

Classification, diagnosis and treatment of sinusitis: Evidence-based clinical practice guidelines

Arnold Noyek MD (Chair), David Brodovsky MD, Stephen Coyle MD, Martin Desrosiers MD, Saul Frenkiel MD, Michael Hawke MD, James D Kellner MD, David A Kirkpatrick MD, Sigmund Kraiden MD, Donald E Low MD, Lionel Mandell MD, Bernard Marlow MD, Gerald F Martin MD, Richard Rival MD, Lalitha Shankar MD, David Vaughan PhD, Ian J Witterick MD

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OBJECTIVE: To provide evidence-based recommendations for classification, diagnosis and treatment of acute, chronic and recurrent acute sinusitis in adults and children.

DATA SOURCES: Review articles, textbooks, other published guidelines and recommendations of task force members.

STUDY SELECTION: One hundred and seventy-one papers addressing one or all of the objectives.

DATA EXTRACTION: Relevant data were collated under each objective.

DATA SYNTHESIS: Validity of diagnostic and treatment evidence was assessed by using the methodological recommendations of Sackett et al and the Canadian Task Force on Periodic Health Examination, respectively. Where there was a paucity of data, consensus of task force members was reached.

CONCLUSIONS: Sinusitis is classified as acute, chronic or recurrent acute disease according to duration and frequency of symptoms and response to therapy (expert opinion). Potential risk factors, concomitant diseases and complications are identified (limited evidence). Diagnosis is based on symptoms, history and physical examination. For adults, independent predictors of acute sinusitis include maxillary toothache, coloured nasal discharge, poor response to nasal decongestants/antihistamines and mucopurulent nasal secretions (good evidence); for children, cough, nasal discharge and fever are common (good evidence). For chronic disease that persists despite adequate therapy and recurrent acute disease, referral to a specialist for investigative measures (nasal endoscopy, computed tomography) is often necessary to determine predisposing anatomical features. Level I evidence supports the use of antibiotics for the treatment of sinusitis; selection is based on the local pattern of bacterial resistance, relative efficacy, safety and cost. Amoxicillin-clavulanate, cefuroxime axetil, cefixime, ciprofloxacin and clarithromycin are approved for the treatment of acute sinusitis in Canada. Amoxicillin, amoxicillin-clavulanate and cefuroxime axetil have been shown to be effective in children. Ciprofloxacin, amoxicillin-clavulanate, clarithromycin and erythromycin have been shown to be effective in chronic disease, although no agents have been approved for this indication. Given changing patterns of bacterial resistance, more up-to-date comparative efficacy data are needed.

Key Words: *Acute sinusitis, Chronic sinusitis, Paediatric sinusitis, Recurrent acute sinusitis, Sinusitis*

Correspondence: Dr Arnold Noyek, Mount Sinai Hospital, 401-600 University Avenue, Toronto, Ontario M5G 1X5. Telephone 416-586-8533, fax 416-586-8600, e-mail cptrato@mtsina.on.ca

Classification, diagnostic et traitement des sinusites : Lignes directrices de pratique clinique basées sur les données

OBJECTIF : Fournir des recommandations basées sur les données pour la classification, le diagnostic et le traitement de la sinusite aiguë et chronique et de la sinusite aiguë récidivante, chez les adultes et les enfants.

SOURCES DES DONNÉES : Articles de synthèse, manuels, autres lignes directrices publiées et recommandations des membres du groupe d'étude.

SÉLECTION DES ÉTUDES : Cent soixante et onze articles portant sur un ou sur l'ensemble des objectifs.

EXTRACTION DES DONNÉES : Des données pertinentes ont été collationnées sous chaque objectif.

SYNTHÈSE DES DONNÉES : La validité des données relatives au diagnostic et au traitement a été évaluée respectivement selon les recommandations méthodologiques de Sackett et coll. et par le *Groupe d'étude canadien sur l'examen médical périodique*. Là où les données étaient rares, les membres du groupe d'étude sont parvenus à un consensus.

CONCLUSIONS : La sinusite est classifiée comme une affection aiguë, chronique ou aiguë récidivante d'après la durée et la fréquence des symptômes et la réponse au traitement (opinion des experts). Les facteurs de risque potentiel, les maladies concomitantes et les complications sont identifiées (valeur des données limitée). Le diagnostic est basé sur les symptômes, les antécédents et l'examen physique. Pour les adultes, les facteurs de prédiction indépendants de la sinusite aiguë comprennent l'algie dentaire au niveau maxillaire, une rhinorrhée colorée, l'inefficacité des décongestionnants/antihistaminiques et une rhinorrhée purulente (bonne valeur des données). Pour les enfants, la toux, la rhinorrhée et la fièvre sont des symptômes courants (valeur adéquate des données). Pour la sinusite chronique qui persiste malgré un traitement adéquat et la sinusite aiguë récidivante, il est souvent nécessaire d'adresser les patients à un spécialiste pour qu'ils subissent des tests (endoscopie nasale, tomodensitométrie) afin de déterminer les facteurs anatomiques prédisposants. Les données de niveau 1 appuient l'utilisation d'antibiotiques pour le traitement de la sinusite ; la sélection des antibiotiques est basée sur le schéma local de résistance bactérienne, l'efficacité relative, l'innocuité et le coût. L'amoxicilline-clavulanate, le céfuroxime axétil, le céfixime, la ciprofloxacine et la clarithromycine sont approuvés pour le traitement de la sinusite aiguë au Canada. L'amoxicilline, l'amoxicilline-clavulanate et le céfuroxime axétil ont démontré leur efficacité chez les enfants. La ciprofloxacine, l'amoxicilline-clavulanate, la clarithromycine et l'érythromycine ont démontré leur efficacité pour la sinusite chronique, même si aucun agent n'a été approuvé pour cette indication. Vu les schémas changeants de la résistance bactérienne, il apparaît nécessaire d'avoir plus de données comparatives et actuelles sur l'efficacité.

Sinusitis is one of the most common medical complaints (1-3), and it is increasing in prevalence in all age groups including children and the elderly (2). Minimal data are available on the incidence of sinusitis in Canada. However, the incidence rate can be extrapolated from data compiled in the United States, where between 13% and 14% of those surveyed indicated that they suffered from sinusitis (4,5).

Of sufferers who seek medical intervention, close to 90% of visits are made to primary care physicians (1,3). Almost all patients are prescribed medication for the treatment of their sinus condition. However, treatment failure is common, primarily because of incorrect selection or inadequate use of an appropriate agent (1-3). Approximately two-thirds of prescriptions are for antihistamine-containing products, despite considerable evidence that these agents do not address treatment of the offending organism. Meanwhile, cure rates as high as 100% have been observed in clinical trials when an appropriate combination of therapies is used in adequate doses. Clearly, information about newer strategies that have proven successful in the management of sinus disease have not been communicated effectively to general practice physicians.

Over the past five to 10 years, significant technological advances have been made in the fields of nasal endoscopy and computed tomography (CT). These technological advances, combined with data obtained from sinus puncture studies, have greatly increased the understanding of the pathophysiology of sinusitis, dramatically improved diagnostic ability, and subsequently changed many traditional attitudes and approaches in the treatment of sinusitis. It is now known that obstruction in the ostiomeatal complex is of primary importance in the pathophysiology of sinusitis (6,7). In addition, common community-acquired infections, both bacterial and viral, are likely to play a primary role in the development of

acute sinusitis (1-3), while allergy may play a role in chronic disease (8,9). Thus, two of the major goals in the management of sinusitis are to achieve and maintain patency of the ostiomeatal complex and to eradicate infection through appropriate antimicrobial therapy.

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- to eradicate infection through appropriate antimicrobial therapy.

The following guidelines on the classification, diagnosis and treatment of sinusitis were developed for use by Canadian clinicians. Each of acute, chronic, recurrent acute and paediatric disease has been reviewed. The recommendations were prepared by a multidisciplinary team over the course of four separate meetings held in July and September 1995, April 1996 and May 1997. Task force members included general practitioners, otolaryngologists, infectious disease specialists, microbiologists and radiologists. A paediatrician was consulted to review sections with paediatric content. Wherever possible, the consensus recommendations for the diagnosis and treatment of sinusitis were based on evidence obtained from published medical research. Evidence was taken from reference papers listed in review articles and other published guidelines, as well as papers recommended for consideration by individual members of this task force. The validity of the diagnostic and prognostic evidence (including complications) was assessed by using the methodology of Sackett et al (10).

