# Sinusitis

## Understanding the current rationale of treatment

**The management of sinusitis has altered dramatically in the last decade, offering new hope to sufferers. There is a clearer understanding of the pathophysiology of sinus disease and new investigative technology. New surgical skills have allowed restoration of ventilation and drainage of the sinuses with functional endoscopic sinus surgery.**

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Sinusitis is a common health care complaint. While acute sinusitis is a relatively easy to diagnose entity, chronic sinusitis can be a challenge, as it tends to mimic several other conditions – from neurological to ophthalmological to rheumatoid to dental. As a result, patients may visit several specialists and the condition tends to be underdiagnosed. Further, many patients with asthma fail to respond to appropriate therapy until sinusitis is diagnosed and treated.

A recent survey conducted in the USA revealed that only 67% of female and 48% of male sinusitis sufferers will see a doctor and that patients will wait six to seven days with 'sinus symptoms' before seeing a doctor.[1] The survey also found that:

- 81% of patients were cured by antibiotics alone
- Up to 40% of patients did not complete the prescribed course of medication
- 28% of patients had more than two attacks of sinusitis per year, mainly due to noncompliance
- 37% of family medical practitioners reported that sinusitis was 'somewhat difficult' to diagnose.

What can be done to improve current diagnosis and therapy and make it more precise?

Also, millions of dollars are spent on 'cold' products annually, several of which contain antihistamines even though histamine levels do not rise during symptomatic respiratory tract infections. Can this money be put to better use?

## Understanding sinusitis

### The functional ostiomeatal complex

Advances in immunology and allergy, imaging techniques, and endoscopic technology have challenged the traditional concepts of sinus disease. It is now known that the location rather

**IN SUMMARY**

- Sinusitis may be underdiagnosed in both children and adults.
- Occlusion of the sinus ostia initiates the sinusitis cycle which, if untreated, leads to the development of chronic sinusitis; ostial blockage creates an ideal culture medium within the sinus; keeping the ostial passages open is essential to allow resolution of sinusitis.
- New methods – nasal endoscopy and CT scanning – can help evaluate patients with both acute and chronic sinusitis. Nasal endoscopy should be performed before CT scanning.
- First-line treatment involves antibiotics and decongestants to control infection, reduce tissue oedema, facilitate drainage and maintain ostial patency.
- Functional endoscopic sinus surgery offers new hope of permanent symptoms relief and possible cure.

than the extent of disease is of major importance symptomatically and diagnostically. Long thought to be the main culprit in recurrent acute or chronic sinusitis, maxillary sinusitis is now known to be secondary in most cases to disease within the so-called ostiomeatal complex.

The functional ostiomeatal complex is defined as the area bounded by the medial orbital wall and the middle turbinate. It includes all of the narrow spaces in the middle meatus that are subject to closure by oedema. Even a minor swelling in this crucial area can result in obstruction and significant symptoms. The resulting reduced aeration and accumulated secretions in the major maxillary and frontal sinuses predispose to infection. Figure 1 shows a cadaver dissection of paranasal sinuses.

## Mucociliary clearance

The well-documented primary physiological roles of the nasal passages include humidification, warming and removal of particulate matter from the inspired air. However, until recently, the role of mucociliary clearance was less well defined.

