American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

CLINICAL PRACTICE GUIDELINE

Clinical Practice Guideline for the Diagnosis and Management of Acute Bacterial Sinusitis in Children Aged 1 to 18 Years

abstract

FREE

OBJECTIVE: To update the American Academy of Pediatrics clinical practice guideline regarding the diagnosis and management of acute bacterial sinusitis in children and adolescents.

METHODS: Analysis of the medical literature published since the last version of the guideline (2001).

RESULTS: The diagnosis of acute bacterial sinusitis is made when a child with an acute upper respiratory tract infection (URI) presents with (1) persistent illness (nasal discharge [of any quality] or daytime cough or both lasting more than 10 days without improvement), (2) a worsening course (worsening or new onset of nasal discharge, daytime cough, or fever after initial improvement), or (3) severe onset (concurrent fever [temperature ≥39°C/102.2°F] and purulent nasal discharge for at least 3 consecutive days). Clinicians should not obtain imaging studies of any kind to distinguish acute bacterial sinusitis from viral URI, because they do not contribute to the diagnosis; however, a contrast-enhanced computed tomography scan of the paranasal sinuses should be obtained whenever a child is suspected of having orbital or central nervous system complications. The clinician should prescribe antibiotic therapy for acute bacterial sinusitis in children with severe onset or worsening course. The clinician should either prescribe antibiotic therapy or offer additional observation for 3 days to children with persistent illness. Amoxicillin with or without clavulanate is the first-line treatment of acute bacterial sinusitis. Clinicians should reassess initial management if there is either a caregiver report of worsening (progression of initial signs/symptoms or appearance of new signs/symptoms) or failure to improve within 72 hours of initial management. If the diagnosis of acute bacterial sinusitis is confirmed in a child with worsening symptoms or failure to improve, then clinicians may change the antibiotic therapy for the child initially managed with antibiotic or initiate antibiotic treatment of the child initially managed with observation.

CONCLUSIONS: Changes in this revision include the addition of a clinical presentation designated as "worsening course," an option to treat immediately or observe children with persistent symptoms for 3 days before treating, and a review of evidence indicating that imaging is not necessary in children with uncomplicated acute bacterial sinusitis. *Pediatrics* 2013;132:e262–e280

Ellen R. Wald, MD, FAAP, Kimberly E. Applegate, MD, MS, FAAP, Clay Bordley, MD, FAAP, David H. Darrow, MD, DDS, FAAP, Mary P. Glode, MD, FAAP, S. Michael Marcy, MD, FAAP, Carrie E. Nelson, MD, MS, Richard M. Rosenfeld, MD, FAAP, Nader Shaikh, MD, MPH, FAAP, Michael J. Smith, MD, MSCE, FAAP, Paul V. Williams, MD, FAAP, and Stuart T. Weinberg, MD, FAAP

KEY WORDS

acute bacterial sinusitis, sinusitis, antibiotics, imaging, sinus aspiration

ABBREVIATIONS

AAP—American Academy of Pediatrics
AOM—acute otitis media
CT—computed tomography
PCV-13—13-valent pneumococcal conjugate vaccine
RABS—recurrent acute bacterial sinusitis
RCT—randomized controlled trial
URI—upper respiratory tract infection

www.pediatrics.org/cgi/doi/10.1542/peds.2013-1071

doi:10.1542/peds.2013-1071

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

INTRODUCTION

Acute bacterial sinusitis is a common complication of viral upper respiratory infection (URI) or allergic inflammation. Using stringent criteria to define acute sinusitis, it has been observed that between 6% and 7% of children seeking care for respiratory symptoms has an illness consistent with this definition.[1–4]

This clinical practice guideline is a revision of the clinical practice guideline published by the American Academy of Pediatrics (AAP) in 2001.[5] It has been developed by a subcommittee of the Steering Committee on Quality Improvement and Management that included physicians with expertise in the fields of primary care pediatrics, academic general pediatrics, family practice, allergy, epidemiology and informatics, pediatric infectious diseases, pediatric otolaryngology, radiology, and pediatric emergency medicine. None of the participants had financial conflicts of interest, and only money from the AAP was used to fund the development of the guideline. The guideline will be reviewed in 5 years unless new evidence emerges that warrants revision sooner.

The guideline is intended for use in a variety of clinical settings (eg, office, emergency department, hospital) by clinicians who treat pediatric patients. The data on which the recommendations are based are included in a companion technical report, published in the electronic pages.[6] The Partnership for Policy Implementation has developed a series of definitions using accepted health information technology standards to assist in the implementation of this guideline in computer systems and quality measurement efforts. This document is available at: http://www2.aap.org/informatics/PPI.html.

This revision focuses on the diagnosis and management of acute sinusitis in children between 1 and 18 years of age. It does not apply to children with subacute or chronic sinusitis. Similar to the previous guideline, this document does not consider neonates and children younger than 1 year or children with anatomic abnormalities of the sinuses, immunodeficiencies, cystic fibrosis, or primary ciliary dyskinesia. The most significant areas of change from the 2001 guideline are in the addition of a clinical presentation designated as "worsening course," inclusion of new data on the effectiveness of antibiotics in children with acute sinusitis,[4] and a review of evidence indicating that imaging is not necessary to identify those children who will benefit from antimicrobial therapy.

METHODS

The Subcommittee on Management of Sinusitis met in June 2009 to identify research questions relevant to guideline revision. The primary goal was to update the 2001 report by identifying and reviewing additional studies of pediatric acute sinusitis that have been performed over the past decade.

Searches of PubMed were performed by using the same search term as in the 2001 report. All searches were limited to English-language and human studies. Three separate searches were performed to maximize retrieval of the most recent and highest-quality evidence for pediatric sinusitis. The first limited results to all randomized controlled trials (RCTs) from 1966 to 2009, the second to all meta-analyses from 1966 to 2009, and the third to all pediatric studies (limited to ages <18 years) published since the last technical report (1999–2009). Additionally, the Web of Science was queried to identify studies that cited the original AAP guidelines. This literature search was replicated in July 2010

Evidence Quality	Preponderance of Benefit or Harm	Balance of Benefit and Harm
A. Well-designed RCTs or diagnostic studies on relevant population	Strong Recommendation	Option
B. RCTs or diagnostic studies with minor limitations;overwhelmingly consistent evidence from observational studies	Recommendation	
C. Observational studies (case-control and cohort design)		
D. Expert opinion, case reports, reasoning from first principles	Option	No Rec
X. Exceptional situations where validating studies cannot be performed and there is a clear preponderance of benefit or harm	Strong Recommendation / Recommendation	

FIGURE 1
Levels of recommendations. Rec, recommendation.

and November 2012 to capture recently published studies. The complete results of the literature review are published separately in the technical report.[6] In summary, 17 randomized studies of sinusitis in children were identified and reviewed. Only 3 trials met inclusion criteria. Because of significant heterogeneity among these studies, formal meta-analyses were not pursued.

The results from the literature review were used to guide development of the key action statements included in this document. These action statements were generated by using BRIDGE-Wiz (Building Recommendations in a Developers Guideline Editor, Yale School of Medicine, New Haven, CT), an interactive software tool that leads guideline development through a series of questions that are intended to create a more actionable set of key action statements.[7] BRIDGE-Wiz also incorporates the quality of available evidence into the final determination of the strength of each recommendation.

The AAP policy statement "Classifying Recommendations for Clinical Practice Guidelines" was followed in designating levels of recommendations (Fig 1).[8] Definitions of evidence-based statements are provided in Table 1. This guideline was reviewed by multiple groups in the AAP and 2 external organizations. Comments were compiled and reviewed by the subcommittee, and relevant changes were incorporated into the guideline.

KEY ACTION STATEMENTS

Key Action Statement 1

Clinicians should make a presumptive diagnosis of acute bacterial sinusitis when a child with an acute URI presents with the following:

- **Persistent illness, ie, nasal discharge (of any quality) or daytime cough or both lasting more than 10 days without improvement;**

OR

- **Worsening course, ie, worsening or new onset of nasal discharge, daytime cough, or fever after initial improvement;**

OR

- **Severe onset, ie, concurrent fever (temperature ≥39°C/102.2°F) and purulent nasal discharge for at least 3 consecutive days (Evidence Quality: B; Recommendation).**

KAS Profile 1

Aggregate evidence quality: B	
Benefit	Diagnosis allows decisions regarding management to be made. Children likely to benefit from antimicrobial therapy will be identified.
Harm	Inappropriate diagnosis may lead to unnecessary treatment. A missed diagnosis may lead to persistent infection or complications
Cost	Inappropriate diagnosis may lead to unnecessary cost of antibiotics. A missed diagnosis leads to cost of persistent illness (loss of time from school and work) or cost of caring for complications.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	None.
Role of patient preference	Limited.
Intentional vagueness	None.
Exclusions	Children aged <1 year or older than 18 years and with underlying conditions.
Strength	Recommendation.

TABLE 1 Guideline Definitions for Evidence-Based Statements

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

The purpose of this action statement is to guide the practitioner in making a diagnosis of acute bacterial sinusitis on the basis of stringent clinical criteria. To develop criteria to be used in distinguishing episodes of acute bacterial sinusitis from other common respiratory infections, it is helpful to describe the features of an uncomplicated viral URI. Viral URIs are usually characterized by nasal symptoms (discharge and congestion/obstruction) or cough or both. Most often, the nasal discharge begins as clear and watery. Often, however, the quality of nasal discharge changes during the course of the illness. Typically, the nasal discharge becomes thicker and more mucoid and may become purulent (thick, colored, and opaque) for several days. Then the situation reverses, with the purulent discharge becoming mucoid and then clear again or simply resolving. The transition from clear to purulent to clear again occurs in uncomplicated viral URIs without the use of antimicrobial therapy.

Fever, when present in uncomplicated viral URI, tends to occur early in the illness, often in concert with other constitutional symptoms such as headache and myalgias. Typically, the fever and constitutional symptoms disappear in the first 24 to 48 hours, and the respiratory symptoms become more prominent (Fig 2).

The course of most uncomplicated viral URIs is 5 to 7 days.[9–12] As shown in Fig 2, respiratory symptoms usually peak in severity by days 3 to 6 and then begin to improve; however, resolving symptoms and signs may persist in some patients after day 10.[9,10]

Symptoms of acute bacterial sinusitis and uncomplicated viral URI overlap considerably, and therefore it is their persistence without improvement that suggests a diagnosis of acute sinusitis.[9,10,13] Such symptoms include nasal discharge (of any quality: thick or thin, serous, mucoid, or purulent) or daytime cough (which may be worse at night) or both. Bad breath, fatigue, headache, and decreased appetite, although common, are not specific indicators of acute sinusitis.[14] Physical examination findings are also not particularly helpful in distinguishing sinusitis from uncomplicated URIs. Erythema and swelling of the nasal turbinates are nonspecific findings.[14] Percussion of the sinuses is not useful. Transillumination of the sinuses is difficult to perform correctly in children and has been shown to be unreliable.[15,16] Nasopharyngeal cultures do not reliably predict the etiology of acute bacterial sinusitis.[14,16]

Only a minority (~6%–7%) of children presenting with symptoms of URI will meet criteria for persistence.[3,4,11] As a result, before diagnosing acute bacterial sinusitis, it is important for the practitioner to attempt to (1) differentiate between sequential episodes of uncomplicated viral URI (which may seem to coalesce in the mind of the patient or parent) from the onset of acute bacterial sinusitis with persistent symptoms and (2) establish whether the symptoms are clearly not improving.

