Otitis Media

TOM PARTNER, NP suggestions

Treat Children with Omnicef (cedirin) as first choice because of less likely allergic reaction 14 mg/kg/d (Once a day x 10 days) but do not exceed total of 600 mg/day; for adults 300 mg bid x 10 days

Second Choice for Children is Amoxicillin 90 mg/kg/d in divided doses but don’t exceed 3 grams per day, for adults 875 mg bid x 10 days

For Adults with severe ear infections try omnicef first, if no improvement then try Augmentin 875 mg big x 10 days

Third Choice for Children is Azithromycin: 10 mg/kg/day x 3 days but do not exceed 500 mg/day: Adults 500 mg q day x 3 days

If children or adults fail first line treat use Augmentin 90 mg/kg/d but dose exceed 857 mg bid

UPTODATE

Acute otitis media in children: Treatment

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INTRODUCTION — Acute otitis media (AOM), also called purulent otitis media and suppurative otitis media, occurs frequently in children. It is the most common diagnosis for which they receive antibiotics [1,2].

The treatment of AOM will be reviewed here. The epidemiology, pathogenesis, diagnosis, complications, and prevention of AOM are discussed separately, as is otitis media with effusion (serous otitis media).

● (See "Acute otitis media in children: Epidemiology, microbiology, clinical manifestations, and complications").
● (See "Acute otitis media in children: Diagnosis").
● (See "Acute otitis media in children: Prevention of recurrence").
● (See "Otitis media with effusion (serous otitis media) in children: Clinical features and diagnosis").
● (See "Otitis media with effusion (serous otitis media) in children: Management").

DIAGNOSIS OF AOM — The clinical diagnosis of acute otitis media (AOM) requires bulging of the tympanic membrane or other signs of acute inflammation and middle ear effusion (picture 1) [3,4]. (See "Acute otitis media in children: Diagnosis", section on 'Diagnosis'.)

The importance of accurate diagnosis of AOM cannot be overstated. Accurate diagnosis ensures appropriate treatment for children with AOM, who require antibiotic therapy, and avoidance of antibiotics in children with otitis media with effusion, in whom antibiotics are unnecessary. Accurate diagnosis also prevents overuse of antibiotics, which leads to an increased prevalence of resistant organisms.

CLINICAL COURSE — With appropriate antibiotic therapy, the systemic and local signs and symptoms of acute otitis media (AOM) usually resolve in 24 to 72 hours [5,6]. Symptoms and signs resolve more slowly in children who are not treated with antibiotic therapy. In a 2013 meta-analysis of seven randomized trials and three observational studies (1409 children), ear pain resolved within three days in 50 percent of children and within seven to eight days in 90 percent of children who did not receive antibiotic therapy [7].

Whether initially treated with antibiotics or not, persistence of middle ear effusion after the resolution of acute symptoms is common. In a prospective study of 2565 children followed from birth, middle ear effusion (diagnosed via pneumatic otoscopy) persisted for weeks to months after the onset of AOM [8]. At two weeks, 70 percent still had effusion; at one month, 40 percent still had effusion; at two months, 20 percent still had effusion; and at three months, 10 percent still had effusion (figure 1).

The clinical features, complications, and management of persistent middle ear effusion are discussed separately. (See "Otitis media with effusion (serous otitis media) in children: Clinical features and diagnosis" and "Otitis media with effusion (serous otitis media) in children: Management").

SYMPTOMATIC THERAPY

Systemic and topical analgesics — Pain is a common feature of acute otitis media (AOM) and may be severe [5]. We recommend treatment to reduce ear pain in children with AOM whether or not they are treated with antibiotics [3].
We suggest oral ibuprofen or acetaminophen for pain control in children with AOM. Topical benzocaine preparations are an alternative for children ≥2 years, but should not be used in children with tympanic membrane perforation. Topical benzocaine is avoided in children <2 years because of the risk of methemoglobinemia [9]. (See “Topical anesthetics in children”, section on 'Benzocaine'.)

In a multicenter trial, 219 children (one to six years of age) with AOM were treated with antibiotics and randomly assigned to receive ibuprofen 10 mg/kg three times per day, acetaminophen 10 mg/kg three times per day, or placebo [10]. On the second day of illness, fewer children who received ibuprofen or acetaminophen had pain (7 and 10 percent, respectively, versus 25 percent among placebo recipients); the reduction in pain was only statistically significant for ibuprofen. However, the dosing regimen that was used for acetaminophen is not that which is typically used (15 mg/kg every four hours).

The efficacy of topical benzocaine and lidocaine in reducing AOM-associated ear pain has also been evaluated in randomized trials [11]. In a trial in which 54 children (5 to 19 years) who presented to an emergency department with ear pain and AOM were randomly assigned to treatment with a topical benzocaine preparation or olive oil placebo, more children in the treatment group reported a 25 percent reduction in ear pain score 30 minutes after treatment (96 versus 70 percent) [12].

