Sinusitis is a widespread disease frequently seen in the primary care setting. There are 32 million cases of chronic sinusitis in the United States annually. Since 1980, the number of office visits per year has tripled, owing partly to a better definition of the disease and improved diagnosis, and the use of antibiotics to treat the disease has quadrupled. Sinusitis accounted for 11.6 million office visits in 2000. There has been some suggestion that antibiotics are overused, particularly in the treatment of acute sinusitis.

Sinusitis is also an expensive ailment, accounting for at least $2.4 billion annually in direct medical costs, and additional indirect costs due to time off from work and loss of productivity. Such indirect expenses are likely to be immense as well, considering the prevalence of the disease and the debility it causes, as measured by the Health-Related Quality of Life Medical Outcomes Survey Short Form 36 (SF-36). In fact, for patients with chronic sinusitis, scores on the quality-of-life index are comparable to those of individuals with congestive heart failure, angina pectoris, and chronic obstructive pulmonary disease.

**Defining Sinusitis**

In 1996, the Rhinosinusitis Task Force Committee, an expert panel of otolaryngologists and other specialists, issued a formal definition of acute sinusitis based on a systematic review of the literature and expert opinion. They defined acute sinusitis as an upper respiratory infection (URI) that worsens after 5 days, persists longer than 10 days, and has more severe symptoms than a typical URI. Major symptoms include purulent nasal discharge; facial fullness, pain, or pressure; hyposmia or anosmia; nasal obstruction; and fever. Chronic sinusitis is a disease of mucosal inflammation and hyperreactivity in which chronic infection plays a prominent role, with other important contributing factors. Acute and chronic sinusitis have similar symptom profiles, except for the longer duration of the latter, but the pathogenesis and treatment of these disorders varies significantly.

(The panel also suggested that the term “rhinosinusitis” be used in lieu of “sinusitis.” Although the term rhinosinusitis highlights the nasal component, it does not differentiate between isolated rhinitis and sinusitis. To establish a clear distinction between sinus inflammation with associated rhinitis and conditions such as allergic rhinitis, the term sinusitis will be used throughout this article.)

**SYMPTOMS**

The Rhinosinusitis Task Force defined major and minor clinical factors associated with the diagnosis of sinusitis. Major clinical factors include purulent nasal discharge; facial fullness, pain, or pressure; hyposmia or anosmia (diminished or lost sense of smell); nasal obstruction; and fever. Minor factors include fatigue, dental pain, ear pressure or fullness, cough, halitosis, and headache. A strong history for sinusitis includes 2 or more major clinical factors or 1 major and 2 or more minor clinical factors. The task force emphasized the finding of nasal purulence on examination, suggesting that this finding alone was adequate for the diagnosis of sinusitis. The presence of 1 major factor (other than fever) or 2 minor factors suggests that sinusitis should be considered in the differential diagnosis. Caution is advised when a patient says, “I have a sinus headache.” Although fatigue, headache, and dental pain can occur as sinusitis symptoms, they are minor symptoms. However, in the appropriate clinical circumstance, pain in the cheeks and teeth are symptoms likely to be diagnostic for maxillary sinusitis.

**CLASSIFICATION**

According to the task force, sinusitis may be classified as follows: Acute sinusitis involves symptoms lasting less than 4 weeks, usually preceded by a viral URI. Subacute sinusitis involves symptoms lasting 4 to 12 weeks that resolve completely after treatment. Recurrent acute sinusitis is typified by a pattern of 4 or more episodes of obstruction per year, with complete resolution of symptoms and a return to normal mucosa between episodes. Recurrent acute sinusitis can be associated with anatomic abnormalities that are visible on a computed tomography (CT) scan. Chronic sinusitis involves symptoms that last longer than 12 weeks and may include acute exacerbations. A subset of chronic sinusitis patients have acute on chronic sinusitis, which includes patients with chronic sinusitis whose symptoms last longer than 12 weeks and whose clinical course involves acute exacerbations.

