Acute Sinusitis in Children

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KEYWORDS

• Rhinosinusitis • Anaerobes • *Streptococcus pneumoniae* • *Haemophilus influenzae* • Antimicrobials

KEY POINTS

- Viral infection of the upper respiratory tract is the most common presentation of rhinosinusitis and the vast majority of cases resolve spontaneously.
- Only a small proportion develops a secondary bacterial infection that will benefit from antimicrobial therapy.
- The most common bacterial isolates from acute rhinosinusitis are *Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis,* Group A beta-hemolytic streptococci, and *Staphylococcus aureus.*
- The proper choice of antibiotic therapy depends on the likely infecting pathogens, bacterial antibiotic resistance, and the pharmacologic profiles of the antibiotics.
- Continuous monitoring of the evolving bacterial etiology of acute bacterial rhinosinusitis is of great importance.

INTRODUCTION

Acute rhinosinusitis is one of the most common health problems in children and has increased in prevalence and incidence.[1] It causes significant physical symptoms, negatively affects quality of life, and can substantially impair daily functioning. Prospective longitudinal studies performed in young children (6–35 months of age) illustrated that viral upper respiratory tract infection (URTI) occurred with an incidence of 6 episodes per patient-year, and that 8% (0.5 episodes per patient-year) were complicated by acute rhinosinusitis.[2] The pathophysiological cause of rhinosinusitis may be obstruction of sinus drainage pathways (sinus ostia), ciliary impairment, and altered mucus quantity and quality.

Acute rhinosinusitis is defined as an inflammation of the mucosal lining of the nasal passage and paranasal sinuses lasting up to 4 weeks, and can be caused by various factors, including environmental irritants, allergy, and viral infection, bacteria, or fungi.

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Pediatr Clin N Am 60 (2013) 409–424
http://dx.doi.org/10.1016/j.pcl.2012.12.002 **pediatric.theclinics.com**
0031-3955/13/$ – see front matter

HISTORY

Suspicion of acute bacterial rhinosinusitis (ABRS) is based on clinical symptoms and signs when at least 2 major or 1 major and 2 minor criteria are present (**Table 1**).[3] The most common presentation is a persistent (and nonimproved) nasal discharge or cough (or both) lasting more than 10 days.[4] Typical clinical manifestations of ABRS in children are cough that worsens at night (80%), nasal symptoms (anterior or posterior discharge, obstruction, and/or congestion) (76%), and fever for more than 3 days (63%). Malodorous fetid breath is common, whereas facial pain and swelling, sore throat, and headache are rare in children. There is only one study of children that correlated the presence of respiratory signs and symptoms with the findings of sinus aspiration.[5]

Differentiating viral URTI from ABRS is critical and remains difficult. The main feature of viral URTI is the presence of nasal symptoms (discharge and congestion/obstruction) or cough or both, and sometimes also a scratchy throat. Fever is absent in most patients and when present it occurs early in the illness. Fever and constitutional symptoms generally disappear within 24 to 48 hours, after which the respiratory symptoms predominate. Most with acute viral rhinosinusitis improved spontaneously after 7 to 12 days. Generally, the nasal discharge is clear and watery initially, but often its quality changes over time. In most individuals, the discharge turns thicker and more mucoid and purulent.[6] After several days, these changes are reversed, with the purulent discharge turning mucoid and then clear, or dry. These changes occur in uncomplicated viral URTIs without the use of antimicrobials.

The characteristic presenting symptoms that are commonly associated with a bacterial rather than viral infection were evaluated by 5 consensus panels, created by 5 national societies.[7–10] The panels highlighted 3 clinical presentations that should prompt consideration of ABRS rather than a viral URTI:

1. Onset with persistent symptoms (respiratory symptoms that are present for more than 10 but fewer than 30 days with no improvement). The criterion of duration of symptoms for 10 or more days or signs and worsening of symptoms within 10 days after initial improvement (double-sickening) is used to differentiate between bacterial versus viral acute rhinosinusitis.[8] Patients manifest low-grade or nonresolving respiratory symptoms. Nasal discharge and daytime cough are common, whereas headache, facial pain, and fever are variable.