In a similar trial in 63 children (3 to 12 years) randomly assigned to topical aqueous lidocaine (lignocaine) or saline, patient-reported pain scores in lidocaine recipients were consistently reduced by at least 25 percent during the first 30 minutes following application [13]. No adverse effects were reported. Further studies of lidocaine are needed to optimize the dose, as well as identify the duration of pain relief and the effectiveness in younger children.

Decongestants and antihistamines — We recommend not using decongestants and/or antihistamines in the symptomatic management of AOM in children.

Studies of the efficacy of antihistamines and decongestants in treating AOM suggest a lack of benefit and a potential for delayed resolution of middle ear fluid. A 2007 systematic review found that decongestants and antihistamines alone or in combination were associated with increased medication side effects and did not improve healing or prevent surgery or other complications in AOM [14]. In addition, treatment with antihistamines may prolong the duration of middle ear effusion [15].

In children with AOM and known or suspected nasal allergy, an oral decongestant or antihistamine may provide symptomatic relief of nasal congestion. When treating such children, practitioners should weigh the potential symptomatic benefit against the reported adverse events and potential for prolongation of middle ear effusion. (See "Pharmacotherapy of allergic rhinitis", section on 'Approach to specific patient groups'.)

The American Academy of Pediatrics recommends that over-the-counter cough and cold medications not be given to infants and children <4 years of age because of the risk of life-threatening side effects [16,17]. (See "The common cold in children: Treatment and prevention", section on 'Symptomatic therapy'.)
Other therapies — We do not suggest distraction, external application of heat or cold, or instillation of olive oil or herbal extracts into the external auditory canal to treat pain in children with AOM. These therapies have been proposed, but there are no placebo-controlled trials that directly address their effectiveness [3].

A topical herbal extract (containing *Allium sativum* [garlic], *Verbascum thapsus* [mullein], *Calendula flores* [marigold], and *Hypericum perforatum* [St. John’s wort] in olive oil) was compared with topical anesthetic treatment in a randomized trial of 103 children (6 to 18 years) with AOM-associated pain [18]. Both groups experienced comparable improvements in pain throughout the three days of the study, but there was no placebo group.

ANTIBIOTIC THERAPY VERSUS OBSERVATION — In addition to pain control, there are two strategies for initial management of acute otitis media (AOM): 1) immediate treatment with antibiotics and 2) observation with initiation of antibiotic therapy if the symptoms and signs worsen or fail to improve after 48 to 72 hours.

The choice of strategy depends upon the age of the child and the laterality and severity of illness:

- We recommend that children <6 months with AOM be treated immediately with an appropriate antibiotic. (See 'Initial antimicrobial therapy' below.)
- We suggest that children six months to two years with AOM be treated immediately with an appropriate antibiotic. (See 'Initial antimicrobial therapy' below.)
- We suggest that children ≥2 years who appear toxic; have persistent otalgia for more than 48 hours; have temperature ≥102.2°F (39°C) in the past 48 hours; have bilateral AOM or otorrhea; or have uncertain access to follow-up be immediately treated with an appropriate antibiotic. (See 'Initial antimicrobial therapy' below.)
- For children ≥2 years who are normal hosts (eg, immune competent, without craniofacial abnormalities) and have unilateral AOM with mild symptoms and signs and no otorrhea, initial observation may be appropriate if the caretakers understand the risks and benefits of such an approach. (See 'Initial observation' below.)

The treatment of otorrhea in children with tympanostomy tubes is discussed separately. (See "Tympanostomy tube otorrhea in children: Causes, prevention, and management", section on 'Treatment'.)

In a 2006 meta-analysis of individual data from six randomized trials (1643 children age six months to 12 years), children who were younger than two years who had bilateral AOM and children with otorrhea benefited most from antibiotic therapy [5]. Among children younger than two years with bilateral AOM, 25 percent (95% CI 14-36 percent) fewer children treated with antibiotics than with symptomatic care continued to have pain and/or fever on days three to seven of illness. Among children with otorrhea, 36 percent (95% CI 19-53 percent) fewer children treated with antibiotics than with symptomatic care continued to have pain and/or fever on days three to seven of illness.

