneumatic otoscopy? (Class I)

Any of the following:
- Moderate or severe TM bulging? (Class I)
- New onset of otitis media? (Class I)
- Mild TM bulging and acute onset (<48 h) of otalgia? (Class II)
- Mild TM bulging and intense erythema of the TM? (Class II)

Is patient aged > 2 y?

Consider observation if caregiver is reliable and there is good follow-up†

(No)

Does patient have signs of severe AOM (severe otalgia or fever > 39°C)? (Class I)

Antibiotic treatment†‡ (Class I)

Does patient have bilateral AOM?

NO

YES

‡ Patients who fail initial treatment after 48–72 hours can be started on amoxicillin-clavulanate 90/6.4 mg/kg/day in 2 divided doses, although there are other alternative regimens. (Class II)

Abbreviations: AOM, acute otitis media; TM, tympanic membrane.

Class Of Evidence Definitions

Each action in the clinical pathways section of Pediatric Emergency Medicine Practice receives a score based on the following definitions.

Class I
- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness
- Level of Evidence:
  - One or more large prospective studies are present (with rare exceptions)
  - High-quality meta-analyses
  - Study results consistently positive and compelling

Class II
- Safe, acceptable
- Probably useful
- Level of Evidence:
  - Generally higher levels of evidence
  - Non-randomized or retrospective studies: historic, cohort, or case control studies
  - Less robust randomized controlled trials
  - Results consistently positive

Class III
- May be acceptable
- Possibly useful
- Considered optional or alternative treatments
- Level of Evidence:
  - Generally lower or intermediate levels of evidence
  - Case series, animal studies, consensus panels
  - Occasionally positive results

Indeterminate
- Continuing area of research
- No recommendations until further research
- Level of Evidence:
  - Evidence not available
  - Higher studies in progress
  - Results inconsistent, contradictory
  - Results not compelling


*First-line therapy is amoxicillin 80-90 mg/kg/day in 2 divided doses for 5–10 days. (Class I) Patients who have received antibiotics within the last 30 days, have a concurrent conjunctivitis, or have a history of recurrent AOM resistant to amoxicillin should receive beta-lactamase coverage (ie, amoxicillin-clavulanate 90/6.4 mg/kg/day in 2 divided doses). (Class II)
† Patients should be reassessed in 48 to 72 hours for treatment failure to determine whether a change in therapy is needed. (Class I)
‡ Patients who fail initial treatment after 48-72 hours can be started on amoxicillin-clavulanate 90/6.4 mg/kg/day in 2 divided doses, although there are other alternative regimens. (Class II)

Signs of middle ear effusion on pneumatic otoscopy? (Class I)
treated with amoxicillin or ampicillin in 4 trials and found a rate difference of 23% in favor of the antibiotics-treated patients. Using the same trials, they also found a rate difference in clinical success of 25% in the placebo group when comparing children aged > 2 years with children aged < 2 years in favor of the older group. Similar results were borne out when looking at treatment with amoxicillin-clavulanate and azithromycin. Analysis of 4 trials showed a rate difference in clinical success of 15% in the amoxicillin-clavulanate-treated group in favor of children aged > 2 years and a rate difference of 14% in the azithromycin-treated group, also in favor of older children.

A 2006 meta-analysis by Rovers et al of 1643 patients sought to identify certain subgroups, including age, that would benefit more from antibiotics than standard observation using data drawn from 6 high-quality RCTs.125 The authors found that, when comparing groups that had received antibiotics versus placebo, there was no statistically significant difference in clinical success between the subgroup of children aged < 2 years versus children aged > 2 years (15% vs 11%). However, the authors did find a difference in pain and/or fever at days 3 to 7 between age subgroups in both the antibiotics-treated group (rate difference of 17% in favor of children aged > 2 y) and the placebo group (rate difference of 13% in favor of children aged > 2 y). They also found a greater rate difference (25% vs 12%) in resolution of pain, fever, or both at days 3 to 7 in children aged < 2 years with bilateral AOM. In 2009, a Cochrane review looked at the same 6 RCTs as Rovers et al plus 4 additional RCTs and concluded that antibiotics were most beneficial in reducing pain in children aged < 2 years with bilateral AOM.126

