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# Upper Respiratory Tract Infections (Including Otitis Media)

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## KEYWORDS

- Evidence based • Rhinosinusitis • Pharyngitis
- Otitis media • Management

Upper respiratory tract infections (including otitis media) are the most common illnesses affecting children.<sup>1</sup> On average, children experience around six to eight upper respiratory tract infections (URTIs) each year.<sup>2</sup> Although these infections usually are mild and self limiting, they occasionally lead to complications that can be life threatening. Most URTIs can be placed within three main categories of infection: rhinosinusitis, pharyngitis, and otitis media. Within each category of illness there is a range of related conditions that may have similar or overlapping clinical presentations.<sup>3</sup> Some judgment is required in determining which part of the respiratory mucosa is most affected. In this article, the term “rhinosinusitis” is used to describe illnesses with predominantly nasal symptoms (including the common cold, nasopharyngitis, and sinusitis). The term “pharyngitis” is used to describe illnesses when sore throat is most prominent (including tonsillitis). The term “otitis media” is used to describe illnesses with predominantly middle ear symptoms (including acute otitis media [AOM], otitis media with effusion [OME], and chronic suppurative otitis media [CSOM]). Children who have cough as the predominant symptom are considered to have bronchitis (a lower respiratory tract infection). To make matters more complicated, all areas of the respiratory mucosa may be affected, simultaneously or at different times, during one illness.

The cause of these respiratory mucosal infections most commonly is viral but can be bacterial (**Table 1**),<sup>4</sup> and many infections involve both viruses and bacteria.<sup>5</sup> In developed countries, both viral and bacterial infections are likely to be self limited. Persistent disease is most likely to indicate a bacterial infection.

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Table 1 Spectrum of disease, accepted terminology, and etiology of the common upper respiratory tract infections in children		
Condition	Related Diagnoses	Etiology
Rhinosinusitis	Common cold, nasopharyngitis, infective rhinitis, acute rhinosinusitis, acute sinusitis, chronic sinusitis	Viral: rhinovirus, coronavirus, enterovirus, parainfluenza, influenza, respiratory syncytial virus, adenovirus, metapneumovirus Bacterial: <i>Streptococcus pneumoniae</i> , <i>Haemophilus influenzae</i> , <i>Moraxella catarrhalis</i> , <i>Staphylococcus aureus</i> , <i>Streptococcus pyogenes</i>
Pharyngitis	Pharyngitis, tonsillitis, recurrent tonsillitis	Viral: adenovirus, respiratory syncytial virus, Epstein-Barr virus, cytomegalovirus, parainfluenza, influenza Bacterial: <i>Streptococcus pyogenes</i> , Group C and G <i>Streptococci</i> , <i>Mycoplasma pneumoniae</i>
Otitis media	Acute otitis media without perforation, acute otitis media with perforation, otitis media with effusion, chronic suppurative otitis media.	Viral: respiratory syncytial virus, influenza, adenovirus, rhinovirus, coronavirus, enterovirus, parainfluenza, metapneumovirus Bacterial: <i>Streptococcus pneumoniae</i> , <i>Haemophilus influenzae</i> , <i>Moraxella catarrhalis</i> , <i>Streptococcus pyogenes</i>

The frequency of infection and association with fever and constitutional symptoms creates significant distress for the child and the family. By understanding the evidence available from high-quality studies, the clinician can advise the families on appropriate action.<sup>6</sup> The goal of this article is to support clinicians in answering the following questions:

1. What happened to children with these conditions when no additional treatment was provided?
2. Which interventions have been assessed in well-designed studies?
3. Which interventions have been shown to improve outcomes?
4. How large is the overall benefit?

#### THE APPROACH TO EVIDENCE USED IN THIS ARTICLE

URTIs are extremely common in children, and there is a long list of potential interventions. Because URTIs are common illnesses, there is no reason why high-quality randomized, controlled trials (RCTs) should not be conducted.<sup>7</sup> In addition, all families experience these conditions and may have strong personal preferences about treatment. The challenge for the clinician is to make an accurate diagnosis and then to match the effective treatment options with the preferences of the family.

This article initially considers the effects of an intervention compared with no intervention. Because each condition covers a spectrum of disease, the acute presentation of the initial URTI is discussed first and then, when appropriate, interventions for persistent disease or complications of the initial complaint are addressed. Because of the focus on trial evidence, not all the information relevant to an individual decision may be discussed. Furthermore, because the clinical course of participants enrolled in RCTs may be different from the clinical course observed in one's own practice, the overall effects of an intervention may need to be adjusted. Despite these limitations, clinicians using this article should be confident that they understand which interventions have been rigorously assessed and the overall findings of these assessments.