**PATHOGENESIS**

The pathogenesis of sinusitis begins with mucosal inflammation. The patient may be predisposed to this inflammation by a variety of factors, including a URI, an allergy, or another type of environmental exposure. Inflammation is followed by mucosal edema, ostial obstruction, and an altered sinus environment in which secretions stagnate and thicken, resulting in a decrease in the pH and PO₂ levels. This altered environment offers a medium in which bacteria can grow, leading to infection. Infection then causes additional mucosal inflammation and the cycle continues (Figure 1). In patients with acute sinusitis, the inflammation resolves with or without treatment with antibiotics, and normal sinus drainage is re-established. In patients with chronic sinusitis there is persistent mucosal inflammation, obstruction of the sinus drainage pathways, and, typically, chronic bacterial infection. The mechanism for the persistent inflammation may be a chronic bacterial infection or a predisposition to chronic mucosal inflammation.
inflammation. Proposed mechanisms for a predisposition include an aberrant immune response, subacute fungal infection, or anatomic abnormalities. Treatment focuses on reducing mucosal inflammation and, when possible, correcting the underlying cause.

**Diagnosis**

History and physical examination are the primary tools for sinusitis evaluation and diagnosis, and may include endoscopy and imaging—typically a coronal sinus CT scan.

**History and Physical Examination**

When taking the patient's history, the physician should focus on the major and minor symptoms. Special attention should be paid to the duration of episodes, number of episodes per year, and whether symptoms have abated completely between episodes. These parameters help to differentiate between acute and chronic sinusitis and assist in directing treatment.

Physical examination should include anterior rhinoscopy, oropharyngeal examination, and otoscopy. Anterior rhinoscopy (nasal speculum examination) should include visualization of the nasal septum, nasal floor, and nasal turbinates (Figure 1). The ability to directly visualize the middle turbinate depends upon the patient's anatomy. The finding that is diagnostic for sinusitis is purulent drainage on the floor of the nose or draining from the middle meatus—the cleft between the middle and inferior turbinates along the lateral nasal wall. This is the drainage site for the maxillary, frontal, and anterior ethmoid sinuses. The sphenoethmoidal recess is located in the posterosuperior nasal cavity and is the common drainage pathway for the posterior ethmoid and sphenoid sinuses (Figure 3). Purulence from these sites may drain through the nasopharynx and be visualized streaming down the posterior pharyngeal wall without being seen on anterior rhinoscopy. Other findings consistent with, but not diagnostic for, acute sinusitis include hyperemia and edema of the nasal mucosa. Nasal polyps, which may be visible on anterior rhinoscopy, are virtually diagnostic for chronic sinusitis, though rarely seen in acute sinusitis.

When acute sinusitis is suspected, it is important to determine whether a bacterial infection is present. The gold standard for making this determination is a sinus puncture with culture; however, this procedure is invasive, impractical, and only evaluates the maxillary sinus. Thus, several authors have attempted to correlate symptoms and physical findings with the presence of bacterial sinusitis. Hansen and colleagues studied 172 patients with suspected bacterial sinusitis referred from primary care physicians and used maxillary sinus aspiration of purulent or mucopurulent fluid as the diagnostic criterion. Data analysis revealed that, of these patients, 53% had pus or mucopurulent fluid on sinus aspiration. Unilateral maxillary pain, maxillary toothache, unilateral tenderness of the maxillary sinus, and mucopurulent nasal discharge were more likely than other symptoms to be associated with positive sinus aspirates. However, the magnitude of the association was small (odds ratio, 1.9-2.5).

Using the same diagnostic criterion for bacterial sinusitis, Berg and Carenfelt studied 155 patients presenting to the emergency room with sinusitis-like symptoms of less than 3 months' duration. They determined that the following 4 findings were associated with an increased likelihood of bacterial infection: a history of purulent nasal discharge with unilateral predominance, a history of facial pain with unilateral predominance, a history of bilateral purulent nasal discharge, and pus in the nasal cavity on physical examination. When at least 2 of these findings were present, 67% to 85% of patients had bacterial sinusitis. If 1 or none was present, fewer than 10% of patients had a bacterial infection. However, because patients with symptoms lasting more than 1 month were included in this study, the results may not be applicable to patients with acute sinusitis.