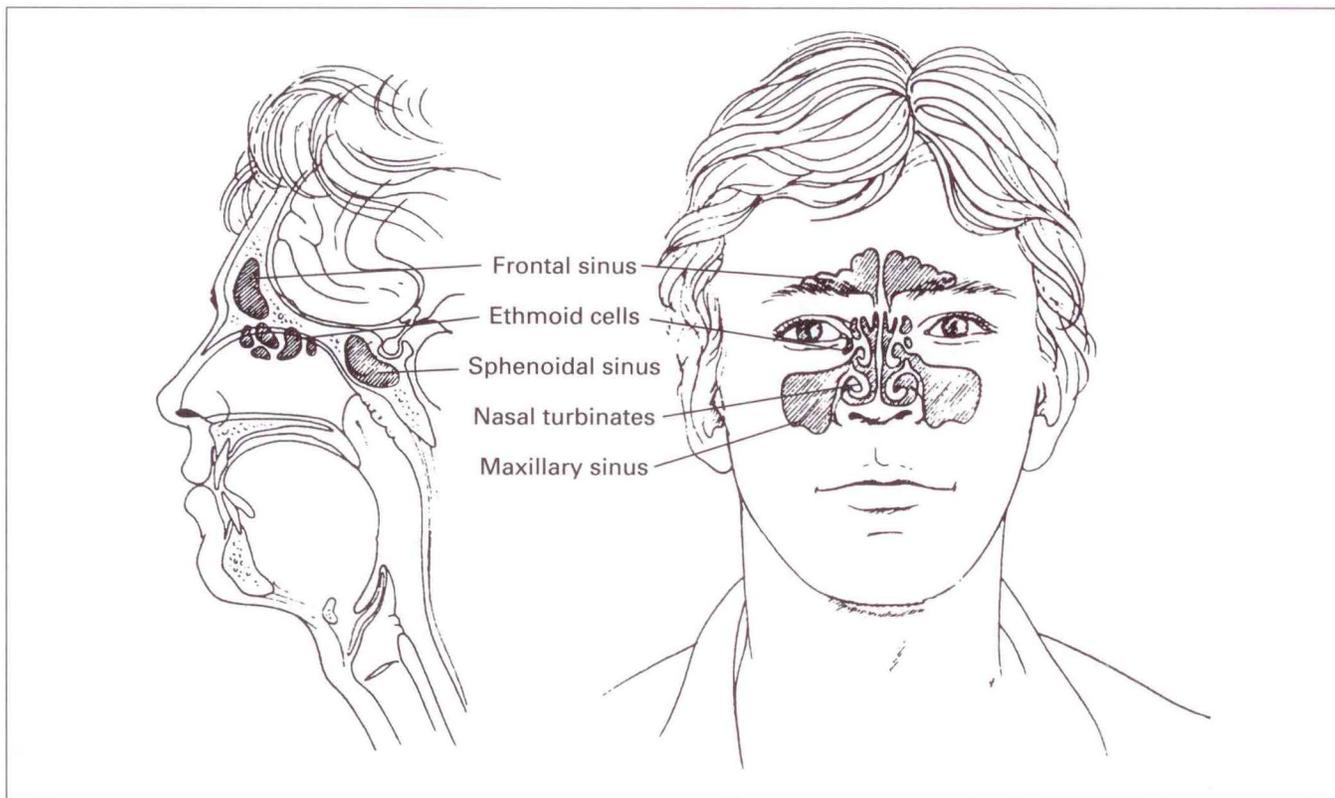


Figure 1) Lateral and anterior views of the paranasal sinuses. Reprinted with the permission of Appleton and Lange Inc from reference 81

Evidence for the treatment of sinusitis has been graded in accordance with the methodology set forth by the Canadian Task Force on the Periodic Health Examination for developing clinical practice guidelines (Appendix 1) (11). Where scientific data were lacking, as was the case for the classification criteria, recommendations were based on the opinions of the authors. Consideration was also given to the recommendations of other expert committees (1-3,6,12-19).

ANATOMY AND PATHOPHYSIOLOGY OF SINUSITIS

Anatomy: A better appreciation of the anatomy of sinus drainage is key to understanding sinusitis. Since the use of endoscopic sinus surgery and with the introduction of CT of the sinus, the anatomy of the sinus drainage tracts and the importance of drainage in the pathogenesis of sinus disorders are better understood (6,20,21).

The paranasal sinuses are epithelium-lined structures, opening laterally off the nasal passages. They comprise eight paired structures: two each of maxillary, frontal, sphenoid and ethmoid sinuses (Figure 1). The sinuses drain through narrow passages called sinus ostia. These are situated in the lateral nasal wall of the nasal passages, lateral to the region of the middle turbinates (Figure 2). In this location, they cannot be visualized with a nasal speculum, and nasal endoscopy is required. The ostiomeatal complex is bordered medially by the middle turbinate, inferiorly by the unciniate process and laterally by the nasal wall (Figure 3). It is through this region that the principal drainage of the sinuses occurs. This area is also adjacent to the region of maximal airflow, at the head of the

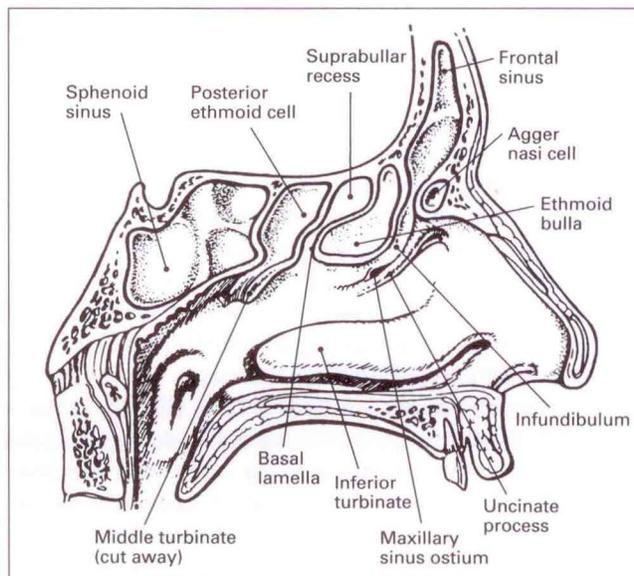


Figure 2) Sagittal view of the paranasal sinuses. Reproduced with permission from reference 121

middle turbinate. Over 50% of nasally inspired air courses over this region (22), and airborne particles are frequently deposited in this area. Any blockage of this region leads to obstruction of sinus drainage and potential development of sinusitis.

In the paediatric population, the midface structures are in the process of development, and, therefore, sinus anatomy is not the same as in the adult population (23-27). The maxillary

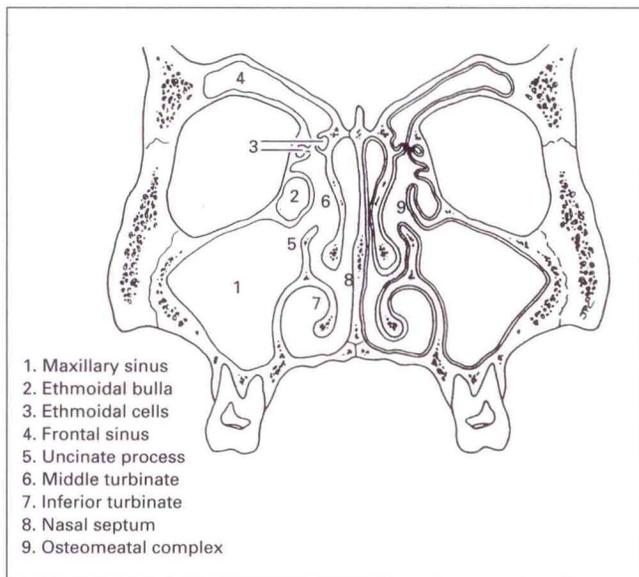


Figure 3) Coronal view of the paranasal sinuses. Reproduced with permission from reference 80

and ethmoid sinuses are evident at birth (24-27) and are the source of problems in the infant, toddler and child; these sinuses are fully developed at three years of age (25). The sphenoid and frontal sinuses are apparent around the ages of three years and three to eight years, respectively (25-27); they are both fully developed by age 12 years (25). In young children, the sinuses are relatively shallow and the ostia are quite wide (26). As adolescence approaches, all sinuses expand and develop to become adultlike (24,25).

