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CLINICAL PRACTICE GUIDELINE

# The Diagnosis and Management of Acute Otitis Media

## abstract

FREE

This evidence-based clinical practice guideline is a revision of the 2004 acute otitis media (AOM) guideline from the American Academy of Pediatrics (AAP) and American Academy of Family Physicians. It provides recommendations to primary care clinicians for the management of children from 6 months through 12 years of age with uncomplicated AOM.

In 2009, the AAP convened a committee composed of primary care physicians and experts in the fields of pediatrics, family practice, otolaryngology, epidemiology, infectious disease, emergency medicine, and guideline methodology. The subcommittee partnered with the Agency for Healthcare Research and Quality and the Southern California Evidence-Based Practice Center to develop a comprehensive review of the new literature related to AOM since the initial evidence report of 2000. The resulting evidence report and other sources of data were used to formulate the practice guideline recommendations.

The focus of this practice guideline is the appropriate diagnosis and initial treatment of a child presenting with AOM. The guideline provides a specific, stringent definition of AOM. It addresses pain management, initial observation versus antibiotic treatment, appropriate choices of antibiotic agents, and preventive measures. It also addresses recurrent AOM, which was not included in the 2004 guideline. Decisions were made on the basis of a systematic grading of the quality of evidence and benefit-harm relationships.

The practice guideline underwent comprehensive peer review before formal approval by the AAP.

This clinical practice guideline is not intended as a sole source of guidance in the management of children with AOM. Rather, it is intended to assist primary care clinicians by providing a framework for clinical decision-making. It is not intended to replace clinical judgment or establish a protocol for all children with this condition. These recommendations may not provide the only appropriate approach to the management of this problem. *Pediatrics* 2013;131:e964–e999

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**KEY WORDS**

acute otitis media, otitis media, otoscopy, otitis media with effusion, watchful waiting, antibiotics, antibiotic prophylaxis, tympanostomy tube insertion, immunization, breastfeeding

**ABBREVIATIONS**

AAFP—American Academy of Family Physicians
AAP—American Academy of Pediatrics
AHRQ—Agency for Healthcare Research and Quality
AOM—acute otitis media
CI—confidence interval
FDA—US Food and Drug Administration
LAIV—live-attenuated intranasal influenza vaccine
MEE—middle ear effusion
MIC—minimum inhibitory concentration
NNT—number needed to treat
OM—otitis media
OME—otitis media with effusion
OR—odds ratio
PCV7—heptavalent pneumococcal conjugate vaccine
PCV13—13-valent pneumococcal conjugate vaccine
RD—rate difference
SNAP—safety-net antibiotic prescription
TIV—trivalent inactivated influenza vaccine
TM—tympanic membrane
WASP—wait-and-see prescription



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**Key Action Statement 1A:** Clinicians should diagnose acute otitis media (AOM) in children who present with moderate to severe bulging of the tympanic membrane (TM) *or* new onset of otorrhea not due to acute otitis externa. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 1B:** Clinicians should diagnose AOM in children who present with mild bulging of the TM *and* recent (less than 48 hours) onset of ear pain (holding, tugging, rubbing of the ear in a nonverbal child) or intense erythema of the TM. Evidence Quality: Grade C. Strength: Recommendation.

**Key Action Statement 1C:** Clinicians should not diagnose AOM in children who do not have middle ear effusion (MEE) (based on pneumatic otoscopy and/or tympanometry). Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 2:** The management of AOM should include an assessment of pain. If pain is present, the clinician should recommend treatment to reduce pain. Evidence Quality: Grade B. Strength: Strong Recommendation.

**Key Action Statement 3A:** Severe AOM: The clinician should prescribe antibiotic therapy for AOM (bilateral or unilateral) in children 6 months and older with severe signs or symptoms (ie, moderate or severe otalgia or otalgia for at least 48 hours or temperature 39°C [102.2°F] or higher). Evidence Quality: Grade B. Strength: Strong Recommendation.

**Key Action Statement 3B:** Nonsevere bilateral AOM in young children: The clinician should prescribe antibiotic therapy for bilateral AOM in children 6 months through 23 months of age without severe signs or symptoms (ie, mild otalgia for less than 48 hours and temperature less than 39°C [102.2°F]). Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 3C:** Nonsevere unilateral AOM in young children: The clinician should either prescribe antibiotic therapy *or* offer observation with close follow-up based on joint decision-making with the parent(s)/caregiver for unilateral AOM in children 6 months to 23 months of age without severe signs or symptoms (ie, mild otalgia for less than 48 hours and temperature less than 39°C [102.2°F]). When observation is used, a mechanism must be in place to ensure follow-up and begin antibiotic therapy if the child worsens or fails to improve within 48 to 72 hours of onset of symptoms. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 3D:** Nonsevere AOM in older children: The clinician should either prescribe antibiotic therapy *or* offer observation with close follow-up based on joint decision-making with the parent(s)/caregiver for AOM (bilateral or unilateral) in children 24 months or older without severe signs or symptoms (ie, mild otalgia for less than 48 hours and temperature less than 39°C [102.2°F]). When observation is used, a mechanism must be in place to ensure follow-up and begin antibiotic therapy if the child worsens or fails to improve within 48 to 72 hours of onset of symptoms. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 4A:** Clinicians should prescribe amoxicillin for AOM when a decision to treat with antibiotics has been made *and* the child has not received amoxicillin in the past 30 days *or* the child does not have concurrent purulent conjunctivitis *or* the child is not allergic to penicillin. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 4B:** Clinicians should prescribe an antibiotic with additional β-lactamase coverage for AOM when a decision to treat with antibiotics has been made, *and* the child has received amoxicillin in the last 30 days *or* has concurrent purulent conjunctivitis, *or* has a history of recurrent AOM unresponsive to amoxicillin. Evidence Quality: Grade C. Strength: Recommendation.

**Key Action Statement 4C:** Clinicians should reassess the patient if the caregiver reports that the child's symptoms have worsened or failed to respond to the initial antibiotic treatment within 48 to 72 hours and determine whether a change in therapy is needed. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 5A:** Clinicians should not prescribe prophylactic antibiotics to reduce the frequency of episodes of AOM in children with recurrent AOM. Evidence Quality: Grade B. Strength: Recommendation.

**Key Action Statement 5B:** Clinicians may offer tympanostomy tubes for recurrent AOM (3 episodes in 6 months or 4 episodes in 1 year with 1 episode in the preceding 6 months). Evidence Quality: Grade B. Strength: Option.

**Key Action Statement 6A:** Clinicians should recommend pneumococcal conjugate vaccine to all children according to the schedule of the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention, American Academy of Pediatrics (AAP), and American Academy of Family Physicians (AAFP). Evidence Quality: Grade B. Strength: Strong Recommendation.

**Key Action Statement 6B: Clinicians should recommend annual influenza vaccine to all children according to the schedule of the Advisory Committee on Immunization Practices, AAP, and AAFP. Evidence Quality: Grade B. Strength: Recommendation.**

**2Key Action Statement 6C: Clinicians should encourage exclusive breastfeeding for at least 6 months. Evidence Quality: Grade B. Strength: Recommendation.**

**Key Action Statement 6D: Clinicians should encourage avoidance of tobacco smoke exposure. Evidence Quality: Grade C. Strength: Recommendation.**

## INTRODUCTION

In May 2004, the AAP and AAFP published the "Clinical Practice Guideline: Diagnosis and Management of Acute Otitis Media".[1] The guideline offered 8 recommendations ranked according to level of evidence and benefit-harm relationship. Three of the recommendations—diagnostic criteria, observation, and choice of antibiotics—led to significant discussion, especially among experts in the field of otitis media (OM). Also, at the time the guideline was written, information regarding the heptavalent pneumococcal conjugate vaccine (PCV7) was not yet published. Since completion of the guideline in November 2003 and its publication in May 2004, there has been a significant body of additional literature on AOM.

Although OM remains the most common condition for which antibacterial agents are prescribed for children in the United States[2,3] clinician visits for OM decreased from 950 per 1000 children in 1995–1996 to 634 per 1000 children in 2005–2006. There has been a proportional decrease in antibiotic prescriptions for OM from 760 per 1000 in 1995–1996 to 484 per 1000 in 2005–2006. The percentage of OM visits resulting in antibiotic prescriptions remained relatively stable (80% in 1995–1996; 76% in 2005–2006).[2] Many factors may have contributed to the decrease in visits for OM, including financial issues relating to insurance, such as copayments, that may limit doctor visits, public education campaigns regarding the viral nature of most infectious diseases, use of the PCV7 pneumococcal vaccine, and increased use of the influenza vaccine. Clinicians may also be more attentive to differentiating AOM from OM with effusion (OME), resulting in fewer visits coded for AOM and fewer antibiotic prescriptions written.

Despite significant publicity and awareness of the 2004 AOM guideline, evidence shows that clinicians are hesitant to follow the guideline recommendations. Vernacchio et al[4] surveyed 489 primary care physicians as to their management of 4 AOM scenarios addressed in the 2004 guideline. No significant changes in practice were noted on this survey, compared with a survey administered before the 2004 AOM guideline. Coco[5] used the National Ambulatory Medical Care Survey from 2002 through 2006 to determine the frequency of AOM visits without antibiotics before and after publication of the 2004 guideline. There was no difference in prescribing rates. A similar response to otitis guidelines was found in Italy as in the United States.[6,7] These findings parallel results of other investigations regarding clinician awareness and adherence to guideline recommendations in all specialties, including pediatrics.[8] Clearly, for clinical practice guidelines to be effective, more must be done to improve their dissemination and implementation.

This revision and update of the AAP/AAFP 2004 AOM guideline[1] will evaluate published evidence on the diagnosis and management of uncomplicated AOM and make recommendations based on that evidence. The guideline is intended for primary care clinicians including pediatricians and family physicians, emergency department physicians, otolaryngologists, physician assistants, and nurse practitioners. The scope of the guideline is the diagnosis and management of AOM, including recurrent AOM, in children 6 months through 12 years of age. It applies only to an otherwise healthy child without underlying conditions that may alter the natural course of AOM, including but not limited to the presence of tympanostomy tubes; anatomic abnormalities, including cleft palate; genetic conditions with craniofacial abnormalities, such as Down syndrome; immune deficiencies; and the presence of cochlear implants. Children with OME without AOM are also excluded.

### Glossary of Terms

**AOM**—the rapid onset of signs and symptoms of inflammation in the middle ear[9,10]

**Uncomplicated AOM**—AOM without otorrhea[1]

**Severe AOM**—AOM with the presence of moderate to severe otalgia *or* fever equal to or higher than 39°C[9,10]

**Nonsevere AOM**—AOM with the presence of mild otalgia and a temperature below 39°C[9,10]

**Recurrent AOM—**3 or more well-documented and separate AOM episodes in the preceding 6 months *or* 4 or more episodes in the preceding 12 months with at least 1 episode in the past 6 months[11,12]

**OME—**inflammation of the middle ear with liquid collected in the middle ear; the signs and symptoms of acute infection are absent[9]

**MEE**—liquid in the middle ear without reference to etiology, pathogenesis, pathology, or duration[9]

**Otorrhea**—discharge from the ear, originating at 1 or more of the following sites: the external auditory canal,

middle ear, mastoid, inner ear, or intracranial cavity

**Otitis externa**—an infection of the external auditory canal

**Tympanometry**—measuring acoustic immittance (transfer of acoustic energy) of the ear as a function of ear canal air pressure[13,14]

**Number needed to treat (NNT)**—the number of patients who need to be treated to prevent 1 additional bad outcome[15]

**Initial antibiotic therapy**—treatment of AOM with antibiotics that are prescribed at the time of diagnosis with the intent of starting antibiotic therapy as soon as possible after the encounter

**Initial observation—**initial management of AOM limited to symptomatic relief, with commencement of antibiotic therapy only if the child's condition worsens at any time or does not show clinical improvement within 48 to 72 hours of diagnosis; a mechanism must be in place to ensure follow-up and initiation of antibiotics if the child fails observation

## METHODS

Guideline development using an evidence-based approach requires that all evidence related to the guideline is gathered in a systematic fashion, objectively assessed, and then described so readers can easily see the links between the evidence and recommendations made. An evidence-based approach leads to recommendations that are guided by both the quality of the available evidence and the benefit-to-harm ratio that results from following the recommendation. Figure 1 shows the relationship of evidence quality and benefit-harm balance in determining the level of recommendation. Table 1 presents the AAP definitions and implications of different levels of evidence-based recommendations.[16]

In preparing for the 2004 AAP guidelines, the Agency for Healthcare Research and Quality (AHRQ) funded and conducted an exhaustive review of the literature on diagnosis and management of AOM.[17–19] In 2008, the AHRQ and the Southern California Evidence-Based Practice Center began a similar process of reviewing the literature published since the 2001 AHRQ report. The AAP again partnered with AHRQ and the Southern California Evidence-Based Practice Center to develop the evidence report, which served as a major source of data for these practice guideline recommendations.[20,21] New key questions were determined by a technical expert panel. The scope of the new report went beyond the 2001 AHRQ report to include recurrent AOM.

The key questions addressed by AHRQ in the 2010 report were as follows:

1. Diagnosis of AOM: What are the operating characteristics (sensitivity, specificity, and likelihood ratios) of clinical symptoms and otoscopic findings (such as bulging TM) to diagnose uncomplicated AOM and to distinguish it from OME?
2. What has been the effect of the use of heptavalent PCV7 on AOM microbial epidemiology, what organisms (bacterial and viral) are associated with AOM since the introduction of PCV7, and what are the patterns of antimicrobial resistance in AOM since the introduction of PCV7?
3. What is the comparative effectiveness of various treatment options for treating uncomplicated AOM in average risk children?
4. What is the comparative effectiveness of different management options for recurrent OM (uncomplicated) and persistent OM or relapse of AOM?
5. Do treatment outcomes in Questions 3 and 4 differ by characteristics of the condition (AOM), patient, environment, and/or health care delivery system?
6. What adverse effects have been observed for treatments for which outcomes are addressed in Questions 3 and 4?

For the 2010 review, searches of PubMed and the Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, and Education Resources Information Center were conducted by using the same search strategies used for the 2001 report for publications from 1998 through June 2010. Additional terms or conditions not considered in the 2001 review (recurrent OM, new drugs, and heptavalent pneumococcal vaccine) were also included. The Web of Science was also used to search for citations of the 2001 report and its peer-reviewed publications. Titles were screened independently by 2

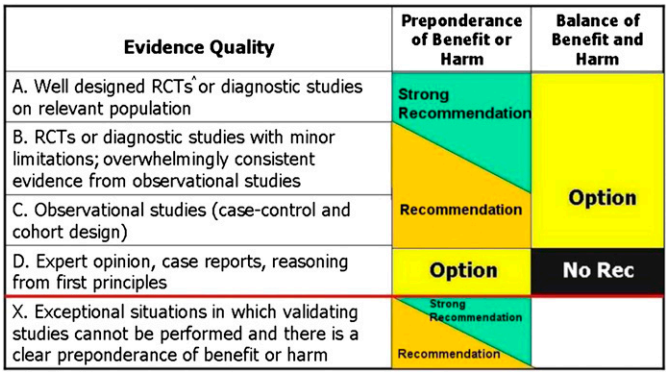


**FIGURE 1**
Relationship of evidence quality and benefit-harm balance in determining the level of recommendation. RCT, randomized controlled trial.

