Sinusitis

ELLEN R. WALD, MD

Viral upper respiratory infections are the most common organic condition presenting to the primary practitioner who cares for children. It has been recognized recently that most uncomplicated viral upper respiratory infections in adults involve both the nose and the sinus cavities; this must be true for children as well. Approximately 5% to 10% of these cases of viral rhinosinusitis in early childhood are complicated by acute bacterial sinusitis. Because children average six to eight colds per year, bacterial sinusitis is a common problem in clinical practice.

ANATOMY AND PHYSIOLOGY
A brief review of the anatomy and physiology of the paranasal sinuses will help clarify certain clinical features of sinus infection. The figure shows a coronal and a sagittal view demonstrating the relationship between the nose and the paranasal sinuses. The nose is divided in the midline by the nasal septum. From the lateral wall of the nose, three shelf-like structures are projected that are designated according to their anatomic position as the inferior, the middle, and (seen best on the sagittal view) the superior turbinate. Beneath the middle and superior turbinates is a meatus that drains two or more of the paranasal sinuses. The maxillary, anterior ethmoids and frontal sinuses drain to the middle meatus, whereas the posterior ethmoids and sphenoid sinuses drain to the superior meatus. Only the lacrimal duct drains to the inferior meatus.
The maxillary and ethmoid sinuses form during the third to fourth gestational month and accordingly, although small, are present at birth. Initially, the maxillary sinus is a slit-like cavity running parallel to the middle turbinate. It gradually enlarges and forms a quadrilateral shape with a volume of approximately 15 ml. It is important to note the position of the outflow tract of the maxillary sinus, which sits high on the medial wall of the sinus cavity. This awkward positioning impedes gravitational drainage and probably predisposes to frequent infections of the maxillary sinus as a complication of viral upper respiratory infections.

The ethmoid sinus is composed of multiple air cells (numbering 3 to 15 on each side) separated by thin bony partitions. Each air cell drains by an independent ostium (measuring 1 to 2 mm) into the middle meatus. The narrow caliber of these draining ostia predispose to obstruction if there is even modest inflammation of the mucosal lining, as is the case in viral respiratory infection or allergy.

The frontal sinus develops from an anterior ethmoid cell and moves to a position above the orbital ridge by the fifth or sixth birthday. Development of the frontal sinuses is not complete until late adolescence. The frontal sinus is not a frequent site of infection, but may be a focus for spread of infection to the orbit or central nervous system. The sphenoid sinuses are immediately anterior to the pituitary fossa and just behind the posterior ethmoids. Isolated involvement of the sphenoid sinuses is rare; they are usually infected as part of a pansinusitis. The sphenoid sinus may also be a site from which infection spreads to the central nervous system.

Recently, interest has focused on the so-called osteomeatal complex (Fig. A). This is the area between the middle and inferior turbinates that represents the confluence of the drainage areas of the frontal, ethmoid, and maxillary sinuses. Within the osteomeatal complex there are several sites in which two mucosal layers come into contact. The cilia move in opposite directions. Accordingly, there may be retention of secretions at this site and the potential for infection even without a physical obstruction of the ostia.

**Physiology**

Three key elements are important to the normal physiology of the paranasal sinuses: the patency of the ostia, the function of the ciliary apparatus, and, integral to the latter, the quality of secretions. Retention of secretions in the paranasal sinuses is usually due to one or more of the following: obstruction of the ostia, reduction in the number or impaired function of the cilia, or overproduction or change in the viscosity of secretions.

**Sinus Ostia**

The ostia of the paranasal sinuses are the key to pathology in the sinus area. The ostia of the maxillary sinuses are small, tubular structures with a diameter of 2.5 mm (cross-sectional area approximately 5 mm) and a length of 6 mm. The diameter of the ostium of each of the individual ethmoid air cells that drain independently into the middle meatus is even smaller, measuring 1 to 2 mm; the anterior are smaller than the posterior. The narrow caliber of these individual ostia sets the stage for obstruction to occur easily and often.