Table 1
Major and minor clinical criteria suggestive of bacterial sinusitis[a]

Major Criteria	Minor Criteria
Facial pain or pressure (requires a second major criterion to constitute a suggestive history)	Headache
Facial congestion or fullness	Fever (for subacute and chronic sinusitis)
Nasal congestion or obstruction	Halitosis
Nasal discharge, purulence, or discolored postnasal drainage	Fatigue
Hyposmia or anosmia	Dental pain
Fever (for acute sinusitis, requires a second major criterion to constitute a strong history)	Cough
Purulence on intranasal examination	Ear pain, pressure, or fullness

[a] A strongly suggestive history requires the presence of 2 major criteria or 1 major and 2 or more minor criteria. A suggestive history requires the presence of 1 major criterion or 2 or more minor criteria.[3]

Confirmation of bacterial infection by sinus aspiration was possible in only about two-thirds of adults with symptoms lasting longer than 7 to 10 days.[11,12] This suggests that additional qualifying clinical features are needed to differentiate viral from ABRS.

2. Onset with severe symptoms (an ill appearance with fever of at least 39°C [102°F] and purulent nasal discharge for at least 3–4 consecutive days at the beginning of illness) (**Table 2**). The onset of fever, headache, and facial pain differs from an uncomplicated viral URTI, as the elevated temperature and purulent nasal discharge in ABRS occur at the beginning of the illness.[13]
3. Worsening symptoms after initial improvement with a new onset of fever, an increase in nasal discharge or cough, or the onset of severe headache (also called "double-sickening").

The symptoms and signs of acute bacterial infection can be divided into nonsevere and severe (see **Table 2**).[14] The severe form carries a higher risk of complications and mandates earlier use of antimicrobial therapy. The combination of high fever and purulent nasal discharge that lasts for at least 3 to 4 days suggests ABRS.

Individuals with ABRS often have edema of nasal mucous membranes, mucopurulent nasal discharge, persistent postnasal drip, fever, and malaise. The quality of the nasal discharge varies, and can be thin or thick, clear mucoid, or purulent. Tenderness and pain of the involved sinus can be induced by percussion of the affected sinus. Cellulitis can also be present overlying the affected sinus. Other findings, especially in acute ethmoiditis, are periorbital cellulitis, edema, and proptosis. Failure to transilluminate the sinus and the presence of nasal voice can be present in many patients. Direct smear of nasal secretions usually shows the predominance of neutrophils, and the observation of numerous eosinophils suggests allergy.

The symptoms are generally protracted and vary considerably in subacute or chronic bacterial sinusitis. Fever can be of low grade or absent. The patient may complain of malaise, easy fatigability, irregular nasal or postnasal discharge, frequent headaches, difficulty in mental concentration, anorexia, and pain or tenderness to palpation over the affected sinus. Cough and nasal congestion can persist, and a sore throat (because of mouth-breathing) is frequent.

BACTERIAL ETIOLOGY

The most common bacteria recovered from pediatric and adult patients with community-acquired, ABRS are *Streptococcus pneumoniae,* nontypeable *Haemophilus influenzae, Moraxella catarrhalis,* Group A beta-hemolytic streptococci, and *Staphylococcus aureus.*[11,15–19] The vaccination of children with the 7-valent pneumococcal vaccine, introduced in 2000 in the United States, brought about the decline in the recovery rate of *S pneumoniae* and an increase in *H influenzae.*[20,21] *S aureus* is

Table 2
Severity of symptoms and signs in acute bacterial sinusitis

Nonsevere	Severe
Rhinorrhea (of any quality)	Purulent (thick, colored, opaque) rhinorrhea
Nasal congestion	Nasal congestion
Cough	Facial pain or headache
Headache, facial pain, and irritability (variable)	Periorbital edema (variable)
Low-grade or no fever	High fever (temperature $\geq$39°C)

a common pathogen in sphenoid sinusitis.[17] Recent data illustrate a significant increase in the rate of recovery of methicillin-resistant *S aureus* (MRSA) in patients with ABRS.[22,23]