Some trials have looked at the effect of age on different antibiotic regimens. The 2010 AHRQ evidence report analyzed 13 such trials and concluded that most of these trials did not find statistically significant differences between the effects of certain antibiotic regimens between age groups. These studies compared the following regimens: (1) amoxicillin versus azithromycin, (2) amoxicillin versus erythromycin, (3) amoxicillin versus wait-and-see, (4) amoxicillin-clavulanate versus azithromycin, (5) amoxicillin-clavulanate versus cefdinir, (6) amoxicillin-clavulanate versus cefprozil, (7) amoxicillin-clavulanate versus cefuroxime, (8) azithromycin versus cefdinir, (9) cefpodoxime 5 days versus 10 days, and (10) cefdinir versus cefprozil.64,71,94,127-136 A meta-analysis of the trials comparing amoxicillin-clavulanate versus azithromycin did not find a statistically significant difference in clinical success in children aged < 2 years or children aged > 2 years.19

Two 2011 RCTs (described earlier in the “Treatment: Antibiotics Versus Placebo” section, page 8) demonstrated that young children had better clinical success with antibiotic therapy. Tahtinen et al found a decrease in the rate of treatment failure in children aged < 3 years treated with amoxicillin-clavulanate versus placebo (18.6% vs 44.9%).60 Hoberman et al also found a decrease in clinical failure rate of 19% by days 4 to 5 and 35% by days 10 to 12 in patients aged < 2 years treated with amoxicillin-clavulanate.67 The amoxicillin-clavulanate-treated children also had lower mean symptom scores over the first 7 days and a small difference in sustained resolution of symptoms (67% vs 53%). Children aged < 2 years with bilateral AOM had higher rates of clinical failure at day 10 to 12 than the unilateral AOM cases, regardless of treatment group (23% in the placebo group [with 9% with unilateral AOM in the placebo group] vs 60% in the amoxicillin-clavulanate group [with 41% with unilateral AOM in the placebo group]).

**What’s New In The 2013 AAP Guidelines**

Children aged < 2 years with AOM are more likely to have treatment failure and may do better with antibiotic treatment. This is especially true for young patients with bilateral AOM. The earlier 2004 AAP/AAPF guidelines recommended antibiotic therapy for all children aged < 6 months and children aged 6 to 24 months with an uncertain diagnosis.7 In the new 2013 AAP guidelines, children aged 6 to 23 months with severe symptoms (eg, fever > 39°C or severe otalgia) or those with bilateral AOM should receive initial antibiotic therapy, while children aged 6 to 23 months with unilateral and nonsevere AOM can be offered the option of watchful waiting.17

**Adverse Events Of Treatment**

Although most antibiotics are relatively safe drugs, they are not benign, and, like any drug, they carry risks. Side effects may include diarrhea, nausea, vomiting, rash, diaper rash, or abdominal pain. A 2004 systematic review looked at 10 studies that compared antibiotics to placebo or observation and found that vomiting, diarrhea, or rash was more common in patients treated with antibiotics (RR, 1.37; 95% CI, 0.62-0.83).137 The watchful-waiting approach is desirable because it has a lower risk of these adverse effects. A 2006 RCT demonstrated that the rate of diarrhea was also significantly higher in patients treated with amoxicillin compared to a wait-and-see approach (23% vs 8%).72

When comparing different antibiotic regimens, most clinical trials did not demonstrate clinically significant differences in adverse event rates. However, 2 studies found that diarrhea was higher in amoxicillin-clavulanate-treated patients (with ranges from 27% to 35%) compared to those treated with cefdinir (10%) and ceftriaxone (14%).84,138 The 2001 AHRQ evidence report found that children treated with 7 to 10 days of amoxicillin-clavulanate had a
Complications Of Acute Otitis Media

Complications of AOM include hearing loss, balance problems, TM perforation, retraction/collapse of the TM, facial paralysis, cholesteatoma, ossicular fixation, and extension of infection to nearby structures (ie, mastoiditis, labyrinthitis, or meningitis). While hearing loss is the most common complication, it occurs after persistent middle ear effusion, often over a period of weeks to months, and it is unlikely that children will present to the ED for this complaint. The most acute and serious complications of AOM are mastoiditis and meningitis.