The factors predisposing to ostial obstruction can be divided into those that cause mucosal swelling and those due to mechanical obstruction. The various factors that may cause mucosal swelling, consequent to either systemic illness or local insults, are shown in Table 1. In addition, those conditions that predispose to mechanical obstruction of sinus ostia are listed.
Although many conditions may lead to ostial closure, viral rhinosinusitis and allergic inflammation are by far the most frequent and most important.

When complete obstruction of the sinus ostium occurs, there is a transient increase in intranasal pressure followed by the development of a negative intranasal pressure. When the ostium opens again, the negative pressure within the sinus cavity relative to atmospheric pressure may allow the introduction of bacteria into the usually sterile sinus cavity. Alternatively, sneezing, sniffing, and nose blowing with altered intranasal pressure may facilitate the entry of bacteria from the posterior nasal chamber, which is heavily colonized, into the sinus cavity. The mucosa of the paranasal sinus continues to secrete actively even after obstruction occurs. Clearance of secretions is impossible when the ostium is totally obstructed. If the ostium is patent but reduced in size, removal of secretions will be delayed.

### Mucociliary Apparatus

Disorders of the mucociliary apparatus in conjunction with reduced patency of the sinus ostia are major pathophysiologic events in acute sinusitis. In the posterior two-thirds of the nasal cavity and within the sinuses, the epithelium is pseudostratified columnar in which most of the cells are ciliated.

The normal motility of the cilia and the adhesive properties of the mucus layer usually protect respiratory epithelium from bacterial invasion. However, certain respiratory viruses may have a direct cytotoxic effect on the cilia. The alteration of cilia number, morphology, and function may facilitate secondary bacterial invasion of the nose and the paranasal sinuses.

### Sinus Secretions

Cilia can beat only in a fluid medium. There appears to be a double layer of mucus in the airways: the gel layer (superficial viscous fluid) and the sol layer (underlying serous fluid). The gel layer acts to trap particulate matter such as bacteria and other debris. The tips of the cilia touch the gel layer during forward movement and thereby move the particulate matter along. The bodies of the cilia, however, move through the sol layer, a fluid thin enough to allow the cilia to beat.

Alterations in the mucus, as in cystic fibrosis or asthma, may impair ciliary activity. The presence of purulent material in the acutely infected sinus may also impair ciliary movement and further compound the effects of ostial closure.

### SYMPTOMS AND SIGNS

#### Acute Bacterial Sinusitis

A major task for the practitioner is to distinguish between an uncomplicated episode of viral rhinosinusitis or allergic rhinosinusitis and a secondary bacterial infection of the paranasal sinuses. During the course of an apparent viral upper respiratory infection, there are two common clinical presentations that suggest that the patient has acute bacterial sinusitis. These can be designated as "persistent" and "severe." The most common presentation is with persistent respiratory symptoms. In the context of acute bacterial sinusitis, persistent symptoms are those that last more than 10 but less than 30 days and have not begun to improve. The 10-day mark separates simple viral rhinosinusitis from bacterial sinusitis and the 30-day mark separates acute bacterial sinusitis from subacute or chronic sinusitis. Most uncomplicated episodes of viral rhinosinusitis will last 5 to 7 days. Although patients may not be asymptomatic, by the tenth day they are virtually always improved. The persistence of respiratory symptoms beyond the 10-day mark, without appreciable improvement, suggests a bacterial complication of the upper respiratory infection. The nasal discharge may be of any quality (thin or thick; clear, mucoid, or purulent) and the cough (which may be dry or wet) must be present in the daytime, although it is often noted to be worse at night. Malodorous breath is frequently reported by parents of preschoolers. Complaints of facial pain and headache are rare, although occasional painless morning eye swelling may have been noted by the parent. The child may not appear very ill and usually, if fever is present, it will be low grade. In this case, it is not the severity of the clinical symptoms but their persistence that calls for attention. In a recent study conducted in Japan, 2,013 consecutive new outpatients with upper respiratory infections were evaluated to determine the usefulness of the 10-day mark as a practical diagnostic approach for acute bacterial sinusitis in children. One hundred forty-six children had respiratory symptoms that lasted more than 10 days. The radiographic examination showed substantial abnormalities of the