Function: Knowledge of the function of an organ is often useful in understanding a disease process. Several reasons for the existence of the sinuses have been proposed. These include producing mucus, influencing resonance, lightening the skull, insulating the brain from temperature changes in the aerodigestive tract or protecting the brain from trauma. However, none of these hypotheses has been proven correct; the function of the paranasal sinuses remains a mystery. Nonetheless, the study of histology and normal physiology of the nose is helpful in understanding modifications in disease.

Ultrastructure: Sinuses are lined with a ciliated, pseudo-stratified respiratory-type epithelium that is thinner than the nasal mucosa. As in the nasal mucosa, serous and mucinous glands, blood vessels and nerve endings are all present, if in reduced numbers (28). Nasal and sinus epithelium are covered with a fine layer of mucus, which has a functional and a protective role. Normal secretion of the mucus-secreting glands is between 500 mL and 10,000 mL per 24 h period. Lysozyme, immunoglobulin A and lactoferrin are present in normal sinus secretions; they have an important defensive role (29).

This mucus exists in two layers – superficial and deep – that act independently of each other. The deep layer surrounds the cilia, is thinner and seems to act as a lubricant for the cilia that beat through it. The cilia project slightly beyond the deep layer into the superficial layer. The superficial portion floats upon the deeper layer and is actively transported by the cilia. It is more mucoid and is involved in trapping particulate mat-

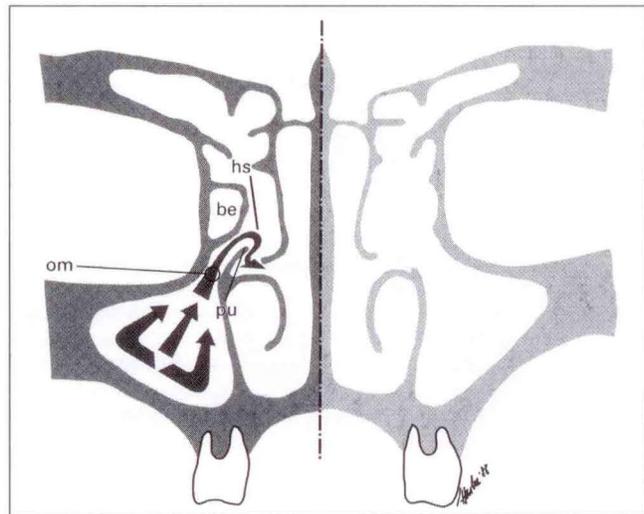


Figure 4) Normal transportation pathways of mucus moving out of the maxillary sinus. Reproduced with permission from reference 30. *be* Ethmoidal bulla; *hs* Hiatus semilunaris; *om* Maxillary ostium; *pu* Uncinate process

ter. The cilia are oriented so as to transport this superficial layer of mucus towards the ostium of the sinuses. This effect has been studied best in the maxillary and frontal sinuses. In the maxillary sinus, mucociliary transport is directed from the base of the sinus and upwards, against gravity, to the natural ostium of the sinus situated superomedially (Figure 4) (30).

It has recently been shown that the paranasal sinuses are also an important site for production of nitric oxide, a neurotransmitter (31). While the exact implications of this finding are not known, nitric oxide influences ciliary motility, has an antiviral effect and may have an important role in host defence against infection.

Pathophysiology: Obstruction of sinus drainage by the narrowing of drainage pathways is believed to be the initiating event in the development of acute sinus infections (Figure 5) (32). This belief is supported by the fact that inoculation of a sinus cavity with a virulent micro-organism in the absence of obstruction is insufficient to produce sinusitis (33).

It is thought that obstruction alters local defence mechanisms and furnishes an environment more favourable to bacterial overgrowth (21). Exactly how this occurs is unknown. It is known that obstruction interferes with mucociliary transport and with clearance of secretions, allowing stagnation and accumulation of secretions within the sinus. After a brief initial increase, pressure within the occluded sinus drops (34) and oxygen content decreases (35). This condition may favour formation of transudates or exudates. A preceding viral infection causes epithelial damage, weakens mucosal defences and facilitates penetration of the bacteria into the sinus mucosa (36).

The histopathological changes that occur following infection have been learned from observations from the rabbit model. In the rabbit model, inoculation of bacteria (*Streptococcus pneumoniae*, *Staphylococcus aureus* and *Bacteroides fragilis*) into an obstructed maxillary sinus leads to development of acute sinusitis. Characteristic histopathological

changes include the development of edema, dilated venules, leukocytic infiltration, and epithelial and squamous cell metaplasia. Mucus-secreting goblet cells – cells not normally found in sinus mucosa – develop. Blood flow to the affected sinus increases, and gas pressure within the affected sinus is reduced in an anaerobic environment (37). Later changes include fibrosis of the lamina propria, gland involution, polyp formation and bone remodelling (38). Curiously, more severe changes are found in the nose, where there is significantly more inflammation and goblet cell development. Ciliary beat frequency is reduced, and nasal transport time prolonged (39). Nothing is known about the effects of occlusion or infection on nitric oxide production by the sinuses. This area may represent an interesting avenue for further research.

The genesis of sinus ostia obstruction may be due to a fixed anatomical obstruction, a swelling of the mucosa or a combination of both (40). Mucosal edema provoked during rhinovirus colds produces a functional ostial obstruction, and this leads to radiological demonstration of sinus opacification in over two-thirds of cases (41). However, only one of 200 patients develops acute sinusitis.

While nasal allergies also contribute to edema and swelling of the nasal mucosa, evidence suggests that allergy has no role in the development of acute sinusitis. In a study from Sweden comparing incidence of upper respiratory tract infections and sinusitis in normal and allergic patients, there was no increase in the frequency or severity of either disease in the allergic population (42). Similar findings were reported by Iwens and Clement (43). Similarly, while nasal polyps may obstruct the ostiomeatal complex as well, patients with nasal polyps rarely develop clinical signs of sinusitis.

A number of anatomical anomalies can obstruct sinus drainage (44). Such restricted areas are more easily obstructed by mucosal swelling. A severely deviated nasal septum may affect the middle turbinate and obstruct the ostiomeatal complex. A pneumatized middle turbinate or a paradoxically curved middle turbinate may also narrow the ostiomeatal complex. An anterior ethmoid cell situated on the roof of the maxillary sinus, called a Haller cell, may obstruct the outflow path of the maxillary sinus.

Recovery from acute inflammation occurs through a combination of local and systemic defence factors, with the mucosal pathology returning to normal (45). Persistent infection or inflammation in a susceptible individual may lead to development of chronic sinusitis or nasal polyps (46).

In summary, an appreciation of the role of the ostiomeatal complex in the genesis of acute and chronic sinusitis is key to understanding the pathogenesis of sinus disorders. Appropriate therapy will necessarily include interventions directed at relief of ostiomeatal complex obstruction as well as control of infection.

INCIDENCE AND PREVALENCE OF SINUSITIS

Most cases of sinusitis are acute in nature. Some of these cases resolve spontaneously, although the number that do is not known. Other cases resolve readily with adequate therapy. The incidence of acute sinusitis parallels the incidence of up-

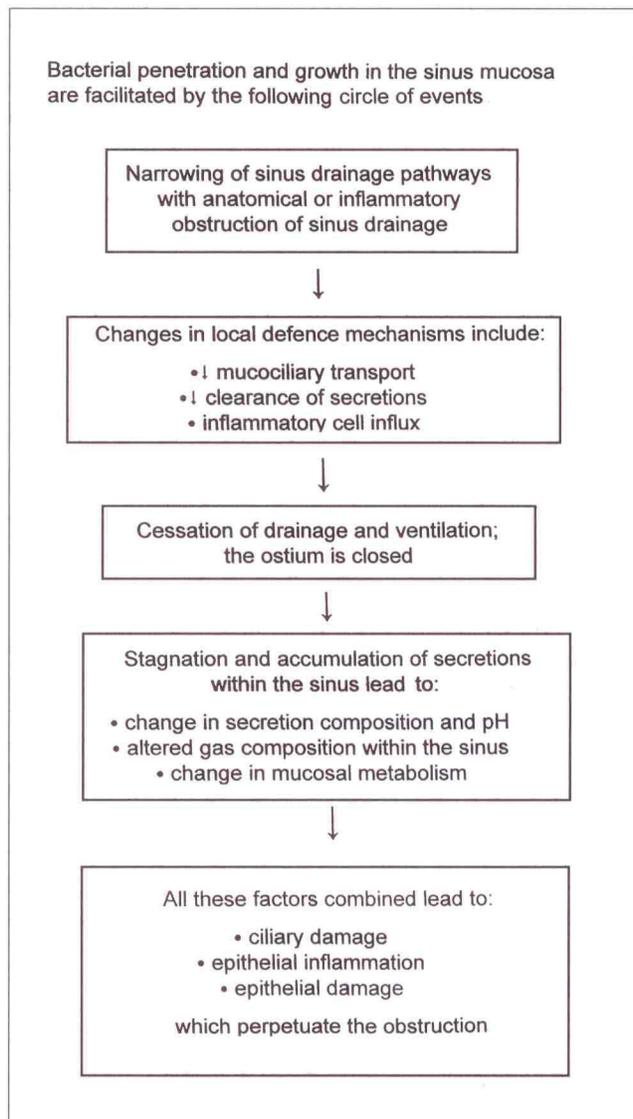


Figure 5) *Pathophysiology of sinusitis*

per respiratory tract infections (URTIs) (47). While only a small percentage of URTIs (0.5%) result in sinus infections in adults (48,49), the incidence is much higher in children (4.0% to 7.3% or 6.5% to 13% depending on the method of estimation used) (50). In either case, it is the frequency of URTIs that makes sinusitis a common complaint in both populations. On average, adults experience two to three URTIs per year, while children experience six to eight per year (49,51-53). According to the 1996 National Population Survey conducted by Health and Welfare Canada, the incidence of sinusitis as diagnosed by a health care professional was approximately 400,000 events per year (54).