The GRADE Working Group has described the steps required to review evidence.<sup>8,9</sup> Ideally, explicit criteria should be used. Although this process has many advantages in terms of transparency, it does not guarantee that recommendations will be consistent across different sets of evidence-based guidelines (although this consistency is the long-term aim).<sup>10</sup> The GRADE Working Group proposes that a recommendation should indicate the decision that the majority of well-informed individuals would make.<sup>8</sup> It is difficult to be dogmatic about interventions for self-limited conditions with a low risk of complications. Therefore, the author has tried to provide a summary of evidence to assist discussions with families (**Tables 2–4**). The author's approach (informed by the best available evidence) is described in **Box 1**.

## IMPORTANT HEALTH OUTCOMES AND TREATMENT EFFECTS

The self-limiting nature of these conditions is of the utmost importance in determining which treatments are indicated. The outcomes the author considers important are (1) persistent disease (short term,  $\leq 14$  days; medium term,  $>2$  weeks to 6 months; and long term  $>6$  months), (2) time to cure, and (3) complications arising from progressive disease. The author considered interventions to have very large effects if they were associated with a reduction in the outcome of interest of more than 80%; large effects were associated with a reduction in outcome of interest of at least 50%.<sup>11</sup> Reductions in outcome of interest between 20% and 50% were considered modest, and reductions of less than 20% were considered slight (or small). Because only a proportion of children who have URTIs experience bad outcomes, even large relative effects may not translate to clinically significant absolute benefits.

## SEARCH STRATEGY

The author's search targeted evidence-based guidelines, evidence-based summaries, systematic reviews, and RCTs of interventions for rhinosinusitis, pharyngitis, and otitis media (**Box 2**). Even this simple strategy identified more than 6500 sources using PubMed alone. Inclusion as an evidence-based guideline, summary, or systematic review required an explicit search strategy and criteria for study inclusion. Inclusion as a clinical trial required randomization. The author used three primary sources to identify relevant information: *Clinical Evidence*;<sup>11</sup> the Cochrane library<sup>12</sup> and Medline (last accessed via PubMed on June 16, 2008). The evidence-based summaries in *Clinical Evidence* have links to major guidelines and use the GRADE Working Group approach to assess quality of evidence and strength of recommendations.<sup>11</sup>

## RESULTS OF SEARCH

The search identified more than 50 evidence-based guidelines, evidence summaries, and systematic reviews (and many more additional RCTs) published since 2000. This

<b>Table 2</b> <b>Treatment effects of interventions for rhinosinusitis in children that have been assessed in randomized, controlled trials</b>		
<b>Intervention</b>	<b>Evidence</b>	<b>Effect</b>
<b>Prevention</b>		
Vitamin C	30 studies (11,350 participants)	No significant reduction in proportion of participants experiencing the common cold (48%)
Echinacea	Three studies (498 participants)	No significant reduction in proportion of participants experiencing the common cold (45%)
<b>Treatment of initial rhinosinusitis</b>		
Antihistamines	Five studies (3492 participants)	No significant reduction in proportion of participants with persistent symptoms at 1 to 2 days (55%)
Vitamin C	Seven studies (3294 participants)	No significant reduction in median duration of symptoms
Antibiotics	Six studies (1147 participants)	No significant reduction in persistent symptoms at 7 days (35% versus 31%); significant reduction in persistence of purulent rhinitis from 42% to 24%
Decongestants	Six studies (643 participants)	Subjective assessment of congestion reduced by 6% after one dose. Effect persisted with repeated doses over 3 days
Zinc lozenges	13 studies (516 participants)	No consistent effects on symptoms
Echinacea	Two studies (200 participants)	Proportion experiencing "full" cold reduced by 12% to 23% but no effect in other studies of different outcomes
<b>Treatment of persistent rhinosinusitis/clinical sinusitis</b>		
Intranasal corticosteroids	Three studies (1792 participants)	Persistent disease reduced from 27% to 19%.
Antibiotics	14 studies (1309 participants)	Persistent disease at around 2 weeks reduced from 60% to 46% in adults and from 46% to 35% in children

article does not include interventions that have been assessed in nonrandomized studies, interventions that have been assessed in studies with fewer than 200 participants (sparse data),<sup>11</sup> or studies of interventions that are available only experimentally.

## **RHINOSINUSITIS**

Rhinosinusitis is an URTI that predominantly affects the nasal part of the respiratory mucosa.<sup>13–15</sup> Common cold infections are caused mainly by viruses (typically rhinovirus, but also coronavirus, respiratory syncytial virus, metapneumovirus, and others).<sup>2</sup> For many colds, no infecting organism can be identified. Common colds usually have a short duration. Symptoms peak within 1 to 3 days and generally clear by 7 to 10 days, although an associated cough (bronchitis) often persists.<sup>2</sup> Most people who have acute rhinosinusitis are assessed and treated in a primary-care setting.