### TABLE 1

<table>
<thead>
<tr>
<th>Factors Predisposing to Sinus Ostial Obstruction</th>
<th>Mechanical Obstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucosal Swelling</td>
<td></td>
</tr>
<tr>
<td>Systemic disorder</td>
<td>Cholanal atresia</td>
</tr>
<tr>
<td>Viral upper respiratory infection</td>
<td>Deviated septum</td>
</tr>
<tr>
<td>Allergic inflammation</td>
<td>Nasal polyps</td>
</tr>
<tr>
<td>Cystic fibrosis</td>
<td>Foreign body</td>
</tr>
<tr>
<td>Immune disorders</td>
<td>Tumor</td>
</tr>
<tr>
<td>Immotile cilia</td>
<td>Ethmoid bullae</td>
</tr>
<tr>
<td>Local insult</td>
<td></td>
</tr>
<tr>
<td>Facial trauma</td>
<td></td>
</tr>
<tr>
<td>Swimming, diving</td>
<td></td>
</tr>
<tr>
<td>Rhinitis medicamentosa</td>
<td></td>
</tr>
</tbody>
</table>
When the clinical history suggests a diagnosis of sinusitis, imaging, computerized tomography, and sinus aspiration may help to confirm it.

maxillary sinuses in 135 (92.5%) of the children. This yielded an incidence of maxillary sinusitis of 6.7% in patients complaining of upper respiratory symptoms.

The less common presentation is a "cold" that seems more severe than usual. The severity is defined by a combination of high fever (at least 39.0°C) and purulent nasal discharge. The quality of nasal discharge undergoes frequent changes during the course of an uncomplicated viral upper respiratory infection. It begins as a watery discharge that becomes thicker, colored, and opaque after a few days. Most often the nasal discharge will remain purulent for several days and then clear again to a mucoid or watery consistency before resolving. If fever is present at all during the course of an episode of viral rhinosinusitis, it is at the outset in association with other constitutional symptoms such as headache and myalgia. Usually the fever disappears and the respiratory symptoms begin. Accordingly, the combination of high fever and purulent nasal discharge for at least 3 to 4 days signals a secondary bacterial infection of the paranasal sinuses. This group of patients may suffer from headaches behind or above the eye and may occasionally experience peri orbital swelling.

Subacute or Chronic Sinusitis

Patients with subacute or chronic sinusitis present with a history of protracted (more than 30 days and not improving) respiratory symptoms. Nasal congestion (obstruction) and cough (day and night) are most common. There is the frequent complaint of sore throat that results from mouth breathing secondary to nasal obstruction. Nasal discharge (of any quality) and headache are less common; fever is rare.

Physical Examination. The patient with bacterial sinusitis may have mucopurulent discharge present in the nose or posterior pharynx. The nasal mucosa is usually erythematous, but may, on occasion, be pale and boggy; the throat may show moderate injection. Examination of the tympanic membranes may show evidence of acute otitis media or otitis media with effusion. The cervical lymph nodes are usually not significantly enlarged or tender. Occasionally there will be either tenderness, as the examiner palpates over or percusses the paranasal sinuses, or appreciable periorbital edema (soft, nontender swelling of the upper and lower eyelid with discoloration of the over-lying skin), or both. Unfortunately, facial tenderness is neither sensitive nor specific. Malodorous breath (in the absence of pharyngitis, poor dental hygiene, or a nasal foreign body) may suggest bacterial sinusitis. None of these characteristics differentiates viral rhinosinusitis from acute bacterial sinusitis.