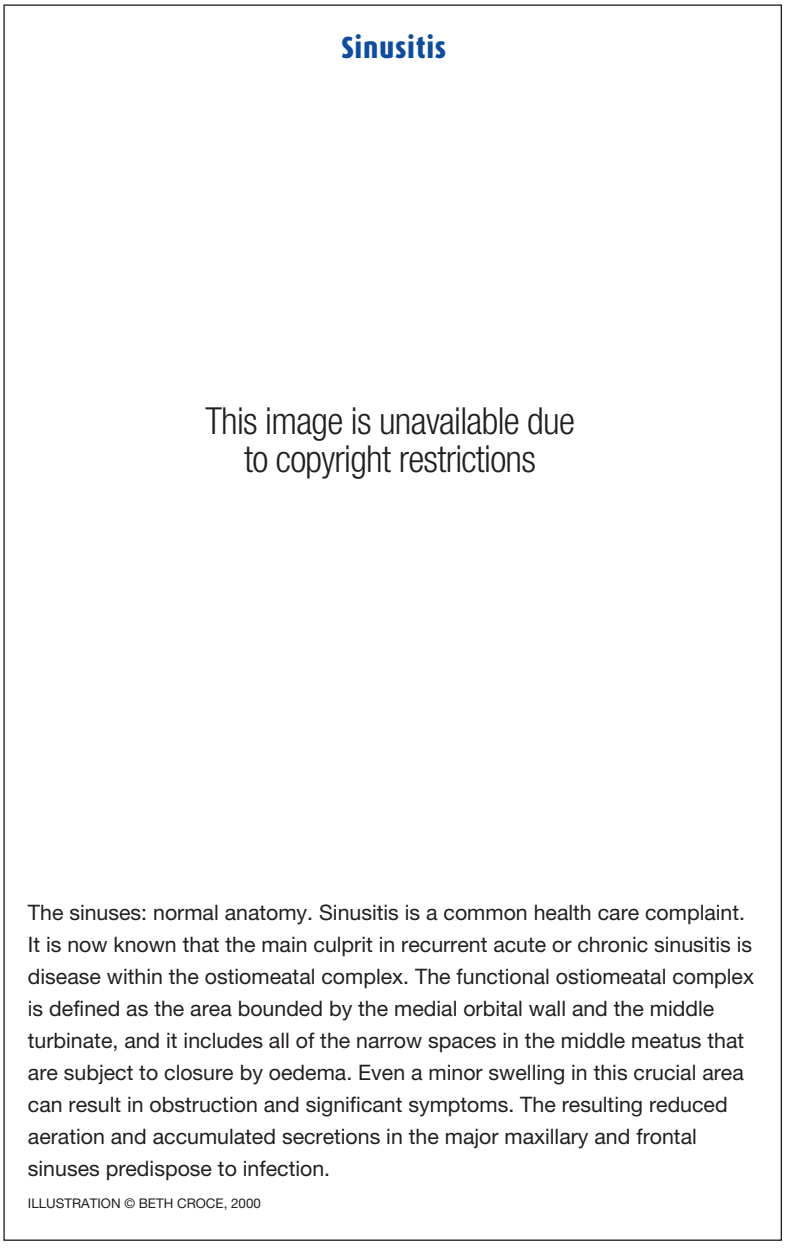
The thin layer of mucus covering the inner surface of the sinuses receives the largest deposits of inhaled particulate matter. Here, in genetically predetermined pathways, the cilia and the thin mucus layer are in constant motion towards the sinus ostia. This mucus is ultimately transported to the pharynx and swallowed. If this transport of mucus, debris and bacteria is impaired, the sinus becomes susceptible to infection.

Mucociliary clearance in the frontal sinus progresses along the interfrontal septal wall to the sinus roof, then moves laterally along the roof and medially along the floor towards the ostium (Figure 2a). Mucus backflow resulting from recirculation in the frontal recess may be a cause of initial infection.

In the maxillary sinuses, mucociliary movement is again toward the ostium. It starts at the sinus floor and radiates along the wall of the sinus superiorly and then towards the ostium (Figure 2b).

Normal ciliary function, an intact mucous membrane and normal mucus production are essential for proper mucociliary clearance. Further, unobstructed flow through the narrow ostiomeatal complex is essential for mucociliary clearance and ventilation.

**Sinusitis**




The sinuses: normal anatomy. Sinusitis is a common health care complaint. It is now known that the main culprit in recurrent acute or chronic sinusitis is disease within the ostiomeatal complex. The functional ostiomeatal complex is defined as the area bounded by the medial orbital wall and the middle turbinate, and it includes all of the narrow spaces in the middle meatus that are subject to closure by oedema. Even a minor swelling in this crucial area can result in obstruction and significant symptoms. The resulting reduced aeration and accumulated secretions in the major maxillary and frontal sinuses predispose to infection.



## Sinus ostial obstruction

Occlusion of the sinus ostia seems to initiate acute sinusitis. Possible causes of sinus ostial obstruction include:

- local mucosal swelling
- local trauma
- anatomical obstruction.