The infection is polymicrobial in about a third of the patients. Enteric bacteria are rarely isolated, and anaerobes account for about 8% of isolates and are usually recovered from ABRS associated with an odontogenic origin, mainly as an extension of the infection from the roots of the premolar or molar teeth.[15,24] *Pseudomonas aeruginosa* and other aerobic and facultative gram-negative rods are mainly recovered from nosocomial rhinosinusitis (mostly in those with nasal tubes or catheters), the immunocompromised, and those with human immunodeficiency virus (HIV) infection[25] or cystic fibrosis.[26]

The dynamics of sinusitis, as well as otitis media, progress through several phases (**Fig. 1**). The early phase is generally viral (mostly rhinovirus, adenovirus, influenza, and parainfluenza viruses) and lasts up to 10 days when complete recovery occurs in 99% of individuals.[27] In a small number of patients, a secondary acute bacterial infection may emerge, generally caused by aerobic bacteria (ie, *S pneumoniae*, *H influenzae,* or *M catarrhalis*). If resolution does not take place, anaerobic bacteria from the oropharyngeal flora become predominant over time.[28] The mechanism by which viruses predispose to bacterial sinusitis may involve viral-bacterial synergy, induction of local inflammation that blocks the sinus ostia, increase of bacterial attachment to the epithelial cells, and disruption of the local immune defense.

DIAGNOSIS

History

Past medical history should evaluate for previous episodes of sinusitis and other respiratory tract infections, previous use of antibiotics, the potential of nasal foreign bodies, attendance at a day care center, immunizations, history of allergy, exposure to cigarette smoke, comorbidities, and previous hospitalization. The presence of any swelling and pain, especially in the facial, forehead, temporal, or orbital area or any other site in the head, should be noted. Information about what makes the symptoms worse or better should be obtained. The length of symptoms, such as cough, nasal secretions, headaches, pain, fever, hyposmia, or dental pain or problems, should be recorded.

Physical Examination

Physical examination should include the following:

- A thorough and complete general and head and neck examination (including the orbit, extraocular motility, the response of the pupils, vision, and cranial nerve function).

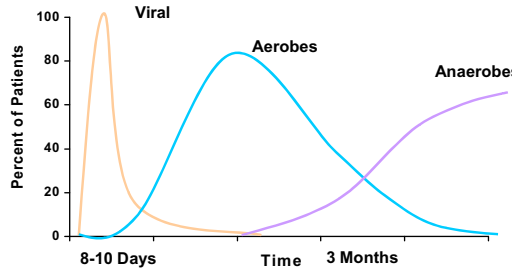

Fig. 1. The chronology of viral and bacterial causes of sinusitis.

- Palpation and/or percussion (over the frontal sinuses, cheeks [maxillary sinuses], and medial orbit [ethmoid sinuses]).
- The nasopharynx should be assessed for postnasal drip and obstruction caused by adenoid hypertrophy, choanal atresia, malignancy, polyps, and septal deviation.
- Nasal examination, including anterior rhinoscopy with a good light source looking for edema, erythema, crusting, purulent secretion, and presence of a foreign body.
- Bending the patient's head forward (when sitting) and holding it at knee level for 45 to 60 seconds can elicit a sensation of fullness and pain at the involved sites (compliance in young patients may be difficult).
- Endoscopic examination performed by an otolaryngologist may localize pus within the nasal cavity, directing the examiner to the involved sinus(es). Bacterial cultures can also be obtained; however, the specimens may contain nasal mucosal flora.
- Transillumination is infrequently used because the findings do not always correlate with the disorder, and reproducibility between observers is poor.
- Indications for referral to an otolaryngologist for maxillary sinus aspiration are the following: failure to improve on antimicrobial therapy, severe facial pain, orbital or intracranial complications, and in the immunocompromised host (because of their unique microbiology).
- The ears should be otoscopically examined, the oral cavity should be observed for any postnasal drip, all teeth (especially the upper molars and premolars) should be inspected for cavities and tenderness, and pressure should be applied on the maxillary sinuses by the examiner's thumbs.

