Acute Sinusitis: Diagnosis and Treatment Update

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Acute sinusitis in adults is manifested by fever, facial pain and purulent rhinorrhea, but children - who rarely have headache or facial tenderness - have persistent cough in addition to fever and purulent rhinorrhea. Sinus transillumination is diagnostically useful only in adults. In children, maxillary sinus radiographs are indicated. New studies show ultrasound examination to be less sensitive than plain radiographs. Cultures obtained by aspiration of the maxillary sinuses are useful in complicated cases. Amoxicillin is still effective as first-line treatment, but treatment failure require a prompt change to trimethoprim-sulfamethoxazole or ciprofloxacin. Nosocomial sinusitis requires coverage for gram-negative bacteria, including *Pseudomonas aeruginosa*. Immunocompromised patients, including those with acquired immunodeficiency syndrome, require treatment for fungal organisms. Decongestants are of unproven value. Referral for irrigation and surgical drainage is indicated for recurrent or recalcitrant sinusitis. Flexible endoscopy allows visualization and debridement of diseased tissue in cases of chronic sinusitis.

Acute sinusitis is an inflammation of the mucosa of one or more of the paranasal sinuses. Since all paranasal sinuses communicate with a bacteriologically contaminated cavity, infection is a component of sinusitis either initially or as the disease evolves. If left untreated, acute sinusitis can be associated with such complications as cellulitis, abscess, meningitis, osteomyelitis and cavernous sinus thrombosis. In children, untreated acute sinusitis can result in facial deformity or serve as a trigger for asthma.

Pathogenesis

The sinuses, which develop at different times during childhood, drain through ostia into the nasal cavity (Table 1 and Figure 2). Sinusitis can be the result of an alteration in ostial size, mucociliary transport, oxygen exchange or mucosal blood flow.

Table 1. Time of Development of Sinuses

Sinus	Time of appearance
Maxillary sinus	Fetal (not clinically significant until 18 to 24 months)
Ethmoid sinus	Birth
Frontal sinus	Sixth year (may be absent in adults)
Sphenoid sinus	Ninth year.

Sinus epithelium is composed of ciliated columnar cells. Cilia clear the sinus by continuously beating toward the ostia. Because the maxillary sinus ostium is located well above the maxillary floor (Figure 2), ciliary motion must overcome gravity to facilitate drainage.

Conditions that decrease ciliary beating can reduce clearance of bacteria and permit suppuration.

The most important factor in the pathogenesis of sinusitis is narrowing of the ostia, either by mucosal inflammation or an anatomic abnormality. Complete ostial obstruction causes the oxygen tension to fall from the normal 117 mm Hg to 80 mm Hg or lower. Low oxygen tension favors the growth of organisms such as pneumococci.

Development of purulence may decrease the oxygen tension to near zero, thus favoring growth of anaerobic bacteria and inhibiting the function of phagocytic cells. Complete ostial obstruction also impairs ventilation and drainage, leading to retention of secretions. There is evidence of decreased immunoglobulin levels in retained secretions, a circumstance that also favors bacterial growth. Clinical factors that predispose a person to acute sinusitis are outlined in Table 2.

Table 2. Risk Factors and Most Likely Organisms in Acute Sinusitis

Risk factors	Predominant organisms
Obstruction of sinus ostia Upper respiratory infection Allergic rhinitis Deviated nasal septum Hypertrophied adenoids Nasal polyps or tumors Nasal foreign bodies Topical decongestant overuse	*Streptococcus pneumoniae* (55%) *Haemophilus influenzae* (20%) respiratory viruses (15%) anaerobes (9%) *Moraxella catarrhalis* group A beta-hemolytic streptococcus alpha-hemolytic streptococcus
Environmental situations Swimming/diving Barotrauma Cold weather	Same as above
Dental infection	Gram-negative bacilli, anaerobic streptococci
Impaired ciliary motility Cystic fibrosis Immotile cilia syndrome Kartagener's syndrome	*Pseudomonas aeruginosa* *Staphylococcus aureus*
Nosocomial infection Nasopharyngeal tubes Nasotracheal tubes Nasal packing	*Escherichia coli; P. aeruginosa* Serratia species polymicrobial organisms

Nasal and cranial fractures	
Immunocompromise	*H. influenzae; S. pneumoniae;*
Systemic illness	Aspergillus species; fungal species
Recent viral infection	causing mucormycosis;
Corticosteroid therapy	*Candida albicans*
Acquired immunodeficiency	*H. influenzae; S. pneumoniae;*
syndrome	*Pseudallescheria boydii;*
	Legionella pneumophila;
	Acanthamoeba castellani.