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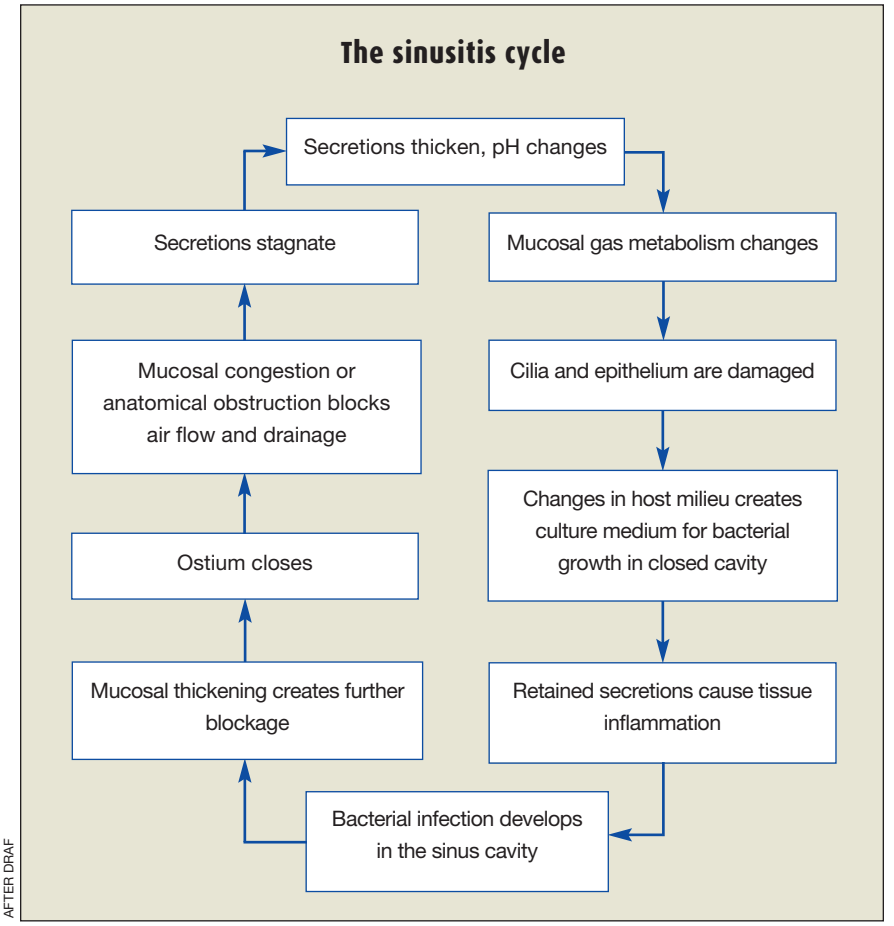



Blockage of the ostia initiates a cycle of events termed 'the sinusitis cycle', leading to symptomatic sinusitis (see the flowchart on this page).

To break the cycle it is essential to reopen and drain the ostia in the ostiomeatal complex.

## Microbiological aspects

Medical tradition has always held the theory that normal healthy paranasal sinuses were sterile. Only recently has this assumption proved false. All sinuses contain some aerobic organisms and some harbour a mixed environment of aerobic and anaerobic organisms. Hence, normal bacterial flora can proliferate as a result of ostial occlusion without introduction of external pathogenic bacteria.

### An altered environment

Functional obstruction of the ostia reduces the oxygen tension within the sinus. The resulting hypoxic, hypercarbic and mildly acidic environment can lead to a change from predominantly aerobic to anaerobic bacterial flora. In addition, the function of the cilia, the sinus mucosa and the bactericidal action of the granulocytes are impaired. The resolution of acute sinus infection is greatly hindered by the oedematous mucosal damage, which further constricts and occludes the ostia.

With bacteria already clearly present in the sinuses, ciliary dysfunction and retention of secretion set the stage for sinus infection. Any of a wide variety of predisposing factors may initiate the process (see later).

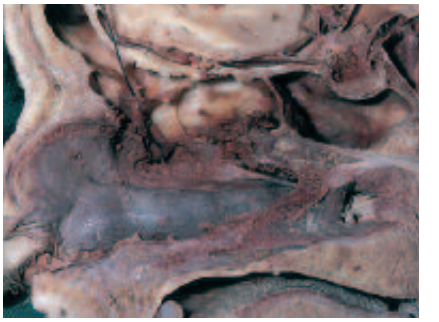


Figure 1. Cadaver dissection of paranasal sinuses.