Signs of sinus infection that can be observed by physical examination are the following:

- Mucopurulent nasal or posterior pharyngeal discharge.
- Erythematous nasal mucosa that can be pale and boggy.
- Signs of throat infection that can be associated with malodorous breath.
- Acute otitis media can be present in association with ABRS.
- Cervical lymphadenitis is rarely present.
- Facial tenderness is inconsistent and nonspecific.
- Periorbital edema with skin discoloration may be present, especially with ethmoid sinusitis.
- Upper molar teeth pathology may be the source of maxillary sinusitis.

Clinical Findings

The location of the facial pain can point to the involved sinus. Maxillary rhinosinusitis is commonly associated with cheeks, frontal with forehead pain, ethmoid with medial canthus, and sphenoid with occipital pain. In patients with chronic infection, changes in motion or position can worsen or alleviate the sinus symptoms.

The gold standard for the diagnosis of ABRS is the isolation of bacteria in high density ($\geq 10^4$ colony-forming units/mL) from the paranasal sinus cavity. Improper decontamination of the paranasal mucosa before aspiration may lead to misinterpretation of results.[5,29–31] Sinus aspiration is an invasive and painful procedure that is impractical in the office setting. Endoscopically guided middle meatus cultures can be used as a surrogate for sinus aspirates in patients with ABRS.[32] The validity of these cultures in children has not been well established, however.

Imaging

Imaging studies, such as plain radiographs or computed tomography (CT), are often used for the diagnosis of ABRS; however, they are nonspecific and cannot differentiate viral from bacterial rhinosinusitis.[33]

More than 50% of children with viral URTI had abnormal maxillary sinus radiographs.[34] Sinus CTs are often abnormal in healthy children,[34,35] and those having CT for nonrespiratory reasons.[36] CT performed on young adults recovering from a cold illustrated that 87% had significant maxillary sinus abnormalities.[36] Magnetic resonance imagining (MRI) illustrated that 68% of symptomatic children with URTI[37] and 42% of healthy children[38] had significant sinus abnormalities.

These findings illustrate that imaging studies in most children with uncomplicated viral URTI will show major abnormalities that are indistinguishable from those associated with ABRS. Therefore, these studies can be useful only when they are negative, as they confirm the absence of ABRS; however, abnormal radiographic studies cannot assist in ABRS diagnosis, and are therefore not required in uncomplicated ABRS. Imaging can be helpful in determining disease location and extent beyond the site of the original source. It may help in supporting the diagnosis or determining the degree of mucosal involvement.[39]

CT or MRI should be generally performed only in children with recurrent or complicated sinusitis or when suppurative complications are suspected. Suppurative complications of ABRS are infrequent, occurring in 3.7% to 11.0% of hospitalized children with sinusitis. They are mainly associated with potential orbital and intracranial complications of sinusitis.[40] CT is best for the assessment of bony and anatomic changes associated with sinusitis and is also helpful in surgical planning and for intraoperative image-guided navigation. MRI is most effective in evaluating the extent of soft tissue inflammation and abnormalities.[41–47]

The American College of Radiology criteria for the adequacy of imaging examinations for ABRS in children[48] stated that both CT and MRI are complementary for the evaluation of suspected orbital and/or intracranial complication of sinusitis. However, the Infectious Diseases Society of America (IDSA) panel favored contrast-enhanced CT over MRI because of its greater value, relative availability, speed, and lack of need for sedation.[49] CT is especially advantageous in children because their sinuses are often asymmetrical and smaller than those in adults.[50]

Differential Diagnosis

Differentiation must be made between allergic rhinitis, other causes of head or facial pain, asthma, and dental disorders. An allergic etiology can be confirmed by history of nasal symptoms and a history of allergy.[14]

ABRS has to be differentiated chronologically from other types of rhinosinusitis. These include recurrent acute, subacute, chronic, and acute exacerbation of chronic rhinosinusitis.