Lindbaek and colleagues investigated the relationship between CT findings and clinical findings in 201 patients with a clinical diagnosis of acute sinusitis. Among the patients who had been

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**Figure 1. Pathogenesis of Sinusitis:**

- Mucosal edema
- Bacterial growth
- Altered sinus environment
  - Secretions stagnate and thicken
  - pH and PO₂ decrease

Adapted from the International Rhinosinusitis Advisory Board, 1997.
given a clinical diagnosis, they found a 63% rate of acute sinusitis as defined by an air-fluid level or complete opacification of any sinus. The best independent clinical predictors of acute sinusitis were worsening of URI symptoms after initial improvement ("double-sickening"), purulent rhinorrhea, and purulent secretions in the nasal cavities.

The Hansen and Berg studies are limited in that they were able to detect acute maxillary sinusitis only. In Lindbaek's study, more than one third of the patients diagnosed with sinusitis (43/127) were found to have air-fluid levels or complete opacification of a sinus other than the maxillary sinus, in the absence of a maxillary sinus abnormality. Thus, the Hansen and Berg studies likely underestimate the prevalence of acute sinusitis. Lindbaek's study, on the other hand, likely overestimates the prevalence of acute sinusitis in his patients, as it has been demonstrated that patients with simple URIs may have air-fluid levels or complete sinus opacification on CT scan.16

Overall, these studies suggest that purulent nasal discharge, maxillary tooth or facial pain (especially when unilateral), unilateral maxillary sinus tenderness, and "double-sickening" are associated with a higher incidence of acute bacterial sinusitis.

**Endoscopy**

Nasal endoscopy is a valuable tool in the diagnosis of sinusitis; however, most primary care physicians unfortunately have neither the equipment nor the training to perform such an examination in their offices. Endoscopy allows clear visualization of the major drainage pathways of the sinuses (the middle meatus and sphenoid recess) as well as of the entire floor of the nose and nasal septum, the eustachian tube orifice, and the nasopharynx. Common endoscopic findings for patients with sinusitis include purulent drainage or edema in the middle meatus or sphenoethmoidal recess, and nasal polyps (particularly with chronic sinusitis).12

Figure 2 shows an endoscopic picture of the left side of a normal nose with clean mucosa, a clear view of the middle turbinate and no evidence of sinusitis. Figure 5 shows an endoscopic view of a patient with chronic sinusitis and nasal polyps. This patient has a poor nasal airway and is likely to complain of nasal obstruction and congestion. Due to their glistening, yellow-gray appearance, the polyps can be seen. Clear drainage and scant purulence are noted. Referral for nasal endoscopy should be strongly considered for patients with acute sinusitis refractory to treatment, recurrent acute sinusitis, or chronic sinusitis.

Endoscopy also allows samples for culture to be taken directly from the middle meatus or sphenoid recess. Blind nasal cultures have demonstrated a poor correlation with maxillary sinus puncture.20 In a recent systematic literature review Benninger et al20 found a 60% to 85% concordance between the results of maxillary sinus tap cultures and endoscopy-guided middle meatal cultures. The strength of their conclusion, however, is limited by the small numbers of patients in the study.
6 series they reviewed; the largest series had 46 patients. Their conclusion should be bolstered by a recent report of 127 patients from Turkey in whom the results of endoscopic middle meatal cultures were compared to the results of ethmoid cultures taken at the time of surgery. The investigators found a higher than 90% correlation between the results of endoscopic middle meatal and ethmoid cultures. A note of caution: These cultures were grown from samples taken primarily from patients with chronic sinusitis and the results, theoretically, could differ in patients with acute sinusitis.

**Coronal Sinus CT Scan**

In current practice, the coronal sinus CT scan is the preferred imaging tool for diagnosing sinusitis. A coronal sinus CT scan provides a view of the bone as well as the soft tissue, which appears gray on the film. The scan should be performed with 3-mm, continuous, direct coronal cuts from anterior to posterior, with the use of bone windows. A typical diagnostic scan is done without contrast. In cases where complications are suspected or additional information is needed, contrast is added and axial images are obtained, but such cases are infrequent.