**TABLE 1** Guideline Definitions for Evidence-Based Statements

| Statement | Definition | Implication |
|---|---|---|
| Strong Recommendation | A strong recommendation in favor of a particular action is made when the anticipated benefits of the recommended intervention clearly exceed the harms (as a strong recommendation against an action is made when the anticipated harms clearly exceed the benefits) and the quality of the supporting evidence is excellent. In some clearly identified circumstances, strong recommendations may be made when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms. | Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present. |
| Recommendation | A recommendation in favor of a particular action is made when the anticipated benefits exceed the harms, but the quality of evidence is not as strong. Again, in some clearly identified circumstances, recommendations may be made when high-quality evidence is impossible to obtain but the anticipated benefits outweigh the harms. | Clinicians would be prudent to follow a recommendation but should remain alert to new information and sensitive to patient preferences. |
| Option | Options define courses that may be taken when either the quality of evidence is suspect or carefully performed studies have shown little clear advantage to 1 approach over another. | Clinicians should consider the option in their decision-making, and patient preference may have a substantial role. |
| No Recommendation | No recommendation indicates that there is a lack of pertinent published evidence and that the anticipated balance of benefits and harms is presently unclear. | Clinicians should be alert to new published evidence that clarifies the balance of benefit versus harm. |

pediatricians with experience in conducting systematic reviews.

For the question pertaining to diagnosis, efficacy, and safety, the search was primarily for clinical trials. For the question pertaining to the effect of PCV7 on epidemiology and microbiology, the group searched for trials that compared microbiology in the same populations before and after introduction of the vaccine or observational studies that compared microbiology across vaccinated and unvaccinated populations.

In total, the reviewers examined 7646 titles, of which 686 titles were identified for further review. Of those, 72 articles that met the predetermined inclusion and exclusion criteria were reviewed in detail. Investigators abstracted data into standard evidence tables, with accuracy checked by a second investigator. Studies were quality-rated by 2 investigators by using established criteria. For randomized controlled trials, the Jadad criteria were used.[22] QUADAS criteria[23] were used to evaluate the studies that pertained to diagnosis. GRADE criteria were applied to pooled analyses.[24] Data abstracted included parameters necessary to define study groups, inclusion/exclusion criteria, influencing factors, and outcome measures. Some of the data for analysis were abstracted by a biostatistician and checked by a physician reviewer. A sequential resolution strategy was used to match and resolve the screening and review results of the 2 pediatrician reviewers.

For the assessment of treatment efficacy, pooled analyses were performed for comparisons for which 3 or more trials could be identified. Studies eligible for analyses of questions pertaining to treatment efficacy were grouped for comparisons by treatment options. Each comparison consisted of studies that were considered homogeneous across clinical practice. Because some of the key questions were addressed in the 2001 evidence report,[17] studies identified in that report were included with newly identified articles in the 2010 evidence report.[20]

Decisions were made on the basis of a systematic grading of the quality of evidence and strength of recommendations as well as expert consensus when definitive data were not available. Results of the literature review were presented in evidence tables and published in the final evidence report.[20]

In June 2009, the AAP convened a new subcommittee to review and revise the May 2004 AOM guideline.[1] The subcommittee comprised primary care physicians and experts in the fields of pediatrics, family practice, otolaryngology, epidemiology, infectious disease, emergency medicine, and guideline methodology. All panel members reviewed the AAP policy on conflict of interest and voluntary disclosure and were given an opportunity to present any potential conflicts with the subcommittee's work. All potential conflicts of interest are listed at the end of this document. The project was funded by the AAP. New literature on OM is continually being published. Although the systematic review performed by AHRQ could not be replicated with new literature, members of the Subcommittee on Diagnosis and Management of Acute Otitis Media reviewed additional articles. PubMed was searched by using the single search term "acute otitis media,"

approximately every 6 months from June 2009 through October 2011 to obtain new articles. Subcommittee members evaluated pertinent articles for quality of methodology and importance of results. Selected articles used in the AHRQ review were also reevaluated for their quality. Conclusions were based on the consensus of the subcommittee after the review of newer literature and reevaluation of the AHRQ evidence. Key action statements were generated using BRIDGE-Wiz (Building Recommendations in a Developers Guideline Editor), an interactive software tool that leads guideline development through a series of questions that are intended to create a more actionable set of key action statements.[25] BRIDGE-Wiz also incorporates the quality of available evidence into the final determination of the strength of each recommendation.

After thorough review by the subcommittee for this guideline, a draft was reviewed by other AAP committees and sections, selected outside organizations, and individuals identified by the subcommittee as experts in the field. Additionally, members of the subcommittee were encouraged to distribute the draft to interested parties in their respective specialties. All comments were reviewed by the writing group and incorporated into the final guideline when appropriate.

This clinical practice guideline is not intended as a sole source of guidance in the management of children with AOM. Rather, it is intended to assist clinicians in decision-making. It is not intended to replace clinical judgment or establish a protocol for the care of all children with this condition. These recommendations may not provide the only appropriate approach to the management of children with AOM.

It is AAP policy to review and update evidence-based guidelines every 5 years.

## KEY ACTION STATEMENTS

### Key Action Statement 1A

**Clinicians should diagnose AOM in children who present with moderate to severe bulging of the TM *or* new onset of otorrhea not due to acute otitis externa. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 1A*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | • Identify a population of children most likely to benefit from intervention.<br>• Avoid unnecessary treatment of those without highly certain AOM.<br>• Promote consistency in diagnosis. |
| Risks, harms, cost | May miss AOM that presents with a combination of mild bulging, intense erythema, or otalgia that may not necessarily represent less severe disease and may also benefit from intervention. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Identification of a population of children with highly certain AOM is beneficial. Accurate, specific diagnosis is helpful to the individual patient. Modification of current behavior of overdiagnosis is a goal. Increased specificity is preferred even as sensitivity is lowered. |
| Intentional vagueness | By using stringent diagnostic criteria, the TM appearance of less severe illness that might be early AOM has not been addressed. |
| Role of patient preferences | None |
| Exclusions | None |
| Strength | **Recommendation** |
| Notes | Tympanocentesis studies confirm that using these diagnostic findings leads to high levels of isolation of pathogenic bacteria. Evidence is extrapolated from treatment studies that included tympanocentesis. |

### Key Action Statement 1B

**Clinicians should diagnose AOM in children who present with mild bulging of the TM *and* recent (less than 48 hours) onset of ear pain (holding, tugging, rubbing of the ear in a nonverbal child) or intense erythema of the TM. (Evidence Quality: Grade C, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 1B*

| Aggregate evidence quality | Grade C |
|---|---|
| Benefits | Identify AOM in children when the diagnosis is not highly certain. |
| Risks, harms, cost | Overdiagnosis of AOM. Reduced precision in diagnosis. |
| Benefits-harms assessment | Benefits greater than harms. |
| Value judgments | None. |
| Intentional vagueness | Criteria may be more subjective. |
| Role of patient preferences | None |
| Exclusions | None |
| Strength | **Recommendation** |
| Notes | Recent onset of ear pain means within the past 48 hours. |

### Key Action Statement 1C

**Clinicians should not diagnose AOM in children who do not have MEE (based on pneumatic otoscopy and/or tympanometry). (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 1C*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Reduces overdiagnosis and unnecessary treatment. Increases correct diagnosis of other conditions with symptoms that otherwise might be attributed to AOM. Promotes the use of pneumatic otoscopy and tympanometry to improve diagnostic accuracy. |
| Risks, harms, cost | Cost of tympanometry. Need to acquire or reacquire skills in pneumatic otoscopy and tympanometry for some clinicians. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | AOM is overdiagnosed, often without adequate visualization of the TM. Early AOM without effusion occurs, but the risk of overdiagnosis supersedes that concern. |
| Intentional vagueness | None |
| Role of patient preferences | None |
| Exclusions | Early AOM evidenced by intense erythema of the TM. |
| Strength | **Recommendation** |

## Purpose of This Section

There is no gold standard for the diagnosis of AOM. In fact, AOM has a spectrum of signs as the disease develops.[26] Therefore, the purpose of this section is to provide clinicians and researchers with a working clinical definition of AOM and to differentiate AOM from OME. The criteria were chosen to achieve high specificity recognizing that the resulting decreased sensitivity may exclude less severe presentations of AOM.

## Changes From AAP/AAFP 2004 AOM Guideline

Accurate diagnosis of AOM is critical to sound clinical decision-making and high-quality research. The 2004 "Clinical Practice Guideline: Diagnosis and Management of AOM"[1] used a 3-part definition for AOM: (1) acute onset of symptoms, (2) presence of MEE, and (3) signs of acute middle ear inflammation. This definition generated extensive discussion and reanalysis of the AOM diagnostic evidence. The 2004 definition lacked precision to exclude cases of OME, and diagnoses of AOM could be made in children with acute onset of symptoms, including severe otalgia and MEE, without other otoscopic findings of inflammation.[27] Furthermore, the use of "uncertain diagnosis" in the 2004 AOM guideline may have permitted diagnoses of AOM without clear visualization of the TM. Earlier studies may have enrolled children who had OME rather than AOM, resulting in the possible classification of such children as improved because their nonspecific symptoms would have abated regardless of therapy.[28–30] Two studies, published in 2011, used stringent diagnostic criteria for diagnosing AOM with much less risk of conclusions based on data from mixed patients.[31,32]

Since publication of the 2004 AOM guideline, a number of studies have been conducted evaluating scales for the presence of symptoms. These studies did not show a consistent correlation of symptoms with the initial diagnosis of AOM, especially in preverbal children.[33–35]

Recent research has used precisely stated stringent criteria of AOM for purposes of the studies.[31,32] The current guideline endorses stringent otoscopic diagnostic criteria as a basis for management decisions (described later). As clinicians use the proposed stringent criteria to diagnose AOM, they should be aware that children with AOM may also present with recent onset of ear pain and intense erythema of the TM as the only otoscopic finding.

## Symptoms

Older children with AOM usually present with a history of rapid onset of ear pain. However, in young preverbal children, otalgia as suggested by tugging/rubbing/holding of the ear, excessive crying, fever, or changes in the child's sleep or behavior pattern as noted by the parent are often relatively nonspecific symptoms. A number of studies have attempted to correlate symptom scores with diagnoses of AOM.

A systematic review[36] identified 4 articles that evaluated the accuracy of symptoms.[37–40] Ear pain appeared useful in diagnosing AOM (combined positive likelihood ratio 3.0–7.3, negative likelihood ratio 0.4–0.6); however, it was only present in 50% to 60% of children with AOM. Conclusions from these studies may be limited, because they (1) enrolled children seen by specialists, not likely to represent the whole spectrum of severity of illness; (2) used a clinical diagnosis of AOM based more on symptomatology rather than on tympanocentesis; and (3) included relatively older children.[37,40]

Laine et al[34] used a questionnaire administered to 469 parents who suspected their children, aged 6 to 35 months, had AOM. Of the children, 237 had AOM using strict otoscopic criteria, and 232 had upper respiratory tract infection without AOM. Restless sleep, ear rubbing, fever, and nonspecific respiratory or gastrointestinal

tract symptoms did not differentiate children with or without AOM.

McCormick et al[30] used 2 symptom scores—a 3-item score (OM-3), consisting of symptoms of physical suffering such as ear pain or fever, emotional distress (irritability, poor appetite), and limitation in activity; and a 5-item score (Ear Treatment Group Symptom Questionnaire, 5 Items [ETG-5]), including fever, earache, irritability, decreased appetite, and sleep disturbance—to assess AOM symptoms at the time of diagnosis and daily during the 10-day treatment or observation period. They found both to be a responsive measure of changes in clinical symptoms. The same group[35] also tested a visual scale, Acute Otitis Media-Faces Scale (AOM-FS), with faces similar to the Wong-Baker pain scale.[41] None of the scales were adequately sensitive for making the diagnosis of AOM based on symptoms. The AOM-FS combined with an otoscopy score, OS-8,[30] were presented as a double-sided pocket card. The combination of AOM-FS and OS-8 was more responsive to change than either instrument alone.

Shaikh et al[33,42] validated a 7-item parent-reported symptom score (Acute Otitis Media Severity of Symptom Scale [AOM-SOS]) for children with AOM, following stringent guidance of the US Food and Drug Administration (FDA) on the development of patient-reported outcome scales. Symptoms included ear tugging/rubbing/holding, excessive crying, irritability, difficulty sleeping, decreased activity or appetite, and fever. AOM-SOS was correlated with otoscopic diagnoses (AOM, OME, and normal middle ear status). AOM-SOS changed appropriately in response to clinical change. Its day-to-day responsiveness supports its usefulness in following AOM symptoms over time.

## Signs of AOM

Few studies have evaluated the relationship of otoscopic findings in AOM and tympanocentesis. A study by Karma et al[43] is often cited as the best single study of otoscopic findings in AOM. However, the study uses only a symptom-based diagnosis of AOM plus the presence of MEE. Thus, children with acute upper respiratory tract infection symptoms and OME would have been considered to have AOM. There also were significant differences in findings at the 2 centers that participated in the study.

The investigators correlated TM color, mobility, and position with the presence of middle ear fluid obtained by tympanocentesis. At 2 sites in Finland (Tampere and Oulu), 2911 children were followed from 6 months to 2.5 years of age. A single otolaryngologist at Tampere and a single pediatrician at Oulu examined subjects. Color, position, and mobility were recorded. Myringotomy and aspiration were performed if MEE was suspected. AOM was diagnosed if MEE was found and the child had fever, earache, irritability, ear rubbing or tugging, simultaneous other acute respiratory tract symptoms, vomiting, or diarrhea. The presence or absence of MEE was noted, but no analyses of the fluid, including culture, were performed. Pneumatic otoscopic findings were classified as follows: color—hemorrhagic, strongly red, moderately red, cloudy or dull, slightly red, or normal; position—bulging, retracted, or normal; and mobility—distinctly impaired, slightly impaired, or normal.

For this analysis, 11 804 visits were available. For visits with acute symptoms, MEE was found in 84.9% and 81.8% at the 2 sites at which the study was performed. There were significant differences among the results at the 2 centers involved in the study. Table 2 shows specific data for each finding.

The combination of a "cloudy," bulging TM with impaired mobility was the best predictor of AOM using the symptom-based diagnosis in this study. Impaired mobility had the highest sensitivity and specificity (approximately 95% and 85%, respectively). Cloudiness had the next best combination of high sensitivity (~74%) and high specificity (~93%) in this study. Bulging had high specificity (~97%) but lower sensitivity (~51%). A TM that was hemorrhagic, strongly red, or moderately red also correlated with the presence of AOM, and a TM that was only "slightly red" was not helpful diagnostically.