### Likely organisms

The usually incriminated organisms in acute sinusitis are *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Chronic sinusitis tends to be polymicrobial, and anaerobic streptococci, veillonella, corynebacterium, other anaerobes, and fungi (aspergillus 90%, mucor and candida 5%) may be cultured. The beta-lactamase producers are *H. influenzae*, *M. catarrhalis*, and anaerobes.

In immunocompromised patients, *Pseudomonas aeruginosa*, mycobacteria and aspergillosis may be found. Nosocomial sinusitis may occur in intensive care units during prolonged intubation – the usual organisms are *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, enterobacter, proteus and staphylococci.

## Predisposing factors

There is now also better recognition of general and local predisposing factors for the development of sinusitis (see Table 1 and below). Nasal allergies, smoking, pollution and familial predisposition are particularly well-recognised predisposing factors. Iatrogenic causes include rhinoplasty operations that have been performed without an understanding of the functional anatomy of the nose.

### Systemic factors

Immune deficiencies, like AIDS, are potential causes of sinusitis and may

manifest with some subtlety. Up to 30% of patients with AIDS have sinusitis.

Other systemic predisposing factors include:

- cystic fibrosis – where the tenacious mucus tends to clog the sinus ostia
- immotile cilia syndrome – which predisposes to mucus retention, closure of ostia and sinusitis
- gastro-oesophageal reflux disease (GORD) – possibly as a result of damage to the mucous membrane and subsequent oedema
- Down syndrome
- Samter's triad (nasal polyposis, aspirin intolerance and asthma)
- pregnancy – complicated by a six-fold increase in the incidence of sinusitis; the associated hormonal milieu may be contributory
- hypogammaglobulinaemia.

### Local factors

Local predisposing factors for sinusitis include upper respiratory tract infections, allergic rhinitis, overuse of topical decongestants, nasal obstructive lesions, and dental abnormalities.

### Childhood sinusitis

Only the ethmoid and maxillary sinuses are present at birth. The ethmoid sinuses are fully developed at approximately 14 years of age and the maxillary sinuses reach full size with the appearance of all the maxillary teeth, sometime during adolescence. The maxillary and ethmoid sinuses are hence the sites of infection in early childhood.

The sphenoid sinus develops after 2 years of age, and the frontal sinuses begin to develop from the ethmoid air cells into the frontal bone by around the age of 6 years.

Infections specific to these sinuses occur after the age of 8 years.

Overall, the incidence of acute sinusitis in children less than 5 years old is significantly higher than in children more than 12 years of age.

### Acute v. chronic sinusitis

If untreated or inadequately treated, acute sinusitis (less than three weeks duration) can lead to subacute and then to chronic sinusitis (more than three months duration).

It is now accepted that chronic sinusitis is generally associated with an anatomical derangement, particularly of the ostiomeatal complex area, the focus point for both ethmoid and maxillary sinus disease. In children, adenoidal hypertrophy and infection play a probable similar role in chronic sinusitis.

## Clinical features

As a result of the interdependence of the sinuses, sinusitis is rarely limited to one sinus and symptomatology may be diffuse.

### Symptoms

Symptoms of acute sinusitis in adults and in childhood are listed in Table 2.

The inferential diagnosis of acute sinusitis is relatively easy compared with that of chronic sinusitis, which may mimic many other conditions that occur