For patients with uncomplicated acute sinusitis, CT scans are neither specific nor cost effective and are rarely used. Air-fluid levels or complete sinus opacification—the CT abnormalities most frequently associated with sinusitis—may be seen in patients in the acute stages of an uncomplicated URI. A rare exception to this is the patient with an apparent orbital or intracranial complication of sinusitis. Such patients should undergo coronal and axial CT scanning of the sinuses with and without contrast, and should be evaluated immediately to determine whether inpatient treatment and surgical sinus drainage are indicated.

For patients with chronic or recurrent acute sinusitis, the timing of a CT scan is critical. It is generally more beneficial to obtain a CT scan following treatment (typically at least 4 weeks after the last episode) than at the time of diagnosis. If the patient remains symptomatic, a CT scan can determine whether there is a chronic infection. Rarely, in patients with a strong history of sinusitis but a normal examination (the "diagnostic dilemma"), a scan is obtained to determine whether sinusitis is present when symptoms are maximal. A normal coronal sinus CT scan in a patient with symptoms is definitive evidence that the patient does not have sinusitis.

Figure 6 shows a coronal sinus CT scan of a patient with acute left maxillary sinusitis. A fluid level, rather than chronic thickening, is discernible, typically indicating acute infection. In making a diagnosis, it is important not to confuse sinusitis with other conditions that might have a similar appearance on CT scan, such as a cold, an allergy, or even a reaction to an environmental exposure. Thus, the overall clinical picture must be carefully considered when prescribing medical treatment, and especially when recommending surgery based on CT imaging.

**Figure 4. Nasal Endoscopy of a Healthy Patient**

Reprinted from Wigand ME.

**Figure 5. Nasal Endoscopy of a Patient With Chronic Sinusitis**

Reprinted from Wigand ME.
Treatment

Treatment for acute and chronic sinusitis varies significantly, whether the consideration is first-line medications or duration of therapy. The vast armamentarium of treatment includes antibiotics, topical and systemic corticosteroids, decongestants, mucolytics, allergy treatment, aspirin desensitization, and surgery. Tailoring the treatment regimen to the individual patient is critical for successful treatment.

Acute Sinusitis

There has been much debate in the primary care literature regarding the appropriate use of antibiotics for the treatment of acute sinusitis. This issue is less controversial in the otolaryngology literature, probably because the patient population seen by the otolaryngologist comprises severe or refractory patients in whom the use of antibiotics is routine. Table 3 provides an antibiotic treatment paradigm for the patient with acute sinusitis.

A number of recent randomized, double-blind, placebo-controlled trials have assessed the efficacy of antibiotics in treating acute bacterial sinusitis. When interpreting the results of these studies, it is critical to consider the diagnostic criteria for acute sinusitis the investigators used in each study. If the criteria in a study were not stringent enough, patients who did not have bacterial sinusitis would inadvertently have been included in the study population, and would have been less likely to have responded to antibiotic therapy.

A meta-analysis of 5 studies by Williams et al found that, when considered in aggregate, 81% of the patients treated with antibiotics and 66% of the controls were responders (indicated by improvement or cure). Of the entire cohort, 47% of those treated with antibiotics and 32% of the controls were considered cured at 10 to 14 days. In 4 of the studies sinus radiography, which lacks accuracy for diagnosing sinusitis, was the tool of choice. In the 1 study that used CT findings of an air-fluid level or complete sinus opacification, 89% of patients who received amoxicillin, 82% of patients who received penicillin, and 56% of controls were substantially improved at day 10 of the study.

Although this meta-analysis revealed overall improvement in patients who received antibiotic therapy, it has been suggested that the magnitude of improvement is not sufficient to justify prescribing antibiotics for all patients with a clinical diagnosis of acute bacterial sinusitis.

Based on a cost-effectiveness model, the Agency for Healthcare Research and Quality has recommended antibiotic therapy for patients with moderate to severe symptoms of acute sinusitis and symptomatic treatment for those with mild symptoms. Among other parameters, the model took into account the following: (1) the prevalence of bacterial sinusitis appears to be between 40% and 50% when signs and symptoms alone are used to establish the diagnosis and (2) antibiotic therapy is moderately effective.