Intervention	Evidence	Effect
<b>Treatment of initial pharyngitis</b>		
Antibiotics	15 studies (3621 participants)	Pain at 3 days reduced from 66% to 48%
	13 studies (2974 participants)	Pain at 7 days reduced from 18% to 12%
	15 studies (3621 participants)	Median time to cure reduced from 4 days to 3 days
	Eight studies (2443 participants)	Peritonsillar abscess within 2 months reduced from 2.3% to 0.1%
	16 studies (10,101 participants)	Rheumatic fever within 2 months reduced from 1.8% to 0.7%
	11 studies (3760 participants)	Otitis media within 14 days reduced from 2% to 0.5%
Analgesics	17 studies (1742 participants)	Pain scores reduced by 25% to 80% within 4 hours; benefits persisted with regular treatment over 2 to 5 days
Corticosteroids	Five studies (421 participants)	Pain reduced by 12 to 24 hours but effects inconsistent
<b>Treatment of recurrent pharyngitis</b>		
(Adeno)Tonsillectomy	Six studies (1618 participants)	Sore throat episodes over 3 years reduced from 2.4 to 1.2 episodes per year

A preceding viral URTI often is the trigger for acute sinusitis; about 0.5% to 5% of common colds become complicated by the development of acute sinusitis.<sup>16</sup> Acute sinusitis is defined pathologically by transient inflammation of the mucosal lining of the paranasal sinuses lasting less than 30 days.<sup>17,18</sup> Clinically, acute sinusitis is characterized by nasal congestion, nasal discharge, and facial pain.<sup>19</sup> The diagnosis of acute sinusitis in infants and children usually is made in children who have purulent nasal drainage persisting beyond 10 days.<sup>17</sup> In straightforward cases, no investigations are required.<sup>17</sup> In more complicated (or frequent) presentations, possible underlying factors include nasal airway obstruction, immunodeficiencies, ciliary dysfunction, cystic fibrosis, and allergic rhinitis. The usual pathogens in acute bacterial sinusitis are *Streptococcus pneumoniae* and *Haemophilus influenzae*, with occasional infection with *Moraxella catarrhalis* and *Staphylococcus aureus*. Rarely, bacterial sinusitis in children leads to rare, life-threatening complications, such as meningitis, cavernous venous thrombosis, and orbital cellulitis.<sup>4</sup>

### **Options for Interventions**

Most children who have rhinosinusitis improve spontaneously within 14 days, and complications from this illness are uncommon. There is evidence about the preventive effects of vitamin C and Echinacea on the onset of the illness.<sup>20,21</sup> Neither of these interventions has been proven to be effective. There is evidence about the treatment effects of antihistamines, vitamin C, antibiotics, decongestants, zinc lozenges, and Echinacea (see **Table 2**).<sup>20–28</sup> Of these interventions, only decongestants have been proven to be effective, but their beneficial effect is small.<sup>26</sup> Decongestants have not

<b>Table 4</b>		
<b>Treatment effects of interventions for otitis media in children that have been assessed in randomized, controlled trials</b>		
<b>Intervention</b>	<b>Evidence</b>	<b>Effect</b>
<b>Prevention</b>		
Conjugate pneumococcal vaccine	Three studies (39,749 participants)	Acute otitis media episodes reduced by 6% (eg, from 1.0 to 0.94 episodes per year); insertion of tympanostomy tubes reduced from 3.8% to 2.9%
Influenza vaccine	11 studies (11,349 participants)	Inconsistent results; modest protection against otitis media during influenza season in some studies
<b>Treatment of initial acute otitis media</b>		
Antihistamines and decongestants	12 studies (2300 participants)	No significant difference in persistent acute otitis media at 2 weeks
Antibiotics	Eight studies (2287 participants)	Persistent pain on day 2 through 7 reduced from 22% to 16%
	Six studies (1643 participants)	Persistent reduced from 55% to 30% in children younger than 2 years old who had with bilateral acute otitis media and from 53% to 19% in children who had acute otitis media with perforation
Myringotomy	Three studies (812 participants)	Early treatment failure increased from 5% to 20%
Analgesics	One study (219 participants)	Persistent pain reduced from 25% to 9% on day 2
<b>Treatment of recurrent acute otitis media</b>		
Antibiotics	16 studies (1483 participants)	Episodes of acute otitis media reduced from 3.0 to 1.5 episodes per year
Adenoidectomy	Six studies (1,060 participants)	No significant reduction in rates of acute otitis media
Tympanostomy tubes	Five studies (424 participants)	Episodes of acute otitis media reduced from 2.0 to 1.0 episodes per year
<b>Treatment of persistent otitis media with effusion</b>		
Antibiotics	Nine studies (1534 participants)	Persistent otitis media with effusion at around 4 weeks reduced from 81% to 68%
Tympanostomy tubes	11 studies (~ 1300 participants)	Modest improvement in hearing (9 dB at 6 months and 6 dB at 12 months); no improvement in language or cognitive assessment
Antihistamines and decongestants	Seven studies (1177 participants)	No difference in persistent otitis media with effusion at 4 weeks (75%)
Autoinflation	Six studies (602 participants)	Inconsistent results; modest improvement in tympanometry at 4 weeks in some studies
Antibiotics plus steroids	Five studies (418 participants)	Persistent otitis media with effusion at 2 weeks reduced from 75% to 52%
<b>Treatment of chronic suppurative otitis media</b>		
Topical antibiotics	Seven studies (1074 participants)	Persistent chronic suppurative otitis media at 2 to 16 weeks reduced from around 75% to 20% to 50%
Ear cleaning	Two studies (658 participants)	Inconsistent results; no reduction in persistent chronic suppurative otitis media at 12 to 16 weeks (78%) in a large African study