The symptoms and signs of ABRS can be divided into nonsevere and severe forms (see **Table 2**).[14] The severe form has a greater risk of complications and mandates earlier use of antimicrobial treatment. In children with subacute or chronic bacterial sinusitis, the symptoms are protracted, fever is uncommon, cough and nasal congestion persist, and a sore throat is common.

TREATMENT

The medical management of ABRS includes the use of antibiotics and adjuvants. The goals of therapy are to eliminate infection, decrease the severity and duration of symptoms, and prevent complications.

The management of sinusitis has become a challenging endeavor because the choice of appropriate antimicrobial agents has become more complex in recent years.

This is because many of the predominant bacterial pathogens have developed resistance to commonly used antibiotics.[51]

Culture obtained through direct aspiration or endoscopy can direct the selection of antimicrobials in the treatment of patients who fail to respond.[28]

The emerging antimicrobial resistance among respiratory pathogens leads to the empiric overuse of broad-spectrum antibiotics, which generates selective pressure that promotes the emergence of greater antimicrobial resistance.[52,53]

Several practice guidelines for the treatment of ABRS have been published in the United States within the past decade.[13,54–60] These guidelines present varying opinions about the clinical criteria for initiation and choice of empiric antimicrobial regimens. The most recent guideline, developed by the IDSA,[49] addresses some of the more controversial areas concerning initial choice of empiric management of ABRS in children and adults.

Empiric antimicrobial therapy should be started as soon as the clinical diagnosis of ABRS is made. Pharmacokinetic/pharmacodynamic principles should guide adequate dosing for respiratory tract infections.[61] The utility of these diagnostic criteria for initiating antibiotic treatment has been validated by 3 randomized clinical trials in children.[62–64] These studies demonstrated significantly higher cure rates in those treated with antibiotics compared with placebo. Some children with mild but persistent symptoms can be observed without giving antimicrobial therapy.[64] These children need close observation and antimicrobials should be administered if improvement has not occurred within 3 days.

Amoxicillin is no longer considered to be adequate for the initial empiric treatment of ABRS in children.[49] The addition of clavulanate improves the amoxicillin coverage against beta-lactamase–producing pathogens in ABRS, estimated to be present in about a quarter of patients. These include 25% to 35% of *H influenzae* and more than 90% of *M catarrhalis*.[65]

The "standard-dose" of amoxicillin-clavulanate is 45 mg/kg/d orally 3 times a day or twice a day or 500 mg orally 3 times a day, and the "high-dose" amoxicillin-clavulanate is 90 mg/kg/d orally twice a day, or 2 g orally twice a day. The primary disadvantages of using the "high-dose" amoxicillin-clavulanate is the added cost and potentially higher incidence of adverse effects. "High-dose" amoxicillin-clavulanate is recommended for children with ABRS from locations with high rates of penicillin-nonsusceptible *S pneumoniae*, recent hospitalization, or antibiotic use within the past month; those with severe infection; those with evidence of systemic toxicity (eg, fever of 39°C [102°F] or higher); those with comorbidities; or those who are immunocompromised.[66,67]

Studies determining *S pneumoniae* penicillin resistance using the revised Clinical Laboratory Standards Institute breakpoints defining penicillin-intermediate (minimal inhibitory concentration [MIC] 4 μg/mL; treatable with "high-dose" amoxicillin) and penicillin-resistant *S pneumoniae* (MIC ≥8 μg/mL; untreatable with amoxicillin), illustrated a higher rate of penicillin susceptibility (89%–93%) than those using earlier breakpoints.[51,65,68,69] These studies suggest that unless the rate of penicillin-nonsusceptible *S pneumoniae* in the community is high (>10%), "standard-dose" amoxicillin-clavulanate should be adequate for the treatment of nonmeningitic *S pneumoniae* infections, including ABRS.

