

## Sinusitis in Children

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### Abstract

*Sinusitis is a common disease in childhood and puberty with significant morbidity and the potential for serious complications. There are two types of acute sinusitis: viral and bacterial. Viral sinusitis develops during a cold. Some children with certain predisposing diseases may develop forms of chronic sinusitis, which is usually not of infectious origin. Children and adolescents may have nonspecific symptoms: fever, nasal congestion, nasal secretion. Less common difficulties include bad breath, reduction sense of smell, and periorbital edema. Headaches and facial pain are rare in children. The most common symptoms are headache, tenderness in the facial area and a stuffy nose.*

**Keywords:** Sinusitis, Facial Pain, Asthma, Comorbidity, Treatment

### Introduction

Sinusitis (also known as rhinosinusitis) is defined as inflammation of one or more of the paranasal sinuses, which develop as outpouchings of the nasal chamber [1]. They enlarge as the child grows, so that the importance of a particular sinus varies with the age of the patient. The maxillary and ethmoid cells are present at birth while the sphenoid and frontal sinuses are not aerated until approximately five and seven years of age, respectively.

The organisms responsible for most cases of acute sinusitis are similar to those implicated in acute otitis media and include *S. pneumoniae*, nontypable *H. influenzae*, *M. catarrhalis*, and *S. aureus*. In contrast, anaerobes, *S. aureus*, alpha *Streptococcus*, and nontypable *H. influenzae* are the predominant infectious etiologies of chronic sinusitis, which is also frequently caused by a noninfectious etiology, chronic hyperplastic eosinophilic sinusitis.

The most common signs and symptoms of acute sinusitis are dry cough (typically occurs at night or during naps), persistent (>7–10 days) nasal discharge, and fever. Children  $\geq 5$  years of age may complain of a headache that is accentuated by leaning forward. Younger patients (<5 years) may have malodorous breath in the absence of a pharyngeal or dental infection. Facial pain and swelling occur, but are not as common as in adults.

Every child seems to have a runny, congested nose sometime throughout the year [2]. This commonly occurs from the fall to spring season. Parents become quite concerned over these symptoms and frequently seek medical attention and advice to address them. Pediatric rhinitis and sinusitis are largely responsible for many upper respiratory symptoms in children.

### Anatomy

The nasal skeleton consists of the nasal bones, the paired lateral cartilages, and the septal cartilage [2]. The septum divides the nasal cavity into two halves. The lateral wall of the nose has three projecting divisions of bones known as turbinates, specifically the inferior, middle, and superior turbinate. The space below each turbinate is called a meatus. The middle meatus plays an essential role in the ventilation and mucociliary clearance of the sinuses, as all the sinuses, with the exception of the sphenoid and posterior ethmoid air cells, open into this meatus. The osteomeatal complex is a culmination of all the openings of the sinus ostia. Its patency or lack thereof, is responsible for many sinus symptoms and the development of sinusitis.

There are four pairs of sinuses that are air-filled bony cavities within the skull. They are lined with the same respiratory epithelium that lines the nose as well as the trachea, bronchi, and the eustachian tubes. This is specifically called pseudostratified ciliated columnar epithelium and, as we will further discuss, is the reason sinusitis and rhinitis are associated with lower airway and middle ear disorders and illnesses.

Each pair of sinuses forms at varying time frames during the course of a child's development. This information is essential to keep in mind when caring for a child with a suspected sinusitis as a sinus can only be responsible for symptoms if it is already developed and pneumatized. The maxillary and ethmoid sinuses are the only two that are formed at birth but are not aerated until 3–4 months of age. The ethmoid sinuses do not exist as a single cavity as the others but consists of several air cells. It typically reaches its adult

size by the age of 12 years. The maxillary sinus continues to grow into puberty and by adulthood is the largest sinus with a volume of 15mL. The sphenoid sinuses begin to form between 3 and 5 years of age and are fully developed at 7–8 years of age. The frontal sinuses are rudimentary before the age of 7 years and continue to develop into adolescence. It is not uncommon to see either a unilateral absence or complete absence of the frontal sinus without negative implications.