PREDISPOSING FACTORS FOR SINUSITIS AND CONCOMITANT DISEASES

Data on potential risk factors and concomitant diseases for sinusitis have largely been limited to observation of commonly found factors in patients already diagnosed with si-

TABLE 1
Predisposing factors of sinusitis and concomitant diseases

Predisposing factors	Reference
Viral upper respiratory tract infections*	25,26,55-58
Anatomic abnormalities	25,26,57,58
Dental infection	25,26,59
Pollution	1,12,25
Smoking	1,12,18,25
Barotrauma	25,60
Otitis media*	25,61
Tonsillitis*	25,61
Acetylsalicylic acid sensitivity	25,26
Cocaine abuse	17,29,63
Concomitant diseases	
Allergy*	25,26,65
Allergic and nonallergic rhinitis	25,26,62-69
Asthma	25,26,55,63,64,69-72,77
Bronchiectasis	16,73
Diabetes mellitus	16,55
Immune deficiency	25,26,55,74,75,76
Sarcoidosis	16
Down's syndrome	25
Cystic fibrosis	25,26,56
Other abnormalities of mucociliary clearance (eg, ciliary dyskinesia, Young's syndrome, Kartagener's syndrome)	25,26,51,55

*Factors for which there is more rigorous evidence

nusitis. As such, with the exception of data derived from two studies, the evidence implicating various risk factors and associated diseases has not been obtained through rigorous scientific method.

In addition to URTIs, any of a number of predisposing factors and concomitant diseases may result in blockage of the sinus ostia, thereby initiating the process of sinus infection

and possibly leading to recurrent acute or chronic disease (Table 1) (1,12,16,17,51,55-75). Many of these concomitant diseases are common in the paediatric population, particularly rhinitis and asthma (25,65,72,76,77). Chronic tonsillitis, adenoidal hypertrophy, chronic otitis media, Down's syndrome and acetylsalicylic acid sensitivity may also play a role in paediatric sinusitis (25,26,76). The presence of any of these conditions may indicate the need for a specialist consultation or referral for specialty care.

DEFINITION OF SINUSITIS

Sinusitis can be defined as inflammation of one or more of the paranasal sinuses, though common use of the term more typically refers to infection of the sinuses (68). Isolated sinus disease rarely occurs without prior rhinitis, and the two diseases are likely interrelated. Because it is more precise, the term 'rhinosinusitis' is used by some specialists rather than 'sinusitis'. 'Sinusitis' was the convention adopted by this working group because, of the two, it is the term more widely recognized by clinicians.

CLASSIFICATION OF SINUSITIS

The classification of sinusitis is based, for the most part, on the opinions of the authors of the present guidelines and on the reports of other expert committees. The patient's status can initially be characterized by using three basic clinical criteria: duration of symptoms, frequency of symptoms and subsequent response to therapy. Ascertaining which sinuses are involved and whether there are any associated complications completes the preliminary diagnostic picture (Figure 6). If deemed necessary, two additional fields of information can be added following the initial consultation: the etiological agents involved and the level of diagnostic accuracy.

Duration and frequency of symptoms and response to ther-

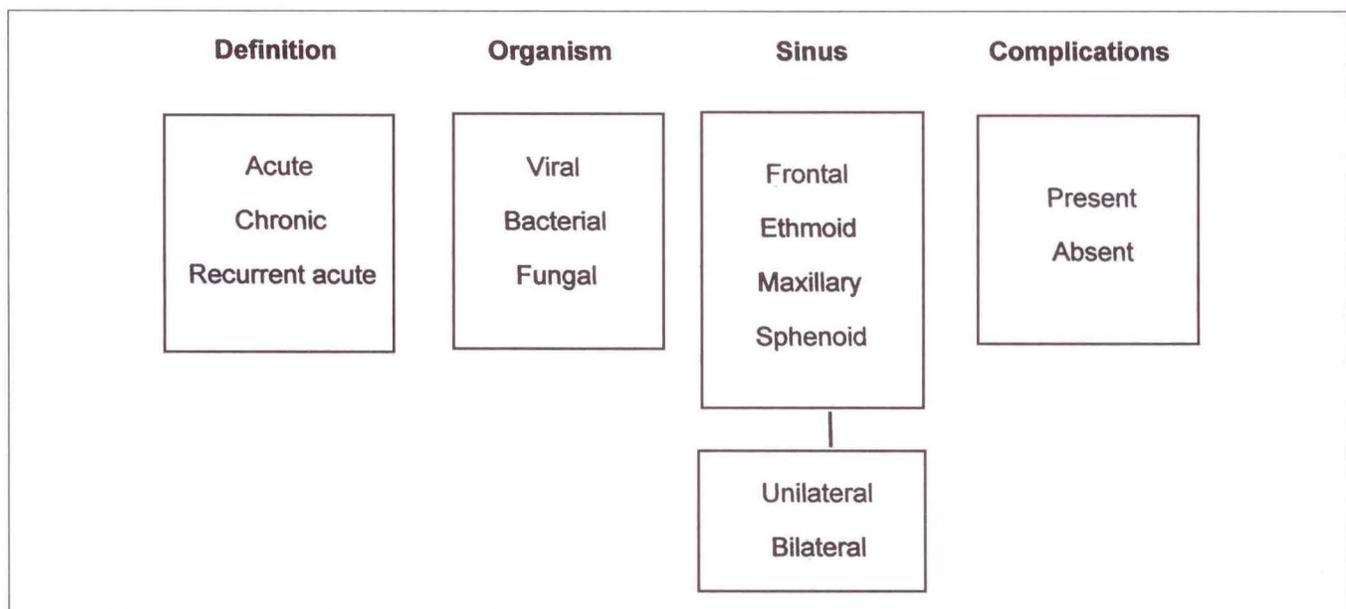


Figure 6) Sinusitis classification chart

apy: At its simplest, sinusitis can be classified into two broad categories: acute and chronic. A third category, recurrent acute sinusitis, has been added to address the issue of multiple acute infections. Note that the duration of infection stated below, as well as the number of infections per year, was somewhat arbitrarily chosen. These figures are not absolutes but are intended as diagnostic guides for the family practice physician. It is actually the resolution of infection without mucosal damage, rather than a defined time interval, that is the distinguishing feature of acute disease (2).

Acute sinusitis is defined as symptomatic infection of the paranasal sinuses of less than one month's duration. The inflammatory changes in the mucosa are readily reversible with appropriate medical management, leaving no significant mucosal damage. There should be no more than three episodes per year, with complete resolution of symptoms between episodes.

Recurrent acute sinusitis is defined as four or more episodes of symptomatic acute inflammation or infection per year, with complete resolution of symptoms between episodes.

Chronic sinusitis involves symptomatic infection of one or more of the paranasal sinuses of more than one month's duration despite appropriate treatment. The inflammatory changes in the mucosa have become established. The longer the sinus infection is present, the greater the possibility that it will cause irreversible changes affecting the nasal mucous membranes and ultimately the ventilation and drainage pathways of the sinuses. However, it is possible that, with removal of the ostial obstruction and proper aeration of the sinus, the damaged mucosa may recover.