A worsening course of signs and symptoms, termed "double sickening," in the context of a viral URI is another presentation of acute bacterial sinusitis.[13,17] Affected children experience substantial and acute worsening of respiratory symptoms (nasal discharge or nasal congestion or daytime cough) or a new fever, often on the sixth or seventh day of illness, after initial signs of recovery from an uncomplicated viral URI. Support for this definition comes from studies in children and adults, for whom antibiotic treatment of worsening symptoms after a period of apparent improvement was associated with better outcomes.[4]

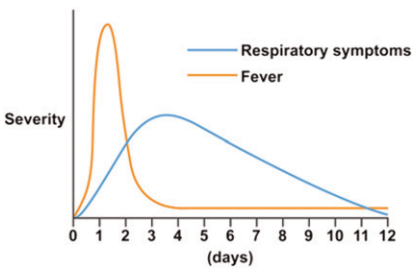

FIGURE 2
Uncomplicated viral URI.

Finally, some children with acute bacterial sinusitis may present with severe onset, ie, concurrent high fever (temperature >39°C) and purulent nasal discharge. These children usually are ill appearing and need to be distinguished from children with uncomplicated viral infections that are unusually severe. If fever is present in uncomplicated viral URIs, it tends to be present early in the illness, usually accompanied by other constitutional symptoms, such as headache and myalgia.[9,13,18] Generally, the constitutional symptoms resolve in the first 48 hours and then the respiratory symptoms become prominent. In most uncomplicated viral infections, including influenza, purulent nasal discharge does not appear for several days. Accordingly, it is the concurrent presentation of high fever and purulent nasal discharge for the first 3 to 4 days of an acute URI that helps to define the severe onset of acute bacterial sinusitis.[13,16,18] This presentation in children is the corollary to acute onset of headache, fever, and facial pain in adults with acute sinusitis.

Allergic and nonallergic rhinitis are predisposing causes of some cases of acute bacterial sinusitis in childhood. In addition, at their onset, these conditions may be mistaken for acute bacterial sinusitis. A family history of atopic conditions, seasonal occurrences, or occurrences with exposure to common allergens and other

allergic diatheses in the index patient (eczema, atopic dermatitis, asthma) may suggest the presence of noninfectious rhinitis. The patient may have complaints of pruritic eyes and nasal mucosa, which will provide a clue to the likely etiology of the condition. On physical examination, there may be a prominent nasal crease, allergic shiners, cobblestoning of the conjunctiva or pharyngeal wall, or pale nasal mucosa as other indicators of the diagnosis.

Key Action Statement 2A

Clinicians should not obtain imaging studies (plain films, contrast-enhanced computed tomography [CT], MRI, or ultrasonography) to distinguish acute bacterial sinusitis from viral URI (Evidence Quality: B; Strong Recommendation).

KAS Profile 2A

Aggregate evidence quality: B; overwhelmingly consistent evidence from observational studies.	
Benefit	Avoids exposure to radiation and costs of studies. Avoids unnecessary therapy for false-positive diagnoses.
Harm	None.
Cost	Avoids cost of imaging.
Benefits-harm assessment	Exclusive benefit.
Value judgments	Concern for unnecessary radiation and costs.
Role of patient preference	Limited. Parents may value a negative study and avoidance of antibiotics as worthy of radiation but panel disagrees.
Intentional vagueness	None.
Exclusions	Patients with complications of sinusitis.
Strength	Strong recommendation.

The purpose of this key action statement is to discourage the practitioner from obtaining imaging studies in children with uncomplicated acute bacterial sinusitis. As emphasized in Key Action Statement 1, acute bacterial sinusitis in children is a diagnosis that is made on the basis of stringent clinical criteria that describe signs, symptoms, and temporal patterns of a URI. Although historically imaging has been used as a confirmatory or diagnostic modality in children suspected to have acute bacterial sinusitis, it is no longer recommended.

The membranes that line the nose are continuous with the membranes (mucosa) that line the sinus cavities, the middle ear, the nasopharynx, and the oropharynx. When an individual experiences a viral URI, there is inflammation of the nasal mucosa and, often, the mucosa of the middle ear and paranasal sinuses as well. The continuity of the mucosa of the upper respiratory tract is responsible for the controversy regarding the usefulness of images of the paranasal sinuses in contributing to a diagnosis of acute bacterial sinusitis.

As early as the 1940s, observations were made regarding the frequency of abnormal sinus radiographs in healthy children without signs or symptoms of current respiratory disease.[19] In addition, several investigators in the 1970s and 1980s observed that children with uncomplicated viral URI had frequent abnormalities of the paranasal sinuses on plain radiographs.[20–22] These abnormalities were the same as those considered to be diagnostic of acute bacterial sinusitis (diffuse opacification, mucosal swelling of at least 4 mm, or an air-fluid level).[16]

As technology advanced and CT scanning of the central nervous system and skull became prevalent, several studies reported on incidental abnormalities of the paranasal sinuses that were observed in children.[23,24] Gwaltney et al[25] showed striking abnormalities (including air-fluid levels) in sinus CT scans of young adults with uncomplicated colds. Manning et al[26] evaluated children undergoing either CT or MRI of the head for indications other than respiratory complaints or suspected sinusitis. Each patient underwent rhinoscopy and otoscopy before imaging and each patient's parent was asked to fill out a questionnaire regarding recent symptoms of URI. Sixty-two percent of patients overall had physical findings or history consistent with an upper respiratory inflammatory process, and 55% of the total group showed some abnormalities on sinus imaging; 33% showed pronounced mucosal thickening or an air-fluid level. Gordts et al[27] made similar observations in children undergoing MRI. Finally, Kristo et al[28] performed MRI in children with URIs and confirmed the high frequency (68%) of major abnormalities seen in the paranasal sinuses.

In summary, when the paranasal sinuses are imaged, either with plain radiographs, contrast-enhanced CT, or MRI in children with uncomplicated URI, the majority of studies will be significantly abnormal with the same kind of findings that are associated with bacterial infection of the sinuses. Accordingly, although normal radiographs or CT or MRI results can ensure that a patient with respiratory symptoms does not have acute bacterial sinusitis, an abnormal image cannot confirm the diagnosis. Therefore, it is not necessary to perform imaging in children with uncomplicated episodes of clinical sinusitis. Similarly, the high likelihood of an abnormal imaging result in a child with an uncomplicated URI indicates that radiographic studies

not be performed in an attempt to eliminate the diagnosis of sinusitis.

Key Action Statement 2B

Clinicians should obtain a contrast-enhanced CT scan of the paranasal sinuses and/or an MRI with contrast whenever a child is suspected of having orbital or central nervous system complications of acute bacterial sinusitis (Evidence Quality: B; Strong Recommendation).

KAS Profile 2B

Aggregate evidence quality: B; overwhelmingly consistent evidence from observational studies.	
Benefit	Determine presence of abscesses, which may require surgical intervention; avoid sequelae because of appropriate aggressive management.
Harm	Exposure to ionizing radiation for CT scans; need for sedation for MRI.
Cost	Direct cost of studies.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	Concern for significant complication that may be unrecognized and, therefore, not treated appropriately.
Role of patient preference	Limited.
Intentional vagueness	None.
Exclusions	None.
Strength	Strong recommendation.

The purpose of this key action statement is to have the clinician obtain contrast-enhanced CT images when children are suspected of having serious complications of acute bacterial sinusitis. The most common complication of acute sinusitis involves the orbit in children with ethmoid sinusitis who are younger than 5 years.[29–31] Orbital complications should be suspected when the child presents with a swollen eye, especially if accompanied by proptosis or impaired function of the extraocular muscles. Orbital complications of acute sinusitis have been divided into 5 categories: sympathetic effusion, subperiosteal abscess, orbital cellulitis, orbital abscess, and cavernous sinus thrombosis.[32] Although sympathetic effusion (inflammatory edema) is categorized as an orbital complication, the site of infection remains confined to the sinus cavities; eye swelling is attributable to the impedance of venous drainage secondary to congestion within the ethmoid sinuses. Alternative terms for sympathetic effusion (inflammatory edema) are preseptal or periorbital cellulitis. The remaining "true" orbital complications are best visualized by contrast-enhanced CT scanning.

Intracranial complications of acute sinusitis, which are substantially less common than orbital complications, are more serious, with higher morbidity and mortality than those involving the orbit. Intracranial complications should be suspected in the patient who presents with a very severe headache, photophobia, seizures, or other focal neurologic findings. Intracranial complications include subdural empyema, epidural empyema, venous thrombosis, brain abscess, and meningitis.[29] Typically, patients with intracranial complications of acute bacterial sinusitis are previously healthy adolescent males with frontal sinusitis.[33,34]

There have been no head-to-head comparisons of the diagnostic accuracy of contrast-enhanced CT scanning to MRI with contrast in the evaluation of orbital and intracranial complications of sinusitis in children. In general, the contrast-enhanced CT scan has been the preferred imaging study when complications of sinusitis are suspected.[35,36] However, there are documented cases in which a contrast-enhanced CT scan has not revealed the abnormality responsible for the clinical presentation and the MRI with contrast has, especially for intracranial complications and rarely for orbital complications.[37,38] Accordingly, the most recent appropriateness criteria from the American College of Radiology endorse both MRI with contrast and contrast-enhanced CT as complementary examinations when evaluating potential complications of sinusitis.[35] The availability and speed of obtaining the contrast-enhanced CT are desirable; however, there is increasing concern regarding exposure to radiation. The MRI, although very sensitive, takes longer than the contrast-enhanced CT and often requires sedation in young children (which carries its own risks). In older children and adolescents who may not require sedation, MRI with contrast, if available, may be preferred when intracranial complications are likely. Furthermore, MRI with contrast should be performed when there is persistent clinical concern or incomplete information has been provided by the contrast-enhanced CT scan.

Key Action Statement 3

Initial Management of Acute Bacterial Sinusitis

3A: "Severe onset and worsening course" acute bacterial sinusitis. The clinician should prescribe antibiotic therapy for acute bacterial sinusitis in children with severe onset or worsening course (signs, symptoms, or both) (Evidence Quality: B; Strong Recommendation).

KAS Profile 3A

Aggregate evidence quality: B; randomized controlled trials with limitations.	
Benefit	Increase clinical cures, shorten illness duration, and may prevent suppurative complications in a high-risk patient population.
Harm	Adverse effects of antibiotics.
Cost	Direct cost of therapy.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	Concern for morbidity and possible complications if untreated.
Role of patient preference	Limited.
Intentional vagueness	None.
Exclusions	None.
Strength	Strong recommendation.