A 2013 meta-analysis of 11 randomized trials (3317 children, 3854 episodes of AOM) comparing antibiotics with placebo found [6]:

- Antibiotics reduced pain at two to three days (7 trials, 2320 patients): 11.6 versus 15.9 percent (relative risk [RR] 0.70 95% CI 0.57-0.86)
• Antibiotics reduced tympanic membrane perforations (4 trials, 991 patients): 1.8 versus 5.2 percent (RR 0.37 95% CI 0.18-0.76)
• Antibiotics reduced contralateral episodes of AOM (4 trials, 906 patients): 10.6 versus 18.8 percent (RR 0.49 95% CI 0.25-0.95)
• Antibiotics did not affect the rate of recurrence (6 trials, 2200 patients): approximately 20 percent
• Antibiotics increased adverse events (vomiting, diarrhea, or rash): 27.3 versus 20.2 percent (RR 1.34 95% CI 1.16-1.55)
• Serious complications (eg, mastoiditis, meningitis) were rare in both the treatment and placebo groups

Randomized trials comparing immediate versus delayed antibiotics have used different outcome measures (eg, parental satisfaction, rate of filled prescriptions, etc) and types of follow-up (eg, telephone versus office examination), but also document earlier resolution of symptoms among children who receive immediate treatment [19-24].

Systematic reviews and meta-analyses suggest that many children with AOM do well, even without antibiotic therapy, and that the benefits of antibiotics are modest [6,25-28]. However, many of the studies included in the meta-analyses had increased risk of bias (related to nonstringent diagnostic criteria, inclusion of children with mild disease, exclusion of patients <2 years of age, use of an inappropriate antibiotic or inappropriate dose, etc), making the results difficult to interpret [29-32].

Individual randomized trials that used stringent diagnostic criteria and experienced otoscopists to make the diagnosis of AOM and appropriate antibiotic regimens to treat AOM indicate that children younger than two years benefit from antibiotic therapy [33,34]. Pooled data from these trials indicate increased rates of treatment failure among placebo recipients <24 months with unilateral nonsevere AOM (40 versus 14 percent among antibiotic recipients; relative risk 0.34, 95% CI (0.18-0.65) [35]. These and other randomized trials suggest that children with “severe” (defined by fever and ear pain score) or bilateral AOM also benefit from antibiotic therapy [35-37].

The 2013 American Academy of Pediatrics (AAP) and American Academy of Family Physicians (AAFP) guideline recommends immediate treatment for children <6 months, children with severe signs or symptoms (defined by moderate or severe ear pain, ear pain for ≥48 hours, or temperature ≥39°C [102.2°F]) and bilateral AOM in children <24 months of age [3]. The 2013 AAP/AAFP guideline recommends either immediate treatment or observation (with pain control) for children between 6 and 24 months with unilateral nonsevere AOM and for children ≥24 months with unilateral or bilateral nonsevere AOM. However, given the additional analysis now available showing a high rate of treatment failure among children <24 months with unilateral nonsevere AOM [35], we suggest that such children be treated with antimicrobial therapy.

Guidelines from other countries (eg, the National Institute for Health and Clinical Excellence in the United Kingdom, the Dutch College of General Practitioners) recommend a no or delayed antibiotic strategy for most children with AOM.

INITIAL ANTIMICROBIAL THERAPY — When the decision is made to treat acute otitis media (AOM) with antimicrobial agents, the selection among available drugs (table 1) is based upon:
Clinical and microbiologic efficacy
Acceptability (taste, texture) of the oral preparation
Absence of side effects and toxicity
Convenience of the dosing schedule
Cost

First-line therapy — We suggest amoxicillin as the first-line therapy for children with AOM who are treated with antibiotics and at low-risk for amoxicillin resistance (ie, have not received a beta-lactam antibiotic in the previous 30 days and do not have concomitant purulent conjunctivitis). The dose is 90 mg/kg per day divided in two doses (maximum 3 g/day).

We suggest amoxicillin-clavulanate as the first-line therapy for children with AOM who are treated with antibiotics and at increased risk of beta-lactam resistance (ie, have received a beta-lactam antibiotic in the previous 30 days or have concomitant purulent conjunctivitis, which is often caused by beta-lactam resistant nontypeable H. influenzae, or have a history of recurrent AOM unresponsive to amoxicillin) [38-41]. The dose is 90 mg/kg per day of amoxicillin and 6.4 mg/kg per day of clavulanate divided in two doses (we suggest a maximum daily dose of the amoxicillin component of 3 g). Adolescents ≥16 years who can take large tablets can use extended-release amoxicillin-clavulanate 1 to 2 g of amoxicillin and 62.5 to 125 mg of clavulanate every 12 hours.

Macrolides (eg, azithromycin, clarithromycin, erythromycin plus sulfisoxazole) and lincosamides (eg, clindamycin) are alternatives for patients who have had immediate hypersensitivity reactions (anaphylaxis, angioedema, bronchospasm, urticaria) to penicillin (table 1). However, macrolides and lincosamides lack activity against most Haemophilus influenzae isolates and approximately one-third of pneumococcal isolates are resistant to macrolides. Patients with other types of allergic reactions can be treated with cefdinir, cefpodoxime, cefuroxime, or intramuscular ceftriaxone. (See ‘Penicillin allergy’ below.)