For the paediatric population (16 years of age or younger), the defining characteristic of acute sinusitis is a history of persistent respiratory symptoms (nasal discharge, cough or both) that have lasted more than 10 days but fewer than 30 days and have not begun to improve. Alternatively, severe symptoms of high fever (greater than 39°C) and purulent nasal discharge for at least four consecutive days are also considered to be indicative of acute disease in the paediatric population (78,79). Chronic sinusitis is characterized by protracted symptoms (nasal discharge or congestion and/or cough) (80) lasting for 30 days or more. Mouth breathing and sore throat are frequent consequences of nasal obstruction (80).

Site of infection: It is now understood that it is the specific site of obstruction that is important in the symptomatology and diagnosis of sinusitis (1). The site of infection may be unilateral or bilateral, involving any or all of the frontal, maxillary, ethmoid and sphenoid sinuses (Figure 1). Typically, acute sinusitis is not difficult to diagnose; pain generally radiates from the affected sinus (1). On the other hand, chronic disease can be particularly difficult to diagnose accurately without using nasal endoscopy and CT techniques because symptoms can be mild and tend not to be well focused. The ethmoid sinuses are frequently the seat of primary infection; inflammation subsequently spreads into the frontal and maxillary sinuses (3). In any case, it is important to remember that disease of the ostio-meatal complex, obstruction of the sinus ostia or both usually precede sinus infection (2). The site, extent or type of infection is secondary to this blockage.

Complications: Complications of sinus disease are important in the classification process because they have a significant impact on the direction of treatment. Some complications (eg, mucopyocele) are contained within a sinus. More frequently, complications occur when infection extends beyond the confines of a paranasal sinus. This can lead to life-threatening emergencies.

Complications of sinus disease include

- orbital cellulitis;
- subperiosteal abscess;
- osteomyelitis;
- meningitis;
- brain abscess;
- epidural and subdural empyema; and
- cavernous sinus thrombosis (81-84).

Note that, for the most part, complications of sinusitis that are listed above are derived from anecdotal observation of patients with diagnosed disease; incidence rates for the adult population are not available. However, several of these orbital-facial complications have been identified in a 25-year retrospective study of 6770 children with sinusitis, 159 of whom had complications (84).

Etiological agents: Viral URIs commonly precede bacterial sinusitis (41,47). Viruses have been recovered from the sinus cavity of patients with acute sinusitis (85-87), and it is known that sinus involvement is part of the 'cold' itself in most patients (41). It is postulated that viral infection of the nasal and/or sinus cavities leads to secondary infection of the sinus cavity (55). The pathogens involved in sinusitis are usually bacterial, although they may also be viral or fungal (85-91).

In acute sinusitis, the most common pathogens are *S pneumoniae* and *Haemophilus influenzae* (Table 2) (55,88). Other pathogens include anaerobes, *Moraxella catarrhalis*, *Streptococcus pyogenes*, *S aureus* and others. Viruses have been found with bacteria in approximately one-fifth of cases (60). Viruses that have been implicated in sinusitis include rhinovirus, influenza virus and parainfluenza virus (85-87). Sinus infections of fungal origin are extremely rare and usually present as nasal polyposis. However, in the compromised patient (diabetic or immunocompromised), a fungal infection may present as cellulitis and become fulminant, and is often rapidly fatal. Fungal groups that have been implicated in sinusitis include most commonly *Aspergillus* species, followed by zygomycoses and *Pseudallescheria* species (88-91).

The profile of infection is somewhat different in chronic disease (Table 2). Chronic sinusitis has an infectious component, although the relationship to any specific bacterial cause has not been well defined (55). It is known that chronic disease tends to be polymicrobial in nature, that anaerobic bacteria are more common than aerobes and that, while still rare, fungal agents are more prominent than in acute sinusitis

TABLE 2
Common bacterial pathogens in sinusitis determined by culture of antral sinus puncture and sinus surgery specimens (references 78,86-88,95,96,99)

	Percentage of culture-positive isolates	
	Adults	Children
Acute sinusitis		
<i>Streptococcus pneumoniae</i>	34-43	37
<i>Haemophilus influenzae</i>	31-35	25
Anaerobic bacteria	7-12	—
<i>Moraxella catarrhalis</i>	4-5	25
<i>Streptococcus pyogenes</i>	2-7	—
<i>Staphylococcus aureus</i>	2-3	—
Chronic sinusitis		
Aerobic bacteria	29-43	20
<i>Streptococcus</i> species	9-14	6
<i>Staphylococcus</i> species	5-14	6
<i>Haemophilus</i> species	1-6	3
Anaerobic bacteria	57-88	80
<i>Bacteroides</i> species	14-27	29
Gram-positive cocci	25-38	23
<i>Fusobacterium</i> species	3-5	5

(1,92-96). However, recovery of these agents does not necessarily implicate them as the primary cause of this condition (55). While episodes of recurrent infection are thought to play a major role in the development of chronic sinusitis, once established, chronic disease is thought to be primarily due to underlying structural damage rather than chronic infection (39).

The profile of microbiological pathogens associated with sinusitis in the paediatric population is distinct from that of the adult population (Table 2). *S pneumoniae*, *H influenzae* and *M catarrhalis* are the most common organisms recovered in children with acute sinusitis (78,97,98). While the incidence of *M catarrhalis* isolates is low in the adult population, the incidence rate in the paediatric population is approximately five times higher. In chronic disease, anaerobes play a major role (98-100); they were isolated in 92% of paediatric patients, while aerobes were isolated in only 38% of patients (99).

Diagnostic accuracy: In any given case, a diagnosis of sinusitis may have been based on clinical evidence alone. Alternatively, it may have included information from any of an endoscopic examination, a CT scan, magnetic resonance imaging (MRI) or other diagnostic technique (eg, dental x-rays). The degree of diagnostic accuracy is related to the comprehensiveness of the history and physical examination; it reflects the amount and quality of information that has been gathered about any one patient.

Other definitions: Terminology in sinus disease has grown rapidly, evolving and expanding over the past five to 10 years

in concert with the technological advances made in endoscopy and CT. Definitions provided by this working group are outlined in Appendix 2.

DIAGNOSIS OF SINUSITIS IN THE PRIMARY CARE SETTING

It is important to ensure that the diagnostic measures recommended in these guidelines address the varying levels of training of, and the resources available to, the primary health care worker who first sees the sinusitis patient. Primary health care workers may include medical students, nurse practitioners, physician assistants, general practitioners and others. They may be located in either urban, rural or remote areas and have varying degrees of access to diagnostic tools such as immunological tests or medical imaging. Referral to a specialist may be indicated for further investigation using endoscopic and CT procedures for cases that do not resolve despite adequate pharmacotherapy or when complications are seen or suspected.

Preliminary diagnostic measures for sinusitis should assess the local disease process and check for any regional abnormalities and predisposing concomitant diseases. It is particularly important that a comprehensive diagnostic picture be assembled, including the symptoms, history and physical examination, because no one criterion is totally reliable as an indicator of disease (17). For the purposes of diagnosis, the most important classification distinction is whether the sinusitis meets the definition of acute or chronic disease. Summary checklists of the key symptoms, historical clues, physical examination techniques and other investigative measures for each of acute, chronic and paediatric sinusitis are presented in Tables 3, 4 and 5, respectively.

Acute sinusitis: In acute sinusitis, the patient presents with signs and symptoms of a URTI (2). From a practical viewpoint, acute sinusitis can be thought of as a persisting 'cold' with 'typical sinus' pain and often copious mucus. The diagnosis of acute sinusitis is primarily clinical and can usually be made from a review of the patient's symptoms, history and a physical examination of the nose, sinuses and related regions (68). It is important that the diagnosis not be based on symptomatology alone because the symptoms of sinusitis are often not readily differentiated from rhinitis (101,102). In fact, many of the symptoms commonly thought to be typical of sinusitis also occur frequently in patients with radiologically normal sinuses (102).

A relatively strong evidence base exists for the diagnosis of acute sinusitis. In 1992, using logistic regression analysis of data collected from 247 symptomatic patients, Williams et al (101) identified five independent predictors of acute sinus disease from a review of the patients' symptoms, history and physical examination (Table 3). These predictors are discussed in detail in the subsections below. To approximate the primary care setting, initial diagnoses were made by general internists rather than otolaryngologists. Diagnoses were subsequently confirmed by radiologists using four radiographic views. Key findings are summarized below.

