Management of Acute Rhinosinusitis, Bronchitis Syndromes, and Acute Otitis Media
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ABSTRACT

PURPOSE: The most common community-acquired acute respiratory illnesses (ARIs) are acute rhinosinusitis, acute bronchitis/acute exacerbation of chronic bronchitis in adults, and acute otitis media in children. This review focuses on the judicious use of empiric antimicrobial therapy for the treatment of these syndromes.

EPIDEMIOLOGY: ARIs affect 30 million patients in the United States and cost approximately US$1.3 billion annually. They are the most common indications for prescription of antimicrobial agents.

REVIEW SUMMARY: Identifying patients who have bacterial ARIs is essential to curbing inappropriate antimicrobial use and related escalation in costs. The most common bacterial causes of ARIs include *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Approximately 25% of *S pneumoniae* are resistant to penicillins and macrolides, whereas one third of *H influenzae* and nearly 100% of *M catarrhalis* produce β-lactamases. Because 15% to 75% of patients with bacterial ARIs may recover spontaneously, antimicrobials should be used as per published guidelines. Finally, minimizing/eliminating exposure to risk factors for ARIs (eg, smoking, allergens) and emphasizing protective practices such as breast-feeding in infancy are essential as preventive measures.

TYPE OF AVAILABLE EVIDENCE: Systematic reviews/meta-analyses, randomized-controlled trials, controlled prospective and retrospective cohort studies, and unstructured reviews.

GRADE OF AVAILABLE EVIDENCE: Good.

CONCLUSION: ARIs are a significant cause of morbidity and contribute significantly to US health costs. The diagnosis of ARIs is mainly clinical and treatment remains largely empiric; awareness in addition to practice of published guidelines for diagnosis and treatment of these syndromes is crucial. Antimicrobial therapy should be used selectively and preventive measures considered whenever feasible.

office visits for otitis media in 2000 and 802 antibacteri-
al prescriptions were administered per 1000 office visits.\textsuperscript{5,6} Acute bacterial otitis media and acute bacterial rhinosi-
usitis are likely the most common indications for the prescription of antimicrobial agents.\textsuperscript{7} It therefore is not surprising to note that ARIs contribute significantly to the nation’s healthcare bill. A conservative estimate of the cost of antibiotic prescriptions for ARIs in the United States in 1998 was about $1.32 billion.\textsuperscript{6} However, actual health-
care costs are substantially higher. For example, estimated costs for otitis media in children under age 13 extrapolated to $5.3 billion in 1998 dollars.\textsuperscript{2} In addition, social costs that include lost work time and lost wages for patients as well as their caregivers (in the case of affected children) are not accounted for by the above studies.

Prompt and accurate diagnosis of ARIs remains the first line of defense against morbidity and costs associated with these illnesses. Clinical diagnosis plays a key role in guiding and limiting the use of laboratory and imaging studies needed to pinpoint an upper respiratory condition. In addition, knowledge of the common infectious causes of ARIs and the antimicrobial susceptibility pat-
tern in their geographic areas is essential for effective therapy and to prevent the evolution and spread of antibiotic resistance. In a study using mailed surveys, chart reviews, and parent telephone interviews, 366 licensed pediatricians and family physicians were sur-
veyed regarding antibiotic treatment for upper respira-
tory tract infections in children. Most physicians (97%) agreed that overdose of antibiotics was a major factor con-
tributing to antibiotic resistance. However, their prac-
tices did not conform to the published guidelines.\textsuperscript{10,11} 69% of physicians considered purulent rhinitis a diag-
nostic finding for sinusitis, 86% prescribed antibiotics for bronchitis regardless of the duration of cough, and 42% prescribed antibiotics for the common cold. Family physicians were significantly more likely than pedi-
tricians to not perform pneumatic otoscopy (46% vs 25%) and to omit the requirement for prolonged symptoms to diagnose sinusitis (median, 4 vs 10 days).\textsuperscript{12} Since treat-
ment remains largely empiric, awareness in addition to practice of published guidelines for diagnosis and treat-
ment of these syndromes is crucial to minimize unneces-
sary procedures or overuse of antibiotics.

In clinical practice, 3 of the most common presenta-
tions of community-acquired ARIs are acute rhinosinu-
ritis, acute bronchitis/AECB in adults, and acute otitis media (AOM) in children. All can be caused by viruses or bacteria; this article primarily focuses on identifying patients with syndromes of bacterial nature and empiric treatment with antimicrobial therapy.

**Diagnosis**

Accurate diagnosis of acute rhinosinusitis, acute bron-
chitis/AECB, and AOM is largely dependent on the patient’s history and the physical examination. Adjunctive laboratory studies are indicated only in few situations.