Oral cephalosporins are inactive against penicillin-resistant *S pneumoniae*.[70,71] The activity of second-generation and third-generation oral cephalosporins (ie, cefaclor, cefuroxime axetil, cefpodoxime, cefprozil, cefdinir, and cefixime) is variable against penicillin-intermediate and resistant *S pneumoniae*. Cefpodoxime, cefuroxime axetil, and cefidnir are moderately active against this organism (<50% susceptible), and cefixime is less effective.[65,70–72] The parenteral third-generation cephalosporins,

cefotaxime and ceftriaxone, are active against all *S pneumoniae,* including penicillin-resistant ones and are the recommended second-line empiric therapy (in place of high-dose amoxicillin-clavulanate) for hospitalized children. The most active oral cephalosporin against both *H influenzae* and *M catarrhalis* (beta-lactamase positive and negative) is cefpodoxime, followed by cefixime, cefuroxime, and cefdinir.[70,73] Cefaclor and cefprozil are least effective.

Because of the variable activity of second-generation and third-generation oral cephalosporins against *S pneumoniae* and *H influenzae,* they are no longer adequate as monotherapy for the initial empiric treatment of ABRS. If an oral cephalosporin is used, a third-generation cephalosporin (eg, cefpodoxime or cefixime) combined with clindamycin is recommended in regions with high isolation rates of penicillin-nonsusceptible *S pneumoniae* ($\geq$10%).

The increased recovery of MRSA in ABRS requires consideration of the need for coverage against these organisms.[74] A comparison of the rate of recovery of MRSA between 2001–2003 and 2004–2006 in 244 patients with ABRS illustrated a significant increase in the rate of recovery of this organism in patients (from 3% of patients to 10%, $P<.01$).[23] This finding suggests the use of greater index of suspicion for the presence of MRSA in sinusitis and greater use of sinus cultures, especially in patients who do not improve or fail antimicrobial treatment after 48 hours of therapy. Because the nose can be a reservoir for *S aureus*, there is a concern that the recovery of *S aureus* could be attributable to contamination by the nasal flora during sinus aspiration or acquisition of middle meatus cultures. Accurate diagnosis of MRSA rhinosinusitis by microbiological cultures is essential for appropriate antimicrobial treatment.

Currently there is insufficient evidence to support the empiric coverage for MRSA in ABRS; however, in seriously ill individuals with suspected orbital or intracranial complication, and hospitalized patients with nosocomial sinusitis, empiric coverage for MRSA is helpful. Although vancomycin is considered the gold standard for therapy of MRSA, the increasing in vitro resistance to vancomycin[74] and reports of clinical failures underscore the need for alternative therapies. Other agents with good in vitro activity include trimethoprim-sulfamethoxazole, clindamycin, linezolid, quinupristin-dalfopristin, daptomycin, and tigecycline.

For children with a history of immediate-type hypersensitivity response to penicillin, levofloxacin is recommended as an alternative to amoxicillin-clavulanate. In those with a history of non–type I hypersensitivity reaction to penicillin, a third-generation oral cephalosporin (eg, cefixime or cefpodoxime) in combination with clindamycin is recommended. Cefixime or cefpodoxime are active against most strains of *H influenzae* and *M catarrhalis,* whereas clindamycin is active against *S pneumoniae,* including penicillin-intermediate and penicillin-resistant strains.[65]

The current treatment guidelines for ABRS that generally recommend a course of antimicrobial therapy for 10 to 14 days are derived from the length of therapy in many of the randomized controlled studies in adults.[10] Some recommend treatment for 7 days beyond the time symptoms had resolved.[75] Data in children, about the optimal duration of therapy, are nonconclusive because the efficacy of shorter courses has not been studied in a rigorous randomized manner.[76] In children with ABRS, the longer treatment duration of 10 to 14 days is still recommended.[49]

Clinically, improvement is expected within 3 to 5 days following initiation of effective antimicrobials.[64] Complete resolution of symptoms occurred in 45% of children with ABRS on antibiotics compared with 11% of those on placebo.[63] A study that compared “high-dose” amoxicillin-clavulanate to placebo illustrated that 19 (83%) of the 23 of children failed in the placebo group and 4 (17.4%) in the antibiotic group failed to improve or worsened within 3 days.[64]