TABLE 3
Checklist for diagnosis of acute sinusitis in the primary care setting

Symptoms	<input type="checkbox"/> Cocaine abuse <input type="checkbox"/> Other diseases, eg, dental disease, diabetes, cystic fibrosis, sarcoidosis, bronchiectasis
<input type="checkbox"/> Maxillary toothache* <input type="checkbox"/> Coloured nasal discharge <input type="checkbox"/> Rhinorrhea <input type="checkbox"/> Pain at mastication <input type="checkbox"/> Cough or bronchitis <input type="checkbox"/> Fever <input type="checkbox"/> Speech indicating 'fullness of sinuses' <input type="checkbox"/> General malaise <input type="checkbox"/> Hyposmia	Physical examination
History	<input type="checkbox"/> Poor response to nasal decongestants or antihistamines <input type="checkbox"/> Antecedent upper respiratory tract infection <input type="checkbox"/> Underlying rhinitis, allergy or asthma <input type="checkbox"/> Immune deficiency <input type="checkbox"/> Trauma (physical, barotrauma, instrumental) <input type="checkbox"/> Smoking, pollution
	<input type="checkbox"/> Mucopurulent secretions For completeness, physical examination should include a local nasal/sinus examination comprising <ul style="list-style-type: none"> <input type="checkbox"/> Rhinoscopy – direct vision (for pus), with or without instrumentation <input type="checkbox"/> Palpation/percussion of the maxillary and frontal sinuses
	Regional examination
	<input type="checkbox"/> Ears <input type="checkbox"/> Upper and lower respiratory tract
	Examination for complications
	<input type="checkbox"/> Orbits (edema, extraocular movement, vision) <input type="checkbox"/> Central nervous system (cranial nerves, pupil reaction, meningismus)

*Diagnosis of acute sinusitis is primarily clinical. Independent predictors of acute disease are shown in bold type, followed by other factors that either correlate positively with acute sinusitis or that may play a role. The probability of confirmed disease increases proportionately with the number of independent predictors present, although the overall clinical impression is more accurate than any one predictor. *Indicative of maxillary sinusitis*

TABLE 4
Checklist for diagnosis of chronic sinusitis in the primary care setting

Symptoms	Physical examination should include local nasal/sinus examination comprising
<input type="checkbox"/> Nasal congestion/obstruction <input type="checkbox"/> Midfacial pain or pressure <input type="checkbox"/> Hyposmia/anosmia <input type="checkbox"/> Headache <input type="checkbox"/> Purulent nasal discharge <input type="checkbox"/> Foul-smelling nasal discharge <input type="checkbox"/> Chronic cough <input type="checkbox"/> Foul breath	<input type="checkbox"/> Rhinoscopy (rigid or flexible scope) <input type="checkbox"/> Sinus palpation (usually not tender) <input type="checkbox"/> Transillumination (no value)
History	Examination for complications
<input type="checkbox"/> Asthma* <input type="checkbox"/> Recurrent acute infections <input type="checkbox"/> Allergic and nonallergic rhinitis <input type="checkbox"/> Immunocompromised host <input type="checkbox"/> Mucociliary abnormalities, eg, ciliary dyskinesia, Kartagener's syndrome, Young's syndrome <input type="checkbox"/> Postnasal discharge <input type="checkbox"/> External pollutants <input type="checkbox"/> Lower airway disease, eg, asthma <input type="checkbox"/> Other systemic illness, eg, cystic fibrosis, sarcoidosis, Wegener's granulomatosis, clinical triad of nasal polyposis, acetylsalicylic acid intolerance and asthma	<input type="checkbox"/> Mucocele <input type="checkbox"/> Proptosis <input type="checkbox"/> Osteomyelitis
Physical examination	Technical and laboratory investigations
<input type="checkbox"/> Nasal polyps <input type="checkbox"/> Purulent rhinorrhea <input type="checkbox"/> Mucosal disease <input type="checkbox"/> Septal deviation <input type="checkbox"/> Tumours <input type="checkbox"/> Foreign bodies <input type="checkbox"/> Turbinate changes <input type="checkbox"/> Atrophic rhinitis	Major indicators on coronal computed tomography are
	<input type="checkbox"/> Obstruction or disease of the ostiomeatal complex <input type="checkbox"/> Mucosal disease <input type="checkbox"/> Fungal disease
	Diagnostic techniques for chronic sinusitis may include any of:
	Imaging
	<input type="checkbox"/> Computed tomography scan <input type="checkbox"/> Magnetic resonance imaging
	Culture
	<input type="checkbox"/> Only pus obtained directly from sinus <input type="checkbox"/> Aerobic, anaerobic, fungal
	Nasal cytology
	<input type="checkbox"/> Eosinophils <input type="checkbox"/> Neutrophils <input type="checkbox"/> Immunology <input type="checkbox"/> Antineutrophil cytoplasmic antibody <input type="checkbox"/> Immunoglobulin levels
	Protein electrophoresis
	<input type="checkbox"/> Allergy <input type="checkbox"/> Skin tests
	Other
	<input type="checkbox"/> Blood sugar <input type="checkbox"/> Human immunodeficiency virus (CD4 and CD8 counts)

*Chronic sinusitis cannot be diagnosed based on symptomatology alone because symptoms tend to be nonspecific and mild in nature and the underlying etiology cannot be established without further investigation. Referral to a specialist is often required. The major indicators of chronic disease are shown in bold type followed by other factors that may play a role. *Most common underlying systemic diagnosis*

TABLE 5
Checklist for diagnosis of paediatric sinusitis in the primary care setting

Symptoms	Physical examination
<input type="checkbox"/> Cough <input type="checkbox"/> Purulent nasal discharge <input type="checkbox"/> Malodorous breath <input type="checkbox"/> Headache <input type="checkbox"/> Fever <input type="checkbox"/> Facial pain <input type="checkbox"/> Swelling (eg, of the orbit)	<input type="checkbox"/> Nasal obstruction <input type="checkbox"/> Purulent secretions <input type="checkbox"/> Enlarged adenoids <input type="checkbox"/> Nasal polyps <input type="checkbox"/> Fever
In addition, the following are also predominant in chronic disease <input type="checkbox"/> Chronic nasal obstruction <input type="checkbox"/> Persistent congestion or recurrent 'colds' <input type="checkbox"/> Postnasal drip <input type="checkbox"/> Mouth breathing <input type="checkbox"/> Sore throat	For completeness, physical examination should include local nasal/sinus examination comprising <input type="checkbox"/> Rhinoscopy – direct vision (for pus), with or without instrumentation <input type="checkbox"/> Palpation/percussion of the maxillary and frontal sinuses
History <input type="checkbox"/> Antecedent viral upper respiratory tract infection <input type="checkbox"/> Presence or family history of rhinitis, allergy or asthma <input type="checkbox"/> Concurrent otitis media or chronic serous otitis <input type="checkbox"/> Trauma <input type="checkbox"/> Environmental pollution <input type="checkbox"/> Presence or family history of other chronic respiratory complaints, eczema, cystic fibrosis, primary ciliary dyskinesia, immune deficiency	Regional examination <input type="checkbox"/> Ears <input type="checkbox"/> Upper and lower respiratory tract In chronic disease, computed tomography is the optimal method of assessment

The two hallmarks of acute sinusitis in infants and children are persistent and severe respiratory symptoms. In chronic disease, similar symptoms are protracted, but are often less severe and are most commonly accompanied by chronic nasal obstruction. Major indicators are shown in bold type followed by other factors that may play a role

- Four independent predictors of acute sinusitis are
 - maxillary toothache;
 - coloured nasal discharge;
 - poor response to nasal decongestants or antihistamines; and
 - mucopurulent nasal secretions upon examination.
- No one factor is 100% predictive of acute disease.
- The probability of confirmed sinusitis increases proportionately with the number of independent predictors present (9% probability when no predictors are present and 92% probability when all predictors are present).
- The physician's overall clinical impression is more accurate than any one predictive factor.

Symptoms: Symptoms that were assessed as independent predictors of sinusitis are maxillary toothache and coloured nasal discharge reported by the patient (101). In addition, patients may exhibit any of a number of other possible symptoms including fever, rhinorrhea, cough or bronchitis, pain on mastication, speech indicating 'fullness of sinuses', general malaise

or hyposmia, which have been shown to correlate positively with sinusitis identified radiologically (102).

Patient history: The one factor from the patients' history that has been assessed as an independent predictor of sinusitis is a poor response to nasal decongestants or antihistamines (101). In addition, a history of URTI preceding sinus complaints was found to correlate positively with sinusitis identified radiologically (102). Other predisposing conditions in the patient's history that may be of interest include the presence of underlying systemic disease, allergy, trauma, defects in mucociliary clearance, dental disease, etc. Refer to the section entitled 'Predisposing factors for sinusitis and concomitant diseases' for a complete list of factors.