DIAGNOSTIC METHODS

When the clinical history suggests a diagnosis of sinusitis, the following procedures may help confirm the diagnosis.

Imaging

Radiography has traditionally been used to evaluate the presence of sinus disease. Standard radiographic projections include an anteroposterior, a lateral, and, for the maxillary sinuses, an occipitomental view. Radiographic findings in patients with acute sinusitis are diffuse opacification, mucosal thickening of at least 4 mm, or an air-fluid level. Although these radiographic findings are not specific for acute sinusitis, they are helpful in confirming the presence of acute bacterial sinusitis in patients with suggestive signs and symptoms.

Chronic sinusitis causes an osteoblastic response in the affected sinus walls. Accordingly, in addition to mucosal thickening and complete opacification, there may be an actual decrease in the size of the sinuses due to increased thickness of the walls. Foci of irregular bone thinning may also be seen.

Much has been written about the frequency of abnormal sinus radiographs in asymptomatic populations of children; however, most studies have been flawed by either inattention to the presence of symptoms and signs of respiratory inflammation or failure to classify abnormal radiographic findings as major or minor. When children older than 1 year of age have neither respiratory signs nor symptoms, their sinus radiographs are almost always normal. However, when children with persistent or severe respiratory symptoms have radiographs demonstrating the presence of an air-fluid level, complete opacification of the sinus cavities, or mucosal thickening of at least 4 to 5 mm, bacteria in high density will be present in a maxillary sinus aspirate 75% of the time.

Sinus radiographs are significantly abnormal in 88% of children younger than 6 years of age with persistent respiratory symptoms. Accordingly, sinus radiographs need not be performed in this age group in children who are suspected to have an episode of acute bacterial sinusitis that is uncomplicated. However, plain radiographs should be obtained to confirm the presence of acute bacterial sinusitis in children younger than 6 years of age who present with severe symptoms and in all children of at least 6 years of age with acute bacterial sinusitis that is suspected on the basis of either persistent or severe symptoms. The clinician can feel confident that plain radio-
graphs provide sufficient information in patients with signs and symptoms of acute bacterial sinusitis that is uncomplicated.\textsuperscript{10}

**Computerized Tomography**

Several studies have examined the frequency of incidental paranasal sinus abnormalities on computerized tomographic (CT) scans of pediatric patients.\textsuperscript{11,12} Again, there has been a failure to obtain information regarding recent signs or symptoms of respiratory infection\textsuperscript{11} or to classify the degree and significance of radiographic abnormalities.\textsuperscript{12} A recent study showed frequent abnormalities on CT scans in patients with a "fresh common cold."\textsuperscript{913} McAlister et al. have highlighted the observation that CT scans are superior to plain radiographs in the delineation of sinus abnormalities, particularly in patients with chronic or recurrent disease.\textsuperscript{14} This is not surprising because plain radiographs are a summation of overlapping structures, whereas CT scans provide many individual images.

CT scans are not necessary for the management of children with uncomplicated acute bacterial sinusitis; they should be reserved for the evaluation of children with (1) complicated sinus disease (either orbital or central nervous system complications), (2) numerous recurrences, or (3) protracted or nonresponsive symptoms (ie, circumstances in which sinus surgery is contemplated).

The osteomeatal complex is the important area of pathology in patients with recurrent acute bacterial sinusitis or chronic sinusitis. This area is best examined with the CT scan. Persistent or residual changes in the sinuses, especially the ethmoids, may be seen even after antimicrobial therapy has been completed in many patients despite the absence of clinical signs and symptoms of disease. These abnormalities indicate persistent inflammation but not necessarily infection.