A 2001 meta-analysis concluded there is no evidence to support any particular antibiotic regimen versus another for treatment of AOM [25]. Amoxicillin 90mg/kg per day divided in two doses (maximum 3 g/day) is the first-line drug of choice because it is effective, safe, relatively inexpensive, and has a narrow microbiologic spectrum [3,42].

Increasing the dose of amoxicillin from 40 mg/kg per day to 90 mg/kg per day increases the concentration of amoxicillin in the middle ear [43]. The increased concentrations provide activity against most intermediate strains of S. pneumoniae, as well as many of the resistant strains. Only S. pneumoniae that are highly resistant to penicillin, approximately 2 percent of pneumococcal isolates using a breakpoint of 8 mcg/mL for highly resistant, will not respond to high-dose amoxicillin [3,44].

Despite the increasing importance of H. influenzae, including beta-lactamase-producing strains, high-dose amoxicillin remains the preferred choice for initial therapy in children who have not a beta-lactam antibiotic in the previous 30 days and do not have concomitant purulent conjunctivitis [3]. Continued monitoring of the microbiology of AOM is necessary to determine when and if a change in first-line therapy is necessary. The presence of beta-lactamase negative, ampicillin-resistant strains in the community is a potential concern. These strains require minimal inhibitory concentrations of amoxicillin that may be at the upper limit of what is achievable in the middle ear.
Such isolates remain uncommon in the United States, but have become common in France and Japan [45]. (See "Acute otitis media in children: Epidemiology, microbiology, clinical manifestations, and complications", section on 'Bacteria'.)

In a 2013 meta-analysis of five trials (1601 children <12 years), once or twice daily dosing with amoxicillin or amoxicillin-clavulanate was similar to three times daily dosing in clinical cure of AOM, recurrence of AOM, and adverse effects [46]. We suggest twice daily dosing based on pharmacokinetic and pharmacodynamic principles, results of double tympanocentesis (ie, before and after treatment) studies demonstrating middle ear sterilization with twice daily regimens, and the lack of any substantial data with once daily regimens (only 33 patients in the meta-analysis received once daily therapy) [47,48].

**Penicillin allergy** — Acceptable alternatives to penicillin in patients with allergy to penicillin depend upon the type of the previous hypersensitivity reaction. (See "Allergy to penicillins" and "Penicillin-allergic patients: Use of cephalosporins, carbapenems, and monobactams".)

**Delayed reaction** — For children who report penicillin allergy but who did not experience an immediate type 1 hypersensitivity reaction (anaphylaxis, angioedema, bronchospasm, or urticaria), we suggest one of the following:

- **Cefdinir** 14 mg/kg per day orally in one or two doses (maximum 600 mg/day)
- **Cefpodoxime** 10 mg/kg orally in two doses (maximum 400 mg/day)
- **Cefuroxime** suspension 30 mg/kg per day orally divided in two doses (maximum 1 g/day)
- **Cefuroxime** tablets 250 mg orally every 12 hours
- **Ceftriaxone** 50 mg/kg intramuscularly once per day (maximum 1 g/day) for one to three doses (if there is symptomatic improvement within 48 hours of the first dose, additional doses are not necessary; if symptoms persist, a second, and if necessary, a third dose are administered [49])

The oral regimens do not achieve sufficient concentration in the middle ear to eradicate penicillin-resistant *S. pneumoniae*.

**Immediate reaction** — Macrolide or lincosamide antibiotics can be used to treat AOM in children who have had an immediate type 1 hypersensitivity reaction (anaphylaxis, angioedema, bronchospasm, or urticaria) to amoxicillin or other beta-lactam antimicrobial agents. However, macrolide or lincosamide resistance is common (approximately 25 to 35 percent) among isolates of *S. pneumoniae*, and macrolides and lincosamides generally are not effective for eradication of *H. influenzae* [45,50,51].

Macrolides and lincosamides available for the treatment of AOM include:

- **Azithromycin** 10 mg/kg per day orally (maximum 500 mg/day) as a single dose on day one and 5 mg/kg per day (maximum 250 mg/day) for days two through five
- **Clarithromycin** 15 mg/kg per day orally divided into two doses (maximum 1 g/day)
- **Erythromycin-sulfisoxazole** 50 mg/kg per day orally of the erythromycin component divided into three to four doses (maximum 2 g/day erythromycin or 6 g/day sulfisoxazole); erythromycin plus sulfisoxazole is often rejected by patients based upon taste and frequency of dosing [52]
- The optimal dose for clindamycin therapy for AOM is uncertain; the American Academy of Pediatrics suggests a dose of 30 to 40 mg/kg per day orally divided in three doses (maximum 1.8 g/day) [3,53].