Mastoiditis

Mastoiditis is a particularly feared complication of AOM. Mastoiditis occurs when bacteria enter the middle ear and spread to the mastoid air cells via a connection called the aditus ad antrum, leading to destruction of the mastoid bone via inflammation. In the era before antibiotics, the incidence of mastoiditis after AOM was 5% to 10%, although it occurs much more rarely in the present day. Most cases of mastoiditis are not preceded by an episode of AOM, and there is concern that failure to treat AOM with antibiotics will result in an increased rate of mastoiditis; however, this has not been borne out in the studies. The AHRQ evidence report in 2001 pooled data from 6 RCTs and 2 cohort studies that showed similar rates of mastoiditis (0.59% vs 0.17%) in children with AOM who were treated initially with antibiotics versus those who received observation. Paradoxically, case studies of pediatric mastoiditis have shown that most cases (in children with or without AOM) occur in children who have received prior antibacterial therapy (36%-87%). One study found a higher rate of mastoiditis in the United Kingdom, Canada, Australia, and the United States (countries with a high rate of initial antibiotic therapy) compared to the Netherlands, Norway, and Denmark. The authors also reported that, although Norway and Denmark prescribed initial antibiotics at a rate nearly double that of the Netherlands, their rates of mastoiditis were comparable; therefore, withholding antibiotics does not appear to increase the risk of mastoiditis.

A 2004 systematic review reported that, out of a combined 2928 children (from 10 studies), including those from the placebo groups and antibiotics groups, there was only 1 case of mastoiditis, which occurred in a child treated with antibiotics. A 2009 retrospective cohort study in the United Kingdom reported a NNT of 4831 cases of AOM to prevent 1 case of mastoiditis. In sum, a watchful-waiting approach for AOM is not likely to increase the risk of mastoiditis, and antibiotics should not be prescribed solely to prevent this complication. Although an association exists between mastoiditis and AOM, the causality is not borne out in the current research, and the relationship between untreated AOM and mastoiditis is less clear.

Meningitis

Similarly, meningitis is a feared complication of AOM that can result from hematogenous spread of bacteria or direct invasion. It was more common in the pre-antibiotic era, but is quite rare today and has not been found to be influenced by initial antibiotic treatment of AOM. A retrospective study of 4860 children with AOM who did not receive initial antibiotic therapy found 0 cases of bacterial meningitis. A retrospective study of 2346 patients with AOM from 1987 to 2008 reported 16 cases of meningitis (an incidence of 0.68%), with half of those cases occurring before 1990.

Complications Of Acute Otitis Media: The Bottom Line

Emergency clinicians should be aware of the serious complications of AOM such as mastoiditis and meningitis but should recognize that these complications are extremely rare and are not affected by withholding antibiotics.

Treatment Summary And 2013 American Academy Of Pediatrics Guidelines

In 2004, the AAP and AAFP partnered with the AHRQ and the Southern California Evidence-Based Practice Center to develop a set of clinical practice guidelines for the treatment of nonsevere AOM. These guidelines were recently revised in 2013. (For a link to the full guideline, see Figure 1.) These guidelines are based on the RCTs and meta-analyses discussed throughout this issue. The guidelines only apply to otherwise healthy children aged 6 months to 12 years. Children with anatomic abnormalities (such as cleft palate), craniofacial abnormalities (including Down syndrome), immunodeficiencies, cochlear implants, or tympanostomy tubes are excluded from these guidelines. Children with recurrent AOM are included in these guidelines (a change from 2004). Additionally, children with severe AOM (defined as moderate to severe otalgia or fever > 39°C) were excluded from the 2004 guidelines but are now incorporated into the 2013 recommendations.

The main changes from the 2004 guidelines are an emphasis on accurate diagnosis using bulging of the TM as a main criterion, a recommendation for antibiotic treatment for bilateral AOM in young children, and the option of watchful waiting in young children with mild disease (the 2004 guidelines only recommended observation if disease was uncertain but promoted antibiotic treatment for certain disease in these patients). The guidelines are now identi-
special for nonsevere disease in young children with unilateral AOM and older children with unilateral or bilateral AOM. All children with severe AOM should be treated with antibiotics.

**Special Circumstances**

**Patients To Exclude From The Watchful-Waiting Approach**

The watchful-waiting approach is only recommended for otherwise healthy children without underlying diseases. Children with anatomic abnormalities (eg, cleft palate, Down syndrome), immunodeficiencies, cochlear implants, or tympanostomy tubes should be managed with antibiotic treatment.

**Patients With Bilateral Acute Otitis Media Or Otorrhea**

Based on a 2006 meta-analysis, children aged < 2 years with bilateral AOM appear to benefit from antibiotic therapy. This same meta-analysis also found that children with otorrhea did better with antibiotics, with a rate difference in symptom resolution of 36% versus 14% in favor of the antibiotics-treated group. Age alone did not affect these results. The authors concluded that antibiotics were beneficial in children aged < 2 years with bilateral AOM and children with otorrhea. The 2013 AAP guidelines have been changed to reflect these findings.