**Acute Rhinosinusitis**

The ethmoid and the maxillary sinuses are present at birth whereas the sphenoid and frontal sinuses appear by ages 5 and 7 or 8, respectively. The common predispos-
ing events for acute bacterial rhinosinusitis are acute viral upper respiratory infections and allergic inflammation.\textsuperscript{13,14} Children have, on average, 6 to 8 viral upper respiratory infections each year and 5% to 13% of these are compi-
lcated by a secondary bacterial infection of the paranasal sinuses.\textsuperscript{15,16} Uncomplicated viral upper respiratory infec-
tions generally last 5 to 7 days and though respiratory symptoms may not have resolved completely they almost always begin to improve by the 10th day.\textsuperscript{17} Therefore, the persistence of respiratory symptoms without any improvement suggests the presence of a secondary bacte-
rial infection. It is, however, important to differentiate consecutive episodes of uncomplicated viral upper respira-
tory tract infections from persistent symptoms. Acute bacterial rhinosinusitis is an infection of the paranasal sinuses with symptoms lasting more than 10 to 14, but fewer than 30, days. Symptoms include nasal or post-
nasal discharge (of any quality), daytime cough (which may become worse at night), or both. Severe symptoms include a fever of at least 102°F (39°C) and purulent nasal discharge present concurrently for at least 3 to 4 consecutive days. Patients also may complain of headaches, generally around the eyes. Physical examina-
tion is not very useful for diagnosis since signs in patients with acute bacterial rhinosinusitis often are similar to those of uncomplicated viral rhinosinusitis. Examination of the nasal mucosa may show mild erythema and swelling of the nasal turbinates with mucopurulent dis-
charge. Facial tenderness is an unreliable sign and is unusual in children, though reproducible unilateral pain present on percussion or direct pressure over the body of the frontal and maxillary sinuses may be a useful sign.\textsuperscript{18} Likewise, observed or reported periorbital swelling is sug-
gestive of ethmoid rhinosinusitis. Examination of the tympanic membranes, pharynx, and cervical lymph nodes generally is not useful.

Transillumination of the sinuses to assess whether fluid is present in the maxillary and frontal sinuses\textsuperscript{19} is difficult to perform correctly and has been shown to be unreliable in children younger than 10 years.\textsuperscript{20} In older children and adults, this sign may be helpful only when the transillumination is found to be either nor-
mal or very abnormal.

Imaging studies are not necessary in any age group to confirm a diagnosis of uncomplicated acute bacterial rhinosinusitis.\textsuperscript{21} This is especially so for children younger than 6 years of age since history alone is highly predictive for disease in this age group.\textsuperscript{22} The need for imaging stud-
ies in children older than 6 years and adults with persist-
ent symptoms, as well as for all children (regardless of age) with severe symptoms, is controversial. Some practi-
tioners may elect to perform sinus radiographs since a normal radiograph is good evidence against bacterial rhi-
Acute bronchitis and AECB present with cough, sputum production, and low-grade fever, with negative radiographic findings on a chest radiograph. Patients with AECB have underlying COPD and typically a history of cigarette smoking, and their chest radio-graphs are unchanged from baseline. The distinction between acute bronchitis/AECB and community-acquired pneumonia (CAP) is important both for stratifying patient risk and for appropriate use of antibiotics. The key diagnostic indicators for CAP are fever and positive radiographic findings on a chest radiograph. However, in busy outpatient practices, physicians often do not have the luxury of reviewing chest radiographs before initial treatment (hospital referral or outpatient antibiotics) and, as a result, the initial presumptive diagnosis frequently rests largely on findings from the history and physical examination.

Acute bronchitis almost always is viral in etiology and the duration most often is transient and self-limited. In patients with prolonged cough (>14 days) and no other findings, pertussis should be considered. AECB, on the other hand, is caused by both bacteria (70%) and viruses (30%). Anthonisen et al classified AECB into 3 degrees based on the presence of 3 symptoms: dyspnea, increased sputum volume, and increased sputum purulence. Severe AECB (type 1) is defined by the presence of all 3 symptoms; moderate AECB (type 2) by the presence of 2 symptoms; and mild exacerbation (type 3) by the presence of only 1 of the 3 symptoms. The differentiation of 3 degrees of severity has figured prominently in AECB research, particularly in investigations of antimicrobial therapy. Most studies have focused on patients with type 1 exacerbation. In these patients, antimicrobial therapy has been found to be beneficial and to reduce morbidity and mortality. By contrast, findings on the benefits of antimicrobial therapy in patients with mild to moderate AECB have been less conclusive. A meta-analysis published in 1995 of AECB studies conducted in the preceding 3 decades identified an overall benefit of antibiotics despite the fact that 2 of the studies showed a benefit of placebo over antibiotics.