If infection is prolonged or relapsing, the mucosa may be damaged irreversibly, leading to chronic sinusitis. The ciliated epithelium is then replaced by stratified squamous epithelium, resulting in decreased clearance of bacteria.

Acute Sinusitis in Adults

The most common symptoms of acute sinusitis in adolescents and adults are fever, headache and facial pain, usually following an upper respiratory viral infection. However, facial pain or tenderness may be absent, and sinus pain may masquerade as toothache. Symptoms may even be limited to anorexia, photophobia and malaise.

The location of facial pain can indicate which sinuses are infected (Table 3). The pain of maxillary sinusitis typically appears within two hours of awakening, intensifies in the early afternoon, then wanes towards the evening. Aching pain or a sensation of facial fullness is typically accentuated by straining, coughing or bending at the waist into a head-down position.

Table 3. Location of Sinus Infection Related to Areas of Pain and Tenderness

Location of infection	Area of pain
Maxillary sinus	Subzygomatic over cheek and upper teeth
Frontal sinus	Forehead above eyebrow
Sphenoidal sinus	Usually retrobulbar, often not well localized
Ethmoid sinus	Periorbital.

Facial tenderness is best assessed by applying pressure with a finger over the sinus areas. Approximately 60 percent of adults who present with postnasal discharge and tenderness over the affected sinus have high titers of bacteria on sinus aspiration.

Nasal discharge is usually seen in the nasal meatus ipsilateral to the infected sinus. The discharge may be thick or thin, and may be clear, mucoid or purulent. If inspection with a nasal speculum (anterior rhinoscopy) fails to reveal discharge, inspection of the posterior pharynx or the use of a pharyngeal mirror (posterior rhinoscopy) may reveal posteriorly draining pus.

Transillumination

Use of transillumination is limited to adults with suspected acute maxillary or frontal sinusitis, but this technique is notoriously unreliable. A completely opaque sinus correlates with active infection, but the results are often dull transillumination and reduced light transmission, which are diagnostically meaningless findings. In addition, transillumination can falsely suggest active disease in patients with chronic sinusitis (persistent mucosal abnormalities may be interpreted as opacification). Transillumination is not a substitute for sinus radiographs. Transillumination of the maxillary sinus is completely unreliable in children under age nine and should not be attempted.

Transillumination is performed in a darkened room. A bright light source (otoscope light is sufficient) is placed over the midpoint of the inferior orbital rim. With the patient's mouth open, the physician assesses the transmission of light through the maxilla and, if possible, the hard palate. To transilluminate the frontal sinus, the light source must be placed inferior to the medial border of the supraorbital ridge. The symmetry of the blush can be evaluated bilaterally.

Atypical Presentations

Acute sinusitis should be considered as a complication of upper respiratory infection when the respiratory infection is accompanied by any of the signs or symptoms listed in Table 4.

Table 4. Less Common Presentations of Sinusitis During Upper Respiratory Viral Infections

Temperature > 39°C (102.2°F)
Purulent, copious nasal discharge
Associated morning periorbital swelling and facial pain
Headaches
A protracted cold (beyond 10 days duration) with nasal discharge or persistent daytime cough.

Acute Sinusitis in Children

Acute sinusitis in children is caused by the same organisms that cause the infection in adults. Maxillary sinusitis is most common in children, and frontal and sphenoid sinusitis is rare. Children at highest risk have allergic rhinitis or upper respiratory infections. In contrast to adults, children rarely have headache or facial tenderness. The usual presentation is persistent cough, fever and purulent rhinorrhea.

The diagnosis of acute sinusitis in children is frequently missed. In one study of children undergoing tonsillectomy for chronic tonsillitis or adenoidectomy, 12 of 33 patients had unexpected opacification of the maxillary sinuses on preoperative radiographs. Diagnosis of acute sinusitis is confirmed by radiography; a single Waters view is usually sufficient.

Diagnostic Procedures for Sinusitis

Radiography

In all age groups, radiography is a sensitive method of diagnosis. The four standard views are listed in Table 5. Data are scarce regarding the sensitivity of radiographs in the diagnosis of sinusitis. When the Waters view is compared to cultures of the maxillary sinus, abnormalities such as air-fluid levels, mucosal thickening of 5 mm or opacification of the sinus are associated with a sensitivity of 70 percent for acute sinusitis. When combined with an appropriate history, abnormal radiographs have an 80 percent sensitivity. Specificity also exceeds 80 percent; tumors and polyps may give false-positive radiographic results.

Table 5. Standard Radiographic Views for Diagnosing Sinusitis

View	Sinus identified
Waters	Maxillary and frontal
Caldwell-Luc	Ethmoid and frontal
Lateral	Sphenoid and maxillary
Submental vertex	Ethmoid.