**Box 1****Suggested approach for assessing and managing a child who has an upper respiratory infection**

1. Take a history of the presenting complaint to elicit the primary symptom: nasal discharge (rhinosinusitis), sore throat (pharyngitis) ear pain, ear discharge, or hearing loss (otitis media). Ask about the frequency and severity of previous URIs. Clarify the duration of illness and the presence of any associated features, including cough (bronchitis), fever, respiratory distress, cyanosis, poor feeding, or lethargy. Determine the concerns, expectations, and preferences of the child and the caregivers. (Grade: very low; level of evidence: cohort studies and other evidence)
2. Examine the child to confirm whether investigation and management should be directed at rhinosinusitis, pharyngitis, or AOM. Assess temperature, pulse and respiratory rate, presence and color of nasal discharge, nasal obstruction, facial tenderness, tonsillar enlargement, tonsillar exudate, cervical lymphadenopathy, presence of cough, presence of middle ear effusion (using pneumatic otoscopy or tympanometry), position and integrity of tympanic membrane, and proptosis. Ensure normal hydration, perfusion, conscious state, and no meningism, periorbital swelling, limitation of eye movements, upper airway obstruction, respiratory distress, or mastoid tenderness. (Grade: very low; level of evidence: cohort studies and other evidence)
3. Investigations
  - Rhinosinusitis: none required unless patient is febrile and less than 3 months of age or danger signs (respiratory distress, cyanosis, poor feeding, or lethargy) are present.  
(Grade: low; level of evidence: cohort studies)
  - Pharyngitis: none required unless patient is febrile and less than 3 months of age or danger signs (respiratory distress, cyanosis, poor feeding, or lethargy) are present.  
(Grade: low; level of evidence: cohort studies)
  - AOM: none required unless patient is febrile and less than 3 months of age or danger signs (respiratory distress, cyanosis, poor feeding, or lethargy) are present.  
(Grade: low; level of evidence: cohort studies)
4. Management
  - Rhinosinusitis: Provide symptomatic pain relief if indicated during watchful waiting with advice to parents on likely course and possible complications. Antibiotics can be considered if there is persistent nasal discharge for more than 10 days or purulent nasal discharge. Decongestants may be used in an older child who has significant nasal obstruction. (Grade: moderate; level of evidence: RCTs)
  - Pharyngitis: Provide symptomatic pain relief if indicated during watchful waiting with advice to parents on likely course and possible complications. Antibiotics can be used if pain is severe and does not respond to analgesics, if there is tonsillar exudate plus cervical lymphadenopathy and no nasal discharge or cough, or if the patient is at high risk of complications (especially rheumatic fever or peritonsillar abscess). (Grade: moderate; level of evidence: RCTs)
  - AOM: Provide symptomatic pain relief if indicated during watchful waiting with advice to parents on likely course and possible complications. Antibiotics can be used if the patient has AOM with perforation or is younger than 2 years old and has bilateral AOM, if there has been no improvement after 48 hours of watchful waiting, or if the patient is at high risk of suppurative complications (especially perforation of the tympanic membrane). (Grade: high; level of evidence: RCTs)



**Box 2**

**A simple PubMed search strategy to identify evidence-based guidelines, evidence-based summaries, systematic reviews, and randomized controlled trials on common upper respiratory tract infections**