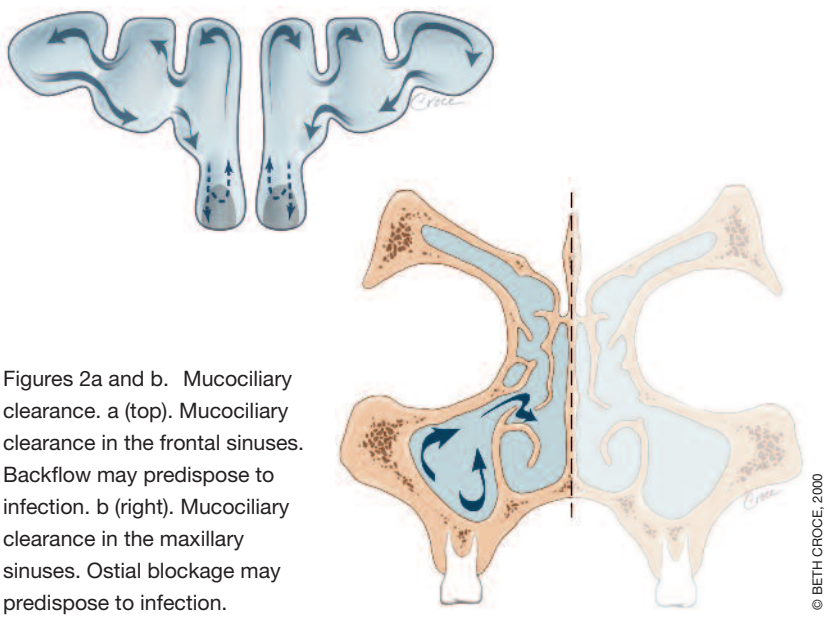
**Table 1. Sinusitis: predisposing factors**

**Systemic**

- cystic fibrosis
- immotile cilia syndrome
- immune deficiency
- family history of allergies
- bronchiectasis
- gastro-oesophageal reflux disease
- stress

**Local**

- upper respiratory tract infection
- nasal allergy
- overuse of topical decongestants
- deviated nasal septum
- nasal polyps
- adenoid hypertrophy
- nasal tumours
- foreign bodies
- barotrauma
- cigarette smoke
- other pollutants
- dental problems
- iatrogenic



Figures 2a and b. Mucociliary clearance. a (top). Mucociliary clearance in the frontal sinuses. Backflow may predispose to infection. b (right). Mucociliary clearance in the maxillary sinuses. Ostial blockage may predispose to infection.

**Table 2. Presenting symptoms of acute sinusitis**

**Adults**

- nasal congestion
- purulent rhinorrhoea
- frontal or medial canthal pain
- periorbital pain
- temporal headache
- antral pain
- toothache
- fever
- daytime cough

**Children**

- rhinorrhoea lasting for more than 10 days
- fetid breath
- prominence of cough
- relative lack of pain

in the head and neck. The symptoms of chronic sinusitis are often nonspecific, poorly localised and mild.

### Signs

Nasal examination may reveal a purulent discharge. Causative factors including a deviated nasal septum, foreign body, or enlarged adenoids may be visualised.

Up to 50% of children with sinusitis have associated eustachian tube malfunction complicated by middle ear problems and hence the ear must be carefully examined.

## Investigations

Diagnosis of clinically suspected sinusitis involves a structural, dental, allergic and immunological evaluation, as well as the exclusion of ancillary disease entities (such as dysmotile cilia syndrome) and complications, such as orbital or intracranial extension of the disease.

### Nasal endoscopy

Nasal endoscopy should become a part of the routine examination of patients with sinusitis. This procedure is performed in the office using a 30-degree telescope, which allows a clear, dynamic view of the nasal cavity including the middle meatus and the nasopharynx (Figure 3).

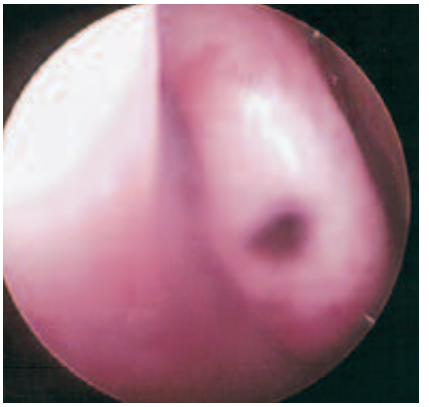


Figure 3. Nasal endoscopy. View of nasal septum, middle turbinate and lateral wall.

Nasal endoscopy also eliminates the need for repeated radiological examinations after medical or surgical therapy.

Endoscopy allows visualisation of:

- mucous membranes
- ethmoid complex (inference)
- drainage
- concha bullosa
- deviated nasal septum
- frontal recess
- eustachian tube opening.

Findings such as septal spurs and a deviating nasal septum obstructing the middle meatus, nasal polyps, mucosal contact between the middle turbinate and uncinate process, hypertrophied inferior turbinates and adenoidal hypertrophy may be missed on inspection of a CT scan but appreciated on nasal endoscopy.