### Facial Pain

Pediatric patients with sinusitis will sometimes complain of facial or periorbital pain, although younger children may simply have a persistent nasal discharge [3]. Dental abscess can be overlooked as a cause of headache-type pain because it is a relatively uncommon finding in children. Therefore, a careful examination of the teeth and gingiva should be performed for all pediatric patients with unexplained headaches. Finally, inflammation of the temporomandibular joint (TMJ) is a rare cause of unilateral headaches in children (TMJ syndrome). These patients typically report increased pain while chewing and have point tenderness over the mandibular condyle.

Pressurelike pain or aching in the area of the frontal sinuses, supraorbital ridge, or infraorbital area in association with fever, nasal congestion, postnasal discharge, or a recent upper respiratory tract infection suggests acute or chronic sinusitis [4]. Redness, swelling, and pain around the eye are suggestive of periorbital cellulitis. The rapid onset of parotid or submandibular area swelling and pain, often occurring in association with meals, is characteristic of obstruction of the salivary duct as a result of stone. Trigeminal neuralgia produces excruciating, lancinating facial pain that occurs in unexpected paroxysms, is initiated by the tactile stimulation of a “trigger point” or simply by chewing or smiling. Temporomandibular joint dysfunction produces pain related to chewing or jaw movement and is most commonly seen in women between the ages of 20 and 40 years; patients may have a history of recent injury to the jaw, recent dental work, or long-standing malocclusion. Facial paralysis associated with facial pain may be noted in patients with malignant parotid tumors. Dislocation of the temporomandibular joint causes sudden local pain and spasm and inability to close the mouth. Acute dystonic reactions to the phenothiazines and antipsychotic medications may closely simulate a number of otherwise perplexing facial and ocular presentations and must be considered. Acute suppurative parotitis usually occurs in the elderly or chronically debilitated patient and causes the rapid onset of fever, chills, and parotid swelling and pain, often involving the entire lateral face.

### Acute Bacterial Sinusitis

The diagnosis of acute bacterial sinusitis is made when a child with an acute upper respiratory tract infection (URI) presents with (1) persistent illness (nasal discharge [of any quality] or daytime cough or both lasting more than 10 days without improvement), (2) a worsening course (worsening or new onset of nasal discharge, daytime cough, or fever after initial improvement), or (3) severe onset (concurrent fever [temperature  $\geq 39^{\circ}\text{C}/102.2^{\circ}\text{F}$ ] and purulent nasal discharge for at least 3 consecutive days) [5]. Clinicians should not obtain imaging studies of any kind to distinguish acute bacterial sinusitis from viral URI, because they do not contribute to the diagnosis; however, a contrast-enhanced comput-

ed tomography scan of the paranasal sinuses should be obtained whenever a child is suspected of having orbital or central nervous system complications. The clinician should prescribe antibiotic therapy for acute bacterial sinusitis in children with severe onset or worsening course. The clinician should either prescribe antibiotic therapy or offer additional observation for 3 days to children with persistent illness. Amoxicillin with or without clavulanate is the firstline treatment of acute bacterial sinusitis. Clinicians should reassess initial management if there is either a caregiver report of worsening (progression of initial signs/symptoms or appearance of new signs/symptoms) or failure to improve within 72 hours of initial management. If the diagnosis of acute bacterial sinusitis is confirmed in a child with worsening symptoms or failure to improve, then clinicians may change the antibiotic therapy for the child initially managed with antibiotic or initiate antibiotic treatment of the child initially managed with observation.

Acute upper respiratory infections (URI), or the common cold, are among the most common infections seen in the world and among the top reason for visits to the doctor [6]. They are also among the leading causes of morbidity and mortality in children.

URIs are generally due to infection with rhinovirus or adenovirus and can occur year round in all age groups. Symptoms can range from mild to severe and may involve various parts of the respiratory tract, resulting tonsillitis, pharyngitis, laryngitis, sinusitis, otitis media, or pneumonia.