**TABLE 2** Otoscopic Findings in Children With Acute Symptoms and MEE[a]

| TM Finding in Acute Visits With MEE | Group I (Tampere, Finland), % | Group II (Oulo, Finland), % |
|---|---|---|
| Color | | |
| Distinctly red | 69.8 | 65.6 |
| Hemorrhagic | 81.3 | 62.9 |
| Strongly red | 87.7 | 68.1 |
| Moderately red | 59.8 | 66.0 |
| Slightly red | 39.4 | 16.7 |
| Cloudy | 95.7 | 80.0 |
| Normal | 1.7 | 4.9 |
| Position | | |
| Bulging | 96.0 | 89 |
| Retracted | 46.8 | 48.6 |
| Normal | 32.1 | 22.2 |
| Mobility | | |
| Distinctly impaired | 94.0 | 78.5 |
| Slightly impaired | 59.7 | 32.8 |
| Normal | 2.7 | 4.8 |

[a] Totals are greater than 100%, because each ear may have had different findings.[43]

McCormick et al reported that a bulging TM was highly associated with the presence of a bacterial pathogen, with or without a concomitant viral pathogen.[44] In a small study, 31 children (40 ears) underwent myringotomy.[45] Bulging TMs had positive bacterial cultures 75% of the time. The percentage of positive cultures for a pathogen increased to 80% if the color of the TM was yellow. The conclusion is that moderate to severe bulging of the TM represents the most important characteristic in the diagnosis of AOM—a finding that has

implications for clinical care, research, and education.

The committee recognized that there is a progression from the presence of MEE to the bulging of the TM, and it is often difficult to differentiate this equivocal appearance from the highly certain AOM criteria advocated in this guideline.[26] As such, there is a role for individualized diagnosis and management decisions. Examples of normal, mild bulging, moderate bulging, and severe bulging can be seen in Fig 2.

### Distinguishing AOM From OME

OME may occur either as the aftermath of an episode of AOM or as a consequence of eustachian tube dysfunction attributable to an upper respiratory tract infection.[46] However, OME may also precede and predispose to the development of AOM. These 2 forms of OM may be considered segments of a disease continuum.[47] However, because OME does not represent an acute infectious process that benefits from antibiotics, it is of utmost importance for clinicians to become proficient in distinguishing normal middle ear status from OME or AOM. Doing so will avoid unnecessary use of antibiotics, which leads to increased adverse effects of medication and facilitates the development of antimicrobial resistance.

### Examination of the TM

Accurate diagnosis of AOM in infants and young children may be difficult. Symptoms may be mild or overlap with those of an upper respiratory tract illness. The TM may be obscured by cerumen, and subtle changes in the TM may be difficult to discern. Additional factors complicating diagnosis may include lack of cooperation from the child; less than optimal diagnostic equipment, including lack of a pneumatic bulb; inadequate instruments for clearing cerumen from the external auditory canal; inadequate assistance for restraining the child; and lack of experience in removing cerumen and performing pneumatic otoscopy.

The pneumatic otoscope is the standard tool used in diagnosing OM. Valuable also is a surgical head, which greatly facilitates cleaning cerumen from an infant's external auditory canal. Cerumen may be removed by using a curette, gentle suction, or irrigation.[48] The pneumatic otoscope should have a light source of sufficient brightness and an air-tight seal that permits application of positive and negative pressure. In general, nondisposable specula achieve a better seal with less pain because of a thicker, smoother edge and better light transmission properties. The speculum size should be chosen to gently seal at the outer portion of the external auditory canal.

Pneumatic otoscopy permits assessment of the contour of the TM (normal, retracted, full, bulging), its color (gray, yellow, pink, amber, white, red, blue), its translucency (translucent, semiopaque, opaque), and its mobility (normal, increased, decreased, absent). The normal TM is translucent, pearly gray, and has a ground-glass appearance (Fig 2A). Specific landmarks can be visualized. They include the short process and the manubrium of the malleus and the pars flaccida, located superiorly. These are easily observed and help to identify the position of the TM. Inward movement of the TM on positive pressure in the external canal and outward movement on negative pressure should occur, especially in the superior posterior quadrant. When the TM is retracted, the short process of the malleus becomes more prominent, and the manubrium appears shortened because of its change in position within the middle ear. Inward motion occurring with positive pressure is restricted or absent, because the TM is frequently as far inward as its range of motion allows. However, outward mobility can be visualized when negative pressure is applied. If the TM does not move perceptibly with applications of gentle positive or negative pressure, MEE is likely. Sometimes, the application of pressure will make an air-fluid interface behind the TM (which is diagnostic of MEE) more evident.[49]

Instruction in the proper evaluation of the child's middle ear status should begin with the first pediatric rotation in medical school and continue throughout postgraduate training.[50]

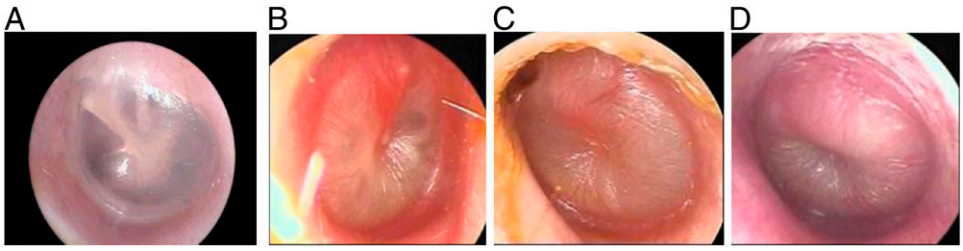


**FIGURE 2**

A, Normal TM. B, TM with mild bulging. C, TM with moderate bulging. D, TM with severe bulging. Courtesy of Alejandro Hoberman, MD.

Continuing medical education should reinforce the importance of, and retrain the clinician in, the use of pneumatic otoscopy.[51] Training tools include the use of a video-otoscope in residency programs, the use of Web-based educational resources,[49,52] as well as simultaneous or sequential examination of TMs with an expert otoscopist to validate findings by using a double headed or video otoscope. Tools for learning the ear examination can be found in a CD distributed by the Johns Hopkins University School of Medicine and the Institute for Johns Hopkins Nursing,[53] also available at http://www2.aap.org/sections/infectdis/video.cfm,[54] and through a Web-based program, ePROM: Enhancing Proficiency in Otitis Media.[52]

### Key Action Statement 2

**The management of AOM should include an assessment of pain. If pain is present, the clinician should recommend treatment to reduce pain. (Evidence Quality: Grade B, Rec. Strength: Strong Recommendation)**

*Key Action Statement Profile: KAS 2*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Relieves the major symptom of AOM. |
| Risks, harms, cost | Potential medication adverse effects. Variable efficacy of some modes of treatment. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Treating pain is essential whether or not antibiotics are prescribed. |
| Intentional vagueness | Choice of analgesic is not specified. |
| Role of patient preferences | Parents may assist in the decision as to what means of pain relief they prefer. |
| Exclusions | Topical analgesics in the presence of a perforated TM. |
| Strength | **Strong Recommendation** |

### Purpose of This Section

Pain is the major symptom of AOM. This section addresses and updates the literature on treating otalgia.

### Changes From AAP/AAFP 2004 AOM Guideline

Only 2 new articles directly address the treatment of otalgia. Both address topical treatment. The 2 new articles are consistent with the 2004 guideline statement. The text of the 2004 guideline is, therefore, reproduced here, with the addition of discussion of the 2 new articles. Table 3 has been updated to include the new references.

### Treatment of Otalgia

Many episodes of AOM are associated with pain.[55] Some children with OME also have ear pain. Although pain is a common symptom in these illnesses, clinicians often see otalgia as a peripheral concern not requiring direct attention.[56] Pain associated with AOM can be substantial in the first few days of illness and often persists longer in young children.[57] Antibiotic therapy of AOM does not provide symptomatic relief in the first 24 hours[58–61] and even after 3 to 7 days, there may be persistent pain, fever, or both in 30% of children younger than 2 years.[62] In contrast, analgesics do relieve pain associated with AOM within 24 hours[63] and should be used whether antibiotic therapy is or is not prescribed; they should be continued as long as needed. The AAP published the policy statement "The Assessment and Management of Acute Pain in Infants, Children, and Adolescents"[64] to assist the clinician in addressing pain in the context of illness. The management of pain, especially during the first 24 hours of an episode of AOM, should be addressed regardless of the use of antibiotics.

Various treatments of otalgia have been used, but none has been well studied. The clinician should select a treatment on the basis of a consideration of benefits and risks and, wherever possible, incorporate parent/caregiver and patient preference (Table 3).

**TABLE 3** Treatments for Otalgia in AOM

| Treatment Modality | Comments |
|---|---|
| Acetaminophen, ibuprofen[63] | Effective analgesia for mild to moderate pain. Readily available. Mainstay of pain management for AOM. |
| Home remedies (no controlled studies that directly address effectiveness) | May have limited effectiveness. |
| Distraction | |
| External application of heat or cold | |
| Oil drops in external auditory canal | |
| Topical agents | |
| Benzocaine, procaine, lidocaine[65,67,70] | Additional, but brief, benefit over acetaminophen in patients older than 5 y. |
| Naturopathic agents[68] | Comparable to amethocaine/phenazone drops in patients older than 6 y. |
| Homeopathic agents[71,72] | No controlled studies that directly address pain. |
| Narcotic analgesia with codeine or analogs | Effective for moderate or severe pain. Requires prescription; risk of respiratory depression, altered mental status, gastrointestinal tract upset, and constipation. |
| Tympanostomy/myringotomy[73] | Requires skill and entails potential risk. |

Since the 2004 guideline was published, there have been only 2 significant new articles.

Bolt et al reported in 2008 on a double-blind placebo-controlled trial at the Australia Children's Hospital emergency department conducted in 2003–2004.[65] They used a convenience sample of children 3 to 17 years of age diagnosed with AOM in the ED. They excluded children with perforation of the TM, pressure-equalizing tube, allergy to local anesthetic or paracetamol, epilepsy, or liver, renal, or cardiac disease. Sixty-three eligible children were randomized to receive aqueous lidocaine or normal saline ear drops up to 3 times in 24 hours. They demonstrated a statistically significant 50% reduction in reported pain at 10 and 30 minutes but not at 20 minutes after application of topical lidocaine, compared with normal saline. Complications were minimal: 3 children reported some dizziness the next day, and none reported tinnitus. A limitation was that some children had received oral acetaminophen before administration of ear drops.

A Cochrane review of topical analgesia for AOM[66] searched the Cochrane register of controlled trials, randomized controlled trials, or quasi-randomized controlled trials that compared otic preparations to placebo or that compared 2 otic preparations. It included studies of adults and children, without TM perforation. It identified 5 trials in children 3 to 18 years of age. Two (including Bolt et al,[65] discussed above) compared anesthetic drops and placebo at diagnosis of AOM. In both studies, some children also received oral analgesics. Three studies compared anesthetic ear drops with naturopathic herbal drops. Naturopathic drops were favored 15 to 30 minutes after installation, and 1 to 3 days after diagnosis, but the difference was not statistically significant. The Cochrane group concluded that there is limited evidence that ear drops are effective at 30 minutes and unclear if results from these studies are a result of the natural course of illness, placebo effect of receiving treatment, soothing effect of any liquid in the ear, or the drops themselves. Three of the studies included in this review were cited in the 2004 AAP guideline[67–69] and the 1 new paper by Bolt et al.[65]

## Key Action Statement 3A

### *Severe AOM*

**The clinician should prescribe antibiotic therapy for AOM (bilateral or unilateral) in children 6 months and older with severe signs or symptoms (ie, moderate or severe otalgia or otalgia for at least 48 hours, or temperature 39°C [102.2°F] or higher). (Evidence Quality: Grade B, Rec. Strength: Strong Recommendation)**

*Key Action Statement Profile: KAS 3A*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Increased likelihood of more rapid resolution of symptoms. Increased likelihood of resolution of AOM. |
| Risks, harms, cost | Adverse events attributable to antibiotics, such as diarrhea, diaper dermatitis, and allergic reactions. Overuse of antibiotics leads to increased bacterial resistance. Cost of antibiotics. |
| Benefits-harms assessment | Preponderance of benefit over harm. |
| Value judgments | None |
| Role of patient preference | None |
| Intentional vagueness | None |
| Exclusions | None |
| Strength | **Strong Recommendation** |

## Key Action Statement 3B

### *Nonsevere Bilateral AOM in Young Children*

**The clinician should prescribe antibiotic therapy for bilateral AOM in children younger than 24 months without severe signs or symptoms (ie, mild otalgia for less than 48 hours, temperature less than 39°C [102.2°F]). (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 3B*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Increased likelihood of more rapid resolution of symptoms. Increased likelihood of resolution of AOM. |
| Risks, harms, cost | Adverse events attributable to antibiotics, such as diarrhea, diaper dermatitis, and allergic reactions. Overuse of antibiotics leads to increased bacterial resistance. Cost of antibiotics. |
| Benefits-harms assessment | Preponderance of benefit over harm. |
| Value judgments | None |
| Role of patient preference | None |
| Intentional vagueness | None |
| Exclusions | None |
| Strength | **Recommendation** |

## Key Action Statement 3C

### *Nonsevere Unilateral AOM in Young Children*

**The clinician should either prescribe antibiotic therapy *or* offer observation with close follow-up based on joint decision-making with the parent(s)/caregiver for unilateral AOM in children 6 months to 23 months of age without severe signs or symptoms (ie, mild otalgia for less than 48 hours, temperature less than 39°C [102.2°F]). When observation is used, a mechanism must be in place to ensure**

**follow-up and begin antibiotic therapy if the child worsens or fails to improve within 48 to 72 hours of onset of symptoms. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 3C*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Moderately increased likelihood of more rapid resolution of symptoms with initial antibiotics. Moderately increased likelihood of resolution of AOM with initial antibiotics. |
| Risks, harms, cost | Adverse events attributable to antibiotics, such as diarrhea, diaper dermatitis, and allergic reactions. Overuse of antibiotics leads to increased bacterial resistance. Cost of antibiotics. |
| Benefits-harms assessment | Moderate degree of benefit over harm. |
| Value judgments | Observation becomes an alternative as the benefits and harms approach balance. |
| Role of patient preference | Joint decision-making with the family is essential before choosing observation. |
| Intentional vagueness | Joint decision-making is highly variable from family to family |
| Exclusions | None |
| Strength | **Recommendation** |
| Note | In the judgment of 1 Subcommittee member (AH), antimicrobial treatment of these children is preferred because of a preponderance of benefit over harm. AH did not endorse Key Action Statement 3C |

## Key Action Statement 3D

### *Nonsevere AOM in Older Children*

**The clinician should either prescribe antibiotic therapy *or* offer observation with close follow-up based on joint decision-making with the parent(s)/caregiver for AOM (bilateral or unilateral) in children 24 months or older without severe signs or symptoms (ie, mild otalgia for less than 48 hours, temperature less than 39°C [102.2°F]). When observation is used, a mechanism must be in place to ensure follow-up and begin antibiotic therapy if the child worsens or fails to improve within 48 to 72 hours of onset of symptoms. (Evidence Quality: Grade B, Rec Strength: Recommendation)**

*Key Action Statement Profile: KAS 3D*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | *Initial antibiotic treatment*: Slightly increased likelihood of more rapid resolution of symptoms; slightly increased likelihood of resolution of AOM. *Initial observation*: Decreased use of antibiotics; decreased adverse effects of antibiotics; decreased potential for development of bacterial resistance. |
| Risks, harms, cost | *Initial antibiotic treatment*: Adverse events attributable to antibiotics such as diarrhea, rashes, and allergic reactions. Overuse of antibiotics leads to increased bacterial resistance. *Initial observation*: Possibility of needing to start antibiotics in 48 to 72 h if the patient continues to have symptoms. Minimal risk of adverse consequences of delayed antibiotic treatment. Potential increased phone calls and doctor visits. |
| Benefits-harms assessment | Slight degree of benefit of initial antibiotics over harm. |
| Value judgments | Observation is an option as the benefits and harms approach balance. |
| Role of patient preference | Joint decision-making with the family is essential before choosing observation. |
| Intentional vagueness | Joint decision-making is highly variable from family to family. |
| Exclusions | None |
| Strength | **Recommendation.** |

## Purpose of This Section

The purpose of this section is to offer guidance on the initial management of AOM by helping clinicians choose between the following 2 strategies:

1. *Initial antibiotic therapy*, defined as treatment of AOM with antibiotics that are prescribed at the time of diagnosis with the intent of starting antibiotic therapy as soon as possible after the encounter.
2. *Initial observation*, defined as initial management of AOM limited to symptomatic relief, with commencement of antibiotic therapy only if the child's condition worsens at any time or does not show clinical improvement within 48 to 72 hours of diagnosis. A mechanism must be in place to ensure follow-up and initiation of antibiotics if the child fails observation.