**Sinus Aspiration**

Although maxillary sinus aspiration is by no means a routine procedure, it can be safely performed by a skilled otolaryngologist in the ambulatory setting using a transnasal approach. Sedation or general anesthesia may be required for adequate immobilization in the young child. Current indications for maxillary sinus aspiration include (1) failure to respond to multiple courses of antibiotics, (2) severe facial pain, (3) orbital or intracranial complications, and (4) evaluation of an immunoincompetent host. There must be careful decongestant and anesthesia of the area beneath the inferior turbinate through which the trocar is passed. Material aspirated from the maxillary sinus should be sent for quantitative aerobic and anaerobic cultures (if possible) and Gram stain. The recovery of bacteria in a density of at least \(10^4\) colony forming units/ml is considered to represent true infection.\textsuperscript{8,15} The finding of at least one organism per high-power field on Gram stain of sinus secretions correlates with the recovery of bacteria in a density of \(10^3\) colony forming units/ml.

**MICROBIOLOGY OF SINUSITIS**

Data on the microbiology of sinusitis in pediatric patients are best organized according to the duration of clinical symptoms. However, a literature review is complicated by varying definitions of acute, subacute, and chronic sinusitis. Several studies performed on ambulatory patients with acute (10 to 30 days) and subacute (30 to 120 days)\textsuperscript{15,17} illnesses have highlighted the important bacterial pathogens as being *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Other much less frequently recovered bacterial species include group A streptococci, group C streptococci, viridans streptococci, peptostreptococci, *Moraxella* species, and *Eikenella corrodens*.\textsuperscript{8} A similar distribution of bacterial pathogens is observed in asthmatic patients with sinusitis. *S. pneumoniae* is most common in all age groups and accounts for 30% to 40% of isolates. *H. influenzae* and *M. catarrhalis* are similar in prevalence and account for approximately 20% of cases. Both *H. influenzae* and *M. catarrhalis* may be beta-lactamase producing and thereby amoxicillin resistant. Neither staphylococci nor respiratory anaerobes are commonly recovered from these patients. Respiratory viral isolates include adenovirus, parainfluenza, influenza, and rhinovirus in approximately 10% of patients. This number would almost certainly be higher if diagnostic aspirates were performed earlier in the course of respiratory symptoms.

In patients with very protracted (years) or severe sinus symptoms (requiring surgical intervention), *Streptococcus aureus* and anaerobic organisms are recovered more frequently. Anaerobes are isolated from patients with maxillary sinusitis of dental origin. The commonly recovered anaerobes are Gram-positive cocci (such as peptococcus and peptostreptococcus) and *Bacteroides* species.\textsuperscript{17} In addition, viridans streptococci and *H. influenzae* are frequently recovered aerobes.

**MEDICAL TREATMENT**

The prescription of antimicrobials is the backbone of the medical management of sinusitis. Table 2 shows a list of antimicrobials potentially useful in patients with acute sinusitis. Amoxicillin (at 40–60 mg/kg/d in 2 divided doses) is acceptable and desirable for the treatment of many cases of bacterial sinusitis in children. This is especially true if the episode of acute bacterial sinusitis is uncomplicated and mild to moderate in degree of severity and if the patient has not recently (< 1 month) been treated with antimicrobial agents. Amoxicillin is effective most of the time, inexpensive, and safe. The latter characteristic is par-
particularly important when treating a condition that has a high spontaneous cure rate.9

Although amoxicillin is preferred in most cases, there are several clinical situations in which a broader spectrum regimen or a higher dose of amoxicillin (90 mg/kg/d in 2 divided doses) is appropriate (Table 3). These include: (1) failure to improve while being treated with amoxicillin, (2) recent treatment with amoxicillin (<1 month), (3) residence in a geographic area with a high prevalence of beta-lactamase-producing H. influenzae, (4) the occurrence of frontal or sphenoidal sinusitis, (5) the occurrence of complicated ethmoidal sinusitis, and (6) presentation with very protracted (more than 30 days) symptoms. Antimicrobials with the most comprehensive coverage for patients with sinusitis are amoxicillin/potassium clavulanate, cefuroxime axetil, and cefpodoxime proxetil. For patients with chronic sinusitis, amoxicillin/potassium clavulanate is especially attractive because the mechanism for resistance of most pathogens in patients with chronic sinusitis is beta-lactamase production. Seven new antimicrobial agents are available for the management of respiratory infections, but have not been evaluated in published studies of acute bacterial sinusitis in children: cefixime, ceftibuten, ceftroxil, cefpodoxime, loracarbef, clarithromycin, and azithromycin. Each of these antibiotics has been investigated in adults with acute sinusitis and found to be satisfactory.