Initial Treatment

Because most patients with a clinical diagnosis of acute sinusitis improve without antibiotic therapy, symptomatic treatment or reassurance is a reasonable initial management strategy for patients with mild symptoms. In most cases, only patients with moderately severe or severe signs and
symptoms of bacterial sinusitis, regardless of duration, should be treated with antibiotics, as should those who improve initially and then experience a worsening of symptoms.

The choice of antibiotic therapy has also been debated. Meta-analyses suggest that amoxicillin or trimethoprim/sulfamethoxazole are as effective as broad-spectrum antibiotics in the treatment of uncomplicated acute bacterial sinusitis.26,33,34 Antibiotic selection should also take into account the incidence of bacterial antibiotic resistance in the community as well as the patient's overall condition. Patients with diabetes, chronic respiratory disease, renal failure, cystic fibrosis, human immunodeficiency virus (HIV) infection, or a history of recent treatment with antibiotics may benefit from broad-spectrum and beta-lactamase–resistant antibiotics such as amoxicillin-clavulanic acid, second-generation cephalosporins, or fluoroquinolones.35

Adjunctive treatments such as topical steroids, topical or systemic alpha-adrenergic agonists, or mucolytic agents are less studied. Lennard et al36 describe a physiologic mechanism by which corticosteroids reduce inflammation in patients with chronic sinusitis. The results of studies by Dolor et al37 and Nayak et al38 demonstrate a clinical role for topical corticosteroids, which appear to provide mild symptomatic relief when used in conjunction with antibiotics. Dolor et al published the results of a randomized, placebo-controlled study that assessed the effects of intranasal fluticasone, a topical corticosteroid, in the treatment of patients with a history of chronic rhinitis or recurrent sinusitis, who present with symptoms of acute sinusitis. In 88 patients they found that the addition of fluticasone to oral cefuroxime axetil and xylometazoline spray led to a significantly higher rate of clinical success (93.5%) compared to placebo (73.9%) (P = .009). In addition, patients treated with fluticasone improved significantly more rapidly (a median of 6 days to clinical success) than did patients in the placebo group (a median of 9.5 days) (P = .01). Despite demonstrating a clinical role for topical corticosteroids, the results of this study are difficult to apply to patients with uncomplicated acute sinusitis in a clinical setting, as the entire study population had a history of sinonasal disease.

Nayak and colleagues describe a multicenter, double-blind, placebo-controlled study, in which 967 outpatients with CT scan-confirmed moderate to severe acute sinusitis received amoxicillin/clavulanate potassium with or without mometasone furoate, a topical corticosteroid. They report an improvement in symptoms in 50% of patients in the mometasone furoate group vs 44% in the placebo group at 15 days. This study also was conducted in patients with recurrent symptoms and the results may be more applicable to patients with chronic sinusitis. Overall, topical corticosteroids appear to provide mild symptomatic relief when used in conjunction with antibiotics for acute sinusitis.

By reducing mucosal edema and decreasing sinus outflow obstruction, short-term use of an alpha-adrenergic decongestant theoretically should be beneficial for the treatment of acute sinusitis. A lack of data in this area precludes a strong recommendation for such treatment; however, the favorable safety profile of these decongestants leads many physicians to include them in the treatment of acute sinusitis.

A lack of data also is problematic when attempting to determine whether mucolytics are effective for treating patients with acute sinusitis. Mucolytics reduce the viscosity of sinonasal secretions and theoretically improve mucociliary transport times. Their clinical efficacy in the treatment of acute sinusitis, however, is not well studied.

Although complications of acute sinusitis are rare, when they do occur the results can be devastating. Although data are lacking on risk of developing a complication, a retrospective review of 649 patients admitted to the hospital for acute or chronic sinusitis found that only 24 patients (3.7%) developed intracranial complications.40 Reports of orbital and intracranial complications, however, are well documented and physicians should be vigilant about monitoring for orbital cellulitis, cranial neuropathies, severe headache, and mental status changes, the earliest signs of orbital and intracranial complications.