"rhinitis"[MeSH Terms] OR "nasopharyngitis"[MeSH Terms] OR "common cold"  
[MeSH Terms] OR "sinusitis"[MeSH Terms] OR "pharyngitis"[MeSH Terms] OR "tonsillitis"[MeSH  
Terms] OR "otitis"[MeSH Terms] AND (practice guideline[pt] OR systematic[sb] OR clinical  
evidence[jour] OR clinical trial[pt]).

been tested in young children. Antibiotics seem to be effective in individuals who have purulent rhinosinusitis, but the beneficial effect is modest.<sup>24</sup>

Given the available evidence from RCTs, most well-informed individuals choose a course of watchful waiting. Symptomatic relief using analgesic agents has not been assessed in RCTs but would be a reasonable in children who have pain or discomfort. Antibiotics are an option for children who have purulent nasal discharge but provide only a modest benefit. Decongestants are an option for older children who have nasal obstruction. It probably is worth persisting with decongestants only when there is symptomatic relief with the first dose.

A small proportion of children go on to develop persistent rhinosinusitis or classic sinusitis. There is evidence about the treatment effects of intranasal corticosteroids (from adult studies) and antibiotics.<sup>17,18,29–33</sup> Both of these interventions seem to be beneficial, but the beneficial effects are modest. If antibiotics are to be used, there no consistent evidence that a longer course of treatment ( $\geq 7$  days) is more effective than a shorter course.<sup>32</sup> There is no evidence to support the belief that any one of the commonly used antibiotics is more effective than the others (although the cephalosporin class of antibiotics does seem to be inferior to amoxicillin-clavulanate).<sup>32</sup> Given the available evidence from RCTs, most well-informed individuals choose either watchful waiting or a trial of antibiotics. Intranasal corticosteroids are a reasonable option in older children, particularly those who have any features of atopy.

## PHARYNGITIS

Pharyngitis is an acute URTI that affects the respiratory mucosa of the throat, resulting in a predominant symptom of pain that may be associated with headache, fever, and general malaise.<sup>3,34,35</sup> In the United States, acute pharyngitis accounts for about 1% of primary care consultations and ranks in the top 20 diagnoses.<sup>34</sup> Infections leading to pharyngitis can be viral or bacterial (**Table 5**). It is difficult to distinguish bacterial infections from viral infections clinically. Studies have found that tonsillar or pharyngeal exudate, tender cervical lymphadenopathy, and recent exposure to streptococcal throat infection are most useful in predicting bacterial infection.<sup>36</sup> A useful clinical prediction rule found that streptococcal infection was present in 50% of children if three of the following features were positive: fever higher than 38°C; tonsillar swelling or exudate; tender cervical lymphadenopathy; and absence of cough. Even without treatment, sore throat resolves in 40% of cases by 3 days and in 85% of cases by 1 week.<sup>3</sup> A small proportion of children experience progression of the illness. Suppurative complications include peritonsillar abscess (quinsy), AOM, and acute sinusitis. Nonsuppurative complications include acute rheumatic fever and acute glomerulonephritis.

### *Options for Interventions*

Most children who have pharyngitis improve spontaneously within 14 days, and complications from this illness are uncommon. There is evidence about the

Condition	Typical Clinical Features
Rhinosinusitis	Febrile illness associated with nasal discharge
Persistent rhinosinusitis	Persistent nasal discharge plus abnormalities on sinus radiographs
Pharyngitis	Febrile illness associated with sore throat plus localizing signs on examination
Recurrent tonsillitis	Recurrent febrile illnesses (more than three per year) associated with sore throat plus localizing signs on examination
Acute otitis media	Clinical diagnosis of acute otitis media with red tympanic membrane and ear pain
Recurrent acute otitis media	Recurrent clinical diagnosis of acute otitis media (three or more episodes in 6 months) with red tympanic membrane and ear pain
Otitis media with effusion	Asymptomatic persistent middle ear effusion confirmed by tympanometry
Chronic suppurative otitis media	Discharge through a perforated tympanic membrane for 2 to 6 weeks

treatment effects of antibiotics, analgesics, and corticosteroids on the onset of illness (see **Table 3**).<sup>3,35,37–41</sup> The beneficial effect of analgesics is large and persists over several days of treatment.<sup>3,40</sup> Antibiotics also have been proven to be effective,<sup>3,37,38</sup> with large to very large beneficial effects for preventing complications (peritonsillar abscess, rheumatic fever, and otitis media). These complications generally affect less than 2% of children, however. Antibiotics have a modest, short-term beneficial effect in improving the sore throat itself. If oral penicillin is used for treatment, there is evidence that a full 10-day course is more effective than shorter courses.<sup>39</sup> There is some evidence that systemic corticosteroids reduce pain within 12 to 24 hours.<sup>3,41</sup>