Other indications for nasal endoscopy include nasal obstruction, unexplained headache, longstanding coryza, epistaxis, hyposmia, cranial nerve palsies, chronic pharyngolaryngitis, suspected lesions of postnasal space, rhinoliquorrhoea, epiphora, snoring, chronic cough and posterior cervical glands.

### Imaging

#### Plain x-rays

Plain radiographs of the sinuses still provide a noninvasive, relatively inexpensive and fast evaluation of the lower third of the nasal cavity, maxillary, frontal, posterior ethmoid, and sphenoid sinuses. Plain radiography is inadequate, however, for the evaluation of the anterior ethmoidal air cells, the upper two-thirds of the nasal cavity, and the frontal recess air passages.

#### CT scanning

CT allows the noninvasive evaluation of the deep ostiomeatal complex, posterior ethmoid and sphenoid sinuses (Figure 4). It should be used when endoscopy fails to explain the symptoms of sinusitis and is usually delayed until antibiotic therapy controls the acute infection.

CT scanning shows:

- anterior ethmoid cells
- upper two-thirds of nasal cavity
- frontal recess
- deformed uncinate process
- concha bullosa
- Agger nasi cells (air cells located anteriorly)
- Haller cells (air cells located inferiorly to orbit)
- reverse scroll concha (middle turbinate bends back on itself)
- adenoidal hypertrophy

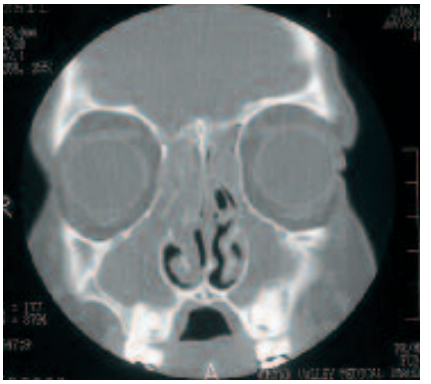


Figure 4. Computed tomography scan showing ethmoid and maxillary sinus involvement.

- orbit
- intracranial extension of infection.

CT not only provides the surgeon with a good anatomical 'map' for surgery but may also help to demonstrate why the patient may have recurring symptoms – in other words to show exactly where surgical correction may be effective.

Approximately 20 to 30% of the normal population will demonstrate areas of mucosal thickening at CT evaluation. CT findings should therefore be corroborated by diagnostic endoscopy and the patient's history. It is also important to point out that very localised minor disease in a critical area can cause severe symptoms, often much more severe than when diffuse mucosal thickening is present.

### Magnetic resonance imaging

MRI is more sensitive than CT in detecting fungal infections, perhaps because of the presence of calcium and ferromagnetic elements in fungal concretions. In addition to its superior soft tissue resolution, MRI can differentiate neoplastic processes from inflammatory disease in most patients.

However, MRI does have limitations in evaluating sinusitis. During the oedematous phase of the nasal cycle, normal nasal mucosa may appear pathological on T2-weighted images. Further, some individuals are able to consciously alter nasal flow and induce changes within the ethmoid sinus – well known in yoga practice. Considerations such as these may account for some of the 10 to 20% of adults referred for a MRI scan of the brain who show asymptomatic sinus disease.

## Management

The guiding principle of management has become the reversal of the 'sinusitis cycle' initiated in the ostiomeatal complex. This leads to reventilation, drainage and recovery of the major frontal and maxillary sinuses. As well as maintaining patency of the sinus ostia, promoting drainage and reducing tissue oedema, the aims of treatment must include the control of infection and symptomatic relief.