**Patients Who Cannot Tolerate Oral Antibiotics**

Patients who cannot tolerate oral intake or are actively vomiting and require antibiotic therapy can be given a single dose of parenteral ceftriaxone 50 mg/kg. Studies show that this is equally effective as low-dose amoxicillin.

**Patients With Penicillin Allergies**

As discussed earlier, many antibiotics are efficacious for AOM. In the majority of patients with a penicillin allergy, cephalosporins can be considered second line. Cross-reactivity to cephalosporins in penicillin-allergic patients was originally reported to be as high as 10%, but recent studies reveal that this is likely an overestimate based on outdated studies from the 1960s and 1970s. A recent meta-analysis found that there was an increase in allergic reactions to first-generation cephalosporins in penicillin-allergic patients (odds ratio [OR] 4.8, CI, 3.7-6.2), but there was no increase in reactions to second- or third-generation cephalosporins.

A 2007 review article concluded that cefdinir, cefuroxime, cepodoxime, and ceftriaxone were not associated with an increased rate of allergic reactions in penicillin-allergic patients and could be used safely to treat AOM. The 2010 guidelines published by the Joint Task Force on Practice Parameters; the American Academy of Allergy, Asthma, and Immunology; the American College of Allergy, Asthma, and Immunology; and the Joint Council of Allergy, Asthma, and Immunology recommend cephalosporin use in patients without a severe and/or recent penicillin allergy when skin test is not available.

**Patients With Chronic Suppurative Otitis Media Or Acute Otitis Media Through Tympanostomy Tubes**

Children who present to the ED with chronic suppurative OM or AOM with otorrhea through tympanostomy tubes present a unique challenge. Both of these conditions involve a perforated or nonintact TM. The natural history of AOM through tympanostomy tubes is unknown; some studies have suggested that otorrhea through tympanostomy tubes can be transient and resolve spontaneously. The pathogens isolated in these cases are similar to AOM in intact TMs, with *S pneumoniae, M catarrhalis,* and *H influenzae* being responsible for the majority of cases. However, *Staphylococcus aureus* and *Pseudomonas aeruginosa* are more prevalent in these patients, especially in older children. These pathogens can infect the external auditory canal and subsequently enter the middle ear via the tympanostomy tube or perforation. For these reasons, the management of these patients is different. Studies have shown that topical agents are more effective in treating chronic suppurative OM and AOM through tympanostomy tubes compared to the systemic oral antibiotics typically prescribed for AOM. In particular, fluoroquinolones have been shown to be very effective, possibly because of their activity against *P aeruginosa* and other gram-negative bacteria. A 2003 systematic review analyzed 11 clinical trials (9 randomized, 2 nonrandomized) to compare 0.3% ofloxacin otic solution to other topical or systemic antibiotics. This review found that ofloxacin otic solution produced a higher cure rate (OR, 2.67; 95% CI, 2.04-3.50), resolution of otorrhea (OR, 2.78; 95% CI, 2.12-3.65), and bacterial eradication rate (OR, 3.86; 95% CI, 2.54-5.87).

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**Figure 1. 2013 American Academy Of Pediatrics Guidelines For Acute Otitis Media**

To access the guidelines, scan the QR code above with an enabled device, or visit http://pediatrics.aappublications.org/content/131/3/e964.full
and also reduced median time to cessation of otorrhea (4 days vs 6 days). A 2008 review article summarized that topical fluoroquinolones are superior to systemic antibiotics, have fewer side effects, and should be first-line treatment for children with AOM through tympanostomy tubes or chronic suppurative OM. The authors commented that addition of topical corticosteroids may be beneficial in reducing the length of illness, although they are more costly than fluoroquinolones alone, and the evidence for their efficacy is not strong.

In 2004, an expert group of pediatric otolaryngologists, pediatricians, and family physicians met in Quebec to develop Canadian guidelines for the treatment of tympanostomy tube otorrhea. Studies have also looked at whether the addition of topical corticosteroids improves clinical outcome. A 2003 RCT compared topical ciprofloxacin to topical ciprofloxacin/dexamethasone in children with AOM through tympanostomy tubes and found a decrease in mean time to cessation of otorrhea (4.22 days vs 5.31 days, \( P = 0.04 \)) and better clinical responses on day 3 and 8 in the group treated with topical ciprofloxacin/dexamethasone; however, there was no significant difference in the clinical response by day 14. A 2004 RCT compared topical ciprofloxacin/dexamethasone to topical ofloxacin and reported that ciprofloxacin/dexamethasone produced better clinical cure rates (90% vs 78%) and fewer treatment failures (4.1% vs 14.1%) by day 18.