There is also a paucity of data pertaining to the appropriate treatment of recurrent acute and subacute sinusitis. In general, these conditions initially are treated in a manner similar to that used to treat acute bacterial sinusitis, with a lower threshold for the use of broad-spectrum antibiotics. When possible, patients who are refractory to treatment should undergo imaging and nasal endoscopy with culture. These patients often benefit from referral to a specialist and may prove to be surgical candidates.

**CHRONIC SINUSITIS**

In patients with chronic sinusitis, treatment focuses on reducing mucosal inflammation. The use of systemic corticosteroids is common, while surgery is reserved for patients who fail drug
therapy. Patients with chronic sinusitis often benefit from a referral to a specialist for endoscopic evaluation with culture. Table 4 provides a treatment paradigm for patients with chronic sinusitis.

While antibiotics are routinely used in the treatment of chronic sinusitis, there is a dearth of evidence in the literature on the effectiveness of this treatment strategy. Endoscopy-guided cultures frequently demonstrate pathogenic bacteria in patients with chronic sinusitis and it appears likely that such bacteria play an important role in mucosal inflammation. Several studies of “maximal medical therapy,” which includes oral antibiotics and systemic steroids as well as various adjunctive therapies (topical steroids, decongestants, mucolytics, and saline nasal sprays), have demonstrated the efficacy of this approach in the treatment of chronic sinusitis. However, the relative importance of antibiotics in this treatment approach has not been determined. Furthermore, most of the studies are retrospective and uncontrolled. Nevertheless, Subramanian et al report significant symptomatic improvement in 80% of patients with chronic sinusitis who were treated with “maximal medical therapy.” Sustained symptomatic benefit (8 weeks after initial therapy) was observed in 65% of patients and a history of nasal polyposis was the most important predictor of sinusitis relapse.

Patients with chronic sinusitis have frequently undergone treatment with multiple antibiotic regimens and broad-spectrum antibiotic coverage is frequently recommended. A high incidence of anaerobic bacteria cultured from patients with chronic sinusitis has led some authors to advocate anaerobic coverage.

Oral prednisone is often used in a burst-and-taper regimen ranging from a dosage of 40 to 0 mg in 10-mg decrements over a period of 2 to 3 weeks (eg, 40 mg daily for the first 4 days, 30 mg daily for the next 4 days, 20 mg daily for the following 4 days, and 10 mg daily for the final 4 days of therapy). There have been no well-designed, randomized, placebo-controlled prospective studies evaluating the efficacy of systemic steroids in the treatment of chronic sinusitis. Multiple retrospective analyses support their use, particularly when patients have nasal polyps. Bonfils et al conducted a retrospective study of 100 consecutive patients with nasal polypos who received long-term follow-up (3 years). Their results suggest that a 5-day course of combined topical and systemic corticosteroid therapy is effective for the treatment of chronic sinusitis with polyps. Other retrospective analyses and uncontrolled prospective studies support the use of systemic corticosteroids in the treatment of chronic sinusitis.

The use of topical corticosteroids in the treatment of chronic sinusitis is supported by a randomized, placebo-controlled trial. In this study, 126 patients with nasal polyposis but no evidence of acute purulent infection were randomized to receive a topical nasal steroid or placebo. The results showed a statistically significant improvement of symptoms and signs in the actively treated groups. The increase in expiratory peak flow index was approximately 60% in the actively treated groups as opposed to 16% in the placebo group. The overall assessment of efficacy showed improvement in approximately 82% of patients in the active treatment groups compared with approximately 43% in the placebo group. The magnitude of improvement reported in this trial appears greater than that reported in other trials. A smaller randomized, placebo-controlled trial of 22 patients showed no change in symptoms, rigid endoscopy scores, acoustic rhinometry, or middle meatal swabs when comparing treatment with a topical nasal steroid vs placebo. Topical steroids are typically used as adjunctive therapy (along with short-term oral steroids and antibiotics) and as maintenance therapy for chronic sinusitis.