In children under one year of age, sinus films are not useful because of false opacification due to facial asymmetry and redundant mucosa. If the child is at least one year old and does not have a current upper respiratory infection, an abnormal maxillary sinus radiograph combined with fever and rhinorrhea correctly predicts acute sinusitis in 75 percent of cases.

Newer Imaging Techniques

Computed tomographic scanning is an expensive but effective technique for diagnosing sinusitis. It is most appropriately used to define the intracranial spread of infection. Sinus ultrasound is more expensive than plain radiography (Waters view) for imaging maxillary sinusitis, and it is no more sensitive.

Maxillary Antrum Aspiration

Maxillary antrum aspiration is indicated only when precise microbial identification is required, such as in failure of antibiotic therapy, in nosocomial infections or in immunodeficient patients. Although the procedure can be performed in the emergency department under local anesthesia, referral to an otolaryngologist is the usual practice. The specimen is obtained by inserting a needle below the inferior turbinate. Specimens should be cultured for anaerobes, aerobes and fungi.

Treatment

Treatment options for sinusitis include antibiotics, decongestants, surgical drainage and corticosteroids. Antibiotic therapy is the only approach that is not controversial.

Antibiotics

The antimicrobial regimens recommended for the treatment of acute sinusitis are similar to those used for acute otitis media (Table 6). The duration of treatment is 10 to 14 days. Treatment failure has been reported in adults treated for seven days; 20 percent of sinus aspirates were still culture-positive.

Table 6. Treatment of Acute Sinusitis*

Preferred Treatment

Adults: amoxicillin, 1.5 to 3.0 g per day, in 3 doses every 8 hours for 10 to 14 days.

Children: amoxicillin, 40 mg per kg per day, in 3 doses every 8 hours for 10 to 14 days.

Options for treatment failure or allergic patients

Adults: trimethoprim-sulfamethoxazole (Bactrim, Septra), 160 mg (trimethoprim) and 800 mg (sulfamethoxazole), in 2 doses every 12 hours for 10 to 14 days.

Children: trimethoprim-sulfamethoxazole pediatric suspension, 8 mg per kg per day (trimethoprim) and 40 mg per kg per day (sulfamethoxazole), in 2 doses every 12 hours for 10 to 14 days.

Alternative drugs

Adults: cefaclor (Ceclor), 250 mg orally every 8 hours for 10 to 14 days.

Children: cefaclor, 20 mg per kg per day, in 3 doses every 8 hours for 10 to 14 days.

Adults: amoxicillin-clavulanate potassium (Augmentin), 1.5 to 3.0 g per day, in 3 doses every 8 hours for 10 to 14 days.

Children: amoxicillin-clavulanate potassium, 40 mg per kg per day, in 3 doses every 8 hours for 10 to 14 days.

Children: erythromycin-sulfisoxazole (Pediazole), 50 mg per kg per day (erythromycin) and 150 mg per kg per day (sulfisoxazole), in 4 doses every 6 hours for 10 to 14 days.

Dental infections

Penicillin VK, 250 mg 4 times per day for 10 to 14 days.

Impaired ciliary motility

Ciprofloxacin (Cipro), 500 mg every 12 hours or dicloxacillin (Dynapen, Pathocil), 500 mg 4 times per days for 10 to 14 days.

Nosocomial infections

Amoxicillin, 250 mg 3 times per day for 10 to 14 days or piperacillin (Pipracil), 2 g IV every 6 hours for 7 days*** or gentamicin (Garamycin), 1.6 mg per kg in a loading dose (subsequent doses based on estimated creatinine clearance) for 7 days.***

Note: Immunocompromised patients may need the addition of amphotericin B** (Fungizone), as well as surgical debridement.

* Uncomplicated by dental infection, instrumentation or immunosuppression.
** Culture and sensitivity tests required to identify organisms.
*** Depending on clinical response.

First-line treatment of acute sinusitis should be directed toward nontypable *Haemophilus influenzae* and *Streptococcus pneumoniae,* which together comprise 74 percent of all significant bacterial strains recovered from adult patients. Amoxicillin is traditionally recommended because it is less expensive than cephalosporins or amoxicillin-clavulanate potassium (Augmentin), and reduces the chance of Stevens-Johnson syndrome, which can follow treatment with trimethoprim-sulfamethoxazole (Bactrim, Septra).