Given the available evidence from RCTs, most well-informed individuals choose symptomatic relief with analgesics and either watchful waiting or antibiotics. Antibiotics would be most appropriate in children at increased risk of complications, those who have features more consistent with a bacterial infection (fever higher than 38°C, tonsillar exudate, enlarged tender cervical nodes, and absence of nasal discharge and cough), and those who have severe pain that does not respond to analgesics. Corticosteroids are an option for children who have severe pain not responding to analgesics or who have very large tonsils that may lead to obstruction.

A small proportion of children go on to develop recurrent tonsillitis. There is evidence on the treatment effects of tonsillectomy.<sup>35,42,43</sup> Tonsillectomy has a large beneficial effect, but the rates of tonsillitis also reduce spontaneously without treatment, so absolute benefits are modest. In addition, the operation itself is associated with postoperative pain and some risk of complications. High-quality trials of prophylactic antibiotic treatment have not been done, but this treatment would be a reasonable option for families who want treatment but decide against surgery. Surgery is likely to be most beneficial in children who have very frequent severe infections. If surgery is the chosen treatment option, cold steel tonsillectomy is associated with less postoperative pain and bleeding than operation by diathermy.<sup>35,44</sup>

## OTITIS MEDIA

Otitis media is an acute URTI that affects the respiratory mucosa of the middle ear cleft. It is a common illness in young children and occurs much less frequently in children more than 6 years old.<sup>45,46</sup> In developed countries, otitis media is the most common indication for antibiotic prescribing and surgery in young children. In the United States, annual costs associated with otitis media were estimated to be \$3 to \$5 billion in the 1990s.<sup>45</sup>

Otitis media is best regarded as a spectrum of disease. The most important conditions are OME, AOM without perforation (AOMwoP), acute otitis media with perforation (AOMwiP), and CSOM. Unfortunately, there currently is a lack of consistency in definitions of different forms of otitis media (especially AOM).<sup>47</sup> Generally, AOM is defined as the presence of a middle ear effusion plus the presence of the symptoms (especially pain) or signs (especially bulging of the tympanic membrane or fresh discharge). The diagnostic criteria used in studies of AOM vary. Some use symptomatic criteria, some use otoscopic criteria, and some require that both symptomatic and otoscopic criteria be met. OME usually is defined as the presence of a middle ear effusion without symptoms or signs of an acute infection. CSOM usually is defined as discharge through a perforated tympanic membrane for longer than 2 to 6 weeks.

Children who have immunodeficiency or craniofacial abnormalities (eg, cleft palate, Down's syndrome) are at increased risk of otitis media. Other risk factors that have been identified in epidemiologic studies include recent respiratory infection, family history, siblings, child care attendance, lack of breast feeding, passive smoke exposure, and use of a pacifier.<sup>48</sup>

Most children experience at least one episode of AOM.<sup>45</sup> The peak incidence of infection occurs between 6 and 12 months. Although the pathogenesis of AOM is multifactorial, both viruses and bacteria are implicated.<sup>45</sup> Bacteria infection with the common respiratory pathogens (*S. pneumoniae*, *H. influenzae*, and *M. catarrhalis*) often is preceded by a viral infection. Viruses (especially respiratory syncytial virus and influenza) can cause AOM without coinfection with bacteria.<sup>45</sup> The pain associated with AOM resolves within 24 hours in around 60% of cases and within 3 days in around 80%.<sup>46</sup> AOM is less likely to resolve spontaneously in children younger than 2 years.<sup>49</sup> Complications of AOM include CSOM, mastoiditis, labyrinthitis, facial palsy, meningitis, intracranial abscess, and lateral sinus thrombosis.<sup>50</sup> Mastoiditis was the most common life-threatening complication in the pre-antibiotic era. It occurred in 18% of children admitted to hospital with AOM in one study.<sup>51</sup> Mastoiditis and all other complications now are rare in developed countries.