This section assumes that the clinician has made an accurate diagnosis of AOM by using the criteria and strategies outlined earlier in this guideline. Another assumption is that a clear distinction is made between the role of analgesics and antibiotics in providing symptomatic relief for children with AOM.

## Changes From Previous AOM Guideline

The AOM guideline published by the AAP and AAFP in 2004 proposed, for the first time in North America, an "observation option" for selected children with AOM, building on successful implementation of a similar policy in the state of New York[74] and the use of a similar paradigm in many countries in Europe. A common feature of both approaches was to prioritize initial antibiotic therapy according to diagnostic certainty, with greater reliance on observation when the diagnosis was uncertain. In response to criticism that allowing an "uncertain

diagnosis" might condone incomplete visualization of the TM or allow inappropriate antibiotic use, this category has been eliminated with greater emphasis now placed on maximizing diagnostic accuracy for AOM.

Since the earlier AOM guideline was published, there has been substantial new research on initial management of AOM, including randomized controlled trials of antibiotic therapy versus placebo or no therapy,[31,32,75] immediate versus delayed antibiotic therapy,[30,76,77] or delayed antibiotic with or without a concurrent prescription.[78] The Hoberman and Tähtinen articles are especially important as they used stringent criteria for diagnosing AOM.[31,32] Systematic reviews have been published on delayed antibiotic therapy,[79] the natural history of AOM in untreated children,[57] predictive factors for antibiotic benefits,[62] and the effect of antibiotics on asymptomatic MEE after therapy.[80] Observational studies provide additional data on outcomes of initial observation with delayed antibiotic therapy, if needed,[81] and on the relationship of previous antibiotic therapy for AOM to subsequent acute mastoiditis.[82,83]

In contrast to the earlier AOM guideline,[1] which recommended antibiotic therapy for all children 6 months to 2 years of age with a certain diagnosis, the current guideline indicates a choice between initial antibiotic therapy or initial observation in this age group for children with unilateral AOM and mild symptoms but only after joint decision-making with the parent(s)/caregiver (Table 4). This change is supported by evidence on the safety of observation or delayed prescribing in young children.[30,31,32,75,76,81] A mechanism must be in place to ensure follow-up and begin antibiotics if the child fails observation.

## Importance of Accurate Diagnosis

The recommendations for management of AOM assume an accurate diagnosis on the basis of criteria outlined in the diagnosis section of this guideline. Many of the studies since the 2004 AAP/AAFP AOM guideline[1] used more stringent and well-defined AOM diagnostic definitions than were previously used. Bulging of the TM was required for diagnosis of AOM for most of the children enrolled in the most recent studies.[31,32] By using the criteria in this guideline, clinicians will more accurately distinguish AOM from OME. The management of OME can be found in guidelines written by the AAP, AAFP, and American Academy of Otolaryngology-Head and Neck Surgery.[84,85]

**TABLE 4** Recommendations for Initial Management for Uncomplicated AOM[a]

| Age | Otorrhea With AOM[a] | Unilateral or Bilateral AOM[a] With Severe Symptoms[b] | Bilateral AOM[a] Without Otorrhea | Unilateral AOM[a] Without Otorrhea |
|---|---|---|---|---|
| 6 mo to 2 y | Antibiotic therapy | Antibiotic therapy | Antibiotic therapy | Antibiotic therapy or additional observation |
| ≥2 y | Antibiotic therapy | Antibiotic therapy | Antibiotic therapy or additional observation | Antibiotic therapy or additional observation[c] |

[a] Applies only to children with well-documented AOM with high certainty of diagnosis (see Diagnosis section).
[b] A toxic-appearing child, persistent otalgia more than 48 h, temperature ≥39°C (102.2°F) in the past 48 h, or if there is uncertain access to follow-up after the visit.
[c] This plan of initial management provides an opportunity for shared decision-making with the child's family for those categories appropriate for additional observation. If observation is offered, a mechanism must be in place to ensure follow-up and begin antibiotics if the child worsens or fails to improve within 48 to 72 h of AOM onset.

## Age, Severity of Symptoms, Otorrhea, and Laterality

Rovers et al[62] performed a systematic search for AOM trials that (1) used random allocation of children, (2) included children 0 to 12 years of age with AOM, (3) compared antibiotics with placebo or no treatment, and (4) had pain or fever as an outcome. The original investigators were asked for their original data.

Primary outcome was pain and/or fever (>38°C) at 3 to 7 days. The adverse effects of antibiotics were also analyzed. Baseline predictors were age <2 years versus ≥2 years, bilateral AOM versus unilateral AOM, and the presence versus absence of otorrhea. Statistical methods were used to assess heterogeneity and to analyze the data.

Of the 10 eligible studies, the investigators of 6 studies[30,75,86–89] provided the original data requested, and 4 did not. A total of 1642 patients were included in the 6 studies from which data were obtained. Of the cases submitted, the average age was 3 to 4 years, with 35% of children younger than 2 years. Bilateral AOM was present in 34% of children, and 42% of children had a bulging TM. Otorrhea was present in 21% of children. The antibiotic and control groups were comparable for all characteristics.

The rate difference (RD) for pain, fever, or both between antibiotic and control groups was 13% (NNT = 8). For children younger than 2 years, the RD was 15% (NNT = 7); for those ≥2 years, RD was 11% (NNT = 10). For unilateral AOM, the RD was 6% (NNT = 17); for bilateral AOM, the RD was 20% (NNT = 5). When unilateral AOM was broken into age groups, among those younger than 2 years, the RD was 5% (NNT = 20), and among those ≥2 years, the RD was 7% (NNT = 15). For bilateral AOM in children younger than 2 years, the RD was 25% (NNT = 4); for

bilateral AOM in children ≥2 years, the RD was 12% (NNT = 9). For otorrhea, the RD was 36% (NNT = 3). One child in the control group who developed meningitis had received antibiotics beginning on day 2 because of worsening status. There were no cases of mastoiditis.

In a Cochrane Review, Sanders et al[59] identified 10 studies that met the following criteria: (1) randomized controlled trial, (2) compared antibiotic versus placebo or antibiotic versus observation, (3) age 1 month to 15 years, (4) reported severity and duration of pain, (5) reported adverse events, and (6) reported serious complications of AOM, recurrent attacks, and hearing problems. Studies were analyzed for risk of bias and assessment of heterogeneity. The studies were the same as analyzed by Rovers et al[62] but included the 4 studies for which primary data were not available to Rovers.[60,61,90,91]

The authors' conclusions were that antibiotics produced a small reduction in the number of children with pain 2 to 7 days after diagnosis. They also concluded that most cases spontaneously remitted with no complications (NNT = 16). Antibiotics were most beneficial in children younger than 2 years with bilateral AOM and in children with otorrhea.

Two recent studies only included children younger than 3 years[32] or younger than 2 years.[31] Both included only subjects in whom the diagnosis of AOM was certain. Both studies used improvement of symptoms and improvement in the appearance of the TM in their definitions of clinical success or failure.

Hoberman et al[31] conducted a randomized, double-blind, placebo-controlled study of the efficacy of antimicrobial treatment on AOM. The criteria for AOM were acute symptoms with a score of at least 3 on the AOM-SOS, a validated symptom scale[33,92]; MEE; and moderate or marked bulging of the TM or slight bulging accompanied by either otalgia or marked erythema of the TM. They chose to use high-dose amoxicillin-clavulanate (90 mg/kg/day) as active treatment, because it has the best oral antibiotic coverage for organisms causing AOM. Included in the study were 291 patients 6 to 23 months of age: 144 in the antibiotic group and 147 in the placebo group. The primary outcome measures were the time to resolution of symptoms and the symptom burden over time. The initial resolution of symptoms (ie, the first recording of an AOM-SOS score of 0 or 1) was recorded among the children who received amoxicillin-clavulanate in 35% by day 2, 61% by day 4, and 80% by day 7. Among children who received placebo, an AOM-SOS score of 0 or 1 was recorded in 28% by day 2, 54% by day 4, and 74% by day 7 ($P = .14$ for the overall comparison). For sustained resolution of symptoms (ie, the time to the second of 2 successive recordings of an AOM-SOS score of 0 or 1), the corresponding values were 20% at day 2, 41% at day 4, and 67% at day 7 with amoxicillin-clavulanate, compared with 14%, 36%, and 53% with placebo ($P = .04$ for the overall comparison). The symptom burden (ie, mean AOM-SOS scores) over the first 7 days were lower for the children treated with amoxicillin-clavulanate than for those who received placebo ($P = .02$). Clinical failure at or before the 4- to 5-day visit was defined as "either a lack of substantial improvement in symptoms, a worsening of signs on otoscopic examination, or both," and clinical failure at the 10- to 12-day visit was defined as "the failure to achieve complete or nearly complete resolution of symptoms and of otoscopic signs, without regard to the persistence or resolution of middle ear effusion." Treatment failure occurred by day 4 to 5 in 4% of the antimicrobial treatment group versus 23% in the placebo group ($P < .001$) and at day 10 to 12 in 16% of the antimicrobial treatment group versus 51% in the placebo group (NNT = 2.9, $P < .001$). In a comparison of outcome in unilateral versus bilateral AOM, clinical failure rates by day 10 to 12 in children with unilateral AOM were 9% in those treated with amoxicillin-clavulanate versus 41% in those treated with placebo (RD, 32%; NNT = 3) and 23% vs 60% (RD, 37%; NNT = 3) in those with bilateral AOM. Most common adverse events were diarrhea (25% vs 15% in the treatment versus placebo groups, respectively; $P = .05$) and diaper dermatitis (51% vs 35% in the treatment versus placebo groups, respectively; $P = .008$). One placebo recipient developed mastoiditis. According to these results, antimicrobial treatment of AOM was more beneficial than in previous studies that used less stringent diagnostic criteria.

Tähtinen et al[32] conducted a randomized, double-blind, placebo-controlled, intention-to-treat study of amoxicillin-clavulanate (40 mg/kg/day) versus placebo. Three hundred nineteen patients from 6 to 35 months of age were studied: 161 in the antibiotic group and 158 in the placebo group. AOM definition was the presence of MEE, distinct erythema over a bulging or yellow TM, and acute symptoms such as ear pain, fever, or respiratory symptoms. Compliance was measured by using daily patient diaries and number of capsules remaining at the end of the study. Primary outcome was time to treatment failure defined as a composite of 6 independent components: no improvement in overall condition by day 3, worsening of the child's condition at any time, no improvement in otoscopic signs by day 8, perforation of the TM,

development of severe infection (eg, pneumonia, mastoiditis), and any other reason for stopping the study drug/placebo.

Groups were comparable on multiple parameters. In the treatment group, 135 of 161 patients (84%) were younger than 24 months, and in the placebo group, 124 of 158 patients (78%) were younger than 24 months. Treatment failure occurred in 18.6% of the treatment group and 44.9% in the placebo group (NNT = 3.8, $P < .001$). Rescue treatment was needed in 6.8% of the treatment group and 33.5% of placebo patients ($P < .001$). Contralateral AOM developed in 8.2% and 18.6% of treatment and placebo groups, respectively ($P = .007$). There was no significant difference in use of analgesic or antipyretic medicine, which was used in 84.2% of the amoxicillin-clavulanate group and 85.9% of the placebo group.

Parents of child care attendees on placebo missed more days of work ($P = .005$). Clinical failure rates in children with unilateral AOM were 17.2% in those treated with amoxicillin-clavulanate versus 42.7% in those treated with placebo; for bilateral AOM, clinical failure rates were 21.7% for those treated with amoxicillin-clavulanate versus 46.3% in the placebo group. Reported rates of treatment failure by day 8 were 17.2% in the amoxicillin-clavulanate group versus 42.7% in the placebo group in children with unilateral AOM and 21.7% vs 46.3% among those with bilateral disease.

Adverse events, primarily diarrhea and/or rash, occurred in 52.8% of the treatment group and 36.1% of the placebo group ($P = .003$). Overall condition as evaluated by the parents and otoscopic appearance of the TM showed a benefit of antibiotics over placebo at the end of treatment visit ($P < .001$). Two placebo recipients developed a severe infection; 1 developed pneumococcal bacteremia, and 1 developed radiographically confirmed pneumonia.

Most studies have excluded children with severe illness and all exclude those with bacterial disease other than AOM (pneumonia, mastoiditis, meningitis, streptococcal pharyngitis). Kaleida et al[91] compared myringotomy alone with myringotomy plus antibiotics. Severe AOM was defined as temperature >39°C (102.2°F) or the presence of severe otalgia. Patients with severe AOM in the group that received only myringotomy (without initial antibiotics) had much worse outcomes.

## Initial Antibiotic Therapy

The rationale for antibiotic therapy in children with AOM is based on a high prevalence of bacteria in the accompanying MEE.[93] Bacterial and viral cultures of middle ear fluid collected by tympanocentesis from children with AOM showed 55% with bacteria only and 15% with bacteria and viruses. A beneficial effect of antibiotics on AOM was first demonstrated in 1968,[94] followed by additional randomized trials and a meta-analysis[95] showing a 14% increase in absolute rates of clinical improvement. Systematic reviews of the literature published before 2011[21,59,62] revealed increases of clinical improvement with initial antibiotics of 6% to 12%.