Increasing the dose of macrolide antibiotics does not overcome macrolide resistance among pneumococcal isolates (as with beta-lactam drugs) [42].

Trimethoprim-sulfamethoxazole (TMP-SMX) may be useful in regions where pneumococcal resistance to TMP-SMX is not a concern, but TMP-SMX should not be used if group A streptococcus (S. pyogenes) is suspected (eg, when there is an associated tympanic membrane perforation). (See 'AOM with perforation' below.)

AOM with perforation — For children with AOM and tympanic membrane perforation, we suggest oral rather than topical antibiotic therapy. We suggest amoxicillin 90 mg/kg per day orally divided in two doses (maximum 3 g/day) as the preferred first-line oral therapy. Because of the possibility of group A streptococcus, an agent other than TMP-SMX should be used. For patients with acute otorrhea, 10 days of oral therapy is more effective than a shorter course [54].

Although topical therapy with quinolone otic drops (ofloxacin or ciprofloxacin) is equivalent to oral therapy for treatment of otorrhea in children with tympanostomy tubes or chronic suppurative otitis media, topical therapy has not been studied in children with AOM and acute perforation [55,56]. Nonantimicrobial topical agents, such as benzocaine or olive oil, should not be used in patients with perforation of the tympanic membrane. (See "Tympanostomy tube otorrhea in children: Causes, prevention, and management", section on 'Treatment'.)

Duration of therapy — We suggest that children <2 years, children with AOM and tympanic membrane perforation, and children with a history of recurrent AOM be treated for 10 days. We suggest that children ≥2 years without tympanic membrane perforation or a history of recurrent AOM be treated for five to seven days.

Most clinical trials and standard pediatric practice provide a 10-day course of an oral antimicrobial agent for the treatment of AOM. However, some data suggest that a shorter course (ie, seven days) may be adequate [57]. Unfortunately, many of the studies comparing short- and long-term antibiotic therapy have significant limitations that preclude definitive conclusions.

The bulk of data from randomized trials suggests that 10-day therapy is more effective in patients younger than two years and is possibly more effective in children between two and five years [58-60].

INITIAL OBSERVATION — We suggest initial observation as an alternative to antimicrobial therapy for children ≥2 years who are normal hosts (eg, immune competent, without craniofacial abnormalities), without otorrhea, and who have mild symptoms and signs of unilateral acute otitis media (AOM) (ie, nonsevere ear pain for <48 hours and temperature <39°C [102.2°F]). Clinicians who recommend initial observation should exercise rigor in diagnosing AOM similar to that in the research protocols that support the safety of this practice. (See 'Antibiotic therapy versus observation' above and "Acute otitis media in children: Diagnosis".)

When the initial observation strategy is chosen, caretakers must understand the risks and benefits, and appropriate follow-up must be ensured so that antibiotic therapy can be initiated if symptoms worsen or persist after 48 to 72 hours [3]. Unilateral AOM at first observation may
rapidly progress to bilateral disease during the early hours of illness. Adequate follow-up may include a parent-initiated visit or phone contact if symptoms worsen or do not improve at 48 to 72 hours, a scheduled follow-up appointment in 48 to 72 hours, or giving parents an antibiotic prescription that can be filled if illness does not improve in this time frame [20,21,61-63]. (See ’Follow-up’ below.)

The 2013 American Academy of Pediatrics and American Academy of Family Physicians guideline suggests initial observation (with pain control) as an option for healthy children (ie, without conditions that predispose to AOM) between 6 and 24 months with unilateral nonsevere AOM and for children ≥24 months with unilateral or bilateral nonsevere AOM [3]. This is a change from the 2004 guidelines, which suggested initial observation as an option for children ≥6 months with “uncertain” diagnosis and children ≥2 years with non-severe illness [64].

Guidelines from other countries (eg, the National Institute for Health and Clinical Excellence in the United Kingdom, the Dutch College of General Practitioners) recommend no antibiotics or delayed antibiotics for most children with AOM.

FOLLOW-UP

Persistent symptoms — Children who fail to improve after 48 to 72 hours of antibiotic therapy should be seen in follow-up to confirm the diagnosis of acute otitis media (AOM), evaluate other causes of persistent symptoms, and determine whether a change in antibacterial therapy is warranted [3]. (See ’Treatment failure’ below.)

Children who worsen or fail to improve after 48 to 72 hours of initial observation and symptomatic treatment without antibiotics should be started on antibiotics. (See ’Initial antimicrobial therapy’ above.)

Resolved symptoms — Follow-up for children whose symptoms have resolved depends upon the child's age and underlying medical problems, particularly language delay or learning problems.