Nasal saline irrigation is another treatment commonly used in combination with topical nasal steroids. A randomized trial found that the addition of nasal saline irrigation improves sinus-related quality of life, decreases symptoms, and decreases medication use in patients with frequent sinusitis. Improvement in the endoscopic appearance of the nose has also been noted with “nasal douching.” Some trials designed to evaluate the efficacy of topical antibiotics vs placebo (saline irrigation) in patients with refractory chronic sinusitis have demonstrated statistically significant improvements in symptomatic and quality-of-life measures in the saline or “placebo”

<table>
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<th>Table 4. Chronic Sinusitis Treatment</th>
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<td>• Diagnose by history/physical examination +/- endoscopy</td>
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<tr>
<td>• Treat with antibiotics (~ 3 weeks)</td>
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<td>• Oral prednisone</td>
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<td>- 40 mg to 0 mg over ~ 3 weeks</td>
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<tr>
<td>• Topical steroids, decongestants, mucolytics, adjunctive treatments as indicated</td>
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<tr>
<td>• Reassess in 1 month</td>
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<td>• CT in approximately 1 month (guided by history)</td>
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Advanced Studies in Medicine

The presence of noninvasive fungus. Long-term sensitivity, nasal polyps, eosinophilic mucin, and virtually all cases of chronic sinusitis. Fungal infection may contribute significantly to extends well beyond these syndromes and that the role of fungi in the pathogenesis of sinusitis. Some believe that include allergic fungal sinusitis (AFS), invasive fungal sinusitis, and mycetoma. Some believe that patients with chronic sinusitis are particularly difficult to treat effectively. Patients with Samter's triad (nasal polyposis, asthma, and allergy to aspirin) are often refractory to traditional medical therapy. Surgery typically provides only temporary relief. Samter's triad patients do, however, appear to benefit significantly from aspirin desensitization therapy and this treatment should be considered in such patients.

Patients with cystic fibrosis (CF) almost invariably develop chronic sinusitis during childhood and frequently have severe disease refractory to drug therapy. While acute sinusitis is common in the pediatric population, chronic sinusitis is rare and children who develop chronic sinusitis should be tested for CF. While surgery may be of some benefit, symptom improvement is of short duration and patients often undergo multiple surgical procedures. Patients with ciliary dyskinesia or Kartagener's syndrome have a clinical course similar to that of patients with CF. Current therapy for these patients is often unsatisfactory and they remain a difficult clinical challenge.

The role of fungal infections in chronic sinusitis is controversial. Several disease processes involving fungi have been well described. These include allergic fungal sinusitis (AFS), invasive fungal sinusitis, and mycetoma. Some believe that the role of fungi in the pathogenesis of sinusitis extends well beyond these syndromes and that fungal infection may contribute significantly to virtually all cases of chronic sinusitis.

AFS is characterized by IgE-mediated hypersensitivity, nasal polyps, eosinophilic mucin, and the presence of noninvasive fungus. Long-term control over AFS is best achieved by eliminating the fungal antigen and preventing recurrence. The first step typically involves endoscopic sinus surgery. Long-term control may be achieved with a combination of immunotherapy, corticosteroids (topical and systemic), and antifungal therapies (topical and systemic).

Invasive fungal disease has also been clearly described, primarily in patients who are severely immunocompromised or have diabetes. This is a rapidly progressing, life-threatening disorder that is treated with broad-spectrum, systemic antifungal therapy in combination with surgical debridement and reconstitution of immune function, when possible.

Fungi also may present in the sinuses as a mycetoma or “fungal ball.” A mycetoma is a dense, extramucosal tangle of fungal hyphae in the absence of tissue invasion. The clinical presentation for such patients is nonspecific; they may be asymptomatic or present with symptoms of chronic sinusitis. These patients may be treated in a manner similar to those with AFS.