### Risk Management Pitfalls For Acute Otitis Media In Children (Continued on page 19)

1. “I gave the patient a script for antibiotics, so he didn’t need pain medication.”
   Always treat a patient’s pain, regardless of the choice to give antibiotics. Ibuprofen and/or acetaminophen are first-line therapies, but topical analgesics may be used as well. Narcotics should be reserved for children with severe otalgia resistant to first-line therapies.

2. “The child had a red TM on otoscopic examination, so I treated him for AOM.”
   Erythema of the TM alone is not specific for AOM. The TM can be red for other reasons, including crying, high fever, and manipulation of the ear canal (such as from cerumen removal). A slightly red TM alone is not predictive of AOM, while a distinctly red or hemorrhagic TM is slightly suggestive. The diagnosis of AOM correlates most with mobility and position (a bulging, immobile TM). The 2013 AAP guidelines require a bulging TM and evidence of middle ear effusion on pneumatic otoscopy for diagnosis of AOM.

3. “It was difficult to perform an otoscopic examination on this child, so to be safe, I skipped it and diagnosed him with AOM and treated him with antibiotics.”
   Clinicians should make their best effort to perform an adequate otoscopic examination in children to spare them from unnecessary antibiotics. The child should be calmed and placed in the caregiver’s lap for examination. Cerumen should be removed if it obstructs the view of the TM (this can be achieved with docusate sodium and irrigation or by manual extraction). The emergency clinician should perform pneumatic otoscopy on all patients to confirm the presence of a middle ear effusion. Certain patients with a definitive diagnosis of AOM may not require antibiotics.

4. “This patient had ongoing ear pain for more than 1 week and signs of middle ear effusion on otoscopic examination but no TM bulging. I treated her with antibiotics.”
   There is no evidence that antibiotics are beneficial for OME. OME, by definition, is not an acute process. AOM requires moderate to severe bulging of the TM or acute onset of symptoms (< 48 h) plus mild TM bulging or intense erythema of the TM for diagnosis.

5. “This patient returned to the ED with persistent middle ear effusion after an episode of AOM. This represented a failure of treatment, so I prescribed a stronger antibiotic.”
   Persistent middle ear effusion is very common after an episode of AOM, but it should resolve after 3 months. Patients with persistent effusions should be referred to their pediatrician, as they may need further testing to assess for hearing loss or cognitive delays. There is no need to change their antibiotic regimen.

6. “I was worried that this patient with AOM would develop a serious complication such as mastoiditis or meningitis if I didn’t treat him with antibiotics.”
   There is no evidence that delayed or withdrawn antibiotics are associated with mastoiditis or meningitis, which are extremely rare.
Patients With Acute Otitis Media Through Tympanostomy Tubes Or Chronic Suppurative Otitis Media: The Bottom Line

In summary, AOM through tympanostomy tubes and chronic suppurative OM are treated differently from AOM. Although observation can be considered in healthy children who appear well, the first-line therapy is a topical fluoroquinolone, with or without a topical corticosteroid.

Controversies And Cutting Edge

The observation (or watchful-waiting) approach has been recommended in the Netherlands and other European countries for 20 years. In the United

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Risk Management Pitfalls For Acute Otitis Media In Children

(Continued from page 18)

complications of AOM. Some studies have shown an association between mastoiditis and recent antibiotic use. Do not prescribe antibiotics solely to avoid these complications.

7. “My patient had a history of recurrent AOM and presented to the ED today with ear pain and findings of AOM on otoscopy. He had no fever and looked well, so I treated him with the watchful-waiting approach.”

History of recurrent AOM was considered a contraindication to observation in the 2004 AAP/AAFP guidelines. The 2013 guidelines do not specifically list recurrent AOM as a contraindication to observation; however, management of these patients can be difficult. Emergency clinicians should consider consulting a specialist or discussing the case with the child’s pediatrician before initiating treatment. Some patients with recurrent AOM may benefit from tympanocentesis to isolate the causative middle ear pathogen, a procedure rarely performed in the ED. The 2013 AAP guidelines recommend amoxicillin-clavulanate (or an alternative antibiotic with beta-lactamase coverage) for patients with a history of recurrent AOM unresponsive to amoxicillin.