3B: "Persistent illness." The clinician should either prescribe antibiotic therapy OR offer additional outpatient observation for 3 days to children with persistent illness (nasal discharge of any quality or cough or both for at least 10 days without evidence of improvement) (Evidence Quality: B; Recommendation).

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

1. Antibiotic therapy, defined as initial treatment of acute bacterial sinusitis with antibiotics, with the intent of starting antibiotic therapy as soon as possible after the encounter.
2. Additional outpatient observation, defined as initial management of acute bacterial sinusitis limited to continued observation for 3 days, with commencement of antibiotic therapy if either the child does not improve clinically within several days of diagnosis or if there is clinical worsening of the child's condition at any time.

KAS Profile 3B

Aggregate evidence quality: B; randomized controlled trials with limitations.	
Benefit	Antibiotics increase the chance of improvement or cure at 10 to 14 days (number needed to treat, 3–5); additional observation may avoid the use of antibiotics with attendant cost and adverse effects.
Harm	Antibiotics have adverse effects (number needed to harm, 3) and may increase bacterial resistance. Observation may prolong illness and delay start of needed antibiotic therapy.
Cost	Direct cost of antibiotics as well as cost of adverse reactions; indirect costs of delayed recovery when observation is used.
Benefits-harm assessment	Preponderance of benefit (because both antibiotic therapy and additional observation with rescue antibiotic, if needed, are appropriate management).
Value judgments	Role for additional brief observation period for selected children with persistent illness sinusitis, similar to what is recommended for acute otitis media, despite the lack of randomized trials specifically comparing additional observation with immediate antibiotic therapy and longer duration of illness before presentation.
Role of patient preference	Substantial role in shared decision-making that should incorporate illness severity, child's quality of life, and caregiver values and concerns.
Intentional vagueness	None.
Exclusions	Children who are excluded from randomized clinical trials of acute bacterial sinusitis, as defined in the text.
Strength	Recommendation.

In contrast to the 2001 AAP guideline,[5] which recommended antibiotic therapy for all children diagnosed with acute bacterial sinusitis, this guideline allows for additional observation of children presenting with persistent illness (nasal discharge of any quality or daytime cough or both for at least 10 days without evidence of improvement). In both guidelines, however, children presenting with severe or worsening illness (which was not defined explicitly in the 2001 guideline[5]) are to receive antibiotic therapy. The rationale for this approach (Table 2) is discussed below.

Antibiotic Therapy for Acute Bacterial Sinusitis

In the United States, antibiotics are prescribed for 82% of children with acute sinusitis.[39] The rationale for antibiotic therapy of acute bacterial sinusitis is based on the recovery of bacteria in high density ($\geq 10^4$ colony-forming units/mL) in 70% of maxillary sinus aspirates obtained from children with a clinical syndrome characterized by persistent nasal discharge, daytime cough, or both.[16,40] Children who present with severe-onset acute bacterial sinusitis are presumed to have bacterial infection, because a temperature of at least 39°C/102.2°F coexisting for at least 3 consecutive days with purulent nasal discharge is not consistent with the well-documented pattern of acute viral URI. Similarly, children with worsening-course acute bacterial sinusitis have a clinical course that is also not consistent with the steady improvement that characterizes an uncomplicated viral URI.[9,10]

Three RCTs have compared antibiotic therapy with placebo for the initial management of acute bacterial sinusitis in children. Two trials by Wald et al[4,41] found an increase in cure or improvement after antibiotic therapy compared with placebo with a number needed to treat of 3 to 5 children. Most children in these studies had persistent acute bacterial sinusitis, but children with severe or worsening illness were also included. Conversely, Garbutt et al,[42] who studied only children with persistent acute bacterial sinusitis, found no difference in outcomes for antibiotic versus placebo. Another RCT by Kristo et al,[43] often cited as showing no benefit from antibiotics for acute bacterial sinusitis, will not be considered further because of methodologic flaws, including weak entry criteria and inadequate dosing of antibiotic treatment.

The guideline recommends antibiotic therapy for severe or worsening acute bacterial sinusitis because of the benefits revealed in RCTs[4,41] and a theoretically higher risk of suppurative complications than for children who present with persistent symptoms. Orbital and intracranial complications of acute bacterial sinusitis have not been observed in RCTs, even when placebo was administered; however, sample sizes have inadequate power to preclude an increased risk. This risk, however, has caused some investigators to exclude children with severe acute bacterial sinusitis from trial entry.[42]

Additional Observation for Persistent Onset Acute Bacterial Sinusitis

The guideline recommends either antibiotic therapy or an additional brief period of observation as initial management strategies for children with persistent acute bacterial sinusitis because, although there are benefits to antibiotic therapy (number needed to treat, 3–5), some children improve on their own, and the risk of suppurative complications is low.[4,41] Symptoms of persistent acute bacterial sinusitis may be mild and have varying effects on a given child's quality of life, ranging from slight (mild cough, nasal discharge) to significant (sleep disturbance, behavioral changes, school or child care absenteeism). The benefits of antibiotic therapy in some trials[4,41] must also be balanced against an increased risk of adverse events (number need to harm, 3), most often self-limited diarrhea, but also including occasional rash.[4]

Choosing between antibiotic therapy or additional observation for initial management of persistent illness sinusitis presents an opportunity for shared decision-making with families (Table 2). Factors that might influence this decision include symptom severity, the child's quality of life, recent antibiotic use, previous experience or outcomes with acute bacterial sinusitis, cost of antibiotics, ease of administration, caregiver concerns about potential adverse effects of antibiotics, persistence of respiratory symptoms, or development of complications. Values and preferences expressed by the caregiver should be taken into consideration (Table 3).

Children with persistent acute bacterial sinusitis who received antibiotic therapy in the previous 4 weeks, those with concurrent bacterial infection (eg, pneumonia, suppurative cervical adenitis, group A streptococcal pharyngitis, or acute otitis media), those with actual or suspected complications of acute bacterial sinusitis, or those with underlying conditions should generally be managed with antibiotic therapy. The latter group includes children with asthma, cystic fibrosis, immunodeficiency, previous sinus surgery, or anatomic abnormalities of the upper respiratory tract.

Limiting antibiotic use in children with persistent acute bacterial sinusitis who may improve on their own reduces common antibiotic-related adverse events, such as diarrhea, diaper dermatitis, and skin rash. The most recent RCT of acute bacterial sinusitis in children[4] found adverse events of 44% with antibiotic and 14% with placebo.

Limiting antibiotics may also reduce the prevalence of resistant bacterial pathogens. Although this is always a desirable goal, no increase in resistant bacterial species was observed within the group of children treated with a single course of antimicrobial agents (compared with those receiving placebo) in 2 recent large studies of antibiotic versus placebo for children with acute otitis media.[44,45]

Key Action Statement 4

Clinicians should prescribe amoxicillin with or without clavulanate as first-line treatment when a decision has been made to initiate antibiotic treatment of acute bacterial sinusitis (Evidence Quality: B; Recommendation).

KAS Profile 4

Aggregate evidence quality: B; randomized controlled trials with limitations.

Benefit	Increase clinical cures with narrowest spectrum drug; stepwise increase in broadening spectrum as risk factors for resistance increase.
Harm	Adverse effects of antibiotics including development of hypersensitivity.
Cost	Direct cost of antibiotic therapy.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	Concerns for not encouraging resistance if possible.
Role of patient preference	Potential for shared decision-making that should incorporate the caregiver's experiences and values.
Intentional vagueness	None.
Exclusions	May include allergy or intolerance.
Strength	Recommendation.

TABLE 2 Recommendations for Initial Use of Antibiotics for Acute Bacterial Sinusitis

Clinical Presentation	Severe Acute Bacterial Sinusitis[a]	Worsening Acute Bacterial Sinusitis[b]	Persistent Acute Bacterial Sinusitis[c]
Uncomplicated acute bacterial sinusitis without coexisting illness	Antibiotic therapy	Antibiotic therapy	Antibiotic therapy or additional observation for 3 days[d]
Acute bacterial sinusitis with orbital or intracranial complications	Antibiotic therapy	Antibiotic therapy	Antibiotic therapy
Acute bacterial sinusitis with coexisting acute otitis media, pneumonia, adenitis, or streptococcal pharyngitis	Antibiotic therapy	Antibiotic therapy	Antibiotic therapy

[a] Defined as temperature ≥39°C and purulent (thick, colored, and opaque) nasal discharge present concurrently for at least 3 consecutive days.

[b] Defined as nasal discharge or daytime cough with sudden worsening of symptoms (manifested by new-onset fever ≥38°C/100.4°F or substantial increase in nasal discharge or cough) after having experienced transient improvement of symptoms.

[c] Defined as nasal discharge (of any quality), daytime cough (which may be worse at night), or both, persisting for >10 days without improvement.

[d] Opportunity for shared decision-making with the child's family; if observation is offered, a mechanism must be in place to ensure follow-up and begin antibiotics if the child worsens at any time or fails to improve within 3 days of observation.

The purpose of this key action statement is to guide the selection of antimicrobial therapy once the diagnosis of acute bacterial sinusitis has been made. The microbiology of acute bacterial sinusitis was determined nearly 30 years ago through direct maxillary sinus aspiration in children with compatible signs and symptoms. The major bacterial pathogens recovered at that time were *Streptococcus pneumoniae* in approximately 30% of children and nontypeable *Haemophilus influenzae* and *Moraxella catarrhalis* in approximately 20% each.[16,40] Aspirates from the remaining 25% to 30% of children were sterile.

Maxillary sinus aspiration is rarely performed at the present time unless the course of the infection is unusually prolonged or severe. Although some authorities have recommended obtaining cultures from the middle meatus to determine the cause of a maxillary sinus infection, there are no data in children with acute bacterial sinusitis that have compared such cultures with cultures of a maxillary sinus aspirate. Furthermore, there are data indicating that the middle meatus in healthy children is commonly colonized with *S pneumoniae*, *H influenzae*, and *M catarrhalis*.[46]

Recent estimates of the microbiology of acute sinusitis have, of necessity, been based primarily on that of acute otitis media (AOM), a condition with relatively easy access to infective fluid through performance of tympanocentesis and one with a similar pathogenesis to acute bacterial sinusitis.[47,48] The 3 most common bacterial pathogens recovered from the middle ear fluid of children with AOM are the same as those that have been associated with acute bacterial sinusitis: *S pneumoniae*, nontypeable *H influenzae*, and *M catarrhalis*.[49] The proportion of each has varied from study to study depending on criteria used for diagnosis of AOM, patient characteristics, and bacteriologic techniques. Recommendations since the year 2000 for the routine use in infants of 7-valent and, more recently, 13-valent pneumococcal conjugate vaccine (PCV-13) have been associated with a decrease in recovery of *S pneumoniae* from ear fluid of children with AOM and a relative increase in the incidence of infections attributable to *H influenzae*.[50] Thus, on the basis of the proportions of bacteria found in middle ear infections, it is estimated that *S pneumoniae* and *H influenzae* are currently each responsible for approximately 30% of cases of acute bacterial sinusitis in children, and *M catarrhalis* is responsible for approximately 10%. These percentages are contingent on the assumption that approximately one-quarter of aspirates of maxillary sinusitis would still be sterile, as reported in earlier studies. *Staphylococcus aureus* is rarely isolated from sinus aspirates in children with acute bacterial sinusitis, and with the exception of acute maxillary sinusitis associated with infections of dental origin,[51] respiratory anaerobes are also rarely recovered.[40,52] Although *S aureus* is a very infrequent cause of acute bacterial sinusitis in children, it is a significant pathogen in the orbital and intracranial complications of sinusitis. The reasons for this discrepancy are unknown.