Acute otitis media

AOM is predominantly a pediatric problem. Patients typically present with acute onset of fever and otalgia (manifested as irritability or pulling of the ear in an infant or toddler) that often is preceded by or concurrent with an uncomplicated viral upper respiratory infection (eg, cough, nasal discharge, or stuffiness). However, clinical history alone is not very specific for the diagnosis of AOM. In a prospective survey among 354 children fever, earache, and excessive crying were present in 90% of patients with AOM but also in 72% of patients without AOM. Therefore, the diagnosis of AOM requires a history of acute onset of signs and symptoms, as described above, in addition to the presence of middle ear effusion (ie, bulging of the tympanic membrane, limited or absent mobility of the tympanic membrane, air-fluid level behind the tympanic membrane, otorhea) and signs and symptoms of middle ear inflammation (eg, distinct erythema of the tympanic membrane or distinct otalgia).

Visualization of the tympanic membrane is essential. The tympanic membrane can be visualized adequately only when the obscuring cerumen has been removed and the child has been adequately restrained for the examination. A normal tympanic membrane is translucent and has a gray or pinkish tint (Figure, A). The membrane has a neutral position and demonstrates full mobility in response to pneumatic otoscopy. Middle ear effusion (Figure, B) is determined by pneumatic otoscopy and is successful only when a speculum of proper shape and diameter is used to permit a seal in the external auditory canal. In a patient with AOM the tympanic membrane tends to be opaque, with a distinct erythema (Figure, C). The membrane bulges, exuding a sense of fullness consistent with accumulation of fluid or pus behind it. Probing with a pneumatic otoscope reveals limited mobility. In children, erythema of the tympanic membrane also can be caused by crying or high fever, but usually is less intense and fades when the child stops crying and/or becomes normothermic. Every effort should be
made to distinguish AOM from otitis media with effusion (OME), which often accompanies viral upper respiratory infections or can be a prelude to or sequela of AOM.30 Patients with OME have middle ear effusion but do not have signs and symptoms of middle ear inflammation. However, distinguishing between the 2 is difficult, resulting in frequent overdiagnosis of AOM. In one study the ability of US physicians to distinguish OME from AOM based on tympanic visualization was 74% for otolaryngologists, 51% for pediatricians, and 46% for general practitioners (P < .0001).30 Though all groups were able to correctly identify abnormal tympanic membranes most of the time, otolaryngologists, pediatricians, and general practitioners overdiagnosed AOM in 11%, 26%, and 26% of cases, respectively.

**MANAGEMENT**

As noted above, these 3 syndromes can be caused by both viruses and bacteria. The previous section described how clinicians can make an effort to distinguish patients with a bacterial cause and therefore consider empiric antimicrobial therapy. The following recommendations assume that such a determination already has been made. Adequate follow-up to see the effect of therapy after 48 to 72 hours of initiation should be considered, particularly in children. Patients who do not show improvement with standard therapy and patients with complications require appropriate referral to an otolaryngologist.

**EMERGING RESISTANCE**

Principal bacterial pathogens associated with acute rhinosinusitis, AECB, and AOM in include Streptococcus pneumoniae, Haemophilus influenzae (non-typeable), and Moraxella catarrhalis.38,39 However, increasing antimicrobial resistance complications and thwart effective treatment. Approximately 25% of all upper respiratory tract isolates of S pneumoniae from children in the United States are not susceptible to penicillin, but this varies widely by geographic location. Of these, approximately 50% are highly resistant to penicillin, and the remaining 50% have intermediate resistance.40,41 Since the mechanism of penicillin resistance in S pneumoniae is an alteration of penicillin-binding proteins, for strains with intermediate resistance this can be overcome by using higher doses of penicillin. S pneumoniae also are increasingly resistant to other antimicrobials and approximately 25% are resistant to macrolides.42 The number of β-lactamase–producing strains of H influenzae and M catarrhalis has risen considerably and, nationwide, 30% to 35% of H influenzae and nearly 100% of M catarrhalis produce β-lactamases.43,44 These strains will not respond to penicillin, even at a higher dose.