We suggest that:

- Children <2 years be seen 8 to 12 weeks after diagnosis (by which time middle ear effusion will have resolved in 80 to 90 percent [figure 1]); many such children will already have a routine healthcare visit scheduled within this time frame
- Children ≥2 years who have language or learning problems be seen 8 to 12 weeks after diagnosis AOM
- Children ≥2 years who are without language or learning problems be followed up at their next health maintenance visit, or sooner if there are concerns regarding persistent hearing loss

The main reason for follow-up of children with resolved symptoms is to monitor the resolution of middle ear effusion which is associated with conductive hearing loss. Persistent middle ear effusion is common after the resolution of acute symptoms. In a large prospective study, middle ear effusion persisted for weeks to months after the onset of AOM in children [figure 1] [8]. (See ’Clinical course’ above.)
The management of persistent middle ear effusion is discussed separately. (See "Otitis media with effusion (serous otitis media) in children: Clinical features and diagnosis", section on 'Hearing loss' and "Otitis media with effusion (serous otitis media) in children: Management", section on 'Overview of management'.)

Tympanic membrane perforation — Tympanic membrane perforation permits drainage of the middle ear abscess and relieves increased middle ear pressure. With the relief of middle ear pressure, the tympanic membrane usually heals quickly, sealing the perforation in hours to days.

If pain occurs or persists in a child with AOM and tympanic membrane perforation, causes other than AOM must be considered. The pain is unlikely to be due to AOM because the pressure of middle ear fluid is relieved when the tympanic membrane is perforated. Other possible causes include:

- Extension of the infection to a contiguous space, such as the mastoid (ie, mastoiditis) (see "Acute mastoiditis in children: Clinical features and diagnosis", section on 'Diagnosis' and "Acute mastoiditis in children: Treatment and prevention", section on 'Overview of management')
- Irritation of the external canal from middle ear drainage, resulting in otitis externa, in which case treatment with a topical quinolone may be beneficial (see "External otitis: Treatment", section on 'Topical therapy')

Nonantimicrobial topical agents, such as benzocaine or olive oil, should not be used to treat pain in patients with perforation of the tympanic membrane.

Patients with perforation that persists for three months or longer (with or without suppurative drainage) should be referred to an otolaryngologist for further management [65]. Prevention of chronic suppurative otitis media entails prompt and appropriate treatment of AOM [66]. Chemoprophylaxis is not warranted. (See "Chronic suppurative otitis media (CSOM): Pathogenesis, clinical manifestations, and diagnosis" and "Chronic suppurative otitis media (CSOM): Prevention, treatment, prognosis, and complications".)

TREATMENT FAILURE

Definition and etiology — Treatment failure is defined by lack of improvement by 48 to 72 hours in a patient treated with antimicrobial therapy.

Fluid may persist in the middle ear for prolonged periods, even when the antimicrobial agents have sterilized the effusion and the acute signs and symptoms are no longer present. Persistent middle ear effusion after the resolution of acute symptoms is not an indication of treatment failure or an indication for additional antibiotic therapy [67]. (See 'Clinical course' above.)

Treatment failure suggests either the initial therapy was not adequate or another disease is present. (See 'Approach' below and "Acute otitis media in children: Diagnosis", section on 'Differential diagnosis'.)

Inadequate therapy is usually related to infection with an organism resistant to beta-lactam antibiotics (nontypeable H. influenzae and drug-resistant S. pneumoniae are becoming increasingly important), but infection with less common organisms, such as Staphylococcus aureus, also must be considered, particularly in children with tympanostomy tubes [68-70].
(See "Acute otitis media in children: Epidemiology, microbiology, clinical manifestations, and complications", section on 'Microbiology' and "Tympanostomy tube otorrhea in children: Causes, prevention, and management", section on 'Pathogens'.)

Approach

Initial treatment failure — We suggest that patients who fail treatment with high-dose amoxicillin be treated with amoxicillin-clavulanate [3]. The dose is 90 mg/kg per day amoxicillin and 6.4 mg/kg per day of clavulanate divided in two doses (we suggest a maximum of 3 g/day). Adolescents ≥16 years who can take large tablets can use extended-release amoxicillin-clavulanate 1 to 2 g of the amoxicillin component and 62.5 to 125 mg of the clavulanate component every 12 hours.

We prefer amoxicillin-clavulanate for children who fail treatment with amoxicillin because of its efficacy against beta-lactamase-producing H. influenzae and Moraxella catarrhalis; for S. pneumoniae, amoxicillin and amoxicillin-clavulanate have similar efficacy.