Ponikau and colleagues have investigated the role of fungi in the pathogenesis of chronic sinusitis. Using a meticulous culture technique in 202 patients with chronic sinusitis with or without polyps, they found that 96% of patients had positive fungal cultures. Interestingly, 100% of the control group—14 normal subjects—had positive fungal cultures as well. These results clearly raised the question of whether the culture methods were hypersensitive. Subsequent investigation using polymerase chain reaction on endoscopy-guided samples from patients with chronic sinusitis revealed a decreased rate of fungal detection, yet again fungal detection rates were similar in controls and patients with chronic sinusitis. This suggests that fungi play a major role in the pathogenesis of chronic sinusitis, it is not merely the presence of fungi but the host response to the fungi that is important. Several uncontrolled trials of systemic or topical antifungal therapies for chronic sinusitis show moderate improvement in symptoms and endoscopic findings. Systemic antifungal medications have multiple side effects and are not Food and Drug Administration (FDA) approved for use in chronic sinusitis. Topical washes also lack FDA approval and large-scale use of such medication raises concerns about the development of fungal resistance. The use of antifungal medications in patients with sinusitis is currently limited to those with refractory chronic sinusitis, who understand the risks of such medication and are aware that the treatment is not FDA approved.

**Surgical Treatment**

Surgery for sinusitis is indicated in some cases, particularly when patients have persistent symptoms and endoscopic and CT abnormalities, despite treatment with the appropriate medical therapies. It is important to keep in mind that surgery does not alter the underlying mucosal hyperactivity in patients with chronic sinusitis and thus is not a cure, but rather an adjunct to appropriate medical therapy. The objective of surgery is to reduce the frequency, duration, and severity of
the episodes. Surgery can remove bony obstruction and edematous mucosa, reestablishing patency of an ostium. The bony ostium itself may also be enlarged, theoretically decreasing the likelihood of future obstruction of the sinus outflow tract. Nasal steroids and nasal irrigation should be continued in the early postoperative period and in the long term as needed.

In numerous retrospective studies, surgery has been shown to be effective in helping patients with chronic sinusitis. In 1991, Matthews et al reported on 155 patients who underwent functional endoscopic sinus surgery (FESS). Ninety-one percent reported improvement at 1 year following surgery. In a 1990 study by Levine et al, 80% of 221 patients available for follow-up after FESS (mean, 17 months) reported relief from chronic sinusitis. In 1998, Senior et al published the results of a long-term follow-up study of 72 patients who had undergone endoscopic sinus surgery; the results indicated that 98% of patients had continued improvement after a mean follow-up of 7.8 years, although 18% required revision surgery. A study by Lund et al in 1991 showed significant improvements in olfaction, olfactory surgery; the results indicated that 98% of patients had continued improvement after a mean follow-up of 17 months, although 18% required revision surgery. A study by Lund et al in 1991 showed significant improvements in olfaction, olfactory threshold, ciliary beat frequency, and other objective criteria.

All of these studies involved patients selected by physicians as candidates likely to benefit from surgery, rather than patients with sinusitis who were randomized to undergo surgery in a controlled study. For this reason, the results may be more favorable than if these had been prospective, randomized, controlled studies. (Surgical “success” was typically defined as a subjective improvement and did not require eradication of disease.) Nevertheless, a significant number of the patients with chronic sinusitis have reported continued benefits at 1 year and even 7 to 8 years after surgery. The surgical revision rate is 18% to 25%, and the most common problems requiring surgical revision are synechiae, ostial stenosis, and obstructing polyps. The serious complication rate (orbital hematoma and cerebrospinal fluid leak) ranges from 0.3% to 1.1% in these studies, and the investigators have reported varying degrees of postoperative bleeding.

**Conclusion**

Sinusitis is a common disease amenable to medical and surgical treatment. Treatment involves diagnosis by history and physical examination as well as endoscopy and CT scanning as indicated. Treatment can be directed by these parameters and may include antibiotics, corticosteroids, and many adjunctive therapies. With proper emphasis on diagnosis and directed treatment, patients' symptoms can be improved and complications avoided.

The future of the diagnosis and treatment of sinusitis will ideally include more investigation into environmental and inherent metabolic causes of mucosal inflammation and reactivity, and the role of osteitis and fungi in mucosal inflammation and infection.

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