Most pathogens are eliminated from the maxillary sinuses by the third day of adequate antimicrobial therapy.[57,77–80] A correlation was noted between time to bacterial eradication and time to clinical resolution.[78] If symptoms and signs worsen despite 3 days of initial empiric antimicrobial therapy, the potential reasons for treatment failure must be evaluated. These include the presence of resistant pathogens, structural abnormalities, or a noninfectious etiology. Similarly, if there is no clinical improvement within 3 to 5 days despite initial empiric antimicrobial therapy, an alternate management strategy should be considered.

Consecutive endoscopic cultures from the maxillary sinus were performed of aspirates obtained from 20 patients with ABRS who failed initial empiric antimicrobial therapy.[81] Increased level of resistance with MIC at least twofold higher than for the pretreatment isolate was identified in half of patients. These findings show that bacterial resistance should be considered in all patients who fail to respond to initial empiric antimicrobial therapy.

In choosing a second-line treatment in those who failed initial antimicrobial choice, an agent with a broader spectrum of activity and in a different antimicrobial class should be considered.[75,82] Antimicrobials selected should be active against penicillin-nonsusceptible *S pneumoniae* and ampicillin-resistant *H influenzae,* as well as other beta-lactamase–producing respiratory pathogens.

The recommended second-line antimicrobial agents suitable for children with treatment failure to first-line agents are amoxicillin-clavulanate (90 mg/kg/d orally twice a day); clindamycin (30–40 mg/kg/d by mouth 3 times a day) *plus* cefixime (8 mg/kg/d orally twice a day) *or* cefpodoxime (10 mg/kg/d orally twice a day); or ceftriaxone (50 mg/kg/d intramuscularly).

It is advisable that cultures be obtained from the involved sinuses in those who have failed to respond to empiric antimicrobial therapy. Identification and susceptibility testing of the isolates can guide the choice of the second-line agent(s). Endoscopically guided middle meatus cultures can be considered as an alternative in older children[83]; however, their reliability in young children has not been established. Sinus puncture can be performed in children whose endoscopic cultures show no growth. Nasopharyngeal cultures are unreliable and are not recommended for the microbiologic diagnosis of ABRS.[32]

ADJUVANT THERAPIES

In addition to antibiotics, other therapies have been used in the management of bacterial sinusitis. These therapies included topical and systemic decongestants, corticosteroids, anti-inflammatory agents, mucolytic agents, humidification, antihistamines, nasal irrigation, saline nasal spray, spicy food, and hot dry air.[84] These agents induce rapid vasoconstriction, improve ostial potency, reduce swelling and congestion of the turbinates, and decrease inflammation at the osteomeatal, thus facilitating sinus drainage. Use of any intranasal medications in children may not be well tolerated.

Neither topical nor oral decongestants and/or antihistamines are recommended as adjunctive treatment in patients with ABRS. Topical decongestants may induce rebound congestion and inflammation, whereas oral antihistamines may induce drowsiness, xerostomia, and other adverse effects.

Even though decongestants and antihistamines are frequently used by those with ABRS, there is minimal evidence supporting that they enhance recovery.[49] Although patients may subjectively feel improvement after using these agents, objective rhinometric measurements do not support this impression.[85–89]

The recommendation against the use of decongestants or antihistamines as adjunctive therapy in ABRS places a relatively high value on avoiding their adverse effects, and a relatively low value on the incremental clinical improvement. These agents may still provide symptom relief in some individuals with viral rhinosinusitis, however.

Reduction in the viscosity and improvement in the quality of mucus can assist in resolution of the infection. Several methods achieve this goal, including nasal saline spray or irrigation, air humidification, adequate hydration, and mucolytic agents.[90,91]

Antihistamines are generally not used to treat bacterial sinusitis, because they can thicken and dry the secretions, which leads to crusting and further blocks the osteomeatal complex. They can be useful, however, if the underlying cause is allergic.