Randomized clinical trials using stringent diagnostic criteria for AOM in young children[31,32] show differences in clinical improvement of 26% to 35% favoring initial antibiotic treatment as compared with placebo. Greater benefit of immediate antibiotic therapy was observed for bilateral AOM[62,96] or AOM associated with otorrhea.[62] In most randomized trials,[30,75,77,88,89] antibiotic therapy also decreased the duration of pain, analgesic use, or school absence and parent days missed from work.

Children younger than 2 years with AOM may take longer to improve clinically than older children,[57] and although they are more likely to benefit from antibiotics,[31,32] AOM in many children will resolve without antibiotics.[62] A clinically significant benefit of immediate antibiotic therapy is observed for bilateral AOM,[62,96] *Streptococcus pneumoniae* infection, or AOM associated with otorrhea.[62]

## Initial Observation for AOM

In systematic reviews of studies that compare antibiotic therapy for AOM with placebo, a consistent finding has been the overall favorable natural history in control groups (NNT = 8–16).[12,59,62,95] However, randomized trials in these reviews had varying diagnostic criteria that would have permitted inclusion of some children with OME, viral upper respiratory infections, or myringitis, thereby limiting the ability to apply these findings to children with a highly certain AOM diagnosis. In more recent AOM studies[31,32] using stringent diagnostic criteria, approximately half of young children (younger than 2–3 years) experienced clinical success when given placebo, but the effect of antibiotic therapy was substantially greater than suggested by studies without precise diagnosis (NNT = 3–4).

Observation as initial management for AOM in properly selected children does not increase suppurative complications, provided that follow-up is ensured and a rescue antibiotic is given for persistent or worsening symptoms.[17] In contrast, withholding of antibiotics in all children with AOM, regardless of clinical course, would risk a return to the suppurative complications observed in the

preantibiotic era. At the population level, antibiotics halve the risk of mastoiditis after AOM, but the high NNT of approximately 4800 patients to prevent 1 case of mastoiditis precludes a strategy of universal antibiotic therapy as a means to prevent mastoiditis.[83]

The favorable natural history of AOM makes it difficult to demonstrate significant differences in efficacy between antibiotic and placebo when a successful outcome is defined by relief or improvement of presenting signs and symptoms. In contrast, when otoscopic improvement (resolution of TM bulging, intense erythema, or both) is also required for a positive outcome,[31,32] the NNT is 3 to 4, compared with 8 to 16 for symptom improvement alone in older studies that used less precise diagnostic criteria. MEE, however, may persist for weeks or months after an AOM episode and is not a criterion for otoscopic failure.

National guidelines for initial observation of AOM in select children were first implemented in the Netherlands[97] and subsequently in Sweden,[98] Scotland,[99] the United States,[1] the United Kingdom,[100] and Italy.[101] All included observation as an initial treatment option under specified circumstances.

In numerous studies, only approximately one-third of children initially observed received a rescue antibiotic for persistent or worsening AOM,[30,32,76,81,89,102] suggesting that antibiotic use could potentially be reduced by 65% in eligible children. Given the high incidence of AOM, this reduction could help substantially in curtailing antibiotic-related adverse events.

McCormick et al[30] reported on 233 patients randomly assigned to receive immediate antibiotics (amoxicillin, 90 mg/kg/day) or to undergo watchful waiting. Criteria for inclusion were symptoms of ear infection, otoscopic evidence of AOM, and nonsevere AOM based on a 3-item symptom score (OM-3) and TM appearance based on an 8-item scale (OS-8). Primary outcomes were parent satisfaction with AOM care, resolution of AOM symptoms after initial treatment, AOM failure and recurrence, and nasopharyngeal carriage of *S pneumoniae* strains resistant to antibiotics after treatment. The study was confounded by including patients who had received antibiotics in the previous 30 days.

In the watchful waiting group, 66% of children completed the study without antibiotics. There was no difference in parent satisfaction scores at day 12. A 5-item symptom score (ETG-5) was assessed at days 0 to 10 by using patient diaries. Subjects receiving immediate antibiotics resolved their symptoms faster than did subjects who underwent watchful waiting ($P$ = .004). For children younger than 2 years, the difference was greater ($P$ = .008). Otoscopic and tympanogram scores were also lower in the antibiotic group as opposed to the watchful waiting group ($P$ = .02 for otoscopic score, $P$ = .004 for tympanogram). Combining all ages, failure and recurrence rates were lower for the antibiotic group (5%) than for the watchful waiting group (21%) at 12 days. By day 30, there was no difference in failure or recurrence for the antibiotic and watchful waiting groups (23% and 24%, respectively). The association between clinical outcome and intervention group was not significantly different between age groups. Immediate antibiotics resulted in eradication of *S pneumoniae* carriage in the majority of children, but *S pneumoniae* strains cultured from children in the antibiotic group at day 12 were more likely to be multidrug resistant than were strains cultured from children in the watchful waiting group.

The decision not to give initial antibiotic treatment and observe should be a joint decision of the clinician and the parents. In such cases, a system for close follow-up and a means of beginning antibiotics must be in place if symptoms worsen or no improvement is seen in 48 to 72 hours.

Initial observation of AOM should be part of a larger management strategy that includes analgesics, parent information, and provisions for a rescue antibiotic. Education of parents should include an explanation about the self-limited nature of most episodes of AOM, especially in children 2 years and older; the importance of pain management early in the course; and the potential adverse effects of antibiotics. Such an approach can substantially reduce prescription fill rates for rescue antibiotics.[103]

A critical component of any strategy involving initial observation for AOM is the ability to provide a rescue antibiotic if needed. This is often done by using a "safety net" or a "wait-and-see prescription,"[76,102] in which the parent/caregiver is given an antibiotic prescription during the clinical encounter but is instructed to fill the prescription only if the child fails to improve within 2 to 3 days or if symptoms worsen at any time. An alternative approach is not to provide a written prescription but to instruct the parent/caregiver to call or return if the child fails to improve within 2 to 3 days or if symptoms worsen.

In one of the first major studies of observation with a safety-net antibiotic prescription (SNAP), Siegel et al[102] enrolled 194 patients with protocol defined AOM, of whom 175 completed the study. Eligible patients were given a SNAP with instructions to fill the prescription only if symptoms worsened or did not improve in 48 hours. The SNAP was valid for 5 days. Pain medicine was recommended to be taken as needed. A phone interview was conducted 5 to 10 days after diagnosis.

One hundred twenty of 175 families did not fill the prescription. Reasons for filling the prescription (more than 1 reason per patient was acceptable) were as follows: continued pain, 23%; continued fever, 11%; sleep disruption, 6%; missed days of work, 3%; missed days of child care, 3%; and no reason given, 5%. One 16-month-old boy completed observation successfully but 6 weeks later developed AOM in the opposite ear, was treated with antibiotics, and developed postauricular cellulitis.

In a similar study of a "wait-and-see prescription" (WASP) in the emergency department, Spiro et al[76] randomly assigned 283 patients to either a WASP or standard prescription. Clinicians were educated on the 2004 AAP diagnostic criteria and initial treatment options for AOM; however, diagnosis was made at the discretion of the clinician. Patients were excluded if they did not qualify for observation per the 2004 guidelines. The primary outcome was whether the prescription was filled within 3 days of diagnosis. Prescriptions were not filled for 62% and 13% of the WASP and standard prescription patients, respectively ($P < .001$). Reasons for filling the prescription in the WASP group were fever (60%), ear pain (34%), or fussy behavior (6%). No serious adverse events were reported.

Strategies to observe children with AOM who are likely to improve on their own without initial antibiotic therapy reduces common adverse effects of antibiotics, such as diarrhea and diaper dermatitis. In 2 trials, antibiotic therapy significantly increased the absolute rates of diarrhea by 10% to 20% and of diaper rash or dermatitis by 6% to 16%.[31,32] Reduced antibiotic use may also reduce the prevalence of resistant bacterial pathogens. Multidrug-resistant *S pneumoniae* continues to be a significant concern for AOM, despite universal immunization of children in the United States with heptavalent pneumococcal conjugate vaccine.[104,105] In contrast, countries with low antibiotic use for AOM have a low prevalence of resistant nasopharyngeal pathogens in children.[106]

### Key Action Statement 4A

**Clinicians should prescribe amoxicillin for AOM when a decision to treat with antibiotics has been made *and* the child has not received amoxicillin in the past 30 days *or* the child does not have concurrent purulent conjunctivitis *or* the child is not allergic to penicillin. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 4A*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Effective antibiotic for most children with AOM. Inexpensive, safe, acceptable taste, narrow antimicrobial spectrum. |
| Risks, harms, cost | Ineffective against β-lactamase–producing organisms. Adverse effects of amoxicillin. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Better to use a drug that has reasonable cost, has an acceptable taste, and has a narrow antibacterial spectrum. |
| Intentional vagueness | The clinician must determine whether the patient is truly penicillin allergic. |
| Role of patient preferences | Should be considered if previous bad experience with amoxicillin. |
| Exclusions | Patients with known penicillin allergy. |
| Strength | **Recommendation.** |

### Key Action Statement 4B

**Clinicians should prescribe an antibiotic with additional β-lactamase coverage for AOM when a decision to treat with antibiotics has been made *and* the child has received amoxicillin in the past 30 days *or* has concurrent purulent conjunctivitis *or* has a history of recurrent AOM unresponsive to amoxicillin. (Evidence Quality: Grade C, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 4B*

| Aggregate evidence quality | Grade C |
|---|---|
| Benefits | Successful treatment of β-lactamase–producing organisms. |
| Risks, harms, cost | Cost of antibiotic. Increased adverse effects. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Efficacy is more important than taste. |
| Intentional vagueness | None. |
| Role of patient preferences | Concern regarding side effects and taste. |
| Exclusions | Patients with known penicillin allergy. |
| Strength | **Recommendation** |

### Key Action Statement 4C

**Clinicians should reassess the patient if the caregiver reports that the child's symptoms have worsened or failed to respond to the initial antibiotic treatment within 48 to 72 hours and determine whether a change in therapy is needed. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 4C*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Identify children who may have AOM caused by pathogens resistant to previous antibiotics. |
| Risks, harms, cost | Cost. Time for patient and clinician to make change. Potential need for parenteral medication. |
| Benefit-harm assessment | Preponderance of benefit. |
| Value judgments | None. |
| Intentional vagueness | "Reassess" is not defined. The clinician may determine the method of assessment. |
| Role of patient preferences | Limited. |
| Exclusions | Appearance of TM improved. |
| Strength | **Recommendation** |

## Purpose of This Section

If an antibiotic will be used for treatment of a child with AOM, whether as initial management or after a period of observation, the clinician must choose an antibiotic that will have a high likelihood of being effective against the most likely etiologic bacterial pathogens with considerations of cost, taste, convenience, and adverse effects. This section proposes first- and second-line antibiotics that best meet these criteria while balancing potential benefits and harms.

## Changes From AAP/AAFP 2004 AOM Guideline

Despite new data on the effect of PCV7 and updated data on the in vitro susceptibility of bacterial pathogens most likely to cause AOM, the recommendations for the first-line antibiotic remains unchanged from 2004. The current guideline contains revised recommendations regarding penicillin allergy based on new data. The increase of multidrug-resistant strains of pneumococci is noted.

## Microbiology

Microorganisms detected in the middle ear during AOM include pathogenic bacteria, as well as respiratory viruses.[107–110] AOM occurs most frequently as a consequence of viral upper respiratory tract infection,[111–113] which leads to eustachian tube inflammation/dysfunction, negative middle ear pressure, and movement of secretions containing the upper respiratory tract infection causative virus and pathogenic bacteria in the nasopharynx into the middle ear cleft. By using comprehensive and sensitive microbiologic testing, bacteria and/or viruses can be detected in the middle ear fluid in up to 96% of AOM cases (eg, 66% bacteria and viruses together, 27% bacteria alone, and 4% virus alone).[114] Studies using less sensitive or less comprehensive microbiologic assays have yielded less positive results for bacteria and much less positive results for viruses.[115–117] The 3 most common bacterial pathogens in AOM are *S pneumoniae*, nontypeable *Haemophilus influenzae*, and *Moraxella catarrhalis*.[111] *Streptococcus pyogenes* (group A β-hemolytic streptococci) accounts for less than 5% of AOM cases. The proportion of AOM cases with pathogenic bacteria isolated from the middle ear fluids varies depending on bacteriologic techniques, transport issues, and stringency of AOM definition. In series of reports from the United States and Europe from 1952–1981 and 1985–1992, the mean percentage of cases with bacterial pathogens isolated from the middle ear fluids was 69% and 72%, respectively.[118] A large series from the University of Pittsburgh Otitis Media Study Group reported bacterial pathogens in 84% of the middle ear fluids from 2807 cases of AOM.[118] Studies that applied more stringent otoscopic criteria and/or use of bedside specimen plating on solid agar in addition to liquid transport media have a reported rate of recovery of pathogenic bacteria from middle ear exudates ranging from 85% to 90%.[119–121] When using appropriate stringent diagnostic criteria, careful specimen handling, and sensitive microbiologic techniques, the vast majority of cases of AOM will involve pathogenic bacteria either alone or in concert with viral pathogens.

Among AOM bacterial pathogens, *S pneumoniae* was the most frequently cultured in earlier reports. Since the debut and routine use of PCV7 in 2000, the ordinal frequency of these 3 major middle ear pathogens has evolved.[105] In the first few years after PCV7 introduction, *H influenzae* became the most frequently isolated middle ear pathogen, replacing *S pneumoniae*.[122,123] Shortly thereafter, a shift to non-PCV7 serotypes of *S pneumoniae* was described.[124] Pichichero et al[104] later reported that 44% of 212 AOM cases seen in 2003–2006 were caused by *H influenzae*, and 28% were caused by *S pneumoniae*, with a high proportion of highly resistant *S pneumoniae*. In that study, a majority (77%) of cases involved recurrent disease or initial treatment failure. A later report[125] with data from 2007 to 2009, 6 to 8 years after the introduction of PCV7 in the United States, showed that PCV7 strains of *S pneumoniae* virtually disappeared from the middle ear fluid of children with AOM who had been vaccinated. However, the frequency of isolation of non-PCV7 serotypes of *S pneumoniae* from the middle ear fluid overall was increased; this has made isolation of *S pneumoniae* and *H influenzae* of children with AOM nearly equal.