CSOM is the most severe form of otitis media.<sup>52</sup> Although there is a lack of well-designed longitudinal studies, CSOM is the type of otitis media most likely to persist without treatment. In developing countries, CSOM occurs as a complication of AOM with perforation and can be a major health issue. The range of bacterial pathogens associated with CSOM is considerably broader than those seen in AOM. *Pseudomonas*, *Staphylococcus*, *Proteus*, and *Klebsiella* species are the most commonly isolated pathogens, and mixed infections are common.<sup>52</sup> Multidrug antibiotic resistance is seen often in *Pseudomonas* infections. The associated hearing loss usually is greater than seen in OME, and CSOM is the most important cause of moderate conductive hearing loss (>40 dB) in many developing countries.<sup>53</sup>

In developed countries, CSOM now is very uncommon. A recent risk factor study in Holland found that most cases of CSOM now occur as a complication of tympanostomy tube insertion.<sup>54</sup> Children who have immunodeficiency and some indigenous populations also are at greatly increased risk. In rural and remote communities in northern Australia, more than 20% of young children are affected.<sup>55</sup>

OME is the most common form of otitis media. The point prevalence in screening studies is around 20% in young children.<sup>45</sup> OME can occur spontaneously, as a component of rhinosinusitis, or following an episode of AOM. The same respiratory bacterial pathogens associated with AOM have been implicated in the pathogenesis of OME. Most children who have OME improve spontaneously within 3 months, and complications from this illness are uncommon.<sup>45</sup> The average hearing loss associated with OME is around 25 dB.<sup>45</sup> Despite large numbers of studies, a causal relationship between OME and speech and language delay has not been proven.<sup>50,56</sup>

Children who have otitis media usually present with features related to (1) pain and fever (AOM); (2) hearing loss (OME); or (3) ear discharge (AOMwiP or CSOM). In some children, otitis media is detected as part of a routine examination. Making an accurate diagnosis is not easy. Generally a good view of the whole tympanic membrane and the use of either pneumatic otoscopy or tympanometry are required to confirm the presence of a middle ear effusion.<sup>47,57</sup> Studies of diagnostic accuracy in AOM have found ear pain to be the most useful symptom, but it is not very reliable on its own. Bulging, opacity, and immobility of the tympanic membrane are highly predictive of AOM. Normal color (pearly gray) of the tympanic membrane makes AOM unlikely.<sup>58</sup>

### **Options for Interventions**

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Most children who have AOM improve spontaneously within 14 days, and complications from this illness are uncommon. There is evidence concerning the preventive effects of conjugate pneumococcal vaccine and influenza vaccine on the onset of illness (see **Table 4**).<sup>46,59–61</sup> Both these vaccines have been shown to be effective, but the beneficial effects in terms of overall rates of infection are slight. The beneficial effects of the conjugate pneumococcal vaccine in reducing the rate of insertion of tympanostomy tubes are modest.<sup>62</sup> Most children do not fall into this risk group. There also is evidence about the treatment effects of antihistamines and decongestants, antibiotics, myringotomy, and analgesics (see **Table 4**).<sup>46,50,51,63</sup> Regular analgesics (paracetamol or ibuprofen) provide a benefit (assessment on day 2), and the beneficial effects are large.<sup>46</sup> Antibiotics also are effective,<sup>49,51</sup> but in most children the short-term beneficial effects are slight. The beneficial effects are modest in children younger than 2 years old who have bilateral AOM and are large in those who have AOMwiP. Studies of initial treatment with antibiotics have not documented a long-term effect. If antibiotics are to be used, there is evidence that a longer course of treatment ( $\geq 7$  days) is more effective, but the beneficial effects are modest (persistent AOM reduced from 22% to 15%).<sup>64</sup> There is no evidence that any one of the commonly used antibiotics is more effective than the others. The use of antihistamines and decongestants has not been shown to be beneficial, and myringotomy seems to be harmful compared with no treatment or antibiotics (see **Table 4**).<sup>46,50,63</sup>

Given the available evidence from RCTs on AOM, most well-informed individuals choose symptomatic relief with analgesics and either watchful waiting or antibiotics. Antibiotics are most appropriate in children younger than 2 years who have bilateral AOM, children who have AOMwiP, children at high risk of complications, and children who already have had 48 hours of watchful waiting. If the child is not in a high-risk group, but the family prefers antibiotic treatment, the clinician should discuss “wait and see” prescribing. Provision of a script for an antibiotic along with advice to use it only if the pain persists for 48 hours can reduce antibiotic use by two thirds (with no negative effect on family satisfaction).<sup>65–67</sup>

A small proportion of children who have AOM experience recurrent AOM (three episodes within 6 months or four episodes within 12 months).<sup>45</sup> There is evidence about the treatment effects of prophylactic antibiotics, adenoidectomy, and tympanostomy

tube insertion.<sup>46,50,68–70</sup> Antibiotics have been proven to be effective, but the beneficial effects are modest. The rates of AOM also reduce spontaneously without treatment, so the absolute benefits are less impressive than anticipated. Insertion of tympanostomy tubes also seems to reduce rates of AOM, and the level of effect is similar to that of antibiotics. Either of these options could be considered in children who have very frequent severe infections, especially infections occurring before the peak of respiratory illness in winter. Children who have tympanostomy tubes may develop a discharging ear, however, so tympanostomy tubes are not a good option in children who are at increased risk of suppurative infections (including those who have immunodeficiency or persistent bacterial rhinosinusitis). In these children, prophylactic antibiotics or prompt antibiotic treatment of infections probably is a more appropriate choice. Adenoidectomy does not seem to be an effective treatment.<sup>50,69,70</sup>