Alternatives to high-dose amoxicillin-clavulanate include:

- **Cefdinir** 14 mg/kg per day orally in one or two doses (maximum 600 mg/day) [71].
- **Cefpodoxime** 10 mg/kg orally in two doses (maximum 400 mg/day).
- **Cefuroxime** suspension 30 mg/kg per day orally divided in two doses (maximum 1 g/day); the spectrum of activity of cefuroxime is excellent for AOM; however, because children may find it unpalatable [52,72], its usefulness as a second-line agent may be limited [49].
- **Cefuroxime** tablets 250 mg orally every 12 hours.
- **Ceftriaxone** 50 mg/kg intramuscularly or intravenously once per day (maximum 1g/day) for one to three doses (if there is symptomatic improvement within 48 hours of first dose, additional doses are not necessary; if symptoms persist, a second, and if necessary, a third dose are administered [49]).

Parenteral ceftriaxone 50 mg/kg achieves high levels in the middle ear and is effective for the treatment of AOM in children who fail amoxicillin [3]; although the US Food and Drug Administration (FDA) has approved a single dose of parenteral ceftriaxone for the treatment of AOM in children, an open-label prospective study suggested that three doses were superior in eradicating penicillin-resistant S. pneumoniae from the middle ear [73].

- **Levofloxacin** 10 mg/kg orally every 12 hours for 10 days for children six months to five years or 10 mg/kg per orally once daily for 10 days for children ≥5 years (maximum 500 to 750 mg/day) [74].

Levofloxacin should be reserved for children with AOM refractory to other drugs (ideally it should only be used in children who have had serotype 19A isolated from the middle ear that is susceptible to levofloxacin) [70]; levofloxacin is not approved by the US FDA for the treatment of AOM, and levofloxacin resistance among S. pneumoniae respiratory isolates has been described in adults [75].
Trimethoprim-sulfamethoxazole, macrolides (eg, erythromycin-sulfisoxazole, azithromycin, clarithromycin), and lincosamides (eg, clindamycin) are not recommended for AOM that fails to respond to treatment with high-dose amoxicillin. Pneumococcal surveillance studies indicate that resistance to these agents is substantial [44,76]. Macrolides and lincosamides have limited activity against nontypeable H. influenzae, which is a more likely pathogen among children who have failed initial amoxicillin therapy.

**Persistent treatment failure** — Referral to a pediatric otolaryngologist and/or pediatric infectious diseases expert may be warranted for children with persistent treatment failure. Tympanocentesis is recommended to make a bacteriologic diagnosis if symptoms persist despite ceftriaxone or other broad spectrum therapies [70]. Tympanocentesis should be performed by an appropriately trained clinician who is comfortable performing the procedure in an awake child (unless there is access to sedation or anesthesia). Alternatively, treatment with levofloxacin and/or tympanostomy tube placement may be appropriate [70].

**RECURRENT AOM** — Recurrent acute otitis media (AOM) is defined by the development of signs and symptoms of AOM soon after completion of successful treatment. It is particularly important to establish the diagnosis of recurrent AOM with bulging of the tympanic membrane and signs of inflammation. Otherwise, persistent middle ear effusion in a child with a febrile upper respiratory infection may be misinterpreted as a recurrent episode and the child may receive antibiotics unnecessarily.

There are no randomized trials to guide treatment of recurrent AOM in children. The approach varies depending upon the therapy that was used for recent episodes. Treatment of recurrent AOM must include coverage for resistant pathogens, particularly S. pneumoniae.

When recurrence occurs **within 30 days of completion** of antimicrobial treatment for the previous episode, we suggest:

- **Ceftriaxone** 50 mg/kg per day intramuscularly (IM) or intravenously (IV) for three days, or
- **Ceftriaxone** 50 mg/kg per dose IM or IV every 36 hours for a total of two doses, or
- **Levofloxacin** 10 mg/kg every 12 hrs orally for 10 days for children six months to five years or 10 mg/kg per once daily for 10 days for children ≥5 years (maximum 500 to 750 mg/day) [74]

When the recurrence occurs **more than 30 days after completion** of the treatment for the previous episode, it is most often due to a different pathogen than the previous episode. Although the child is at higher risk for a nonsusceptible pathogen, we suggest high dose amoxicillin-clavulanate as initial therapy, even if the child received amoxicillin-clavulanate for the previous episode.

Tympanostomy tube insertion may be warranted for children with ≥3 distinct and well-documented episodes of AOM within six months or ≥4 episodes within 12 months. (See "Acute otitis media in children: Prevention of recurrence", section on "Tympanostomy tubes".)

**AIRPLANE TRAVEL** — Children with Eustachian tube dysfunction, including those with acute otitis media (AOM) may have pain during airplane descent [77,78]. Most commercial airplanes have pressurized cabins, with the pressure equal to that at 7000 to 10,000 feet. During the flight, middle ear pressure gradually equilibrates through swallowing or absorption of air by the middle
ear mucosa. With airplane descent, the pressure in the cabin increases to that at landing altitude. If middle ear pressure does not increase accordingly (ie, if the Eustachian tube "locks in" the reduced pressure, due to obstruction of the nasopharyngeal orifice), the tympanic membrane may be forced medially and stretched, which can lead to painful barotrauma: bleeding into the tympanic membrane (picture 2), formation of fluid exudates in the middle ear, and occasionally to tympanic membrane rupture [79]. Upper respiratory infection appears to be a predisposing condition for aerotitis (inflammation of the ear caused by changes in atmospheric pressure, also known as barotitis). (See "Ear barotrauma", section on 'Etiology'.)