Antimicrobial susceptibility patterns for *S pneumoniae* vary considerably from community to community. Isolates obtained from surveillance centers nationwide indicate that, at the present time, 10% to 15% of upper respiratory tract isolates of *S pneumoniae* are nonsusceptible to penicillin[53,54]; however, values for penicillin nonsusceptibility as high as 50% to 60% have been reported in some areas.[55,56] Of the organisms that are resistant, approximately half are highly resistant to penicillin and the remaining half are intermediate in resistance.[53,54,56–59] Between 10% and 42% of *H influenzae*[56–59] and close to 100% of *M catarrhalis* are likely to be β-lactamase positive and nonsusceptible to amoxicillin. Because of dramatic geographic variability in the prevalence of β-lactamase–positive *H influenzae*, it is extremely desirable for the practitioner to be familiar with local patterns of susceptibility. Risk factors for the presence of organisms

likely to be resistant to amoxicillin include attendance at child care, receipt of antimicrobial treatment within the previous 30 days, and age younger than 2 years.[50,55,60]

Amoxicillin remains the antimicrobial agent of choice for first-line treatment of uncomplicated acute bacterial sinusitis in situations in which antimicrobial resistance is not suspected. This recommendation is based on amoxicillin's effectiveness, safety, acceptable taste, low cost, and relatively narrow microbiologic spectrum. For children aged 2 years or older with uncomplicated acute bacterial sinusitis that is mild to moderate in degree of severity who do not attend child care and who have not been treated with an antimicrobial agent within the last 4 weeks, amoxicillin is recommended at a standard dose of 45 mg/kg per day in 2 divided doses. In communities with a high prevalence of nonsusceptible *S pneumoniae* (>10%, including intermediate- and high-level resistance), treatment may be initiated at 80 to 90 mg/kg per day in 2 divided doses, with a maximum of 2 g per dose.[55] This high-dose amoxicillin therapy is likely to achieve sinus fluid concentrations that are adequate to overcome the resistance of *S pneumoniae,* which is attributable to alteration in penicillin-binding proteins on the basis of data derived from patients with AOM.[61] If, within the next several years after licensure of PCV-13, a continuing decrease in isolates of *S pneumoniae* (including a decrease in isolates of nonsusceptible *S pneumoniae)* and an increase in β-lactamase–producing *H influenzae* are observed, standard-dose amoxicillin-clavulanate (45 mg/kg per day) may be most appropriate.

Patients presenting with moderate to severe illness as well as those younger than 2 years, attending child care, or who have recently been treated with an antimicrobial may receive high-dose amoxicillin-clavulanate (80–90 mg/kg per day of the amoxicillin component with 6.4 mg/kg per day of clavulanate in 2 divided doses with a maximum of 2 g per dose). The potassium clavulanate levels are adequate to inhibit all β-lactamase–producing *H influenzae* and *M catarrhalis*.[56,59]

A single 50-mg/kg dose of ceftriaxone, given either intravenously or intramuscularly, can be used for children who are vomiting, unable to tolerate oral medication, or unlikely to be adherent to the initial doses of antibiotic.[62–64] The 3 major bacterial pathogens involved in acute bacterial sinusitis are susceptible to ceftriaxone in 95% to 100% of cases.[56,58,59] If clinical improvement is observed at 24 hours, an oral antibiotic can be substituted to complete the course of therapy. Children who are still significantly febrile or symptomatic at 24 hours may require additional parenteral doses before switching to oral therapy.

The treatment of patients with presumed allergy to penicillin has been controversial. However, recent publications indicate that the risk of a serious allergic reaction to second- and third-generation cephalosporins in patients with penicillin or amoxicillin allergy appears to be almost nil and no greater than the risk among patients without such allergy.[65–67] Thus, patients allergic to amoxicillin with a non–type 1 (late or delayed, >72 hours) hypersensitivity reaction can safely be treated with cefdinir, cefuroxime, or cefpodoxime.[66–68] Patients with a history of a serious type 1 immediate or accelerated (anaphylactoid) reaction to amoxicillin can also safely be treated with cefdinir, cefuroxime, or cefpodoxime. In both circumstances, clinicians may wish to determine individual tolerance by referral to an allergist for penicillin and/or cephalosporin skin-testing before initiation of therapy.[66–68] The susceptibility of *S pneumoniae* to cefdinir, cefpodoxime, and cefuroxime varies from 60% to 75%,[56–59] and the susceptibility of *H influenzae* to these agents varies from 85% to 100%.[56,58] In young children (<2 years) with a serious type 1 hypersensitivity to penicillin and moderate or more severe sinusitis, it may be prudent to use a combination of clindamycin (or linezolid) and cefixime to achieve the most comprehensive coverage against both resistant *S pneumoniae* and *H influenzae*. Linezolid has excellent activity against all *S pneumoniae*, including penicillin-resistant strains, but lacks activity against *H influenzae* and *M catarrhalis*. Alternatively, a quinolone, such as levofloxacin, which has a high level of activity against both *S pneumoniae* and *H influenzae*, may be prescribed.[57,58] Although the use of quinolones is usually restricted because of concerns for toxicity, cost, and emerging resistance, their use in this circumstance can be justified.

Pneumococcal and *H influenzae* surveillance studies have indicated that resistance of these organisms to trimethoprim-sulfamethoxazole and azithromycin is sufficient to preclude their use for treatment of acute bacterial sinusitis in patients with penicillin hypersensitivity.[56,58,59,69]

The optimal duration of antimicrobial therapy for patients with acute bacterial sinusitis has not received systematic study. Recommendations based on clinical observations have varied widely, from 10 to 28 days of treatment. An alternative suggestion has been made that antibiotic therapy be continued for 7 days after the patient becomes free of signs and symptoms.[5] This strategy has the advantage of individualizing the treatment of each patient, results in a minimum course of 10 days, and

avoids prolonged antimicrobial therapy in patients who are asymptomatic and therefore unlikely to adhere to the full course of treatment.[5]

Patients who are acutely ill and appear toxic when first seen (see below) can be managed with 1 of 2 options. Consultation can be requested from an otolaryngologist for consideration of maxillary sinus aspiration (with appropriate analgesia/anesthesia) to obtain a sample of sinus secretions for Gram stain, culture, and susceptibility testing so that antimicrobial therapy can be adjusted precisely. Alternatively, inpatient therapy can be initiated with intravenous cefotaxime or ceftriaxone, with referral to an otolaryngologist if the patient's condition worsens or fails to show improvement within 48 hours. If a complication is suspected, management will differ depending on the site and severity.

A recent guideline was published by the Infectious Diseases Society of America for acute bacterial rhinosinusitis in children and adults.[70] Their recommendation for initial empirical antimicrobial therapy for acute bacterial sinusitis in children was amoxicillin-clavulanate based on the concern that there is an increasing prevalence of *H influenzae* as a cause of sinusitis since introduction of the pneumococcal conjugate vaccines and an increasing prevalence of β-lactamase production among these strains. In contrast, this guideline from the AAP allows either amoxicillin or amoxicillin-clavulanate as first-line empirical therapy and is therefore inclusive of the Infectious Diseases Society of America's recommendation. Unfortunately, there are scant data available regarding the precise microbiology of acute bacterial sinusitis in the post–PCV-13 era. Prospective surveillance of nasopharyngeal cultures may be helpful in completely aligning these recommendations in the future.

Key Action Statement 5A

Clinicians should reassess initial management if there is either a caregiver report of worsening (progression of initial signs/symptoms or appearance of new signs/symptoms) OR failure to improve (lack of reduction in all presenting signs/symptoms) within 72 hours of initial management (Evidence Quality: C; Recommendation).

KAS Profile 5A

Aggregate evidence quality: C; observational studies	
Benefits	Identification of patients who may have been misdiagnosed, those at risk of complications, and those who require a change in management.
Harm	Delay of up to 72 hours in changing therapy if patient fails to improve.
Cost	Additional provider and caregiver time and resources.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	Use of 72 hours to assess progress may result in excessive classification as treatment failures if premature; emphasis on importance of worsening illness in defining treatment failures.
Role of patient preferences	Caregivers determine whether the severity of the patient's illness justifies the report to clinician of the patient's worsening or failure to improve.
Intentional vagueness	None.
Exclusions	Patients with severe illness, poor general health, complicated sinusitis, immune deficiency, previous sinus surgery, or coexisting bacterial illness.
Strength	Recommendation.

The purpose of this key action statement is to ensure that patients with acute bacterial sinusitis who fail to improve symptomatically after initial management are reassessed to be certain that they have been correctly diagnosed and to consider initiation of alternate therapy to hasten resolution of symptoms and avoid complications. "Worsening" is defined as progression of presenting signs or symptoms of acute bacterial sinusitis or onset of new signs or symptoms. "Failure to improve" is lack of reduction in presenting signs or symptoms of acute bacterial sinusitis by 72 hours after diagnosis and initial management; patients with persistent but improving symptoms do not meet this definition.

The rationale for using 72 hours as the time to assess treatment failure for acute bacterial sinusitis is based on clinical outcomes in RCTs. Wald et al[41] found that 18 of 35 patients (51%) receiving placebo demonstrated symptomatic improvement within 3 days of initiation of treatment; only an additional 3 patients receiving placebo (9%) improved between days 3 and 10. In the same study, 48 of 58 patients (83%) receiving antibiotics were cured or improved within 3 days; at 10 days, the overall rate of improvement was 79%, suggesting that no additional patients improved between days 3 and 10. In a more recent study, 17 of 19 children who ultimately failed initial therapy with either antibiotic or placebo demonstrated failure to improve within 72 hours.[4] Although Garbutt et al[42] did not report the percentage of patients who improved by day 3, they did demonstrate that the majority of improvement in symptoms occurred within

the first 3 days of study entry whether they received active treatment or placebo.

Reporting of either worsening or failure to improve implies a shared responsibility between clinician and caregiver. Although the clinician should educate the caregiver regarding the anticipated reduction in symptoms within 3 days, it is incumbent on the caregiver to appropriately notify the clinician of concerns regarding worsening or failure to improve. Clinicians should emphasize the importance of reassessing those children whose symptoms are worsening whether or not antibiotic therapy was prescribed. Reassessment may be indicated before the 72-hour process by which such reporting occurs should be discussed at the time the initial management strategy is determined.