A small proportion of children who have AOMwIP go on to develop CSOM. In developed countries, CSOM occurs most commonly as a complication of tympanostomy tube placement. There is evidence about the treatment effects of topical antibiotics, topical antiseptics, systemic antibiotics, and ear cleaning.<sup>52,53,71–73</sup> The interpretation of a large number of small studies is challenging, but topical antibiotics have been proven to be effective, although the beneficial effects vary from large to modest. Most studies have not documented a long-term effect. Topical antibiotics also seem to be more effective than antiseptics and systemic antibiotics.<sup>53</sup> The role of topical antibiotics plus systematic antibiotics is unclear.<sup>74</sup> Cleaning the middle ear discharge has not been proven to be effective in RCTs but generally is regarded as necessary before insertion of topical antibiotics (at least in children who have profuse discharge). Although not seen in RCTs, there also is a very small risk of ototoxicity associated with most topical antibiotics (except topical quinolones) and topical antiseptics.<sup>50</sup> For children who do not respond to prolonged courses of topical antibiotics, two small studies (85 participants) have documented high cure rates and large beneficial effects associated with 2 to 3 weeks of intravenous antipseudomonal antibiotics (such as ceftazidime).<sup>75,76</sup>

Given the available evidence from RCTs on CSOM, most well-informed individuals choose topical antibiotic treatment. Even though this treatment is effective, prolonged or repeated courses of treatment often are required. If prolonged or repeated courses of topical antibiotic are needed, topical quinolones provide a slight benefit in terms of risk of ototoxicity.

OME affects all children but usually is asymptomatic.<sup>45</sup> A small proportion of children have persistent OME with associated hearing loss. There is evidence that screening to identify young children who have OME or hearing loss associated with OME is not effective in developed countries.<sup>77</sup> There also is evidence on the treatment effects of antibiotics, insertion of tympanostomy tubes, autoinflation devices, antihistamines and decongestants, and antibiotics plus steroids (see **Table 4**).<sup>49,51,78–85</sup> Early insertion of tympanostomy tubes (compared with watchful waiting with the option of later insertion) improves hearing at 6 and 12 months, but the beneficial effect is modest.<sup>78,79,81</sup> This improvement in hearing has not been associated with improvement in language development or cognitive assessment scores.<sup>81</sup> Tympanostomy tubes usually last 6 to 12 months, and there is no evidence of any ongoing benefit after they have been extruded. Antibiotics also have been shown to be an effective treatment, but the beneficial effects are slight and do not seem to persist long term.<sup>50,78,79</sup> Combining antibiotics with steroids seems to provide short-term benefits, but again the beneficial effect is modest.<sup>78,85</sup> There is some evidence that autoinflation devices are effective.<sup>78,83</sup> but the benefits are modest and have been documented to be only short term. Antihistamines and decongestants provide no benefit (see **Table 4**).<sup>78,79,84</sup>

Given the available evidence from RCTs on OME, most well-informed individuals initially choose a course of watchful waiting. For children who have persistent OME in both ears associated with hearing loss despite watching waiting for 6 to 12 months, a trial of antibiotics is reasonable. Insertion of tympanostomy tubes is most appropriate in children when the primary concern is conductive hearing loss and communication difficulties. Children who have the most severe conductive hearing loss are most likely to benefit. Children who experience frequent suppurative infections (including those who have immunodeficiency or persistent bacterial rhinosinusitis) are at greatest risk of developing CSOM as a complication of tympanostomy tubes. Families should be informed that a small proportion of children suffer recurrent persistent OME when the tympanostomy tubes are extruded and may need a second operation. In these children, tympanostomy tubes plus adenoidectomy is a reasonable option.<sup>79,80</sup>

### SUMMARY

URTIs are the most common illnesses affecting children. Most illnesses are mild and resolve completely without specific treatment. Multiple interventions have been assessed in the treatment of rhinosinusitis, pharyngitis, and otitis media. None of the interventions had substantial absolute benefits for the populations studied. Therefore, for most children, symptomatic relief and watchful waiting (including education of the parents about important danger signs) is the most appropriate treatment option. Antibiotics have a role in children who have persistent bacterial infection and those at risk of complications.

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