### Chronic Sinusitis

Chronic sinusitis should be suspected in children with very protracted respiratory symptoms: nasal discharge, nasal obstruction, or cough that has lasted for more than 30 days [7]. Some experts define chronic sinusitis as symptoms that persist for at least 90 days. Although the nasal discharge is most often purulent, it may be thin and clear. Occasionally nasal discharge is minimal or absent, and cough and throat clearing are more prominent due to discharge from the posterior ethmoids. Once again, the cough should be present during the daytime, although it is usually reported to be worse at night. When nasal obstruction due to nasal congestion is pronounced, sore throat is frequently present upon awakening secondary to mouth breathing. In addition, the patient may complain of facial pain, headache, or malaise. The appetite may be poor, sleep is frequently impaired, and school performance may suffer. However, unless these less specific complaints are accompanied by respiratory symptoms, they should not be attributed to sinus infection. Fever is less prominent and found less frequently than in acute sinusitis.

In most children less than 10 years of age, the physical examination is generally not very helpful for making a specific diagnosis of acute bacterial sinusitis. On the contrary, if the mucopurulent material can be removed from the nose, and the nasal mucosa is treated with topical vasoconstrictors, pus may be seen coming from the middle meatus. The latter observation and periorbital swelling or facial tenderness (when present) are probably the most specific findings in acute bacterial sinusitis.

The signs of chronic sinusitis are not specific. They include mucopurulent nasal discharge, hypertrophied nasal turbinates, and (occasionally) intranasal polyps. The last are seen principally in

association with allergy or cystic fibrosis.

### **Sinusitis and Asthma**

Chronic rhinosinusitis and asthma frequently coexist in the same individual [8]. A recent evaluation of sinus CT, pulmonary function, sputum eosinophilia, and nitric oxide in exhaled air in patients with severe asthma showed a direct relationship between sinonasal mucosal thickness and bronchial inflammation. Histologic samples from patients with rhinosinusitis and asthma demonstrate similar inflammatory cell infiltrate with biopsies of the upper and lower airway mucosa being almost interchangeable in appearance. During upper respiratory infection, patients with asthma experience selective increases in inflammatory cytokines and reduced T-cell responsiveness to steroids.

Sinusitis in patients with asthma may be acute or chronic, infectious or not. Therapy will depend on the specific presentation. Acute disease usually refers to symptoms of less than 3-weeks duration. Most common symptoms in children are cough and rhinorrhea, with headache, fever, and positional pressure being much more likely in adults. If upper respiratory infection symptoms persist for more than 7–10 days, or if there is fulminant rhinorrhea, acute bacterial sinusitis is reasonably likely and therapy should include antibiotics directed to typical pathogens as well as topical corticosteroids to reduce inflammation. Nasal saline may also be helpful for reducing symptoms. In situations where disease persists for many weeks or months, the likelihood of noninfectious inflammation increases, and the chance for resolution with antibiotics decreases. While a trial of antibiotic therapy is warranted, more attention must be paid to underlying structural problems and imaging studies (usually CT) to elucidate these. Therapy is more likely to include short-term oral corticosteroids, nasal saline lavage, and nasal corticosteroids. Adults are more likely than children to have chronic hyperplastic sinusitis with nasal polyps. There may be value in using leukotriene antagonists in this situation, considering cysteinyl leukotriene concentrations in sinus tissue from patients with this chronic situation. To date there are no published controlled trials of anti-leukotriene therapy in acute or chronic sinus disease.

### **Comorbidity**

Comorbid medical conditions are common in pediatric asthma and can be associated with greater asthma severity [9]. Allergic rhinitis and atopic dermatitis are atopic diseases which share with asthma an allergic oversensitivity leading to allergic inflammation and are often present in children with asthma. Chronic rhinosinusitis is often present in youth with asthma and is an independent risk factor for asthma exacerbations. Gastroesophageal reflux disease is also common and can affect asthma through the activation of vagal reflexes and/or microaspiration especially in youth with severe or difficult to treat asthma. Obstructive sleep apnea may occur along with asthma, especially as the two conditions share predisposing factors. Vocal cord dysfunction (VCD) is a functional disorder in which the vocal cords close abnormally during inhalation, which may be diagnosed as treatment-resistant asthma. While asthma and VCD sometimes co-exist, the treatments are different and asthma medications will not improve VCD. Finally, asthma and obesity are highly comorbid, and further, these youth experience greater asthma severity and poorer asthma-related outcomes (e.g., more

frequent symptoms, ED visits) than their non-obese peers with asthma. Obesity may be a risk factor for asthma due to the generation of unique inflammatory mediators (e.g., leptin, C-reactive protein) that lead to airway dysfunction. This is compounded by the fact that children with asthma may refrain from exercise, leading to weight gain.