Key Action Statement 5B

If the diagnosis of acute bacterial sinusitis is confirmed in a child with worsening symptoms or failure to improve in 72 hours, then clinicians may change the antibiotic therapy for the child initially managed with antibiotic OR initiate antibiotic treatment of the child initially managed with observation (Evidence Quality: D; Option based on expert opinion, case reports, and reasoning from first principles).

KAS Profile 5B

Aggregate evidence quality: D; expert opinion and reasoning from first principles.	
Benefit	Prevention of complications, administration of effective therapy.
Harm	Adverse effects of secondary antibiotic therapy.
Cost	Direct cost of medications, often substantial for second-line agents.
Benefits-harm assessment	Preponderance of benefit.
Value judgments	Clinician must determine whether cost and adverse effects associated with change in antibiotic is justified given the severity of illness.
Role of patient preferences	Limited in patients whose symptoms are severe or worsening, but caregivers of mildly affected children who are failing to improve may reasonably defer change in antibiotic.
Intentional vagueness	None.
Exclusions	None.
Strength	Option.

mark if the patient is substantially worse, because it may indicate the development of complications or a need for parenteral therapy. Conversely, in some cases, caregivers may think that symptoms are not severe enough to justify a change to an antibiotic with a less desirable safety profile or even the time, effort, and resources required for reassessment. Accordingly, the circumstances under which caregivers report back to the clinician and the

The purpose of this key action statement is to ensure optimal antimicrobial treatment of children with acute bacterial sinusitis whose symptoms worsen or fail to respond to the initial intervention to prevent complications and reduce symptom severity and duration (see Table 4).

Clinicians who are notified by a caregiver that a child's symptoms are worsening or failing to improve should confirm that the clinical diagnosis of acute bacterial sinusitis corresponds to the patient's pattern of illness, as defined in Key Action Statement 1. If caregivers report worsening of symptoms at any time in a patient for whom observation was the initial intervention, the clinician should begin treatment as discussed in Key Action Statement 4. For patients whose symptoms are mild and who have failed to improve but have not worsened, initiation of antimicrobial agents or continued observation (for up to 3 days) is reasonable.

If caregivers report worsening of symptoms after 3 days in a patient initially treated with antimicrobial agents, current signs and symptoms should be reviewed to determine whether acute bacterial sinusitis is still the best diagnosis. If sinusitis is still the best diagnosis, infection with drug-resistant bacteria is probable, and an alternate antimicrobial agent may be administered. Face-to-face reevaluation of the patient is desirable. Once the decision is made to change medications, the clinician should consider the limitations of the initial antibiotic coverage, the anticipated susceptibility of residual bacterial pathogens, and the ability of antibiotics to adequately penetrate the site of infection. Cultures of sinus or nasopharyngeal secretions in patients with initial antibiotic failure have identified a large percentage of bacteria with resistance to the original antibiotic.[71,72] Furthermore, multidrug-resistant *S pneumoniae* and β-lactamase–positive *H influenzae* and *M catarrhalis* are more commonly isolated after previous antibiotic exposure.[73–78] Unfortunately, there are no studies in children that have investigated the microbiology of treatment failure in acute bacterial sinusitis or cure rates using second-line antimicrobial agents. As a result, the likelihood of adequate antibiotic coverage for resistant organisms must be

addressed by extrapolations from studies of acute otitis media in children and sinusitis in adults and by using the results of data generated in vitro. A general guide to management of the child who worsens in 72 hours is shown in Table 4.

NO RECOMMENDATION

Adjuvant Therapy

Potential adjuvant therapy for acute sinusitis might include intranasal corticosteroids, saline nasal irrigation or lavage, topical or oral decongestants, mucolytics, and topical or oral antihistamines. A recent Cochrane review on decongestants, antihistamines, and nasal irrigation for acute sinusitis in children found no appropriately designed studies to determine the effectiveness of these interventions.[79]

Intranasal Steroids

The rationale for the use of intranasal corticosteroids in acute bacterial sinusitis is that an antiinflammatory agent may reduce the swelling around the sinus ostia and encourage drainage, thereby hastening recovery. However, there are limited data on how much inflammation is present, whether the inflammation is responsive to steroids, and whether there are differences in responsivity according to age. Nonetheless, there are several RCTs in adolescents and adults, most of which do show significant differences compared with placebo or active comparator that favor intranasal steroids in the reduction of symptoms and the patient's global assessment of overall improvement.[80–85] Several studies in adults with acute bacterial sinusitis provide data supporting the use of intranasal steroids as either monotherapy or adjuvant therapy to antibiotics.[81,86] Only one study did not show efficacy.[85]

There have been 2 trials of intranasal steroids performed exclusively in children: one comparing intranasal corticosteroids versus an oral decongestant[87] and the other comparing intranasal corticosteroids with placebo.[88] These studies showed a greater rate of complete resolution[87] or greater reduction in symptoms in patients receiving the steroid preparation, although the effects were modest.[88] It is important to note that nearly all of these studies (both those reported in children and adults) suffered from substantial methodologic problems. Examples of these methodologic problems are as follows: (1) variable inclusion criteria for sinusitis, (2) mixed populations of allergic and nonallergic subjects, and (3) different outcome criteria. All of these factors make deriving a clear conclusion difficult. Furthermore, the lack of stringent criteria in selecting the subject population increases the chance that the subjects had viral URIs or even persistent allergies rather than acute bacterial sinusitis.

The intranasal steroids studied to date include budesonide, flunisolide, fluticasone, and mometasone. There is no reason to believe that one steroid would be more effective than another, provided equivalent doses are used.

Potential harm in using nasal steroids in children with acute sinusitis includes the increased cost of therapy, difficulty in effectively administering nasal sprays in young children, nasal irritation and epistaxis, and potential systemic adverse effects of steroid use. Fortunately, no clinically significant steroid adverse effects have been discovered in studies in children.[89–96]

Saline Irrigation

Saline nasal irrigation or lavage (not saline nasal spray) has been used to remove debris from the nasal cavity and temporarily reduce tissue edema (hypertonic saline) to promote drainage from the sinuses. There have been very few RCTs using saline nasal irrigation or lavage in acute sinusitis, and these have had mixed results.[97,98] The 1 study in children showed greater improvement in nasal airflow and quality of life as well as a better rate of improvement in total symptom score when compared with placebo in patients treated with antibiotics and decongestants.[98] There are 2 Cochrane reviews published on the use of saline nasal irrigation in acute sinusitis in adults that showed variable results. One review published in 2007[99] concluded that it is a beneficial adjunct, but the other, published in 2010,[100] concluded that most trials were too small or contained too high a risk of bias to be confident about benefits.

Nasal Decongestants, Mucolytics, and Antihistamines

Data are insufficient to make any recommendations about the use of oral or topical nasal decongestants, mucolytics, or oral or nasal spray antihistamines as adjuvant therapy for acute bacterial sinusitis in children.[79] It is the opinion of the expert panel that antihistamines should not be used for the primary indication of acute bacterial sinusitis in any child, although such therapy might be helpful in reducing typical allergic symptoms in patients with atopy who also have acute sinusitis.

OTHER RELATED CONDITIONS

Recurrence of Acute Bacterial Sinusitis

Recurrent acute bacterial sinusitis (RABS) is an uncommon occurrence in healthy children and must be distinguished from recurrent URIs, exacerbations of allergic rhinitis, and chronic sinusitis. The former is defined by episodes of bacterial infection of the paranasal sinuses lasting fewer than 30 days and separated by intervals of

TABLE 3 Parent Information Regarding Initial Management of Acute Bacterial Sinusitis

How common are sinus infections in children?	Thick, colored, or cloudy mucus from your child's nose frequently occurs with a common cold or viral infection and does not by itself mean your child has sinusitis. In fact, fewer than 1 in 15 children get a true bacterial sinus infection during or after a common cold.
How can I tell if my child has bacterial sinusitis or simply a common cold?	Most colds have a runny nose with mucus that typically starts out clear, becomes cloudy or colored, and improves by about 10 d. Some colds will also include fever (temperature >38°C [100.4°F]) for 1 to 2 days. In contrast, acute bacterial sinusitis is likely when the pattern of illness is persistent, severe, or worsening. 1. *Persistent* sinusitis is the most common type, defined as runny nose (of any quality), daytime cough (which may be worse at night), or both for at least 10 days without improvement. 2. *Severe* sinusitis is present when fever (temperature ≥39°C [102.2°F]) lasts for at least 3 days in a row and is accompanied by nasal mucus that is thick, colored, or cloudy. 3. *Worsening* sinusitis starts with a viral cold, which begins to improve but then worsens when bacteria take over and cause new-onset fever (temperature ≥38°C [100.4°F]) or a substantial increase in daytime cough or runny nose.
If my child has sinusitis, should he or she take an antibiotic?	Children with *persistent* sinusitis may be managed with either an antibiotic or with an additional brief period of observation, allowing the child up to another 3 days to fight the infection and improve on his or her own. The choice to treat or observe should be discussed with your doctor and may be based on your child's quality of life and how much of a problem the sinusitis is causing. In contrast, all children diagnosed with *severe* or *worsening* sinusitis should start antibiotic treatment to help them recover faster and more often.
Why not give all children with acute bacterial sinusitis an immediate antibiotic?	Some episodes of *persistent* sinusitis include relatively mild symptoms that may improve on their own in a few days. In addition, antibiotics can have adverse effects, which may include vomiting, diarrhea, upset stomach, skin rash, allergic reactions, yeast infections, and development of resistant bacteria (that make future infections more difficult to treat).

at least 10 days during which the patient is asymptomatic. Some experts require at least 4 episodes in a calendar year to fulfill the criteria for this condition. Chronic sinusitis is manifest as 90 or more uninterrupted days of respiratory symptoms, such as cough, nasal discharge, or nasal obstruction.

Children with RABS should be evaluated for underlying allergies, particularly allergic rhinitis; quantitative and functional immunologic defect(s), chiefly immunoglobulin A and immunoglobulin G deficiency; cystic fibrosis; gastroesophageal reflux disease; or dysmotile cilia syndrome.[101] Anatomic abnormalities obstructing one or more sinus ostia may be present. These include septal deviation, nasal polyps, or concha bullosa (pneumatization of the middle turbinate); atypical ethmoid cells with compromised drainage; a lateralized middle turbinate; and intrinsic ostiomeatal anomalies.[102] Contrast-enhanced CT, MRI, or endoscopy or all 3 should be performed for detection of obstructive conditions, particularly in children with genetic or acquired craniofacial abnormalities.