In a study of tympanocentesis over 4 respiratory tract illness seasons in a private practice, the percentage of

*S pneumoniae* initially decreased relative to *H influenzae*. In 2005–2006 (*N* = 33), 48% of bacteria were *S pneumoniae*, and 42% were *H influenzae*. For 2006–2007 (*N* = 37), the percentages were equal at 41%. In 2007–2008 (*N* = 34), 35% were *S pneumoniae*, and 59% were *H influenzae*. In 2008–2009 (*N* = 24), the percentages were 54% and 38%, respectively, with an increase in intermediate and nonsusceptible *S pneumoniae*.[126] Data on nasopharyngeal colonization from PCV7-immunized children with AOM have shown continued presence of *S pneumoniae* colonization. Revai et al[127] showed no difference in *S pneumoniae* colonization rate among children with AOM who have been unimmunized, underimmunized, or fully immunized with PCV7. In a study during a viral upper respiratory tract infection, including mostly PCV7-immunized children (6 months to 3 years of age), *S pneumoniae* was detected in 45.5% of 968 nasopharyngeal swabs, *H influenzae* was detected in 32.4%, and *M catarrhalis* was detected in 63.1%.[128] Data show that nasopharyngeal colonization of children vaccinated with PCV7 increasingly is caused by *S pneumoniae* serotypes not contained in the vaccine.[129–132] With the use of the recently licensed 13-valent pneumococcal conjugate vaccine (PCV13),[133] the patterns of nasopharyngeal colonization and infection with these common AOM bacterial pathogens will continue to evolve.

Investigators have attempted to predict the type of AOM pathogenic bacteria on the basis of clinical severity, but results have not been promising. *S pyogenes* has been shown to occur more commonly in older children[134] and to cause a greater degree of inflammation of the middle ear and TM, a greater frequency of spontaneous rupture of the TM, and more frequent progression to acute mastoiditis compared with other bacterial pathogens.[134–136] As for clinical findings in cases with *S pneumoniae* and nontypeable *H influenzae*, some studies suggest that signs and symptoms of AOM caused by *S pneumoniae* may be more severe (fever, severe earache, bulging TM) than those caused by other pathogens.[44,121,137] These findings were refuted by results of the studies that found AOM caused by nontypeable *H influenzae* to be associated with bilateral AOM and more severe inflammation of the TM.[96,138] Leibovitz et al[139] concluded, in a study of 372 children with AOM caused by *H influenzae* (*N* = 138), *S pneumoniae* (*N* = 64), and mixed *H influenzae* and *S pneumoniae* (*N* = 64), that clinical/otologic scores could not discriminate among various bacterial etiologies of AOM. However, there were significantly different clinical/otologic scores between bacterial culture negative and culture positive cases. A study of middle ear exudates of 82 cases of bullous myringitis has shown a 97% bacteria positive rate, primarily *S pneumoniae*. In contrast to the previous belief, mycoplasma is rarely the causative agent in this condition.[140] Accurate prediction of the bacterial cause of AOM on the basis of clinical presentation, without bacterial culture of the middle ear exudates, is not possible, but specific etiologies may be predicted in some situations. Published evidence has suggested that AOM associated with conjunctivitis (otitis-conjunctivitis syndrome) is more likely caused by nontypeable *H influenzae* than by other bacteria.[141–143]

## Bacterial Susceptibility to Antibiotics

Selection of antibiotic to treat AOM is based on the suspected type of bacteria and antibiotic susceptibility pattern, although clinical pharmacology and clinical and microbiologic results and predicted compliance with the drug are also taken into account. Early studies of AOM patients show that 19% of children with *S pneumoniae* and 48% with *H influenzae* cultured on initial tympanocentesis who were not treated with antibiotic cleared the bacteria at the time of a second tympanocentesis 2 to 7 days later.[144] Approximately 75% of children infected with *M catarrhalis* experienced bacteriologic cure even after treatment with amoxicillin, an antibiotic to which it is not susceptible.[145,146]

Antibiotic susceptibility of major AOM bacterial pathogens continues to change, but data on middle ear pathogens have become scanty because tympanocentesis is not generally performed in studies of children with uncomplicated AOM. Most available data come from cases of persistent or recurrent AOM. Current US data from a number of centers indicates that approximately 83% and 87% of isolates of *S pneumoniae* from all age groups are susceptible to regular (40 mg/kg/day) and high-dose amoxicillin (80–90 mg/kg/day divided twice daily), respectively.[130,147–150] Pediatric isolates are smaller in number and include mostly ear isolates collected from recurrent and persistent AOM cases with a high percentage of multidrug-resistant *S pneumoniae*, most frequently nonvaccine serotypes that have recently increased in frequency and importance.[104]

High-dose amoxicillin will yield middle ear fluid levels that exceed the minimum inhibitory concentration (MIC) of all *S pneumoniae* serotypes that are intermediately resistant to penicillin (penicillin MICs, 0.12–1.0 μg/mL), and many but not all highly resistant serotypes (penicillin MICs, ≥2 μg/mL) for a longer period of the dosing interval and has been shown to improve bacteriologic and clinical efficacy

compared with the regular dose.[151–153] Hoberman et al[154] reported superior efficacy of high-dose amoxicillin-clavulanate in eradication of *S pneumoniae* (96%) from the middle ear at days 4 to 6 of therapy compared with azithromycin.

The antibiotic susceptibility pattern for *S pneumoniae* is expected to continue to evolve with the use of PCV13, a conjugate vaccine containing 13 serotypes of *S pneumoniae*.[133,155,156] Widespread use of PCV13 could potentially reduce diseases caused by multidrug-resistant pneumococcal serotypes and diminish the need for the use of higher dose of amoxicillin or amoxicillin-clavulanate for AOM.

Some *H influenzae* isolates produce β-lactamase enzyme, causing the isolate to become resistant to penicillins. Current data from different studies with non-AOM sources and geographic locations that may not be comparable show that 58% to 82% of *H influenzae* isolates are susceptible to regular- and high-dose amoxicillin.[130,147,148,157,158] These data represented a significant decrease in β-lactamase–producing *H influenzae*, compared with data reported in the 2004 AOM guideline.

Nationwide data suggest that 100% of *M catarrhalis* derived from the upper respiratory tract are β-lactamase–positive but remain susceptible to amoxicillin-clavulanate.[159] However, the high rate of spontaneous clinical resolution occurring in children with AOM attributable to *M catarrhalis* treated with amoxicillin reduces the concern for the first-line coverage for this microorganism.[145,146] AOM attributable to *M catarrhalis* rarely progresses to acute mastoiditis or intracranial infections.[102,160,161]

## Antibiotic Therapy

High-dose amoxicillin is recommended as the first-line treatment in most patients, although there are a number of medications that are clinically effective (Table 5). The justification for the use of amoxicillin relates to its effectiveness against common AOM bacterial pathogens as well as its safety, low cost, acceptable taste, and narrow microbiologic spectrum.[145,151] In children who have taken amoxicillin in the previous 30 days, those with concurrent conjunctivitis, or those for whom coverage for β-lactamase–positive *H influenzae* and *M catarrhalis* is desired, therapy should be initiated with high-dose amoxicillin-clavulanate (90 mg/kg/day of amoxicillin, with 6.4 mg/kg/day of clavulanate, a ratio of amoxicillin to clavulanate of 14:1, given in 2 divided doses, which is less likely to cause diarrhea than other amoxicillin-clavulanate preparations).[162]

Alternative initial antibiotics include cefdinir (14 mg/kg per day in 1 or 2 doses), cefuroxime (30 mg/kg per day in 2 divided doses), cefpodoxime (10 mg/kg per day in 2 divided doses), or ceftriaxone (50 mg/kg, administered intramuscularly). It is important to note that alternative antibiotics vary in their efficacy against AOM pathogens. For example, recent US data on in vitro susceptibility of *S pneumoniae* to cefdinir and cefuroxime are 70% to 80%, compared with 84% to 92% amoxicillin efficacy.[130,147–149] In vitro efficacy of cefdinir and cefuroxime against *H influenzae* is approximately 98%, compared with 58% efficacy of amoxicillin and nearly 100% efficacy of amoxicillin-clavulanate.[158] A multicenter double tympanocentesis open-label study of

**TABLE 5** Recommended Antibiotics for (Initial or Delayed) Treatment and for Patients Who Have Failed Initial Antibiotic Treatment

| Initial Immediate or Delayed Antibiotic Treatment | | Antibiotic Treatment After 48–72 h of Failure of Initial Antibiotic Treatment | |
|---|---|---|---|
| Recommended First-line Treatment | Alternative Treatment (if Penicillin Allergy) | Recommended First-line Treatment | Alternative Treatment |
| Amoxicillin (80–90 mg/ kg per day in 2 divided doses) | Cefdinir (14 mg/kg per day in 1 or 2 doses) | Amoxicillin-clavulanate[a] (90 mg/kg per day of amoxicillin, with 6.4 mg/kg per day of clavulanate in 2 divided doses) | Ceftriaxone, 3 d Clindamycin (30–40 mg/kg per day in 3 divided doses), with or without third-generation cephalosporin |
| or | Cefuroxime (30 mg/kg per day in 2 divided doses) | or | Failure of second antibiotic |
| Amoxicillin-clavulanate[a] (90 mg/kg per day of amoxicillin, with 6.4 mg/kg per day of clavulanate [amoxicillin to clavulanate ratio, 14:1] in 2 divided doses) | Cefpodoxime (10 mg/kg per day in 2 divided doses) | Ceftriaxone (50 mg IM or IV for 3 d) | Clindamycin (30–40 mg/kg per day in 3 divided doses) plus third-generation cephalosporin |
| | Ceftriaxone (50 mg IM or IV per day for 1 or 3 d) | | Tympanocentesis[b] Consult specialist[b] |

IM, intramuscular; IV, intravenous.

[a] May be considered in patients who have received amoxicillin in the previous 30 d or who have the otitis-conjunctivitis syndrome.

[b] Perform tympanocentesis/drainage if skilled in the procedure, or seek a consultation from an otolaryngologist for tympanocentesis/drainage. If the tympanocentesis reveals multidrug-resistant bacteria, seek an infectious disease specialist consultation.

[c] Cefdinir, cefuroxime, cefpodoxime, and ceftriaxone are highly unlikely to be associated with cross-reactivity with penicillin allergy on the basis of their distinct chemical structures. See text for more information.

cefdinir in recurrent AOM attributable to *H influenzae* showed eradication of the organism in 72% of patients.[163]

For penicillin-allergic children, recent data suggest that cross-reactivity among penicillins and cephalosporins is lower than historically reported.[164–167] The previously cited rate of cross-sensitivity to cephalosporins among penicillin-allergic patients (approximately 10%) is likely an overestimate. The rate was based on data collected and reviewed during the 1960s and 1970s. A study analyzing pooled data of 23 studies, including 2400 patients with reported history of penicillin allergy and 39 000 with no penicillin allergic history concluded that many patients who present with a history of penicillin allergy do not have an immunologic reaction to penicillin.[166] The chemical structure of the cephalosporin determines the risk of cross-reactivity between specific agents.[165,168] The degree of cross-reactivity is higher between penicillins and first-generation cephalosporins but is negligible with the second- and third-generation cephalosporins. Because of the differences in the chemical structures, cefdinir, cefuroxime, cefpodoxime, and ceftriaxone are highly unlikely to be associated with cross-reactivity with penicillin.[165] Despite this, the Joint Task Force on Practice Parameters; American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology; and Joint Council of Allergy, Asthma and Immunology[169] stated that "cephalosporin treatment of patients with a history of penicillin allergy, selecting out those with severe reaction histories, show a reaction rate of 0.1%." They recommend a cephalosporin in cases without severe and/or recent penicillin allergy reaction history when skin test is not available.

Macrolides, such as erythromycin and azithromycin, have limited efficacy against both *H influenzae* and *S pneumoniae*.[130,147–149] Clindamycin lacks efficacy against *H influenzae*. Clindamycin alone (30–40 mg/kg per day in 3 divided doses) may be used for suspected penicillin-resistant *S pneumoniae*; however, the drug will likely not be effective for the multidrug-resistant serotypes.[130,158,166]

Several of these choices of antibiotic suspensions are barely palatable or frankly offensive and may lead to avoidance behaviors or active rejection by spitting out the suspension. Palatability of antibiotic suspensions has been compared in many studies.[170–172] Specific antibiotic suspensions such as cefuroxime, cefpodoxime, and clindamycin may benefit from adding taste-masking products, such as chocolate or strawberry flavoring agents, to obscure the initial bitter taste and the unpleasant aftertaste.[172,173] In the patient who is persistently vomiting or cannot otherwise tolerate oral medication, even when the taste is masked, ceftriaxone (50 mg/kg, administered intramuscularly in 1 or 2 sites in the anterior thigh, or intravenously) has been demonstrated to be effective for the initial or repeat antibiotic treatment of AOM.[174,175] Although a single injection of ceftriaxone is approved by the US FDA for the treatment of AOM, results of a double tympanocentesis study (before and 3 days after single dose ceftriaxone) by Leibovitz et al[175] suggest that more than 1 ceftriaxone dose may be required to prevent recurrence of the middle ear infection within 5 to 7 days after the initial dose.

### Initial Antibiotic Treatment Failure

When antibiotics are prescribed for AOM, clinical improvement should be noted within 48 to 72 hours. During the 24 hours after the diagnosis of AOM, the child's symptoms may worsen slightly. In the next 24 hours, the patient's symptoms should begin to improve. If initially febrile, the temperature should decline within 48 to 72 hours. Irritability and fussiness should lessen or disappear, and sleeping and drinking patterns should normalize.[176,177] If the patient is not improved by 48 to 72 hours, another disease or concomitant viral infection may be present, or the causative bacteria may be resistant to the chosen therapy.

Some children with AOM and persistent symptoms after 48 to 72 hours of initial antibacterial treatment may have combined bacterial and viral infection, which would explain the persistence of ongoing symptoms despite appropriate antibiotic therapy.[109,178,179] Literature is conflicting on the correlation between clinical and bacteriologic outcomes. Some studies report good correlation ranging from 86% to 91%,[180,181] suggesting continued presence of bacteria in the middle ear in a high proportion of cases with persistent symptoms. Others report that middle ear fluid from children with AOM in whom symptoms are persistent is sterile in 42% to 49% of cases.[123,182] A change in antibiotic may not be required in some children with mild persistent symptoms.

In children with persistent, severe symptoms of AOM and unimproved otologic findings after initial treatment, the clinician may consider changing the antibiotic (Table 5). If the child was initially treated with amoxicillin and failed to improve, amoxicillin-clavulanate should be used. Patients who were given amoxicillin-clavulanate or oral third-generation cephalosporins may receive intramuscular ceftriaxone (50 mg/kg). In the treatment of AOM unresponsive to initial antibiotics, a 3-day course of ceftriaxone has been shown to be better than a 1-day regimen.[175]

Although trimethoprim-sulfamethoxazole and erythromycin-sulfisoxazole had been useful as therapy for patients with AOM, pneumococcal surveillance studies have indicated that resistance to these 2 combination agents is substantial.[130,149,183] Therefore, when patients fail to improve while receiving amoxicillin, neither trimethoprim-sulfamethoxazole[184] nor erythromycin-sulfisoxazole is appropriate therapy.