Physical examination: Physical examination techniques include palpation of the frontal and maxillary sinuses as well as transillumination and direct vision of the nasal cavity. Mucopurulent nasal secretions and abnormal transillumination were identified as independent predictors of acute sinusitis that are evident from physical examination (101). In addition, pus in the middle or inferior meatus was shown to correlate positively with radiographic evidence of sinusitis (102).

Williams et al (101) reported that abnormal transillumination was an independent predictor of acute disease. However, there is considerable controversy in the literature surrounding the use of this technique. The consensus of this working group is that transillumination is an unreliable predictor of disease; its use is not recommended.

Technical and laboratory investigations, which are important in providing a definitive diagnosis, are generally not required unless complications are predicted. In uncomplicated cases, a preliminary diagnosis of acute sinusitis based on symptoms, history and physical examination is usually sufficient to determine subsequent therapy. Routine x-rays are not necessary for the diagnosis of acute sinusitis.

Although not commonly available to the primary care physician, CT is the gold standard technique for visualizing sinus anatomy (6). This technique is principally reserved for non-resolving or chronic sinusitis. In combination with nasal endoscopy, CT provides a comprehensive picture of the sinus cavities and, most importantly, the ethmoid sinus (2,7,17). MRI does not play a role in the diagnosis of acute sinusitis unless there are discrepancies in the diagnosis of intracranial abnormalities on CT. Finally, ultrasonography is not a useful technique for determining a diagnosis of acute sinusitis.

Acute sinusitis is frequently localized to a particular sinus. Typically, acute disease is well defined, with pain radiating from the affected sinus. Therefore, the site of infection can often be determined based on a pattern of common complaints (3). Briefly, the profile of acute sinusitis localized to the ethmoid sinus includes periorbital headache and inner canthal pain made worse by coughing or straining (3). When localized to the maxillary sinus, presentation includes temporal headache or toothache and malar pain. The presentation of acute frontal sinusitis includes severe headache and tenderness on palpating the floor of the sinus or on percussion of the frontal bone. Finally, the presentation of acute sphenoid sinusitis includes a deep-seated headache and retro-orbital or occipital pain, which may radiate to the vertex. Within 24 to 48 h, non-responding acute frontal sinusitis and acute sphenoid sinusitis can become medical emergencies that may require referral to a specialist (3). Clinical pictures, diagnostic profiles and algorithms of acute sinusitis for each of the sinus groups, as well as specific clues for the progression to chronic disease (which may be useful diagnostically), have been presented by Kennedy (1-3) in 1990, 1994 and 1995.

Chronic sinusitis: Chronic sinusitis is an ongoing disease process with an underlying etiology that persists despite adequate pharmacotherapy. It can be particularly difficult to diagnose because symptoms tend to linger and physical findings may be subtle (1). A complete history is much more important in chronic disease to ascertain clues to the underlying etiology. Chronic or recurrent acute sinusitis often requires referral to a specialist for further evaluation because investigative measures, including nasal endoscopy and CT, are usually indicated to elucidate the predisposing anatomical factor(s). In rare cases, sinus puncture may also be indicated. Ultimately, endoscopic surgery may be required to achieve adequate sinus ventilation and drainage when repeated courses of appropriate antibiotic therapy fail to eradicate the infection (2,7,13,17,55, 103-105).

In contrast to the profile presented for acute sinusitis, the evidence base for the diagnosis of chronic sinusitis is relatively weak. No study has been conducted to ascertain which of the many possible signs, symptoms and other factors might

serve as independent predictors of chronic disease. Thus, the following section is not based on data available from a statistical evaluation of this population; rather, it represents the views and clinical experience of members of this task force. Again, consideration has been given to the opinions and recommendations of other such committees.

Symptoms: Major symptomatic indicators of chronic disease are thought to be nasal congestion or obstruction, midfacial pain and pressure, and hyposmia (Table 4). Other symptoms that may occur include nasal discharge, headache, foul breath and cough.

Patient history: URTI was found to correlate positively with a diagnosis of chronic sinusitis (106), and asthma is the disease most commonly associated with chronic sinusitis (16,17,69-72). However, any number of other factors in the patient's history may provide clues to the root cause of chronic infection. A history of recurrent acute infections or postnasal discharge may indicate chronic disease, or the infection may be secondary to any of a number of other conditions or diseases including exposure to external pollutants, allergies, other lower-airways or systemic diseases, mucociliary abnormalities or immune deficiencies.

Physical examination: Major indicators of chronic sinusitis that are evident on physical examination are nasal polyps and purulent rhinorrhea. Similarly, dental abscess, which can also be an indicator of chronic disease, is readily evident on physical examination. Transillumination is of no value as a diagnostic tool in chronic disease. Rather, the sinuses should be examined by using endoscopy techniques, which allow for visualization of the surface mucosa of the ethmoid air cells. Evidence of polyps and other possible causes of obstruction, such as mucosal disease, septal deviation, turbinate changes, etc. can be seen by using this procedure. The physical examination should also include investigations for the presence of complications such as mucocele, osteomyelitis or periorbital cellulitis.

Plain radiographs and ultrasound are of no value in the diagnosis of chronic disease. The gold standard for investigation of the sinus cavities is CT, which is usually a complementary procedure to nasal endoscopy (2,6). CT allows for visualization of subtle mucosal changes and anatomical obstructions to sinus mucociliary clearance. It is indicated when the diagnosis is in question or for preoperative planning before endoscopic sinus surgery. Extensive training is required to diagnose sinus disease reliably with CT or nasal endoscopy. Major indicators of chronic sinusitis that can be identified with CT are obstruction of the ostiomeatal complex and mucosal disease. While rare, fungal disease can also be identified with this technique.

Other investigations that may be performed or requested by the specialist to ascertain the nature or cause of persistent disease include sinus puncture and culture studies, nasal cytology, immunological tests, allergy skin tests, etc.

Recurrent acute sinusitis: Each episode of recurrent acute sinusitis is similar to the acute situation. However, there may well be an underlying disease process involved, either local or systemic, that contributes to the repeated infections. There-

fore, investigations used to establish a diagnosis should follow those outlined above for chronic disease.

Paediatric sinusitis: Physical examination and a careful history are usually sufficient to diagnose uncomplicated sinusitis in the paediatric population (Table 5) (23,107). A high index of suspicion for the presence of sinusitis is helpful in its diagnosis, particularly in younger patients who are unable to describe symptoms. While nonspecific factors such as URTI, otitis media and allergies commonly precede or coexist with sinusitis, they do not, in general, increase the likelihood of sinusitis. Only when more specific factors are present, such as prolonged or severe signs and symptoms of URTI, is the likelihood of sinusitis increased. Other more specific features, such as history of ciliary dyskinesia or immune deficiency, are very uncommon; likewise, surgically modifiable abnormalities are uncommon, and these can usually be ruled in or out with a careful history and physical examination. While sinus surgery is widely used in the treatment of chronic disease (108,109), surgical intervention should be undertaken only after optimal medical management has failed. Some evidence exists to support the diagnostic indicators outlined below for acute sinusitis in a paediatric population. As with the adult population, the evidence base for the diagnosis of chronic sinusitis is weak.

Symptoms: Cough and nasal discharge are the most common complaints in paediatric patients with radiographic evidence of acute sinusitis (78,79,97). The incidence of symptoms ranges from the most frequent cough (80%), purulent rhinorrhea (76%) and malodorous breath (50%) to the less common headache (33%), fever (30%), facial pain (30%) and swelling (30%) (97). Sinusitis was found to be the second most common cause of cough in the paediatric population (110). In very young children who are unable to describe their symptoms, acute sinusitis can be diagnosed as respiratory symptoms that are more severe and/or persistent than usual (76).

Chronic sinusitis in children is characterized by persistent nasal symptoms (discharge or congestion) and/or cough (both night and day) lasting 30 days or more (80,111). Symptoms become less severe and protracted, with chronic nasal obstruction being the most common complaint (23). Other predominant symptoms include postnasal drip, malodorous breath, mouth breathing, sore throat (especially in the morning) and persistent or recurrent 'colds' (26,80). Pain is not a major symptom in the paediatric population because the ostia are relatively wide and the sinus cavities do not usually retain pus under pressure (26). While headache often accompanies both acute and chronic disease, only older children are able to identify and localize this symptom (76).