The microbiology of RABS is similar to that of isolated episodes of acute bacterial sinusitis and warrants the same treatment.[72] It should be recognized that closely spaced sequential courses of antimicrobial therapy may foster the emergence of antibiotic-resistant bacterial species as the causative agent in recurrent episodes. There are no systematically evaluated options for prevention of RABS in children. In general, the use of prolonged prophylactic antimicrobial therapy should be avoided and is not usually recommended for children with recurrent acute otitis media. However, when there are no recognizable predisposing conditions to remedy in children with RABS, prophylactic antimicrobial agents may be used for several months during the respiratory season. Enthusiasm for this strategy is tempered by concerns regarding the encouragement of bacterial resistance. Accordingly, prophylaxis should only be considered in carefully selected children whose infections have been thoroughly documented.

Influenza vaccine should be administered annually, and PCV-13 should be administered at the recommended ages for all children, including those with RABS. Intranasal steroids and nonsedating antihistamines can be helpful for children with allergic rhinitis, as can antireflux medications for those with gastroesophageal reflux disease. Children with anatomic abnormalities may require endoscopic surgery for removal of or reduction in ostiomeatal obstruction.

The pathogenesis of chronic sinusitis is poorly understood and appears to be multifactorial; however, many of the conditions associated with RABS

TABLE 4 Management of Worsening or Lack of Improvement at 72 Hours

Initial Management	Worse in 72 Hours	Lack of Improvement in 72 Hours
Observation	Initiate amoxicillin with or without clavulanate	Additional observation or initiate antibiotic based on shared decision-making
Amoxicillin	High-dose amoxicillin-clavulanate	Additional observation or high-dose amoxicillin-clavulanate based on shared decision-making
High-dose amoxicillin-clavulanate	Clindamycin[a] and cefixime OR linezolid and cefixime OR levofloxacin	Continued high-dose amoxicillin-clavulanate OR clindamycin[a] and cefixime OR linezolid and cefixime OR levofloxacin

[a] Clindamycin is recommended to cover penicillin-resistant *S pneumoniae*. Some communities have high levels of clindamycin-resistant *S pneumoniae*. In these communities, linezolid is preferred.

have also been implicated in chronic sinusitis, and it is clear that there is an overlap between the 2 syndromes.[101,102] In some cases, there may be episodes of acute bacterial sinusitis superimposed on a chronic sinusitis, warranting antimicrobial therapy to hasten resolution of the acute infection.

Complications of Acute Bacterial Sinusitis

Complications of acute bacterial sinusitis should be diagnosed when the patient develops signs or symptoms of orbital and/or central nervous system (intracranial) involvement. Rarely, complicated acute bacterial sinusitis can result in permanent blindness, other neurologic sequelae, or death if not treated promptly and appropriately. Orbital complications have been classified by Chandler et al.[32] Intracranial complications include epidural or subdural abscess, brain abscess, venous thrombosis, and meningitis.

Periorbital and intraorbital inflammation and infection are the most common complications of acute sinusitis and most often are secondary to acute ethmoiditis in otherwise healthy young children. These disorders are commonly classified in relation to the orbital septum; periorbital or preseptal inflammation involves only the eyelid, whereas postseptal (intraorbital) inflammation involves structures of the orbit. Mild cases of preseptal cellulitis (eyelid <50% closed) may be treated on an outpatient basis with appropriate oral antibiotic therapy (high-dose amoxicillin-clavulanate for comprehensive coverage) for acute bacterial sinusitis and daily follow-up until definite improvement is noted. If the patient does not improve within 24 to 48 hours or if the infection is progressive, it is appropriate to admit the patient to the hospital for antimicrobial therapy. Similarly, if proptosis, impaired visual acuity, or impaired and/or painful extraocular mobility is present on examination, the patient should be hospitalized, and a contrast-enhanced CT should be performed. Consultation with an otolaryngologist, an ophthalmologist, and an infectious disease expert is appropriate for guidance regarding the need for surgical intervention and the selection of antimicrobial agents.

Intracranial complications are most frequently encountered in previously healthy adolescent males with frontal sinusitis.[33,34] In patients with altered mental status, severe headache, or Pott's puffy tumor (osteomyelitis of the frontal bone), neurosurgical consultation should be obtained. A contrast-enhanced CT scan (preferably coronal thin cut) of the head, orbits, and sinuses is essential to confirm intracranial or intraorbital suppurative complications; in such cases, intravenous antibiotics should be started immediately. Alternatively, an MRI may also be desirable in some cases of intracranial abnormality. Appropriate antimicrobial therapy for intraorbital complications include vancomycin (to cover possible methicillin-resistant *S aureus* or penicillin-resistant *S pneumoniae*) and either ceftriaxone, ampicillin-sulbactam, or piperacillin-tazobactam.[103] Given the polymicrobial nature of sinogenic abscesses, coverage for anaerobes (ie, metronidazole) should also be considered for intraorbital complications and should be started in all cases of intracranial complications if ceftriaxone is prescribed.

Patients with small orbital, subperiosteal, or epidural abscesses and minimal ocular and neurologic abnormalities may be managed with intravenous antibiotic treatment for 24 to 48 hours while performing frequent visual and mental status checks.[104] In patients who develop progressive signs and symptoms, such as impaired visual acuity, ophthalmoplegia, elevated intraocular pressure (>20 mm), severe proptosis (>5 mm), altered mental status, headache, or vomiting, as well as those who fail to improve within 24 to 48 hours while receiving antibiotics, prompt surgical intervention and drainage of the abscess should be undertaken.[104] Antibiotics can be tailored to the results of culture and sensitivity studies when they become available.

AREAS FOR FUTURE RESEARCH

Since the publication of the original guideline in 2001, only a small number of high-quality studies of the diagnosis and treatment of acute bacterial sinusitis in children have been published.[5] Ironically, the number of published guidelines on the topic (5) exceeds the number of prospective,

placebo-controlled clinical trials of either antibiotics or ancillary treatments of acute bacterial sinusitis. Thus, as was the case in 2001, there are scant data on which to base recommendations. Accordingly, areas for future research include the following:

Etiology

1. Reexamine the microbiology of acute sinusitis in children in the postpneumococcal conjugate vaccine era and determine the value of using newer polymerase chain reaction–based respiratory testing to document viral, bacterial, and polymicrobial disease.
2. Correlate cultures obtained from the middle meatus of the maxillary sinus of infected children with cultures obtained from the maxillary sinus by puncture of the antrum.
3. Conduct more and larger studies to more clearly define and correlate the clinical findings with the various available diagnostic criteria of acute bacterial sinusitis (eg, sinus aspiration and treatment outcome).
4. Develop noninvasive strategies to accurately diagnose acute bacterial sinusitis in children.
5. Develop imaging technology that differentiates bacterial infection from viral infection or allergic inflammation, preferably without radiation.

Treatment

1. Determine the optimal duration of antimicrobial therapy for children with acute bacterial sinusitis.
2. Evaluate a "wait-and-see prescription" strategy for children with persistent symptom presentation of acute sinusitis.
3. Determine the optimal antimicrobial agent for children with acute bacterial sinusitis, balancing the incentives of choosing narrow-spectrum agents against the known microbiology of the disease and resistance patterns of likely pathogens.
4. Determine the causes and treatment of subacute, recurrent acute, and chronic bacterial sinusitis.
5. Determine the efficacy of prophylaxis with antimicrobial agents to prevent RABS.
6. Determine the effects of bacterial resistance among *S pneumoniae*, *H influenzae*, and *M catarrhalis* on outcome of treatment with antibiotics by the performance of randomized, double-blind, placebo-controlled studies in well-defined populations of patients.
7. Determine the role of adjuvant therapies (antihistamines, nasal corticosteroids, mucolytics, decongestants, nasal irrigation, etc) in patients with acute bacterial sinusitis by the performance of prospective, randomized clinical trials.
8. Determine whether early treatment of acute bacterial sinusitis prevents orbital or central nervous system complications.
9. Determine the role of complementary and alternative medicine strategies in patients with acute bacterial sinusitis by performing systematic, prospective, randomized clinical trials.
10. Develop new bacterial and viral vaccines to reduce the incidence of acute bacterial sinusitis.

SUBCOMMITTEE ON ACUTE SINUSITIS

Ellen R. Wald, MD, FAAP (Chair, Pediatric Infectious Disease Physician: no financial conflicts; published research related to sinusitis)
Kimberly E. Applegate, MD, MS, FAAP (Radiologist, AAP Section on Radiology: no conflicts)
Clay Bordley, MD, MPH, FAAP (Pediatric Emergency and Hospitalist Medicine physician: no conflicts)
David H. Darrow, MD, FAAP (Otolaryngologist, AAP Section on Otolaryngology–Head and Neck Surgery: no conflicts)
Mary P. Glode, MD, FAAP (Pediatric Infectious Disease Physician, AAP Committee on Infectious Disease: no conflicts)
S. Michael Marcy, MD, FAAP (General Pediatrician with Infectious Disease Expertise, AAP Section on Infectious Diseases: no conflicts)
Nader Shaikh, MD, FAAP (General Academic Pediatrician: no financial conflicts; published research related to sinusitis)
Michael J. Smith, MD, MSCE, FAAP (Epidemiologist, Pediatric Infectious Disease Physician: research funding for vaccine clinical trials from Sanofi Pasteur and Novartis)
Paul V. Williams, MD, FAAP (Allergist, AAP Section on Allergy, Asthma, and Immunology: no conflicts)
Stuart T. Weinberg, MD, FAAP (PPI Informatician, General Academic Pediatrician: no conflicts)
Carrie E. Nelson, MD, MS (Family Physician, American Academy of Family Physicians: employed by McKesson Health Solutions)
Richard M. Rosenfeld, MD, MPH, FAAP (Otolaryngologist, AAP Section on Otolaryngology–Head and Neck Surgery, American Academy of Otolaryngology–Head and Neck Surgery: no financial conflicts; published research related to sinusitis)

CONSULTANT

Richard N. Shiffman, MD, FAAP (Informatician, Guideline Methodologist, General Academic Pediatrician: no conflicts)

STAFF

Caryn Davidson, MA

REFERENCES

1. Aitken M, Taylor JA. Prevalence of clinical sinusitis in young children followed up by primary care pediatricians. *Arch Pediatr Adolesc Med.* 1998;152(3):244–248
2. Kakish KS, Mahafza T, Batieha A, Ekteish F, Daoud A. Clinical sinusitis in children attending primary care centers. *Pediatr Infect Dis J.* 2000;19(11):1071–1074
3. Ueda D, Yoto Y. The ten-day mark as a practical diagnostic approach for acute paranasal sinusitis in children. *Pediatr Infect Dis J.* 1996;15(7):576–579