Tympanocentesis should be considered, and culture of middle ear fluid should be performed for bacteriologic diagnosis and susceptibility testing when a series of antibiotic drugs have failed to improve the clinical condition. If tympanocentesis is not available, a course of clindamycin may be used, with or without an antibiotic that covers nontypeable *H influenzae* and *M catarrhalis*, such as cefdinir, cefixime, or cefuroxime.

Because *S pneumoniae* serotype 19A is usually multidrug-resistant and may not be responsive to clindamycin,[104,149] newer antibiotics that are not approved by the FDA for treatment of AOM, such as levofloxacin or linezolid, may be indicated.[185–187] Levofloxacin is a quinolone antibiotic that is not approved by the FDA for use in children. Linezolid is effective against resistant Gram-positive bacteria. It is not approved by the FDA for AOM treatment and is expensive. In children with repeated treatment failures, every effort should be made for bacteriologic diagnosis by tympanocentesis with Gram stain, culture, and antibiotic susceptibility testing of the organism (s) present. The clinician may consider consulting with pediatric medical subspecialists, such as an otolaryngologist for possible tympanocentesis, drainage, and culture and an infectious disease expert, before use of unconventional drugs such as levofloxacin or linezolid.

When tympanocentesis is not available, 1 possible way to obtain information on the middle ear pathogens and their antimicrobial susceptibility is to obtain a nasopharyngeal specimen for bacterial culture. Almost all middle ear pathogens derive from the pathogens colonizing the nasopharynx, but not all nasopharyngeal pathogens enter the middle ear to cause AOM. The positive predictive value of nasopharyngeal culture during AOM (likelihood that bacteria cultured from the nasopharynx is the middle ear pathogen) ranges from 22% to 44% for *S pneumoniae*, 50% to 71% for nontypeable *H influenzae*, and 17% to 19% for *M catarrhalis*. The negative predictive value (likelihood that bacteria not found in the nasopharynx are not AOM pathogens) ranges from 95% to 99% for all 3 bacteria.[188,189] Therefore, if nasopharyngeal culture is negative for specific bacteria, that organism is likely not the AOM pathogen. A negative culture for *S pneumoniae*, for example, will help eliminate the concern for multidrug-resistant bacteria and the need for unconventional therapies, such as levofloxacin or linezolid. On the other hand, if *S pneumoniae* is cultured from the nasopharynx, the antimicrobial susceptibility pattern can help guide treatment.

## Duration of Therapy

The optimal duration of therapy for patients with AOM is uncertain; the usual 10-day course of therapy was derived from the duration of treatment of streptococcal pharyngotonsillitis. Several studies favor standard 10-day therapy over shorter courses for children younger than 2 years.[162,190–194] Thus, for children younger than 2 years and children with severe symptoms, a standard 10-day course is recommended. A 7-day course of oral antibiotic appears to be equally effective in children 2 to 5 years of age with mild or moderate AOM. For children 6 years and older with mild to moderate symptoms, a 5- to 7-day course is adequate treatment.

## Follow-up of the Patient With AOM

Once the child has shown clinical improvement, follow-up is based on the usual clinical course of AOM. There is little scientific evidence for a routine 10- to 14-day reevaluation visit for all children with an episode of AOM. The physician may choose to reassess some children, such as young children with severe symptoms or recurrent AOM or when specifically requested by the child's parent.

Persistent MEE is common and can be detected by pneumatic otoscopy (with or without verification by tympanometry) after resolution of acute symptoms. Two weeks after successful antibiotic treatment of AOM, 60% to 70% of children have MEE, decreasing to 40% at 1 month and 10% to 25% at 3 months after successful antibiotic treatment.[177,195] The presence of MEE without clinical symptoms is defined as OME. OME must be differentiated clinically from AOM and requires infrequent additional monitoring but not antibiotic therapy. Assurance that OME resolves is particularly important for parents of children with cognitive or developmental delays that may be affected adversely by transient hearing loss associated with MEE. Detailed recommendations for the management of the child with OME can be found in the evidence-based guideline from the AAP/AAFP/American Academy of Otolaryngology-Head and Neck Surgery published in 2004.[84,85]

### Key Action Statement 5A

**Clinicians should *NOT* prescribe prophylactic antibiotics to reduce the frequency of episodes of AOM in children with recurrent AOM. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 5A*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | No adverse effects from antibiotic. Reduces potential for development of bacterial resistance. Reduced costs. |
| Risks, harms, cost | Small increase in episodes of AOM. |
| Benefit-harm assessment | Preponderance of benefit. |
| Value judgments | Potential harm outweighs the potential benefit. |
| Intentional vagueness | None. |
| Role of patient preferences | Limited. |
| Exclusions | Young children whose only alternative would be tympanostomy tubes. |
| Strength | **Recommendation** |

### Key Action Statement 5B

**Clinicians may offer tympanostomy tubes for recurrent AOM (3 episodes in 6 months or 4 episodes in 1 year, with 1 episode in the preceding 6 months). (Evidence Quality: Grade B, Rec. Strength: Option)**

*Key Action Statement Profile: KAS 5B*

| Aggregate evidence quality | **Grade B** |
|---|---|
| Benefits | Decreased frequency of AOM. Ability to treat AOM with topical antibiotic therapy. |
| Risks, harms, cost | Risks of anesthesia or surgery. Cost. Scarring of TM, chronic perforation, cholesteatoma. Otorrhea. |
| Benefits-harms assessment | Equilibrium of benefit and harm. |
| Value judgments | None. |
| Intentional vagueness | Option based on limited evidence. |
| Role of patient preferences | Joint decision of parent and clinician. |
| Exclusions | Any contraindication to anesthesia and surgery. |
| Strength | **Option** |

### Purpose of This Section

Recurrent AOM has been defined as the occurrence of 3 or more episodes of AOM in a 6-month period or the occurrence of 4 or more episodes of AOM in a 12-month period that includes at least 1 episode in the preceding 6 months.[20] These episodes should be well documented and separate acute infections.[11]

Winter season, male gender, and passive exposure to smoking have been associated with an increased likelihood of recurrence. Half of children younger than 2 years treated for AOM will experience a recurrence within 6 months. Symptoms that last more than 10 days may also predict recurrence.[196]

### Changes From AAP/AAFP 2004 AOM Guideline

Recurrent AOM was not addressed in the 2004 AOM guideline. This section addresses the literature on recurrent AOM.

### Antibiotic Prophylaxis

Long-term, low-dose antibiotic use, referred to as antibiotic prophylaxis or chemoprophylaxis, has been used to treat children with recurrent AOM to prevent subsequent episodes.[85] A 2006 Cochrane review analyzed 16 studies of long-term antibiotic use for AOM and found such use prevented 1.5 episodes of AOM per year, reducing in half the number of AOM episodes during the period of treatment.[197] Randomized placebo-controlled trials of prophylaxis reported a decrease of 0.09 episodes per month in the frequency of AOM attributable to therapy (approximately 0.5 to 1.5 AOM episodes per year for 95% of children). An estimated 5 children would need to be treated for 1 year to prevent 1 episode of OM. The effect may be more substantial for children with 6 or more AOM episodes in the preceding year.[12]

This decrease in episodes of AOM occurred only while the prophylactic antibiotic was being given. The modest benefit afforded by a 6-month course of antibiotic prophylaxis does not have longer-lasting benefit after cessation of therapy. Teele showed no differences between children who received prophylactic antibiotics compared with those who received placebo in AOM recurrences or persistence of OME.[198]

Antibiotic prophylaxis is not appropriate for children with long-term MEE or for children with infrequent episodes of AOM. The small reduction in frequency of AOM with long-term antibiotic prophylaxis must be weighed against the cost of such therapy; the potential adverse effects of antibiotics, principally allergic reaction and gastrointestinal tract consequences, such as diarrhea; and their contribution to the emergence of bacterial resistance.

### Surgery for Recurrent AOM

The use of tympanostomy tubes for treatment of ear disease in general, and for AOM in particular, has been controversial.[199] Most published studies of surgical intervention for OM focus on children with persistent MEE with or without AOM. The literature on surgery for recurrent AOM as defined here is scant. A lack of consensus among otolaryngologists regarding the role of surgery for recurrent AOM was reported in a survey of Canadian otolaryngologists in which 40% reported they would "never," 30% reported they would "sometimes," and 30% reported they would "often or always" place tympanostomy tubes for a hypothetical 2-year-old child with frequent OM without persistent MEE or hearing loss.[200]

Tympanostomy tubes, however, remain widely used in clinical practice for both OME and recurrent OM.[201] Recurrent

AOM remains a common indication for referral to an otolaryngologist.

Three randomized controlled trials have compared the number of episodes of AOM after tympanostomy tube placement or no surgery.[202] Two found significant improvement in mean number of AOM episodes after tympanostomy tubes during a 6-month follow-up period.[203,204] One study randomly assigned children with recurrent AOM to groups receiving placebo, amoxicillin prophylaxis, or tympanostomy tubes and followed them for 2 years.[205] Although prophylactic antibiotics reduced the rate of AOM, no difference in number of episodes of AOM was noted between the tympanostomy tube group and the placebo group over 2 years. A Cochrane review of studies of tympanostomy tubes for recurrent AOM analyzed 2 studies[204,206] that met inclusion criteria and found that tympanostomy tubes reduced the number of episodes of AOM by 1.5 episodes in the 6 months after surgery.[207] Tympanostomy tube insertion has been shown to improve disease-specific quality-of-life measures in children with OM.[208] One multicenter, nonrandomized observational study showed large improvements in a disease-specific quality-of-life instrument that measured psychosocial domains of physical suffering, hearing loss, speech impairment, emotional distress, activity limitations, and caregiver concerns that are associated with ear infections.[209] These benefits of tympanostomy tubes have been demonstrated in mixed populations of children that include children with OME as well as recurrent AOM.

Beyond the cost, insertion of tympanostomy tubes is associated with a small but finite surgical and anesthetic risk. A recent review looking at protocols to minimize operative risk reported no major complications, such as sensorineural hearing loss, vascular injury, or ossicular chain disruption, in 10 000 tube insertions performed primarily by residents, although minor complications such as TM tears or displaced tubes in the middle ear were seen in 0.016% of ears.[210] Long-term sequelae of tympanostomy tubes include TM structural changes including focal atrophy, tympanosclerosis, retraction pockets, and chronic perforation. One meta-analysis found tympanosclerosis in 32% of patients after placement of tympanostomy tubes and chronic perforations in 2.2% of patients who had short-term tubes and 16.6% of patients with long-term tubes.[211]

Adenoidectomy, without myringotomy and/or tympanostomy tubes, did not reduce the number of episodes of AOM when compared with chemoprophylaxis or placebo.[212] Adenoidectomy alone should not be used for prevention of AOM but may have benefit when performed with placement of tympanostomy tubes or in children with previous tympanostomy tube placement in OME.[213]

## Prevention of AOM: Key Action Statement 6A

### *Pneumococcal Vaccine*

**Clinicians should recommend pneumococcal conjugate vaccine to all children according to the schedule of the Advisory Committee on Immunization Practices, AAP, and AAFP. (Evidence Quality: Grade B, Rec. Strength: Strong Recommendation)**

*Key Action Statement Profile: KAS 6A*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Reduced frequency of AOM attributable to vaccine serotypes. Reduced risk of serious pneumococcal systemic disease. |
| Risks, harms, cost | Potential vaccine side effects. Cost of vaccine. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Potential vaccine adverse effects are minimal. |
| Intentional vagueness | None. |
| Role of patient preferences | Some parents may choose to refuse the vaccine. |
| Exclusions | Severe allergic reaction (eg, anaphylaxis) to any component of pneumococcal vaccine or any diphtheria toxoid-containing vaccine. |
| Strength | **Strong Recommendation** |

## Key Action Statement 6B

**Influenza Vaccine: Clinicians should recommend annual influenza vaccine to all children according to the schedule of the Advisory Committee on Immunization Practices, AAP, and AAFP. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 6B*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | Reduced risk of influenza infection. Reduction in frequency of AOM associated with influenza. |
| Risks, harms, cost | Potential vaccine adverse effects. Cost of vaccine. Requires annual immunization. |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Potential vaccine adverse effects are minimal. |
| Intentional vagueness | None |
| Role of patient preferences | Some parents may choose to refuse the vaccine. |
| Exclusions | See CDC guideline on contraindications (http://www.cdc.gov/flu/professionals/acip/shouldnot.htm). |
| Strength | **Recommendation** |

### Key Action Statement 6C

**Breastfeeding: Clinicians should encourage exclusive breastfeeding for at least 6 months. (Evidence Quality: Grade B, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 6C*

| Aggregate evidence quality | Grade B |
|---|---|
| Benefits | May reduce the risk of early AOM. Multiple benefits of breastfeeding unrelated to AOM. |
| Risk, harm, cost | None |
| Benefit-harm assessment | Preponderance of benefit. |
| Value judgments | The intervention has value unrelated to AOM prevention. |
| Intentional vagueness | None |
| Role of patient preferences | Some parents choose to feed formula. |
| Exclusions | None |
| Strength | **Recommendation** |

### Key Action Statement 6D

**Clinicians should encourage avoidance of tobacco smoke exposure. (Evidence Quality: Grade C, Rec. Strength: Recommendation)**

*Key Action Statement Profile: KAS 6D*

| Aggregate evidence quality | Grade C |
|---|---|
| Benefits | May reduce the risk of AOM. |
| Risks, harms, cost | None |
| Benefits-harms assessment | Preponderance of benefit. |
| Value judgments | Avoidance of tobacco exposure has inherent value unrelated to AOM. |
| Intentional vagueness | None |
| Role of patient preferences | Many parents/caregivers choose not to stop smoking. Some also remain addicted, and are unable to quit smoking. |
| Exclusions | None |
| Strength | **Recommendation** |

## Purpose of This Section

The 2004 AOM guideline noted data on immunizations, breastfeeding, and lifestyle changes that would reduce the risk of acquiring AOM. This section addresses new data published since 2004.

## Changes From AAP/AAFP 2004 AOM Guideline

PCV7 has been in use in the United States since 2000. PCV13 was introduced in the United States in 2010. The 10-valent pneumococcal nontypeable *H influenzae* protein D-conjugate vaccine was recently licensed in Europe for prevention of diseases attributable to *S pneumoniae* and nontypeable *H influenzae*. Annual influenza immunization is now recommended for all children 6 months of age and older in the United States.[214,215] Updated information regarding these vaccines and their effect on the incidence of AOM is reviewed.

The AAP issued a new breastfeeding policy statement in February 2012.[216] This guideline also includes a recommendation regarding tobacco smoke exposure. Bottle propping, pacifier use, and child care are discussed, but no recommendations are made because of limited evidence. The use of xylitol, a possible adjunct to AOM prevention, is discussed; however, no recommendations are made.