Cost effectiveness must always be a consideration, and effective treatment

**Table 3. Sinusitis: antimicrobial therapy**

| Antibiotic | Effective against | Comments |
|---|---|---|
| Amoxycillin (Alphamox, Amohexal, Amoxil, Bgramin, Cilamox, Moxacin, SBPA Amoxycillin) | Streptococci<br>Pneumococci<br>Most *Haemophilus influenzae* | • Cheap, safe and effective first-line therapy<br>• High cure rate accounted for partly by spontaneous cure |
| Amoxycillin–clavulanate (Augmentin, Ausclav, Clamoxyl) | *H. Influenzae*<br>*Moraxella catarrhalis*<br>*Escherichia coli*<br>Bacteroides and other anaerobes | • Effective against beta-lactamase producers<br>• Taken with food to avoid gastrointestinal upset |
| Cefuroxime axetil (Zinnat) | *H. Influenzae*<br>*M. catarrhalis* | • Effective against beta-lactamase producers<br>• Avoid in penicillin-sensitive individuals |
| Roxithromycin (Biaxsig, Rulide) | *Streptococcus pneumoniae*<br>*M. catarrhalis*<br>*Staphylococcus aureus*<br>*Mycoplasma pneumoniae* | • Effective against beta-lactamase producers<br>• Use with care in patients taking theophylline or digoxin |
| Trimethoprim–sulfamethoxazole (Bactrim, Cosig Forte, Resprim, SBPA Sulfamethoxazole and Trimethoprim, Septrin) | *S. pneumoniae*<br>*H. influenzae*<br>*M. catarrhalis*<br>*S. aureus*<br>Enterobacteria | • Effective against beta-lactamase producers<br>• Use with care in patients with glucose-6-phosphate dehydrogenase deficiency |

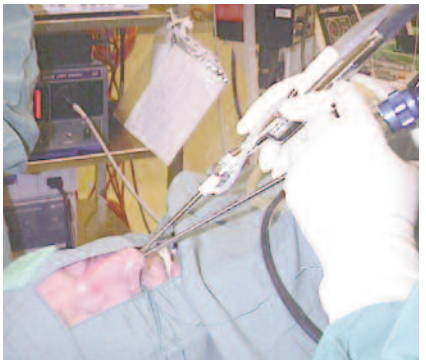


Figure 5. Functional endoscopic sinus surgery in progress.

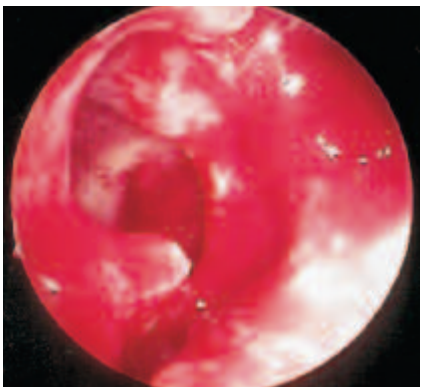


Figure 6. Middle meatal antrostomy as performed during functional endoscopic sinus surgery.

will reduce the need for future examinations and treatments, lead to savings in pain and inconvenience, and a reduction in absenteeism.

## Antimicrobial therapy

The goals of antimicrobial therapy are to:

- relieve symptoms of acute illness
- prevent subacute morbidity
- forestall the development of chronic sinusitis
- prevent intracranial complications, such as meningitis and brain abscess
- avoid antibiotic overuse.

The choice of first-line antibiotic is determined by the most likely organism (see Table 3), antibiotic resistance and whether or not the patient has a history of penicillin allergy.

Anaerobic bacteria are found in 10% of acute sinus infections and in 88% of chronic sinus infections. Anaerobic bacteria predominate in sinusitis of dentogenic origin. Dental amalgam may enter the sinus and promote the growth of *Aspergillus fumigatus*.

Due to resistant organisms, antibiotics not recommended in sinusitis include penicillin, erythromycin, cephalexin and tetracycline. The resistance of *H. influenzae* to cefaclor (Ceclor, Keflor, Vercef) is rising. Also, with cefaclor an illness like serum sickness has been reported in children up to six months after therapy.

Roxithromycin may decrease the viscosity of mucus.

About 40 to 50% of proven acute sinusitis resolves spontaneously. Despite this, in uncomplicated acute sinusitis, amoxycillin is an appropriate first-line antibiotic. If the patient is penicillin-sensitive, a trimethoprim–sulfamethoxazole combination could be used. (These antibiotics could be prescribed for a period of two weeks in responders.) Amoxycillin–clavulanate and roxithromycin are appropriate second-line antibiotics.

In subacute and chronic sinusitis, a four week course of antibiotics is suggested if there is a response to the prescribed agent. Amoxycillin–clavulanate is an appropriate first-line choice. If the patient is penicillin-sensitive, roxithromycin could be used. In amoxycillin–clavulanate nonresponders, roxithromycin may be used as a second-line agent.