4. Wald ER, Nash D, Eickhoff J. Effectiveness of amoxicillin/clavulanate potassium in the treatment of acute bacterial sinusitis in children. *Pediatrics*. 2009;124(1):9–15
5. American Academy of Pediatrics, Subcommittee on Management of Sinusitis and Committee on Quality Improvement. Clinical practice guideline: management of sinusitis. *Pediatrics*. 2001;108(3):798–808
6. Smith MJ. AAP technical report: evidence for the diagnosis and treatment of acute uncomplicated sinusitis in children: a systematic review. 2013, In press.
7. Shiffman RN, Michel G, Rosenfeld RM, Davidson C. Building better guidelines with BRIDGE-Wiz: development and evaluation of a software assistant to promote clarity, transparency, and implementability. *J Am Med Inform Assoc*. 2012;19(1):94–101
8. American Academy of Pediatrics, Steering Committee on Quality Improvement and Management. Classifying recommendations for clinical practice guidelines. *Pediatrics*. 2004;114(3):874–877
9. Gwaltney JM, Jr, Hendley JO, Simon G, Jordan WS Jr. Rhinovirus infections in an industrial population. II. Characteristics of illness and antibody response. *JAMA*. 1967;202(6):494–500
10. Pappas DE, Hendley JO, Hayden FG, Winther B. Symptom profile of common colds in school-aged children. *Pediatr Infect Dis J*. 2008;27(1):8–11
11. Wald ER, Guerra N, Byers C. Frequency and severity of infections in day care: three-year follow-up. *J Pediatr*. 1991;118(4 pt 1):509–514
12. Wald ER, Guerra N, Byers C. Upper respiratory tract infections in young children: duration of and frequency of complications. *Pediatrics*. 1991;87(2):129–133
13. Meltzer EO, Hamilos DL, Hadley JA, et al. Rhinosinusitis: establishing definitions for clinical research and patient care. *J Allergy Clin Immunol*. 2004;114(6 suppl):155–212
14. Shaikh N, Wald ER. Signs and symptoms of acute sinusitis in children. *Pediatr Infect Dis J*. 2013; in press
15. Wald ER. The diagnosis and management of sinusitis in children: diagnostic considerations. *Pediatr Infect Dis*. 1985;4(6 suppl):S61–S64
16. Wald ER, Milmoe GJ, Bowen A, Ledesma-Medina J, Salamon N, Bluestone CD. Acute maxillary sinusitis in children. *N Engl J Med*. 1981;304(13):749–754
17. Lindbaek M, Hjortdahl P, Johnsen UL. Use of symptoms, signs, and blood tests to diagnose acute sinus infections in primary care: comparison with computed tomography. *Fam Med*. 1996;28(3):183–188
18. Wald ER. Beginning antibiotics for acute rhinosinusitis and choosing the right treatment. *Clin Rev Allergy Immunol*. 2006;30(3):143–152
19. Maresh MM, Washburn AH. Paranasal sinuses from birth to late adolescence. II. Clinical and roentgenographic evidence of infection. *Am J Dis Child*. 1940;60:841–861
20. Glasier CM, Mallory GB, Jr, Steele RW. Significance of opacification of the maxillary and ethmoid sinuses in infants. *J Pediatr*. 1989;114(1):45–50
21. Kovatch AL, Wald ER, Ledesma-Medina J, Chiponis DM, Bedingfield B. Maxillary sinus radiographs in children with nonrespiratory complaints. *Pediatrics*. 1984;73(3):306–308
22. Shopfner CE, Rossi JO. Roentgen evaluation of the paranasal sinuses in children. *Am J Roentgenol Radium Ther Nucl Med*. 1973;118(1):176–186
23. Diament MJ, Senac MO, Jr, Gilsanz V, Baker S, Gillespie T, Larsson S. Prevalence of incidental paranasal sinuses opacification in pediatric patients: a CT study. *J Comput Assist Tomogr*. 1987;11(3):426–431
24. Glasier CM, Ascher DP, Williams KD. Incidental paranasal sinus abnormalities on CT of children: clinical correlation. *AJNR Am J Neuroradiol*. 1986;7(5):861–864
25. Gwaltney JM, Jr, Phillips CD, Miller RD, Riker DK. Computed tomographic study of the common cold. *N Engl J Med*. 1994;330(1):25–30
26. Manning SC, Biavati MJ, Phillips DL. Correlation of clinical sinusitis signs and symptoms to imaging findings in pediatric patients. *Int J Pediatr Otorhinolaryngol*. 1996;37(1):65–74
27. Gordts F, Clement PA, Destryker A, Desprechins B, Kaufman L. Prevalence of sinusitis signs on MRI in a non-ENT paediatric population. *Rhinology*. 1997;35(4):154–157
28. Kristo A, Uhari M, Luotonen J, et al. Paranasal sinus findings in children during respiratory infection evaluated with magnetic resonance imaging. *Pediatrics*. 2003;111(5 pt 1):e586–e589
29. Brook I. Microbiology and antimicrobial treatment of orbital and intracranial complications of sinusitis in children and their management. *Int J Pediatr Otorhinolaryngol*. 2009;73(9):1183–1186
30. Sultesz M, Csakanyi Z, Majoros T, Farkas Z, Katona G. Acute bacterial rhinosinusitis and its complications in our pediatric otolaryngological department between 1997 and 2006. *Int J Pediatr Otorhinolaryngol*. 2009;73(11):1507–1512
31. Wald ER. Periorbital and orbital infections. *Infect Dis Clin North Am*. 2007;21(2):393–408
32. Chandler JR, Langenbrunner DJ, Stevens ER. The pathogenesis of orbital complications in acute sinusitis. *Laryngoscope*. 1970;80(9):1414–1428
33. Kombogiorgas D, Seth R, Modha J, Singh J. Suppurative intracranial complications of sinusitis in adolescence. Single institute experience and review of the literature. *Br J Neurosurg*. 2007;21(6):603–609
34. Rosenfeld EA, Rowley AH. Infectious intracranial complications of sinusitis, other than meningitis in children: 12 year review. *Clin Infect Dis*. 1994;18(5):750–754
35. American College of Radiology. Appropriateness criteria for sinonasal disease. 2009. Available at: www.acr.org/~/media/8172B4DE503149248E64856857674BB5.pdf. Accessed November 6, 2012
36. Triulzi F, Zirpoli S. Imaging techniques in the diagnosis and management of rhinosinusitis in children. *Pediatr Allergy Immunol*. 2007;18(suppl 18):46–49
37. McIntosh D, Mahadevan M. Failure of contrast enhanced computed tomography scans to identify an orbital abscess. The benefit of magnetic resonance imaging. *J Laryngol Otol*. 2008;122(6):639–640
38. Younis RT, Anand VK, Davidson B. The role of computed tomography and magnetic resonance imaging in patients with sinusitis with complications. *Laryngoscope*. 2002;112(2):224–229
39. Shapiro DJ, Gonzales R, Cabana MD, Hersh AL. National trends in visit rates and antibiotic prescribing for children with acute sinusitis. *Pediatrics*. 2011;127(1):28–34
40. Wald ER, Reilly JS, Casselbrant M, et al. Treatment of acute maxillary sinusitis in childhood: a comparative study of amoxicillin and cefaclor. *J Pediatr*. 1984;104(2):297–302
41. Wald ER, Chiponis D, Ledesma-Medina J. Comparative effectiveness of amoxicillin and amoxicillin-clavulanate potassium in acute paranasal sinus infections in children: a double-blind, placebo-controlled trial. *Pediatrics*. 1986;77(6):795–800
42. Garbutt JM, Goldstein M, Gellman E, Shannon W, Littenberg B. A randomized, placebo-controlled trial of antimicrobial treatment for children with clinically diagnosed acute sinusitis. *Pediatrics*. 2001;107(4):619–625