The emerging problem in the management of acute or recurrent sinusitis is infection caused by penicillin and cephalosporin-resistant pneumococci.18 The frequency of penicillin-resistant pneumococci varies geographically and many isolates of pneumococci are resistant to other commonly used antimicrobials such as sulfamethoxazole-trimethoprim. Therapeutic options include high-dose amoxicillin (80 to 90 mg/kg/d), azithromycin, trimethoprim-sulfamethoxazole, clindamycin, and rifampin. The optimal therapy for these infections is not known; antibiotic selection should be guided by susceptibility results, when available.

Patients with acute sinusitis may require hospitalization because of systemic toxicity or inability to take oral antimicrobials. These patients may be treated with cefotaxime at a dosage of 200 mg/kg/d, intravenously, in four divided doses, or amoxicillin/sulbactam at a dose of 200 mg/kg/d, intravenously, in four divided doses.

Clinical improvement is prompt in nearly all children treated with an appropriate antimicrobial agent. Patients febrile at the initial encounter will become afebrile, and there is a remarkable reduction of nasal discharge and cough within 48 hours. If the patient worsens or does not improve in 48 hours, clinical reevaluation is appropriate. If the diagnosis is unchanged, sinus aspiration may be considered for precise bacteriologic information. Alternatively, an antimicrobial agent effective against beta-lactamase-producing bacterial species and penicillin-resistant pneumococci should be prescribed.

The appropriate duration of antimicrobial therapy for patients with sinusitis has not been systematically investigated. Many patients have a brisk response to antimicrobial intervention and experience dramatic improvement in respiratory symptoms in 3 to 4 days. For these patients, 10 days of treatment is adequate.
For patients who respond more slowly, a reasonable recommendation is to treat until the patient is asymptomatic and then for an additional 7 days. A short regimen of sulfamethoxazole-trimethoprim (3 days) has been compared with a standard 10-day course in adults with presumed bacterial sinusitis. Although the authors concluded that 3 days of antibiotics were as effective as 10 days, many of their patients may have had viral rhinosinusitis rather than acute bacterial sinusitis.

Adjuvant therapies such as antihistamines, decongestants, and anti-inflammatory agents have received limited evaluation. Limited study of systemic decongestants has shown their effect to be an increase in the patency (but not the diameter) of the maxillary sinus ostium and a decrease in nasal airway resistance. Their overall impact on the clinical course of episodes of acute bacterial sinusitis has not been reported. Furthermore, sequential CT scans have shown that decongestants have little or no effect in promptly draining the sinuses. This may be due, in part, to the viscous quality of sinus secretions in patients with rhinosinusitis. Antihistamines have not been routinely recommended in the treatment of either viral rhinosinusitis or acute bacterial sinusitis. However, recent data generated during experimentally induced rhinovirus infections showed a reduction of sneezing and rhinorrhea in volunteers receiving an antihistamine.

The potential role of topical intranasal steroids as an adjunct to antibiotics in the treatment of acute bacterial sinusitis has recently been evaluated in children and adults. The availability of agents with a rapid onset of activity prompts consideration of these agents for the management of acute symptoms. These agents may exert a modest beneficial effect during the second week of treatment. Further prospective studies will be necessary to fully evaluate the role of these agents in acute bacterial sinusitis.