### Pneumococcal Vaccine

Pneumococcal conjugate vaccines have proven effective in preventing OM caused by pneumococcal serotypes contained in the vaccines. A meta-analysis of 5 studies with AOM as an outcome determined that there is a 29% reduction in AOM caused by all pneumococcal serotypes among children who received PCV7 before 24 months of age.[217] Although the overall benefit seen in clinical trials for all causes of AOM is small (6%–7%),[218–221] observational studies have shown that medical office visits for otitis were reduced by up to 40% comparing years before and after introduction of PCV7.[222–224] Grijvala[223] reported no effect, however, among children first vaccinated at older ages. Poehling et al[225] reported reductions of frequent AOM and PE tube use after introduction of PCV7. The observations by some of greater benefit observed in the community than in clinical trials is not fully understood but may be related to effects of herd immunity or may be attributed to secular trends or changes in AOM diagnosis patterns over time.[223,226–229] In a 2009 Cochrane review,[221] Jansen et al found that the overall reduction in AOM incidence may only be 6% to 7% but noted that even that small rate may have public health relevance. O'Brien et al concurred and noted in addition the potential for cost savings.[230] There is evidence that serotype replacement may reduce the long-term efficacy of pneumococcal conjugate vaccines against AOM,[231] but it is possible that new pneumococcal conjugate vaccines may demonstrate an increased effect on reduction in AOM.[232–234] Data on AOM reduction secondary to the PCV13 licensed in the United States in 2010 are not yet available.

The *H influenzae* protein D-conjugate vaccine recently licensed in Europe has potential benefit of protection against 10 serotypes of *S pneumoniae* and nontypeable *H influenzae*.[221,234]

### Influenza Vaccine

Most cases of AOM follow upper respiratory tract infections caused by viruses, including influenza viruses. As many as two-thirds of young children with influenza may have AOM.[235] Investigators have studied the efficacy of trivalent inactivated influenza vaccine (TIV) and live-attenuated intranasal influenza vaccine (LAIV) in preventing AOM. Many studies have demonstrated 30% to 55% efficacy of influenza vaccine in prevention of AOM during the respiratory illness season.[6,235–239] One study reported no benefit of TIV in reducing AOM burden; however, 1 of the 2 respiratory illness seasons during which this study was conducted had a relatively low influenza activity. A pooled analysis[240] of 8 studies comparing LAIV versus TIV or placebo[241–248] showed a higher efficacy of LAIV compared with both placebo and with TIV. Influenza vaccination is now recommended for all children 6 months of age and older in the United States.[214,215]

### Breastfeeding

Multiple studies provide evidence that breastfeeding for at least 4 to 6 months reduces episodes of AOM and recurrent AOM.[249–253] Two cohort studies, 1 retrospective study[250] and 1 prospective study,[253] suggest a dose response, with some protection from partial breastfeeding and the greatest protection from exclusive breastfeeding through 6 months of age. In multivariate analysis controlling for exposure to child care settings, the risk of nonrecurrent otitis is 0.61 (95% confidence interval [CI]: 0.4–0.92) comparing exclusive breastfeeding through 6 months of age with no breastfeeding or breastfeeding less than 4 months. In a prospective cohort, Scariatti[253] found a significant dose-response effect. In this study, OM was self-reported by parents. In a systematic review, McNiel et al[254] found that when exclusive breastfeeding was set as the normative standard, the recalculated odds ratios (ORs) revealed the risks of any formula use. For example, any formula use in the first 6 months of age was significantly associated with increased incidence of OM (OR: 1.78; 95% CI: 1.19–2.70; OR: 4.55; 95% CI: 1.64–12.50 in the available studies; pooled OR for any formula in the first 3 months of age, 2.00; 95% CI: 1.40–2.78). A number of studies[255–259] addressed the association of AOM and other infectious illness in infants with duration and exclusivity of breastfeeding, but all had limitations and none had a randomized controlled design. However, taken together, they continue to show a protective effect of exclusive breastfeeding. In all studies, there has been a predominance of white subjects, and child care attendance and smoking exposure may not have been completely controlled. Also, feeding methods were self-reported.

The consistent finding of a lower incidence of AOM and recurrent AOM with increased breastfeeding supports the AAP recommendation to encourage exclusive breastfeeding for the first 6 months of life and to continue for at least the first year and beyond for as long as mutually desired by mother and child.[216]

### Lifestyle Changes

In addition to its many other benefits,[260] eliminating exposure to passive tobacco smoke has been postulated to reduce the incidence of AOM in infancy.[252,261–264] Bottles and pacifiers have been associated with AOM. Avoiding supine bottle feeding ("bottle propping") and reducing or eliminating pacifier use in the second 6 months of life may reduce AOM incidence.[265–267] In a recent cohort study, pacifier use was associated with AOM recurrence.[268]

During infancy and early childhood, reducing the incidence of upper respiratory tract infections by altering child care-center attendance patterns can reduce the incidence of recurrent AOM significantly.[249,269]

### Xylitol

Xylitol, or birch sugar, is chemically a pentitol or 5-carbon polyol sugar alcohol. It is available as chewing gum, syrup, or lozenges. A 2011 Cochrane review[270] examined the evidence for the use of xylitol in preventing recurrent AOM. A statistically significant 25% reduction in the risk of occurrence of AOM among healthy children at child care centers in the xylitol group compared with the control group (relative risk: 0.75; 95% CI: 0.65 to 0.88; RD: –0.07; 95% CI: –0.12 to –0.03) in the 4 studies met criteria for analysis.[271–274] Chewing gum and lozenges containing xylitol appeared to be more effective than syrup. Children younger than 2 years, those at the greatest risk of having AOM, cannot safely use lozenges or chewing gum. Also, xylitol needs to be given 3 to 5 times a day to be effective. It is not effective for treating AOM and it must be taken daily throughout the respiratory illness season to have an effect. Sporadic or as-needed use is not effective.

### Future Research

Despite advances in research partially stimulated by the 2004 AOM guideline, there are still many unanswered clinical questions in the field. Following are possible clinical research questions that still need to be resolved.

## Diagnosis

There will probably never be a gold standard for diagnosis of AOM because of the continuum from OME to AOM. Conceivably, new techniques that could be used on the small amount of fluid obtained during tympanocentesis could identify inflammatory markers in addition to the presence of bacteria or viruses. However, performing tympanocentesis studies on children with uncomplicated otitis is likely not feasible because of ethical and other considerations.

Devices that more accurately identify the presence of MEE and bulging that are easier to use than tympanometry during office visits would be welcome, especially in the difficult-to-examine infant. Additional development of inexpensive, easy-to-use video pneumatic otoscopes is still a goal.

## Initial Treatment

The recent studies of Hoberman[31] and Tähtinen[32] have addressed clinical and TM appearance by using stringent diagnostic criteria of AOM. However, the outcomes for less stringent diagnostic criteria, a combination of symptoms, MEE, and TM appearance not completely consistent with OME can only be inferred from earlier studies that used less stringent criteria but did not specify outcomes for various grades of findings. Randomized controlled trials on these less certain TM appearances using scales similar to the OS-8 scale[35] could clarify the benefit of initial antibiotics and initial observation for these less certain diagnoses. Such studies must also specify severity of illness, laterality, and otorrhea.

Appropriate end points must be established. Specifically is the appearance of the TM in patients without clinical symptoms at the end of a study significant for relapse, recurrence, or persistent MEE. Such a study would require randomization of patients with unimproved TM appearance to continued observation and antibiotic groups.

The most efficient and acceptable methods of initial observation should continue to be studied balancing the convenience and benefits with the potential risks to the patient.

## Antibiotics

Amoxicillin-clavulanate has a broader spectrum than amoxicillin and may be a better initial antibiotic. However, because of cost and adverse effects, the subcommittee has chosen amoxicillin as first-line AOM treatment. Randomized controlled trials comparing the 2 with adequate power to differentiate clinical efficacy would clarify this choice. Stringent diagnostic criteria should be the standard for these studies. Antibiotic comparisons for AOM should now include an observation arm for patients with nonsevere illness to ensure a clinical benefit over placebo. Studies should also have enough patients to show small but meaningful differences.

Although there have been studies on the likelihood of resistant *S pneumoniae* or *H influenzae* in children in child care settings and with siblings younger than 5 years, studies are still needed to determine whether these and other risk factors would indicate a need for different initial treatment than noted in the guideline.

New antibiotics that are safe and effective are needed for use in AOM because of the development of multidrug-resistant organisms. Such new antibiotics must be tested against the currently available medications.

Randomized controlled trials using different durations of antibiotic therapy in different age groups are needed to optimize therapy with the possibility of decreasing duration of antibiotic use. These would need to be performed initially with amoxicillin and amoxicillin-clavulanate but should also be performed for any antibiotic used in AOM. Again, an observation arm should be included in nonsevere illness.

## Recurrent AOM

There have been adequate studies regarding prophylactic antibiotic use in recurrent AOM. More and better controlled studies of tympanostomy tube placement would help determine its benefit versus harm.

## Prevention

There should be additional development of vaccines targeted at common organisms associated with AOM.[275] Focused epidemiologic studies on the benefit of breastfeeding, specifically addressing AOM prevention, including duration of breastfeeding and partial versus exclusive breastfeeding, would clarify what is now a more general database. Likewise, more focused studies of the effects of lifestyle changes would help clarify their effect on AOM.

## Complementary and Alternative Medicine

There are no well-designed randomized controlled trials of the usefulness of complementary and alternative medicine in AOM, yet a large number of families turn to these methods. Although most alternative therapies are relatively inexpensive, some may be costly. Such studies should compare the alternative therapy to observation rather than antibiotics and only use an antibiotic arm if the alternative therapy is shown to be better than observation. Such studies should focus on children with less stringent criteria of AOM but using the same descriptive criteria for the patients as noted above.

## DISSEMINATION OF GUIDELINES

An Institute of Medicine Report notes that "Effective multifaceted implementation strategies targeting both individuals and healthcare systems should be employed by implementers to promote adherence to trustworthy [clinical practice guidelines]."[230]

Many studies of the effect of clinical practice guidelines have been performed. In general, the studies show little overt change in practice after a guideline is published. However, as was seen after the 2004 AOM guideline, the number of visits for AOM and the number of prescriptions for antibiotics for AOM had decreased publication. Studies of educational and dissemination methods both at the practicing physician level and especially at the resident level need to be examined.


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*(Continued from first page)*

All clinical practice guidelines from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

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**Bell et al. Adolescent and Young Adult Male Health: A Review. *Pediatrics*. 2013;132(3):535–546**

A production error occurred in the article by Bell et al, titled "Adolescent and Young Adult Male Health: A Review" published in the September 2013 issue of *Pediatrics* (2013;132[3]:535–546; originally published online August 12, 2013; doi: 10.1542/peds.2012-3414). On page 535, the series note read "This is the 10th article in our series, 'Transitions to Adult Care.'" This should have read "This is the first article in our series on Adolescent Health." It has been corrected online.

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**Chen et al. Cost-effectiveness of Augmenting Universal Hepatitis B Vaccination with Immunoglobin Treatment. *Pediatrics.* 2013;131(4):e1135–e1143**

An error occurred in the article by Chen et al, titled "Cost-effectiveness of Augmenting Universal Hepatitis B Vaccination with Immunoglobin Treatment" published in the April 2013 issue of *Pediatrics* (2013;131[4]:e1135–e1143; originally published online March 25, 2013; doi:10.1542/peds.2012-1262). On page e1142, under Acknowledgments, this reads: "This project was conducted while Drs Chen and Toy were fellows of the Takemi Program in International Health at Harvard School of Public Health." This should have read: "This project was conducted when Drs Chen and Toy were fellows of the Takemi Program in International Health at Harvard School of Public Health. Dr Yeh was supported by the National Institutes of Health's National Cancer Institute (K07-CA143044)."

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**Eng et al. Bisphenol A and Chronic Disease Risk Factors in US Children. *Pediatrics.* 2013;132(3):e637–e645**

An error occurred in the article by Eng et al, titled "Bisphenol A and Chronic Disease Risk Factors in US Children" published in the September 2013 issue of *Pediatrics* (2013;132[3]:e637–e645; originally published online August 19, 2013; doi:10.1542/peds.2013-0106). On page e637, the author order for this publication was incorrectly listed as follows: "Donna S. Eng, MD,[a] Achamyeleh Gebremariam, MS,[b] John D. Meeker, ScD,[c] Karen Peterson, DSc, MD, MPH,[c] Vasantha Padmanabhan, PhD,[a,c] and Joyce M. Lee, MD, MPH.[a,b]" This should have read: "Donna S. Eng, MD,[a] Joyce M. Lee, MD, MPH,[a,b] Achamyeleh Gebremariam, MS,[b] John D. Meeker, ScD,[c] Karen Peterson, DSc, MD, MPH,[c] and Vasantha Padmanabhan, PhD.[a,c]"

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**Lieberthal AS, Carroll AE, Chonmaitree T, et al. Clinical Practice Guideline: The Diagnosis and Management of Acute Otitis Media. *Pediatrics*. 2013;131(3): e964–e999**

An error occurred in the following publication: Lieberthal AS, Carroll AE, Chonmaitree T, et al. Clinical Practice Guideline: The Diagnosis and Management of Acute Otitis Media. *Pediatrics*. 2013;131(3):e964–e999. The dosing for ceftriaxone in Table 5 was incorrect. The corrected Table 5 follows.

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**TABLE 5** Recommended Antibiotics for (Initial or Delayed) Treatment and for Patients Who Have Failed Initial Antibiotic Treatment

| Initial Antibiotic Treatment at AOM Diagnosis or After Observation | | Antibiotic Treatment After 48–72 Hours of Initial Antibiotic Treatment Failure | |
|---|---|---|---|
| Recommended First-Line Treatment | Alternative Treatment | Recommended First-Line Treatment | Alternative Treatment |
| Amoxicillin (80–90 mg/kg per day)<br><br>OR<br><br>Amoxicillin–clavulanate[a] (90 mg/kg per day of amoxicillin, with 6.4 mg/kg per day of clavulanate) | Cefdinir (14 mg/kg per day in 1 or 2 doses),<br>Cefuroxime (30 mg/kg per day in 2 divided doses),<br>Cefpodoxime (10 mg/kg per day in 2 divided doses), or<br>Ceftriaxone (50 mg/kg per day IM or IV for 1 to 3 d) | Amoxicillin–clavulanate (90 mg/kg per day of amoxicillin, with 6.4 mg/kg per day of clavulanate)<br><br>OR<br><br>Ceftriaxone (50 mg/kg per day IM or IV for 3 d) | Ceftriaxone, 3 d, or Clindamycin (30–40 mg/kg per day in 3 divided doses), with or without second- or third-generation cephalosporin<br><br>Clindamycin plus second- or third-generation cephalosporin<br>Tympanocentesis[b]<br>Consult specialist[b] |

[a] May be considered in patients who have received amoxicillin in the previous 30 d or who have the otitis–conjunctivitis syndrome.

[b] Perform tympanocentesis/drainage if skilled in the procedure or seek a consult from an otolaryngologist for tympanocentesis/drainage. If the tympanocentesis reveals multidrug-resistant bacteria, then seek an infectious disease specialist consultation.

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