8. “These parents seem pretty aggressive. They won’t be happy if I don’t treat their child with antibiotics. Even if I give them a script to hold and instruct them to fill it in 48 to 72 hours if the child does not improve, they’ll probably just go straight to the pharmacy from the ED to fill it.”

Recent studies have shown that parents are satisfied with a watchful-waiting approach as long as the child’s pain is addressed. Around 80% of parents did not fill their prescription. It is important for emergency clinicians to explain their instructions clearly, provide reassurance, and treat pain. Note that if the child has had multiple previous episodes of AOM that were treated with antibiotics, the parents are more likely to fill the prescription than if this is the child’s first episode.

9. “This child had AOM. I got a complete blood count to see how high his white count was and a culture of his ear drainage to see what the inciting pathogen was.”

Routine complete blood counts are not recommended in nonsevere AOM as they do not contribute to management. In an immunocompromised patient, they may be helpful. Routine culture and gram stain of middle ear fluid is not recommended, although it may help guide treatment in patients with persistent AOM or chronic AOM.

10. “This child had AOM. Antibiotics are very safe drugs, so I didn’t have to worry about adverse reactions from treatment.”

While antibiotics are some of the safer drugs on the market, they are not without side effects. Diarrhea, vomiting, and rash are commonly seen in children prescribed antibiotics for AOM and the risk is greater for children who receive broad-spectrum antibiotics such as amoxicillin-clavulanate. Parents should be educated about possible side effects when children need to be treated with antibiotics.
In the United States, it was considered an option in the 2004 guidelines; again, in the 2013 it may be “offered” to patients. This wording, without a strong recommendation for observation over initial antibiotic therapy, coupled with (largely unfounded) physician beliefs about parental attitudes, difficulty of follow-up, and lack of physician education has resulted in many physicians viewing watchful waiting as a controversial approach to AOM. Recent studies have shown that many physicians do not advocate this approach to their patients. With the recent publication of the 2013 guidelines and further research, the acceptance of this approach may improve.

The use of complementary medicine (e.g., homeopathy, acupuncture, herbal remedies, chiropractic treatments, and nutritional supplements) for the treatment of AOM is growing in popularity. As the use of antibiotics for AOM continues to be questioned, the use of alternative remedies may increase. Topical naturopathic extracts have shown some use in treating otalgia (see the “Pain Control” section on page 12). A consistent benefit from homeopathic regimens has not been found. A RCT of 75 children with middle ear effusion and ear pain randomized to an individualized homeopathy medicine or placebo found no difference in treatment failure, but they did find a decrease in symptoms at 24 and 64 hours after treatment in favor of the homeopathy group. Another RCT of 57 patients with a history of recurrent AOM who were not surgical candidates were randomized to routine pediatric care versus routine care plus osteopathic manipulative treatment. The latter group was found to have fewer subsequent episodes of AOM, fewer surgical procedures, and an increased frequency in normal tympanograms. Although some of these studies show promising results, larger studies need to be conducted. Emergency clinicians should be familiar with these treatments and their efficacies, as patients may present to the ED having already tried them.

### Disposition

Most patients can be discharged home from the ED. Admission is rarely needed, unless patients have severe AOM and other comorbidities. Other indications for inpatient admission include: failure to tolerate oral intake, severe nausea/vomiting, uncontrolled pain requiring narcotics, or abnormal vital signs (other than fever alone). For patients who can be safely discharged from the ED, follow-up is very important in discharge instructions. Patients should be given clear instructions to follow up within 48 to 72 hours if symptoms are worsened or unchanged. There needs to be a reliable adult with access to medical care who is able to observe the child during this time period. Follow-up may consist of a return visit to the ED, phone contact with the pediatrician, scheduled follow-up appointment with the pediatrician, routine follow-up phone contact by the emergency clinician, or filling of the safety-net antibiotic prescription.

Patients should be warned about the possible sequelae of AOM, especially persistent middle ear effusion. It is common immediately following an episode of AOM and should resolve by 3 months. Patients should be advised to follow up with their pediatricians because more tests and procedures may be needed to assure that the effusion has resolved. These children are at risk for hearing loss as well as cognitive and language delays that may accompany hearing loss.