**THERAPEUTIC RECOMMENDATIONS**

**ACUTE RHILOSINUSITIS**

The Sinus and Allergy Health Partnership recently updated its recommendations for treatment of bacterial rhinosinusitis in adults.30 For patients with mild disease and no antibiotic use in the previous 4 to 6 weeks, any of 5 antibiotics are deemed appropriate: amoxicillin/clavu-
lanate; amoxicillin 1.5 to 4 g/day; cefdinir; cefpodoxime; cefuroxime. If a patient has moderately severe disease or mild disease associated with recent antibiotic exposure, 4 therapeutic options are recommended: a fluoroquinolone (gatifloxacin, levofloxacin, or moxifloxacin); amoxicillin/clavulanate; ceftriaxone; or combination therapy with high-dose amoxicillin or clindamycin for gram-positive coverage plus cefixime or rifampin for gram-negative coverage. A therapeutic switch should be considered if the patient fails to respond after 72 hours. When selecting an alternate therapy, any coverage limitations of the initial treatment should be taken into account.

Similar recommendations are applied to treatment of children. For children with mild to moderate symptoms and no risk factors for the presence of penicillin-resistant isolates (daycare attendance, recent antimicrobial treatment), high-dose amoxicillin (90 mg/kg/day in 2 divided doses) is used as first-line therapy. For those who show no improvement at 72 hours, or who have severe symptoms or risk factors for the presence of penicillin-resistant isolates, high-dose amoxicillin/clavulanate (amoxicillin 90 mg/kg/day with clavulanate 6.4 mg/kg/day in 2 divided doses) should be administered. Other alternatives at this stage include cefdinir (14 mg/kg/day once daily), cefpodoxime (10 mg/kg/day once daily), and cefuroxime (30 mg/kg/day in 2 divided doses). If the child fails to improve with this therapy, imaging and/or sinus drainage is recommended. Alternatively, a trial with intravenous cefotaxime/ceftriaxone may be started.

The duration of therapy for patients with acute bacterial rhinosinusitis often is empiric, lasting 10, 14, or 21 days. Alternatively, antimicrobial therapy should be continued for 7 days after the patient becomes asymptomatic. This strategy results in a minimum of 10 days but avoids prolonged courses of antibiotics in patients who are asymptomatic.

### Table 1. Palatability Ratings for Common Antimicrobial Suspensions*†

<table>
<thead>
<tr>
<th>Product</th>
<th>Appearance</th>
<th>Smell</th>
<th>Texture</th>
<th>Taste</th>
<th>After-taste</th>
<th>Overall Taste</th>
<th>Taste Adjusted for Duration and Dosing</th>
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<tbody>
<tr>
<td>Cefdinir</td>
<td>3rd</td>
<td>2nd</td>
<td>2nd</td>
<td>2nd</td>
<td>3rd</td>
<td>2nd</td>
<td>2nd</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>2nd</td>
<td>3rd</td>
<td>6th</td>
<td>4th</td>
<td>5th</td>
<td>4th</td>
<td>1st</td>
</tr>
<tr>
<td>Amoxicillin/clavulanate</td>
<td>9th ‡</td>
<td>10th</td>
<td>9th</td>
<td>8th</td>
<td>7th</td>
<td>9th</td>
<td>12th</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>7th</td>
<td>7th</td>
<td>7th</td>
<td>5th</td>
<td>4th</td>
<td>5th</td>
<td>10th</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>9th ‡</td>
<td>6th</td>
<td>8th</td>
<td>9th</td>
<td>10th</td>
<td>10th</td>
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<tr>
<td>Cefuroxime</td>
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<td>11th</td>
<td>10th</td>
<td>10th</td>
<td>11th</td>
<td>11th</td>
<td>11th</td>
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</table>

* Amoxicillin is not shown as it was used as the standard for comparison in this study.
† Data from Steele RW, et al.7
‡ Tied for 9th place.

### Acute Bronchitis/Acute Exacerbation of Chronic Bronchitis

Acute bronchitis does not require antimicrobial therapy but therapy with bronchodilators may be considered, instead. Patients with suspected pertussis may be treated with a macrolide/azalide (clarithromycin/azithromycin). Anti-microbials should be used judiciously for uncomplicated mild and moderate AECB. In patients with severe or complicated AECB, antimicrobial therapy should be combined with bronchodilators and oral corticosteroids. Smokers should be advised to stop smoking. Antimicrobial therapy includes use of either amoxicillin/clavulanate, macrolides/azalides (clarithromycin/azithromycin), or fluoroquinolones such as gatifloxacin, levofloxacin, or moxifloxacin. Patients with FEV1 of <50% of predicted or who typically have >4 exacerbation events per year are at risk for gram-negative pathogens such as Pseudomonas or Klebsiella and should receive a fluoroquinolone or high-dose amoxicillin/clavulanate. Such individuals frequently require hospitalization and parenteral antibiotics. The duration of therapy varies from 5 to 10 days depending on the antimicrobial used.