### **ICU Patient**

Nosocomial maxillary sinusitis is a common entity in intubated patients and should be included in the differential diagnosis of fever in an ICU patient [10]. Either two major criteria (cough, purulent nasal discharge) or one major plus two minor criteria (headache, earache, facial or tooth pain, malodorous breath, sore throat, or wheezing) suggest acute bacterial sinusitis in the outpatient setting; however, in critically ill patients, these signs may not be evident. Additionally, sinus films may be of limited value and sinus computed tomography (CT) or magnetic resonance imaging (MRI) scans may be difficult to obtain. For a definitive diagnosis, puncture and sampling of the involved sinus under aseptic technique should be performed. A prospective study of new-onset fever in surgical ICU patients after excluding bacteremia, catheter-related infections, or pneumonia found sinusitis diagnosed by three-view sinus films accounted for 24% of fevers, and the predominant microbiology was *Klebsiella* and *Pseudomonas*. Another study found the common pathogens by maxillary sinus aspirates were *Acinetobacter* (32%) and anaerobes (21%) and a combination of a nasal decongestant and topical nasal steroid was effective in decreasing the incidence of sinusitis in mechanically ventilated trauma patients.

### **Diagnosis**

Acute bacterial sinusitis is an inflammation of the mucosal lining of one or more of the paranasal sinuses [11]. While acute viral sinusitis is a normal accompaniment of an upper respiratory infection, in approximately 1 out of 15 cases it may be followed by acute bacterial sinusitis. Outpatient treatment will suffice for most cases of bacterial sinusitis, although a patient may require inpatient therapy if there is evidence of toxicity, failure of outpatient treatment, or an underlying immunodeficiency. Serious complications of bacterial sinusitis can occur secondary to the spread of infection. The most common are periorbital and orbital cellulitis. Less often, intracranial extension can cause a brain abscess, meningitis, or cavernous venous sinus thrombosis. Uncommonly, cranial vault involvement may result from a frontal sinusitis (Pott puffy tumor), most commonly in a teenaged male.

A history of recurrent bacterial sinusitis raises the possibility of an underlying chronic allergic condition, immunodeficiency, or a defect (anatomical or mechanical) causing poor sinus drainage (cystic fibrosis, immotile cilia, sinonasal polyps).

Although sinus aspiration remains the gold standard for diagnosis of acute sinusitis, it is rarely practiced outside of the research setting [12]. Furthermore, few recent studies have used aspiration as a criterion for study entry or used bacteriologic cure as an outcome. Despite these microbiologic limitations, evidence from the trials summarized previously can answer a slightly different question: which (if any) clinical, laboratory, and/or radiologic findings are able to discriminate between children who are likely to benefit

from antimicrobial therapy and those who are not?

The most commonly used diagnostic criterion for acute bacterial sinusitis is persistent or prolonged duration of symptoms for 10 to 14 days. This criterion is based on the observation that most viral upper respiratory tract infections last 5 to 7 days.

Purulent rhinorrhea, nasal congestion, and headache are other common findings used to diagnose sinusitis.

Headaches are not a common complaint during childhood [13]. The younger child does not voice the concern, and there is no objective measure of the presence or degree of headache. Often, the discomfort may produce irritability, crying, and moodiness, but there is no way to document its cause. Holding the head, resting the head on a cold tile floor, pulling out hair, and head banging have been seen as indicators of headache in the child who is unable to verbalize the discomfort. As the child grows older, they may be able to express the location of the discomfort and to some extent the degree of discomfort. Although headaches may result from chronic rhinosinusitis, they also may represent vascular headaches (i.e., migraines) or be due to stress or allergy.