### Summary

AOM is commonly seen in the ED. Emergency clinicians may be challenged with the diagnosis of AOM and, subsequently, the approach to treatment. Based on a large breadth of research, the latest published guidelines on AOM released in 2013 by the AAP recommend pneumatic otoscopy as the gold standard for diagnosis of AOM, specifically requiring a bulging TM with decreased mobility for diagnosis. All patients with severe AOM (severe otalgia or high fever), regardless of age, and young children aged 6 to 23 months with bilateral AOM should be treated with antibiotics. Otherwise healthy children with no contraindications to observation with a diagnosis of nonsevere AOM (which must be unilateral in children aged 6 to 23 months) can be treated with antibiotics or offered observation. The first-line antibiotic therapy is amoxicillin 80 to 90 mg/kg/
day in 2 divided doses for 10 days in children aged < 2 years or those with severe disease (although 5 to 7 days may be sufficient for older children with mild disease). Patients / parents may be given a prescription and told not to fill it unless the child has worsened symptoms or is unimproved in 48 to 72 hours. A watchful-waiting method is safe, effective, and acceptable to parents. All patients should receive adequate pain control and thorough follow-up instructions.

**Case Conclusions**

Your first patient, the 3-year-old girl with earache, fever, and a bulging, immobile TM, met the clinical criteria for AOM diagnosis and was classified as nonsevere AOM. She had no risk factors that would exclude her from being a candidate for observational therapy, and she was also a candidate for short-term therapy (5 days) given that she was over age 2 and had nonsevere disease. You explained to the parent that it is safe and effective to treat children with AOM conservatively, and you gave her a prescription for amoxicillin 90 mg/kg/day x 5 days and instructed her to fill it if the child was unimproved or had worsened symptoms in the next 48 to 72 hours. You also gave the parent a prescription for ibuprofen, 10 mg/kg every 6 hours, as needed. You instructed the parent on the warning signs of worsening injury and told her that she could follow up with their pediatrician or return to the ED.

Your second patient, the 2-year-old brother with ear pulling, opacity, and decreased mobility of the TM was diagnosed with OME, likely secondary to an upper respiratory infection. You explained to the parent that his condition did not need to be treated with antibiotics, but you did instruct her to follow up with their pediatrician in several weeks to make sure the effusion has resolved and there was no lasting hearing loss. You also gave them a prescription for ibuprofen, 10 mg/kg every 6 hours, as needed for his comfort.

**References**

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study will be included in bold type following the references, where available. The most informative references cited in this paper, as determined by the author, will be noted by an asterisk (*) next to the number of the reference.


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2. Which statement about the clinical predictors of AOM is true?
   a. A fever is highly predictive of AOM.
   b. Parents are almost always right in predicting when their child has AOM.
   c. Otalgia is the best clinical predictor of AOM.
   d. Physicians are often able to predict the diagnosis of AOM based on clinical history alone.

3. Which of the following is most helpful in the diagnosis of AOM?
   a. CT scan of the head
   b. Complete blood count
   c. Tympanocentesis with gram stain and culture
   d. Pneumatic otoscopy

4. What is the most specific TM finding seen in patients with AOM?
   a. Bulging of the TM
   b. Redness of the TM
   c. Cloudy TM
   d. Impaired TM mobility

5. Which statement correctly describes the watchful-waiting with a safety-net antibiotic prescription approach?
   a. Patients are discharged without an antibiotic prescription and instructed to follow up with their pediatrician in 48 to 72 hours
   b. The patient is given antibiotics in the ED, sent home with a prescription, and instructed to follow up with their pediatrician in 48 to 72 hours
   c. Patients are discharged without an antibiotic prescription and instructed to return to the ED in 48 to 72 hours so the emergency clinician can determine if they will need antibiotics
   d. Parents are given an antibiotic prescription and instructed to fill it if the child’s symptoms are worsened or unimproved in 48 to 72 hours

6. What is the first-line antibiotic in treating non-severe, uncomplicated AOM?
   a. Ceftriaxone 50 mg IM
   b. Amoxicillin 90 mg/kg/day
   c. Amoxicillin 45 mg/kg/day
   d. Azithromycin 10 mg/kg/day

7. What is an acceptable alternative initial antibiotic in patients with a nonsevere penicillin-allergy?
   a. Cefazolin
   b. Cefdinir
   c. Levofloxacin
   d. Azithromycin

8. Which of the following statements about persistent AOM is true?
   a. Patients with failure of amoxicillin therapy should be given amoxicillin-clavulanate 90/6.4 mg/kg/day.
   b. Erythromycin-sulfisoxazole and sulfamethoxazole-trimethoprim are recommended for treatment of persistent AOM.
   c. Patients with failure of amoxicillin-clavulanate therapy can be given a 1-time dose of ceftriaxone 50 mg/kg IM.
   d. Persistence of middle ear effusion after AOM requires a change in antibiotic therapy.