## Adjunctive therapy

### Decongestants

To meet the management goals for acute sinusitis, decongestants are necessary – they can reduce tissue oedema, facilitate drainage and help to maintain the patency of ostia.

Topical decongestants include tramazoline (Spray-Tish), oxymetazoline (Chemists' Own Decongestant Nasal Spray, Dimetapp 12 Hour Nasal Decongestant Spray, Drixine Nasal, Logicin Rapid Relief Nasal Spray), and xylometazoline (Otrivin) sprays.

These may be used to a maximum of four days to avoid risk of rebound vasodilatation. When longer usage is required, oral decongestants (ie. pseudoephedrine) must be used with appropriate caution.

### Steroids

Topical or systemic steroids can be helpful in reducing mucosal swelling in patients with chronic sinusitis who have allergies and polyps. The topical potency of budesonide (Budamax, Rhinocort) is twice that of beclomethasone dipropionate (Aldecin Hayfever Aqueous Nasal Spray, Aldecin Nasal, Beconase AQ); the systemic potency of budesonide is also 2.5 times lower. Oral steroids may prove useful in the more severe circumstances.

However, steroids are not first-line treatment for acute sinusitis.

### Antihistamines

Antihistamines have not proved effective in the management of acute sinusitis and are not usually indicated as symptomatic or adjunctive therapy. The appropriate role of antihistamines is for the treatment of allergic manifestations. Moreover, antihistamines can lead to further mucus inspissation and clogging.

### Nonpharmacological agents

Some physicians may scoff at nonpharmacological measures and dismiss them as folklore. Garlic does have an active ingredient, n-allylthiosulphinate, that provides a short-lived decongestant effect. Horseradish is another remedy often claimed by patients to be effective in 'clearing the sinuses'. No scientific data is available to support these claims.

The following measures are short-lived in effectiveness and must be repeated as symptoms recur:

- Steam inhalation – provides effective symptomatic relief; various astringents (e.g. eucalyptus oil) may be added
- Saline sprays (Fess, Narium Nasal Mist) – help to liquify secretions and moisturise the nasal mucosa
- Mucoevacuants (e.g. bromhexine hydrochloride [Bisolvon]) – reduce mucus viscosity and may be of some benefit to some patients
- Aspirin and nonsteroidal anti-inflammatory agents – provide pain relief, bearing in mind that sensitivity occurs in some patients with sinusitis, gastrointestinal bleeding may occur in some adults, and there is a risk of Reye's syndrome in childhood.

### Functional endoscopic sinus surgery

The aims of therapy should go beyond the resolution of the immediate infection and address the possible development of chronicity. Chronic sinusitis is mainly a disease of obstruction, with inflammation as a secondary manifestation. For patients with chronic sinusitis that fails to respond to antibiotic therapy and for recurrent acute sinusitis associated with abnormalities of the ostiomeatal complex, functional endoscopic sinus surgery offers real hope of permanent relief from the symptoms of sinusitis (Figure 5).

Precise indications for functional endoscopic sinus surgery are difficult to define, making strict criteria impossible to list, however surgery should be considered when:

- chronic sinusitis fails to respond to appropriate medical therapy
- recurrent acute sinusitis is known to be related to abnormalities of the ostiomeatal complex.

The primary surgical approach is now focused on the area of the middle meatus and the ostiomeatal complex, leaving the maxillary and frontal sinus mucosal involvement to eventually resolve. The change from the past has been away from the radical stripping of sinus mucosa towards re-establishing ventilation and drainage and allowing the secondarily involved mucosa to recover over time (see Figure 6). The development of new instrumentation has thus centred on mucosal sparing.

Extension of this technique now also allows otorhinolaryngologists to do nasal endoscopic dacrycystorhinostomy, pituitary surgery, and optic nerve and orbital decompressions with a significant decrease in morbidity.

## Conclusion

The functional ostiomeatal complex is now known to be of major importance in acute and chronic sinusitis. Even a minor swelling in this crucial area can result in significant symptoms. Unalleviated acute sinusitis can progress to chronic disease. Maintaining patency of the sinus ostia is essential to allow resolution of sinusitis.

If antimicrobial and other adjunctive medical measures cannot achieve this, functional endoscopic sinus surgery may offer hope of permanent relief of symptoms. MT

## Reference

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## Further reading

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