However, the incidence of infection with penicillin-resistant *H. influenzae,* since its first description in 1974, has been increasing. Resistance is conferred by beta-lactamases, which also hydrolyze ampicillin, amoxicillin, carbenicillin (Geocillin) and some cephalosporins. Because the beta-lactamase is plasmid-produced, it is sometimes missed by ordinary disc-sensitivity tests. Current prevalence varies from 5 to 30 percent, depending on the geographic area surveyed. The proportion of *H. influenza* sinusitis infections rises to 60 percent in cases of treatment failure. While less than 5 percent of sinusitis infections are due to *Moraxella catarrhalis* (formerly *Branhamella catarrhalis*), this organism is also resistant to penicillin. Therefore, failure of acute sinusitis to respond promptly to amoxicillin requires treatment with agents resistant to beta-lactamases, such as trimethoprim-sulfamethoxazole, cefaclor (Ceclor) and amoxicillin-clavulanate potassium.

Sinusitis in patients with impaired ciliary motility can be caused by *Pseudomonas aeruginosa* and *Staphylococcus aureus;* therefore, ciprofloxacin (Cipro) can be used, with dicloxacillin (Dynapen, Pathocil) as a second choice. Nosocomial sinusitis can result from

infection with gram-negative bacteria, not only Pseudomonas species but also *Escherichia coli,* Serratia species and polymicrobial organisms. These infections can be treated with ciprofloxacin or with intravenous piperacillin (Pipracil) or an aminoglycoside.

Sinusitis in immunocompromised patients, including diabetics, patients taking corticosteroids or even patients with a history of recent viral infection, may be caused by fungal organisms. This type of infection requires amphotericin B (Fungizone) and surgical debridement. Sinusitis in patients with acquired immunodeficiency syndrome is usually caused by *H. influenzae* or *S. pneumoniae,* but *Legionella pneumophila, Pseudallescheria boydii* or *Acanthamoeba castellani* may also be the etiology.

Decongestants

Limited studies of patients with rhinitis show that oral decongestants can decrease nasal resistance. No data show that decongestants prevent rhinitis from escalating to sinusitis.

Topical decongestants such as phenylephrine, phenylpropanolamine or oxymetazoline shrink nasal mucous membranes and improve ostial drainage and symptoms of upper respiratory infection. Their harmful effects include ciliostasis, which inhibits the normal clearance of secretions and infected material. They also decrease blood flow to the mucosa, which lowers oxygen tension and impairs delivery of antibiotics to the sinuses. Therefore, topical decongestants should not be used indiscriminately for symptomatic relief. Until more data are available, patients for whom topical decongestants are prescribed should be followed closely for signs of worsening sinusitis.

Irrigation, Surgical Drainage and Endoscopy

Irrigation and drainage of the infected sinus may result in dramatic relief of pain and prevent otherwise irreversible mucosal damage. Continuous irrigation seems particularly promising. With this technique, a needle is passed into the maxillary sinus through the lateral nasal wall beneath the inferior turbinate. An irrigation tube is inserted, and saline solution is alternately injected and extracted. This method is thought to be tolerated better than the usual technique of repeated puncture irrigation. If sinusitis continues or recurs despite appropriate antibiotic treatment, surgery may be required.

The easiest surgical drainage, and the approach desired in children, is through a nasoantral window. The otolaryngologist creates this window by surgically opening the most inferior portion of the inferior meatus. This gives gravitational drainage to the maxillary sinus. An anterior intra-oral approach to the maxillary sinuses is the Caldwell-Luc antrotomy. Because complications are not uncommon, including recurrent nasal obstruction in 28 percent of patients, the Caldwell-Luc procedure should be reserved for cases of suppurative intraorbital or intracranial complications.

More radical surgery is reserved for infections with fungal organisms. These infections are rarely cured by antifungal therapy alone.

Rigid telescopes (endoscopes) can visualize all parts of the patient's nose. They have been used to evaluate and treat chronic and recurrent sinusitis of the maxillary, ethmoid and frontal sinuses. Endoscopy permits surgical access to the sinuses, and diseased tissue can be endoscopically removed from the middle turbinate, middle meatus and anterior ethmoid sinus. This procedure can restore normal mucociliary clearance and reduce persistent inflammation.

Corticosteroid treatment has not been shown to enhance cure rates or relieve symptoms; its immunosuppressive properties can, in theory, prolong or worsen acute sinusitis.

New Directions

While sinusitis has been linked to asthma since the 19th century, there is now evidence of a causal relationship between the two. Rachelefsky and colleagues showed that of 48 children with sinusitis and asthma, 79 percent were able to discontinue bronchodilator therapy after resolution of sinusitis with antibiotic therapy. Of patients with both sinusitis and asthma, more than 90 percent had sinusitis that preceded asthma. The most popular hypothesis is that reflex bronchoconstriction results from stimulation of parasympathetic fibers in the reticular formation, which adjoin (and are presumably stimulated by) nuclei of the afferent trigeminal nerve from the nose and sinuses. Further studies are needed to evaluate the relationship between sinusitis and asthma.