9. What is the most common complication of AOM?
   a. Hearing loss
   b. Mastoiditis
   c. Meningitis
   d. Balance problems

10. Which of the following is a contraindication to observation therapy?
    a. Sibling with history of AOM
    b. Daycare
    c. Immunocompromised state
    d. Age of 7 months with unilateral AOM
Physician CME Information

Date of Original Release: April 1, 2013. Date of most recent review: March 15, 2013. Termination date: April 1, 2016.

Accreditation: EB Medicine is accredited by the Accreditation Council for Continuing Medical Education (ACCMCE) to provide continuing medical education for physicians. This activity has been planned and implemented in accordance with the Essential Areas and Policies of the ACCME.

Credit Designation: EB Medicine designates this enduring material for a maximum of 4 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

AEEP Accreditation: Pediatric Emergency Medicine Practice is also approved by the American College of Emergency Physicians for 48 hours of AEEP Category I credit per annual subscription.

AAP Accreditation: This ongoing medical education activity has been reviewed by the American Academy of Pediatrics and is acceptable for a maximum of 48 AAP credits per year. These credits can be applied toward the AAP CME/CPD Award available to Fellows and Candidate Fellows of the American Academy of Pediatrics.

AOA Accreditation: Pediatric Emergency Medicine Practice is eligible for up to 48 American Osteopathic Association Category 2A or 2B credit hours per year.

Needs Assessment: The need for this educational activity was determined by a survey of medical staff, including the editorial board of this publication, review of morbidity and mortality data from the CDC, AHA, NCHS, and AACP, and evaluation of prior activities for emergency physicians.

Target Audience: This enduring material is designed for emergency medicine physicians, physician assistants, nurse practitioners, and residents.

Goals: Upon completion of this activity, you should be able to: (1) demonstrate medical decision-making based on the strongest clinical evidence; (2) cost-effectively diagnose and treat the most critical ED presentations; and (3) describe the most common medicolegal pitfalls for each topic covered.

Discussion of Investigational Information: As part of the newsletter, faculty may be presenting investigational information about pharmaceutical products that is outside Food and Drug Administration approved labeling. Information presented as part of this activity is intended solely as continuing medical education and is not intended to promote off-label use of any pharmaceutical product.

Faculty Disclosure: It is the policy of EB Medicine to ensure objectivity, balance, independence, transparency, and scientific rigor in all CME-sponsored educational activities. All faculty participating in the planning or implementation of a sponsored activity are expected to disclose to the audience any relevant financial relationships and to assist in resolving any conflict of interest that may arise from the relationship. Presenters must also make a meaningful disclosure to the audience of their discussions of unlabeled or unapproved drugs or devices. In compliance with all ACCME Essentials, Standards, and Guidelines, all faculty for this CME activity were asked to complete a full disclosure statement. The information received is as follows: Dr. Nesbit, Dr. Powers, Dr. Vernacchio, Dr. Wang, Dr. Vella, and their related parties report no significant financial interest or other relationship with the manufacturer(s) of any commercial product(s) discussed in this educational presentation. Dr. Pichichero reported the following disclosures for 2011-2013: research grants to academic institution, Novartis Vaccines, Pfizer Inc. (Wyeth), Sanofi Pasteur SA, Crucell; ad hoc consulting honoraria: Novartis Vaccines, Pfizer Inc. (Wyeth), Sanofi Pasteur SA. Dr. Pichichero is not an employee of, affiliated with, nor does he have any financial interest in any pharmaceutical or vaccine manufacturing companies.

Commercial Support: This issue of Pediatric Emergency Medicine Practice did not receive any commercial support.

Method of Participation: • Print Semester Program: Paid subscribers who read all CME articles during each Pediatric Emergency Medicine Practice 6-month testing period, complete the CME Answer And Evaluation Form distributed with the June and December issues, and return it according to the published instructions are eligible for up to 4 hours of CME credit for each issue.

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Hardware/Software Requirements: You will need a Macintosh or PC with internet access and capabilities to access the website.

Additional Policies: For additional policies, including our statement of conflict of interest, source of funding, statement of informed consent, and statement of human and animal rights, visit http://www.ebmedicine.net/policies.