Some children experience recurrent or chronic episodes of sinusitis. The most common cause of recurrent sinusitis is recurrent viral upper respiratory infection, often a consequence of attendance at day care or the presence of an older school-age sibling in the household. Other predisposing conditions include allergic and non-allergic rhinitis, cystic fibrosis, an immunodeficiency disorder (insufficient or dysfunctional immunoglobulins), ciliary dyskinesia, or an anatomic problem. The evaluation of children with recurrent or chronic sinusitis should include consideration of consultation with an allergist, a sweat test, quantitative immunoglobulins, and a mucosal biopsy to assess ciliary function and structure. If specific allergens are identified or an allergic diathesis is documented, therapy might include desensitization, antihistamines, or topical intranasal steroids. If a treatable immunodeficiency is identified, specific immunoglobulin therapy should be initiated. Several recent studies performed in children with recurrent or persistent symptoms of sinus disease have shown frequent but mild immune deficiencies. Fifty-two percent of more than 500 patients from four different centers had immunologic defects such as partial deficiency in IgA, partial IgG subclass deficiency, and/or poor responsiveness to some of the polysaccharide antigens. The contribution, if any, of these modest immunologic abnormalities to the clinical course of these patients is unknown.

A trial of antimicrobial prophylaxis may be appropriate if there is no treatable underlying disorder. Although antimicrobial prophylaxis has not been studied in patients with recurrent acute sinusitis, it has proved to be a useful strategy in reducing symptomatic episodes of acute otitis media in patients with recurrent ear disease. Patients selected for a trial of antibiotic prophylaxis should have had at least three episodes of acute bacterial sinusitis in 6 months or more episodes in 12 months. If patients do not respond to maximal medical therapy, surgical intervention may be appropriate.

The major complications of acute sinusitis are shown in Table 4. Subperiosteal abscess of the orbit and intracranial abscesses are the most common. They will be signaled by eye swelling, proptosis, and impaired extraocular eye movements in cases of orbital infection and signs of increased intracranial pressure, meningeal irritation, and focal neurologic deficits in the case of intracranial pus. A CT scan is essential for diagnosis. Antibiotic therapy and surgical drainage are usually required for successful treatment.

Surgical Therapy

Patients with acute sinusitis hardly ever require surgical intervention, unless they present with orbital...
or central nervous system complications. Rarely, sinus aspiration may be required to ventilate a sinus that has not responded to aggressive antimicrobial management.

When patients with recurrent acute or chronic sinusitis fail to improve with maximal medical therapy (including a trial of antimicrobial prophylaxis), sinus surgery should be considered. Early surgical efforts focused on creation of a nasotemporal window within the maxillary sinus. This additional dependent ostium was thought to facilitate gravitational drainage. However, these efforts proved to be relatively ineffective, in part because cilia that line the maxillary sinus still transport secretions toward the natural meatus. In addition, patency of the window was usually brief. A recent retrospective review of the efficacy of nasal antral windows in children showed improvement of only 27% of patients at the 6-month follow-up.27

The role of adenotonsillitisectomy in the management of sinusitis is unclear. Consultation with an otolaryngologist will permit a nasopharyngeal examination to evaluate tonsil and adenoid size. If these structures are enlarged sufficiently to cause obstruction and stasis of secretions, then removal should be considered.28

Currently, the focus of surgical therapy is on the osteomeatal unit highlighted in the figure. With the use of an endoscope, most current surgical efforts attempt enlargement of the natural meatus of the maxillary outflow tract (by excising the uncinate process and the ethmoid bullae) and performance of an anterior ethmoidectomy.29 A pilot study assessing the safety and efficacy of endoscopic sinus surgery in children with chronic sinusitis reported that 71% of the patients were considered normal by their parents 1 year postoperatively.29 Subsequently, 23 articles have been published reporting the outcome of patients who experienced endoscopic sinus surgery. A recently published meta-analysis of outcomes of pediatric functional endoscopic sinus surgery reported on eight of these studies and the unpublished experience of the authors.30 The overall success was approximately 89% with a follow-up of 3.7 years, and a major complication rate of 0.6%. The precise population of children most likely to benefit from this surgery has not been delineated.

REFERENCES