The diagnosis of sinusitis in a severely immunocompromised child is both a medical and surgical emergency because of the risk of invasive fungal infection [14]. The primary fungi of concern include the Zygomycetes (also referred to as Mucor), *Aspergillus* spp. and as well as number of less common dematiaceous fungi (such as *Curvularia*, *Bipolaris*, *Fusarium* etc). Such patients are at risk for fungal extension into critical vessels as well as the CNS and aggressive surgical debridement is often necessary. Rarely, acute infection in an otherwise healthy host can extend from the paranasal sinuses into the orbit or cranial vault. This complication occurs more often in boys (approximately 2:1 gender ratio) and intracranial extension typically occurs in older children (mean age of 11–13 years). While typical acute sinusitis pathogens can be involved, particularly for intraorbital disease, other organisms predominant in intracranial infection. Common organisms associated with intracranial extension of sinusitis include *Streptococcus milleri* group, *Propionibacterium acnes* and *S. aureus* as well as anaerobes such as *Peptostreptococcus* spp., *Fusobacterium* spp. and *Prevotella*. Notably, both intracranial and intraorbital extension of sinus disease is frequently a polymicrobial infection. An additional rare complication of frontal sinusitis is the development of osteomyelitis of the frontal bone which if a subperiosteal abscess develops may manifest as the so-called Pott's puffy tumor.

## Treatment

Treatment for acute sinusitis consists of an antipyretic for fever, an analgesic for pain, and an antibiotic for the specific organism involved [15]. Oxymetazoline hydrochloride (Afrin), supplied as nose drops or a nasal spray, shrinks the edematous mucous membranes and allows infected material to drain from the sinuses and relieve pain. To avoid a rebound effect, this type of nasal spray should be used for only 3 days at a time; otherwise, it actually causes more nasal congestion than was present originally. Warm compresses to the sinus area may also encourage drainage and relieve pain. Some children need acetaminophen (Tylenol) for pain.

Sinusitis is considered by many adults to be a minor illness. It

needs to be treated, however, because it can have serious complications if the infection spreads from the sinuses to invade the facial bone (osteomyelitis) or the middle ear (otitis media). Chronic sinusitis can also interfere with school and social interactions because of the constant pain.

Children with acute sinusitis are usually managed in the primary care setting, with the goals of treatment being to eradicate the infection, prevent complications, and provide symptomatic relief [16]. Otolaryngologic consultation is not necessary in most cases but should be obtained for continued worsening of symptoms in spite of appropriate antibiotic therapy, recurrent episodes of sinusitis, persistence of symptoms after two courses of antibiotic therapy, comorbid immunodeficiency, nosocomial infection, or complications of sinusitis. Ophthalmologic or neurosurgical consultation should be obtained when orbital or intracranial complications develop. The goals of management of acute sinusitis include providing adequate drainage of secretions and selecting appropriate systemic treatment of the likely bacterial pathogens.

Ostiomeatal obstruction is the predisposing condition in the pathogenesis of most patients with acute sinusitis. Restoring patency of the affected sinus ostium is of paramount importance when managing these patients and can be achieved by medical and surgical means.  $\alpha$ -Adrenergic topical vasoconstrictors, such as phenylephrine hydrochloride or oxymetazoline hydrochloride, provide an excellent local vasoconstrictor effect, but should only be used for 3 to 5 days because of the risk of rebound congestion, vasodilation, and rhinitis medicamentosa when used for longer periods. Oral decongestant therapy has not been found to be more effective than placebo in children with acute sinusitis but may be used for symptomatic relief of common cold symptoms.

## Conclusion

Chronic sinusitis is a term used when sinusitis lasts longer than three months. This form of inflammation is the result of acute sinusitis that is untreated and/or inadequately treated. If the inflammatory process lasts longer than three months, there is an irreversible disorder of sinus drainage, as well as other immunobiochemical changes of the sinus mucosa. The main problems that occur in a chronic inflammatory condition are persistent squeezing of secretions, which occurs mostly behind the nose into the throat, indefinite pain of lower intensity in the sinuses and a long-lasting subfebrile condition. Due to the proximity of the paranasal sinuses to the brain and eyes, acute bacterial sinusitis can cause serious complications: periorbital and orbital cellulitis, meningitis, cavernous sinus thrombosis, subdural empyema, epidural abscess and brain abscess.

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