Interventions to equalize middle ear and atmospheric pressure have not been well studied in controlled trials. We suggest that children be awake during descent and chewing gum or food (or sucking on a pacifier or bottle if they are too young to chew gum or food) to open the Eustachian tube and facilitate equalization of middle ear pressure [80]. Autoinflation via the Valsalva maneuver (forced exhalation with the mouth and nose closed) or a purpose-manufactured nasal balloon also may be helpful in older children [81]. In younger children, nasal bulb suction may be helpful. We do not suggest pre-flight treatment with antihistamines or decongestants. In a randomized trial, predeparture administration of pseudoephedrine did not decrease ear pain, but was associated with increased drowsiness [82].

There is little published information describing other adverse effects of airplane travel in children with AOM. However, there are no reports of extratemporal extension of AOM related to flying.

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient information: Ear infections (otitis media) (The Basics)" and "Patient information: Ruptured eardrum (The Basics)")
- Beyond the Basics topic (see "Patient information: Ear infections (otitis media) in children (Beyond the Basics)"

SUMMARY AND RECOMMENDATIONS

- The diagnosis of acute otitis media (AOM) requires bulging of the tympanic membrane or other signs of acute inflammation and middle ear effusion (picture 1). The importance of accurate diagnosis is crucial to avoidance of unnecessary treatment. (See 'Diagnosis of AOM' above and "Acute otitis media in children: Diagnosis", section on 'Diagnosis'.)
- We suggest oral ibuprofen or acetaminophen to treat ear pain in children with AOM (Grade 2B). Topical benzocaine preparations are an alternative for children ≥2 years, but should not
be used in children with tympanic membrane perforation. We recommend NOT using decongestants and/or antihistamines (Grade 1A). (See ‘Symptomatic therapy’ above.)

- The choice of initial treatment with antibiotics or observation depends upon the age of the child and the laterality and severity of illness (see ‘Antibiotic therapy versus observation’ above):
  - We recommend that children with AOM who are <6 months be treated with antibiotics (Grade 1A).
  - We suggest that children with AOM who are between six months and two years be treated with antibiotics (Grade 2A).
  - We suggest that children ≥2 years who appear toxic; have persistent otalgia for more than 48 hours; have temperature ≥102.2°F (39°C) in the past 48 hours; have bilateral AOM or otorrhea; or have uncertain access to follow-up be immediately treated with an appropriate antibiotic (Grade 2A).
  - For children ≥2 years who are normal hosts (eg, immune competent, without craniofacial abnormalities) and have unilateral AOM with mild symptoms and signs and no otorrhea, initial observation may be appropriate if the caretakers understand the risks and benefits of such an approach.

- When antibiotic treatment is warranted, we suggest amoxicillin as the first-line therapy for AOM in most children (Grade 2B). The dose is 90 mg/kg per day (maximum 3 g/day) divided in two doses. We suggest amoxicillin-clavulanate as the first-line therapy for children with AOM who have received a beta-lactam antibiotic in the previous 30 days or have concomitant purulent conjunctivitis (Grade 2A). The dose is 90 mg/kg per day of amoxicillin and 6.4 mg/kg per day of clavulanate divided in two doses. (See ‘First-line therapy’ above.)

- Macrolides or clindamycin are an alternative for patients who have had immediate hypersensitivity reactions (eg, anaphylaxis, angioedema, bronchospasm, urticaria) to penicillin (table 1). However, macrolides and clindamycin lack activity against most Haemophilus influenzae isolates and approximately one-third of pneumococcal isolates. Patients with other types of allergic reactions can be treated with cefdinir, cefpodoxime, cefuroxime, or intramuscular ceftriaxone. (See ‘Penicillin allergy’ above.)

- We generally treat children <2 years, children with tympanic membrane perforation, and children with recurrent AOM for 10 days. We generally treat children ≥2 years without a history of recurrent AOM for five to seven days. (See ‘Duration of therapy’ above.)

- Treatment failure is defined by lack of symptomatic improvement 48 to 72 hours after initiation of antimicrobial therapy. We suggest that patients who fail first-line therapy be treated with amoxicillin-clavulanate (Grade 2B). Alternatives include cefdinir, cefpodoxime, cefuroxime, and ceftriaxone. (See ‘Initial treatment failure’ above.)