Intranasal corticosteroids offer modest symptomatic improvement and minimal adverse effects with short-term use.[92] They are recommended as an adjunct to antibiotics in the empiric treatment of ABRS, mainly in those with a history of allergic rhinitis. Steroids have a delayed onset of action, and clinical improvement may take 7 to 10 days. They are always used in conjunction with antimicrobial therapy.

Systemic corticosteroids are rarely necessary in the treatment of allergic rhinitis, because of the generally good efficacy of topical corticosteroids.[93]

SURGICAL TREATMENT

Surgical drainage may be needed in those who fail medical therapy, especially when complications occur. The goals of surgery are to allow drainage of purulent material and prevent persistence, recurrence, progression, and complications. This is accomplished by removing diseased tissue, and promoting drainage (or obliteration if this is not possible) while considering the cosmetic outcome. Functional endoscopic sinus surgery has become the main surgical technique used. Endoscopic surgery achieves success in more than three-fourths of patients in both adults and children.[94,95] Radical procedures are used when rhinosinusitis is complicated by orbital or intracranial involvement.

COMPLICATIONS

When not treated promptly and properly, sinus infection can spread via anastomosing veins or by direct extension to nearby structures.[96] Orbital complications are categorized[97] into 5 stages according to their severity. Contiguous spread to the orbital area can result in periorbital cellulitis, subperiosteal abscess, orbital cellulitis, and abscess. Sinusitis can extend to the central nervous system, where it can cause cavernous sinus thrombosis; retrograde meningitis; and epidural, subdural, and brain abscesses.[96,97] Orbital symptoms often precede intracranial extension.[96] Osteomyelitis of the frontal bone often originates from a spreading thrombophlebitis.[96] A periostitis of the frontal sinus causes an osteitis and a periostitis of the outer membrane, which produces a tender, puffy swelling of the forehead.

Complications of sinusitis are rare, but can be life threatening. Diagnosis is assisted by observing local tenderness and dull pain, and is confirmed by CT and nuclear isotope scanning. The most common bacterial causes are anaerobic bacteria and *S aureus*. Management includes surgical drainage and antimicrobial therapy that covers all ABRS organisms, *S aureus* including MRSA, and anaerobes.[96] For central nervous system infections, drugs that penetrate the central nervous system and cover the likely organisms should be used (eg, a combination of vancomycin, ceftriaxone, and metronidazole). Antibiotics should be administered for at least 6 weeks.

SUMMARY

Viral infection of the upper respiratory tract is the most common presentation of rhinosinusitis and the vast majority of cases resolve spontaneously. Only a small proportion develops a secondary bacterial infection that will benefit from antimicrobial therapy. ABRS is generally diagnosed in the presence of more than 7 to 10 days and fewer than 30 days of nasal discharge. The most common bacterial isolates from acute rhinosinusitis are *S pneumoniae, H influenzae, M catarrhalis,* Group A beta-hemolytic streptococci, and *S aureus.* Aerobic gram-negative rods, including *P aeruginosa,* are common in nosocomial sinusitis, the immunocompromised, and those with HIV infection or cystic fibrosis. Fungus and *P aeruginosa* are common causes of sinusitis in neutropenic patients. The proper choice of antibiotic therapy depends on the likely infecting pathogens, bacterial antibiotic resistance, and the pharmacologic profiles of the antibiotics. In addition to antibiotics, adjuvant therapies and surgery are used in the management of bacterial sinusitis.

Because there are currently no good markers that define viral rhinosinusitis from ABRS, many clinicians elect when in doubt to administer antimicrobials to their patients; however, this approach is one of the main contributors to the increase of resistance to antimicrobials of respiratory pathogens that has made the management of true bacterial rhinosinusitis more challenging. The introduction of new vaccinations against *S pneumoniae* and the expected new vaccines against other potential sinus pathogens (ie, non–type b *H influenzae*) may change the bacterial etiology of ABRS. The increased recovery of MRSA is an example of such a change. Continuous monitoring of the evolving bacterial etiology of ABRS is therefore of great importance.

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