43. Kristo A, Uhari M, Luotonen J, Ilkko E, Koivunen P, Alho OP. Cefuroxime axetil versus placebo for children with acute respiratory infection and imaging evidence of sinusitis: a randomized, controlled trial. *Acta Paediatr*. 2005;94(9):1208–1213
44. Hoberman A, Paradise JL, Rockette HE, et al. Treatment of acute otitis media in children under 2 years of age. *N Engl J Med*. 2011;364(2):105–115
45. Tahtinen PA, Laine MK, Huovinen P, Jalava J, Ruuskanen O, Ruohola A. A placebo-controlled trial of antimicrobial treatment for acute otitis media. *N Engl J Med*. 2011;364(2):116–126
46. Gordts F, Abu Nasser I, Clement PA, Pierard D, Kaufman L. Bacteriology of the middle meatus in children. *Int J Pediatr Otorhinolaryngol*. 1999;48(2):163–167
47. Parsons DS, Wald ER. Otitis media and sinusitis: similar diseases. *Otolaryngol Clin North Am*. 1996;29(1):11–25
48. Revai K, Dobbs LA, Nair S, Patel JA, Grady JJ, Chonmaitree T. Incidence of acute otitis media and sinusitis complicating upper respiratory tract infection: the effect of age. *Pediatrics*. 2007;119(6). Available at: www.pediatrics.org/cgi/content/full/119/6/e1408
49. Klein JO, Bluestone CD. *Textbook of Pediatric Infectious Diseases*. 6th ed. Philadelphia, PA: Saunders; 2009
50. Casey JR, Adlowitz DG, Pichichero ME. New patterns in the otopathogens causing acute otitis media six to eight years after introduction of pneumococcal conjugate vaccine. *Pediatr Infect Dis J*. 2010;29(4):304–309
51. Brook I, Gober AE. Frequency of recovery of pathogens from the nasopharynx of children with acute maxillary sinusitis before and after the introduction of vaccination with the 7-valent pneumococcal vaccine. *Int J Pediatr Otorhinolaryngol*. 2007;71(4):575–579
52. Wald ER. Microbiology of acute and chronic sinusitis in children. *J Allergy Clin Immunol*. 1992;90(3 pt 2):452–456
53. Centers for Disease Control and Prevention. Effects of new penicillin susceptibility breakpoints for *Streptococcus pneumoniae*—United States, 2006-2007. *MMWR Morb Mortal Wkly Rep*. 2008;57(50):1353–1355
54. Centers for Disease Control and Prevention. Active Bacterial Core Surveillance (ABCs): Emerging Infections Program Network. 2011. Available at: www.cdc.gov/abcs/reports-findings/survreports/spneu09.html. Accessed November 6, 2012
55. Garbutt J, St Geme JW, III, May A, Storch GA, Shackelford PG. Developing community-specific recommendations for first-line treatment of acute otitis media: is high-dose amoxicillin necessary? *Pediatrics*. 2004;114(2):342–347
56. Harrison CJ, Woods C, Stout G, Martin B, Selvarangan R. Susceptibilities of *Haemophilus influenzae, Streptococcus pneumoniae*, including serotype 19A, and *Moraxella catarrhalis* paediatric isolates from 2005 to 2007 to commonly used antibiotics. *J Antimicrob Chemother*. 2009;63(3):511–519
57. Critchley IA, Jacobs MR, Brown SD, Traczewski MM, Tillotson GS, Janjic N. Prevalence of serotype 19A Streptococcus pneumoniae among isolates from U.S. children in 2005-2006 and activity of faropenem. *Antimicrob Agents Chemother*. 2008;52(7):2639–2643
58. Jacobs MR, Good CE, Windau AR, et al. Activity of ceftaroline against recent emerging serotypes of *Streptococcus pneumoniae* in the United States. *Antimicrob Agents Chemother*. 2010;54(6):2716–2719
59. Tristram S, Jacobs MR, Appelbaum PC. Antimicrobial resistance in *Haemophilus influenzae*. *Clin Microbiol Rev*. 2007;20(2):368–389
60. Levine OS, Farley M, Harrison LH, Lefkowitz L, McGeer A, Schwartz B. Risk factors for invasive pneumococcal disease in children: a population-based case-control study in North America. *Pediatrics*. 1999;103(3). Available at: www.pediatrics.org/cgi/content/full/103/3/e28
61. Seikel K, Shelton S, McCracken GH Jr. Middle ear fluid concentrations of amoxicillin after large dosages in children with acute otitis media. *Pediatr Infect Dis J*. 1997;16(7):710–711
62. Cohen R, Navel M, Grunberg J, et al. One dose ceftriaxone vs. ten days of amoxicillin/clavulanate therapy for acute otitis media: clinical efficacy and change in nasopharyngeal flora. *Pediatr Infect Dis J*. 1999;18(5):403–409
63. Green SM, Rothrock SG. Single-dose intramuscular ceftriaxone for acute otitis media in children. *Pediatrics*. 1993;91(1):23–30
64. Leibovitz E, Piglansky L, Raiz S, Press J, Leiberman A, Dagan R. Bacteriologic and clinical efficacy of one day vs. three day intramuscular ceftriaxone for treatment of nonresponsive acute otitis media in children. *Pediatr Infect Dis J*. 2000;19(11):1040–1045
65. DePestel DD, Benninger MS, Danziger L, et al. Cephalosporin use in treatment of patients with penicillin allergies. *J Am Pharm Assoc*. 2008;48(4):530–540
66. Pichichero ME. A review of evidence supporting the American Academy of Pediatrics recommendation for prescribing cephalosporin antibiotics for penicillin-allergic patients. *Pediatrics*. 2005;115(4):1048–1057
67. Pichichero ME, Casey JR. Safe use of selected cephalosporins in penicillin-allergic patients: a meta-analysis. *Otolaryngol Head Neck Surg*. 2007;136(3):340–347
68. Park MA, Koch CA, Klemawesch P, Joshi A, Li JT. Increased adverse drug reactions to cephalosporins in penicillin allergy patients with positive penicillin skin test. *Int Arch Allergy Immunol*. 2010;153(3):268–273
69. Jacobs MR. Antimicrobial-resistant Streptococcus pneumoniae: trends and management. *Expert Rev Anti Infect Ther*. 2008;6(5):619–635
70. Chow AW, Benninger MS, Brook I, et al; Infectious Diseases Society of America. IDSA clinical practice guideline for acute bacterial rhinosinusitis in children and adults. *Clin Infect Dis*. 2012;54(8):e72–e112
71. Brook I, Gober AE. Resistance to antimicrobials used for therapy of otitis media and sinusitis: effect of previous antimicrobial therapy and smoking. *Ann Otol Rhinol Laryngol*. 1999;108(7 pt 1):645–647
72. Brook I, Gober AE. Antimicrobial resistance in the nasopharyngeal flora of children with acute maxillary sinusitis and maxillary sinusitis recurring after amoxicillin therapy. *J Antimicrob Chemother*. 2004;53(2):399–402
73. Dohar J, Canton R, Cohen R, Farrell DJ, Felmingham D. Activity of telithromycin and comparators against bacterial pathogens isolated from 1,336 patients with clinically diagnosed acute sinusitis. *Ann Clin Microbiol Antimicrob*. 2004;3(3):15–21
74. Jacobs MR, Bajaksouzian S, Zilles A, Lin G, Pankuch GA, Appelbaum PC. Susceptibilities of *Streptococcus pneumoniae* and *Haemophilus influenzae* to 10 oral antimicrobial agents based on pharmacodynamic parameters: 1997 U.S. surveillance study. *Antimicrob Agents Chemother*. 1999;43(8):1901–1908
75. Jacobs MR, Felmingham D, Appelbaum PC, Gruneberg RN. The Alexander Project 1998-2000: susceptibility of pathogens isolated from community-acquired respiratory tract infection to commonly used antimicrobial agents. *J Antimicrob Chemother*. 2003;52(2):229–246

76. Lynch JP, III, Zhanel GG. *Streptococcus pneumoniae*: epidemiology and risk factors, evolution of antimicrobial resistance, and impact of vaccines. *Curr Opin Pulm Med*. 2010;16(3):217–225
77. Sahm DF, Jones ME, Hickey ML, Diakun DR, Mani SV, Thornsberry C. Resistance surveillance of *Streptococcus pneumoniae, Haemophilus influenzae* and *Moraxella catarrhalis* isolated in Asia and Europe, 1997-1998. *J Antimicrob Chemother*. 2000; 45(4):457–466
78. Sokol W. Epidemiology of sinusitis in the primary care setting: results from the 1999-2000 respiratory surveillance program. *Am J Med*. 2001;111(suppl 9A):19S–24S
79. Shaikh N, Wald ER, Pi M. Decongestants, antihistamines and nasal irrigation for acute sinusitis in children. *Cochrane Database Syst Rev*. 2010;(12):CD007909
80. Dolor RJ, Witsell DL, Hellkamp AS, Williams JW, Jr, Califf RM, Simel DL. Comparison of cefuroxime with or without intranasal fluticasone for the treatment of rhinosinusitis. The CAFFS Trial: a randomized controlled trial. *JAMA*. 2001;286(24):3097–3105
81. Meltzer EO, Bachert C, Staudinger H. Treating acute rhinosinusitis: comparing efficacy and safety of mometasone furoate nasal spray, amoxicillin, and placebo. *J Allergy Clin Immunol*. 2005;116(6):1289–1295
82. Meltzer EO, Charous BL, Busse WW, Zinreich SJ, Lorber RR, Danzig MR. Added relief in the treatment of acute recurrent sinusitis with adjunctive mometasone furoate nasal spray. The Nasonex Sinusitis Group. *J Allergy Clin Immunol*. 2000;106 (4):630–637
83. Meltzer EO, Orgel HA, Backhaus JW, et al. Intranasal flunisolide spray as an adjunct to oral antibiotic therapy for sinusitis. *J Allergy Clin Immunol*. 1993;92(6):812–823
84. Nayak AS, Settipane GA, Pedinoff A, et al. Effective dose range of mometasone furoate nasal spray in the treatment of acute rhinosinusitis. *Ann Allergy Asthma Immunol*. 2002;89(3):271–278
85. Williamson IG, Rumsby K, Benge S, et al. Antibiotics and topical nasal steroid for treatment of acute maxillary sinusitis: a randomized controlled trial. *JAMA*. 2007; 298(21):2487–2496
86. Zalmanovici A, Yaphe J. Intranasal steroids for acute sinusitis. *Cochrane Database Syst Rev*. 2009;(4):CD005149
87. Yilmaz G, Varan B, Yilmaz T, Gurakan B. Intranasal budesonide spray as an adjunct to oral antibiotic therapy for acute sinusitis in children. *Eur Arch Otorhinolaryngol*. 2000;257(5):256–259
88. Barlan IB, Erkan E, Bakir M, Berrak S, Basaran MM. Intranasal budesonide spray as an adjunct to oral antibiotic therapy for acute sinusitis in children. *Ann Allergy Asthma Immunol*. 1997;78(6):598–601
89. Bruni FM, De Luca G, Venturoli V, Boner AL. Intranasal corticosteroids and adrenal suppression. *Neuroimmunomodulation*. 2009;16 (5):353–362
90. Kim KT, Rabinovitch N, Uryniak T, Simpson B, O'Dowd L, Casty F. Effect of budesonide aqueous nasal spray on hypothalamic-pituitary-adrenal axis function in children with allergic rhinitis. *Ann Allergy Asthma Immunol*. 2004;93(1):61–67
91. Meltzer EO, Tripathy I, Maspero JF, Wu W, Philpot E. Safety and tolerability of fluticasone furoate nasal spray once daily in paediatric patients aged 6-11 years with allergic rhinitis: subanalysis of three randomized, double-blind, placebo-controlled, multicentre studies. *Clin Drug Investig*. 2009;29(2):79–86
92. Murphy K, Uryniak T, Simpson B, O'Dowd L. Growth velocity in children with perennial allergic rhinitis treated with budesonide aqueous nasal spray. *Ann Allergy Asthma Immunol*. 2006;96(5):723–730
93. Ratner PH, Meltzer EO, Teper A. Mometasone furoate nasal spray is safe and effective for 1-year treatment of children with perennial allergic rhinitis. *Int J Pediatr Otorhinolaryngol*. 2009;73(5):651–657
94. Skoner DP, Gentile DA, Doyle WJ. Effect on growth of long-term treatment with intranasal triamcinolone acetonide aqueous in children with allergic rhinitis. *Ann Allergy Asthma Immunol*. 2008;101(4): 431–436
95. Weinstein S, Qaqundah P, Georges G, Nayak A. Efficacy and safety of triamcinolone acetonide aqueous nasal spray in children aged 2 to 5 years with perennial allergic rhinitis: a randomized, double-blind, placebo-controlled study with an open-label extension. *Ann Allergy Asthma Immunol*. 2009;102(4):339–347
96. Zitt M, Kosoglou T, Hubbell J. Mometasone furoate nasal spray: a review of safety and systemic effects. *Drug Saf*. 2007;30(4): 317–326
97. Adam P, Stiffman M, Blake RL Jr. A clinical trial of hypertonic saline nasal spray in subjects with the common cold or rhinosinusitis. *Arch Fam Med*. 1998;7(1):39–43
98. Wang YH, Yang CP, Ku MS, Sun HL, Lue KH. Efficacy of nasal irrigation in the treatment of acute sinusitis in children. *Int J Pediatr Otorhinolaryngol*. 2009;73(12): 1696–1701
99. Harvey R, Hannan SA, Badia L, Scadding G. Nasal saline irrigations for the symptoms of chronic rhinosinusitis. *Cochrane Database Syst Rev*. 2007;(3):CD006394
100. Kassel JC, King D, Spurling GK. Saline nasal irrigation for acute upper respiratory tract infections. *Cochrane Database Syst Rev*. 2010;(3):CD006821
101. Shapiro GG, Virant FS, Furukawa CT, Pierson WE, Bierman CW. Immunologic defects in patients with refractory sinusitis. *Pediatrics*. 1991;87(3):311–316
102. Wood AJ, Douglas RG. Pathogenesis and treatment of chronic rhinosinusitis. *Postgrad Med J*. 2010;86(1016):359–364
103. Liao S, Durand ML, Cunningham MJ. Sinogenic orbital and subperiosteal abscesses: microbiology and methicillin-resistant Staphylococcus aureus incidence. *Otolaryngol Head Neck Surg*. 2010;143(3):392–396
104. Oxford LE, McClay J. Medical and surgical management of subperiosteal orbital abscess secondary to acute sinusitis in children. *Int J Pediatr Otorhinolaryngol*. 2006;70(11):1853–1861