### Acute Otitis Media

The American Academy of Pediatrics (AAP) has published guidelines for the management of otitis media in children. Adults may be managed in the same way as can older children. Treatment includes use of analgesics when pain is present. Patients with AOM may not require antimicrobials and their use should be guided as shown in Table 2. When indicated, high-dose amoxicillin (80 to 90 mg/kg/day) is the initial antimicrobial of choice. For severe illness amoxicillin/clavulanate is used, instead. The duration of therapy is 10 days for children under age 5 or for severe illness, but otherwise is 5 to 7 days. If the patient cannot tolerate oral medication, intramuscular ceftriaxone may be used for 3 consecutive days. Failure to respond in 48 hours may be managed as follows: if no therapy was used initially, antimicrobial therapy should be instituted as specified above; if amoxicillin was used as initial therapy, the patient should be switched to amoxicillin/clavulanate; if amoxicillin/clavulanate was used as initial therapy, the patient should be switched to ceftriaxone or tympanocentesis should be considered.

Fluoroquinolones are not recommended in children but may be considered in adults, though there are very few data about their use for AOM. Hearing testing is recommended in children when OME persists for ≥3 months.
PREVENTION

Minimizing or eliminating exposure to risk factors is essential for prevention of ARIs. This includes reducing exposure to active or passive smoking, dust, and allergens. Underlying disorders including but not limited to anatomic defects (eg, polyps, deviated nasal septum, etc), allergies, and immunodeficiency should be investigated thoroughly and the appropriate corrective measures instituted. Exclusive breast-feeding for at least the first 6 or more months of life protects infants from single and recurrent episodes of otitis media, so this should be encouraged. Supine bottle feeding (“bottle propping”) should be avoided; reducing or eliminating pacifier use in the second 6 months of life has been postulated to reduce the incidence of AOM in infancy.

Immunizations form a significant preventive measure for both children and adults. Children should receive their routine immunizations including the 7-valent pneumococcal conjugate vaccine, which has been shown to be modestly protective for otitis media. In addition, individuals ≥65 years and other high-risk individuals should receive the pneumococcal polysaccharide vaccine. Influenza vaccine should be administered to children who are between 6 and 23 months of age; close contacts of children under 23 months of age; children and adults with risk factors (eg, asthma, cardiac disease, HIV, diabetes, sickle cell disease, etc); healthcare workers; adults ≥65 years; all women who are or will be pregnant during the influenza season; residents of nursing homes and long-term care facilities; and other high-risk individuals. Influenza immunization has been shown to reduce AOM during the respiratory illness season by almost 30% in children over age 2. Children younger than 2 years of age who meet the criteria for respiratory syncytial virus (RSV) prophylaxis should receive monthly monoclonal RSV antibody during the RSV season.

Antimicrobial prophylaxis for prevention of recurrent episodes of acute bacterial rhinosinusitis is controversial. Though antimicrobial prophylaxis has been used in children with recurrent episodes of AOM, there is little support for its use due to concerns of increased prevalence of antimicrobial resistance.

Tympanostomy tubes are beneficial in children ≥6 months with middle ear effusion and recurrent otitis media (≥3 episodes of AOM in 6 months, or ≥4 episodes in 12 months). However, the role of tympanostomy tubes in the absence of middle ear effusion (or for recurrent otitis media) is less clear.

CONCLUSION

ARIs are a significant cause of morbidity and contribute significantly to health costs in the United States. The diagnosis of respiratory tract infections relies heavily on clinical history and physical examination. Since treatment remains largely empiric, awareness in addition to practice of published guidelines for diagnosis and treatment of these syndromes is crucial to minimize unnecessary procedures or overuse of antibiotics. Antimicrobial therapy should be used selectively only when indicated. Preventive measures should be considered whenever feasible.

Table 2. Management of Acute Otitis Media in Children

<table>
<thead>
<tr>
<th>Patient’s Age</th>
<th>Certain Diagnosis</th>
<th>Uncertain Diagnosis</th>
</tr>
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<tbody>
<tr>
<td>&lt;6 months</td>
<td>Treat</td>
<td>Treat</td>
</tr>
<tr>
<td>6 months–2 years</td>
<td>Treat</td>
<td>May not treat; observe if not severe†</td>
</tr>
<tr>
<td>&gt;2 years</td>
<td>May not treat; observe if not severe†</td>
<td>Observe†</td>
</tr>
</tbody>
</table>

*Data from AAP guidelines for management of otitis media.†Observe means symptomatic relief only with deferment of antimicrobials and reevaluation after 48-72 hours. Severe illness means moderate to severe otalgia or fever ≥39°C.

REFERENCES