Patient history: Viral URTI is the most common predisposing factor in paediatric sinusitis. Given that the normal occurrence is six to eight URTIs per year, toddlers may have rhinorrhea for more than four months of the year. Factors such as a daycare setting may increase this number considerably (50). URTIs last a mean of 6.6 days for one- to two- year-olds and 8.9 days for children younger than one year (50). Between 6.5% and 13.1% of infants and preschoolers had symptoms lasting longer than 15 days; between 4.0% and 7.3% developed sinusitis (50).

Obtaining a detailed patient history is particularly impor-

tant in chronic disease because paediatric patients frequently exhibit signs of other concurrent illnesses (80). Over 50% of allergic children with chronic respiratory symptoms showed signs of abnormalities on sinus radiographs (65). Twenty-five per cent of paediatric patients with chronic sinusitis also had chronic asthma (77). Approximately 50% of children with chronic disease also showed signs of acute otitis media or chronic serous otitis. Infected teeth are rarely a cause of sinusitis in children.

Patient history should include onset, duration and seasonality of respiratory symptoms; quality and laterality of nasal discharge; quality and timing of cough; presence, quality and frequency of headache; other infections (eg, otitis media); previous therapies and results; allergies; and presence or family history of hayfever, asthma, eczema, cystic fibrosis, primary ciliary dyskinesia, immunodeficiency or chronic respiratory complaints (80).

Physical examination: Any of nasal obstruction, purulent secretions, enlarged adenoids or nasal polyps may be evident on physical examination. However, completeness of the examination increases with increasing age of the patient. It is important to appreciate that only the maxillary and ethmoid sinuses are evident by radiography in early infancy. The sphenoid sinuses are visible around three years of age, and the frontal sinuses appear between three and seven years of age (26).

In chronic disease, the physical examination is of limited value because sinusitis cannot readily be distinguished from the various other causes of rhinitis (80). It also may prove difficult to perform in very young patients (76). Transillumination has been shown to be of no value in the diagnosis of paediatric sinusitis (107). As with adults, CT is the optimal method to perform a thorough examination of the paediatric patient with suspected or proved anatomical abnormalities (80).

As with the adult population, there is no need to perform sinus radiographs to confirm a diagnosis of acute sinusitis in children. In part, this is because empirical therapy is inexpensive and safe.

Diagnostic tools - X-ray: Imaging of the paranasal sinuses with x-ray techniques is of limited value to the general practitioner to confirm a diagnosis of uncomplicated acute disease in the larger paranasal sinuses. Air fluid levels or opacification on x-ray is evidence of acute sinusitis provided that this evidence is consistent with a clinical diagnosis (ie, trauma and medical conditions such as a bleeding disorder have been excluded) (102,112). Abnormalities of the maxillary sinus can be identified by using a Waters' view (2,3,113). Similarly, abnormalities of the frontal and sphenoid sinuses can be identified with a Caldwell view and a lateral view, respectively (2,3). Mucosal thickening or the finding of a mucous retention cyst, both of which are readily evident on plain sinus radiographs, is not necessarily indicative of sinusitis. An opacified maxillary sinus may be hypoplasia of the maxillary sinus; CT is the only way to confirm this diagnosis. These patients are unnecessarily subjected to antibiotic treatment if misdiagnosed with sinusitis on positive x-rays (114). In addition, a normal radiograph does not exclude the presence of sinusitis, and no

view is adequate to visualize the ethmoid sinus, which in most cases is the primary site of disease. Plain radiographs are also inadequate to evaluate the upper two-thirds of the nasal cavity, and the infundibular, middle meatus and frontal recess passages (2,6). Consequently, plain x-rays are not a reliable indicator of sinus disease. While this technique can be of some use to the general practitioner, it is limited both in terms of its sensitivity and specificity. Its use is not recommended.

It is also important for the general practitioner to be aware that the changes observed on x-ray may persist long after acute symptoms have subsided (88). Therefore, treatment should be directed to the patient's clinical symptoms rather than findings on x-ray. Similarly, the effectiveness of therapy should be monitored clinically. Repeat x-rays are not of value diagnostically, nor do they have a role in the monitoring of treatment of uncomplicated acute sinusitis. If complications are suspected or if symptoms persist despite adequate treatment (ie, chronic or recurrent acute disease), the patient should be referred to a specialist.

CT: For acute sinusitis with complications or impending complications, the otolaryngologist usually requests a biplanar CT scan in the coronal and axial planes (115). Where complications are suspected, a contrast-enhanced CT of the head and orbital structures is done. It is important to establish whether infection has spread outside the confines of the paranasal sinuses. By using CT, sinus disease (ie, ethmoid sinus disease) can be detected in over 90% of symptomatic patients who have no evidence of infection on plain sinus radiographs. However, CT requires extensive training to diagnose sinus disease accurately. Misdiagnosis can occur. For example, simple mucosal thickening during a normal nasal cycle in asymptomatic patients can be misdiagnosed as sinus disease (116). Work is underway to develop a standardized reporting scheme for use by radiologists to facilitate the presentation of CT scan findings and minimize potential inaccuracies in reporting (117). It is always important to interpret imaging data in a clinical context, including clinically relevant symptoms and physical examination (118).

In the case of chronic sinusitis, endoscopic examination should precede imaging. The imaging procedure of choice is coronal CT examination, without intravenous contrast media. The anatomy of the paranasal sinuses is best seen with this view. CT scans provide the most accurate visualization of the ostiomeatal complex. Scans usually focus on the frontal recess, infundibulum and middle meatus because anomalies are common in these areas in chronic disease (6,7,104,119,120). Knowledge of sinus anatomy has been greatly advanced by the development of CT (121).

MRI: While not generally used, MRI can be complementary to CT in specific circumstances (6,17). It is useful when CT has not provided a diagnosis, and is excellent for visualization of tissue pathology and assessment of the complications of sinusitis. It is particularly useful when malignancy is suspected or in cases of fungal disease or sphenoid sinus lesions. In addition, MRI is superior to CT for the evaluation of the intracranial spread of infection.

Antral puncture: Antral puncture studies have been invaluable

in establishing the pathogens involved in acute and chronic disease. The technique of sinus puncture, aspiration and culture is considered the gold standard for obtaining microbiological evidence of maxillary sinusitis (68). These studies are rarely indicated in acute sinusitis; however, they can be of considerable diagnostic value in the case of a severely ill patient who does not respond satisfactorily to treatment (eg, immunosuppressed patients in intensive care unit settings).

TREATMENT OF SINUSITIS

In recent years, significant advances have been made in the understanding of the underlying pathophysiology of sinusitis. These discoveries, made by using endoscopy and CT procedures, combined with the microbiological data from sinus puncture studies, have revolutionized the treatment of sinus disease.

It is understood that obstruction and infection, rather than allergy and allergic inflammation, are at the root of sinus disease. Thus, antibiotics are considered first-line therapy in the management of sinus infection. Studies are underway to ascertain whether topical steroids are a useful adjunct to treat the inflammatory component of this disease. While widely used, antihistamines do not address the pathogenesis of this disease.

The goals of therapy are to relieve symptoms of acute disease, break the cycle leading to chronic disease and achieve sustained sinus health. To attain these goals

- patency of the ostiomeatal complex must be re-established and maintained;
- infection must be controlled;
- tissue inflammation must be reduced;
- drainage of the affected sinus(es) must be facilitated; and
- environmental irritants should be reduced or eliminated (2).

In both acute and chronic conditions, a polytherapeutic approach is usually necessary to combat sinus disease effectively. Antibiotics are essential in resolving bacterial infection in the sinus cavity. Decongestants and mucocleaners may help achieve and maintain ostial patency and facilitate drainage. Topical corticosteroids may be necessary to reduce tissue inflammation and edema. In the case of chronic sinusitis, oral steroids may also be indicated. It is important to note that, even in chronic disease, removal of the ostial obstruction and aeration of the sinus can lead to recovery of the damaged mucosa.

Evidence base: Objective evaluation of different therapies in the treatment of sinusitis can be established with radiological, clinical or bacteriological evidence. While such data are lacking for other pharmacotherapies, the efficacy of antibiotics in acute sinusitis has been established in randomized, controlled

TABLE 6
Incidence of bacterial resistance in the United States and Canada in the 1990s (references 126-137)

Isolates	Canada	United States
Adult population	28.4%	30%
Beta-lactamase positive <i>Haemophilus influenzae</i>		
Beta-lactamase positive <i>Moraxella catarrhalis</i>	90%	92%
Intermediate penicillin-resistant <i>Streptococcus pneumoniae</i> *	8.4%	15%
Highly penicillin-resistant <i>S pneumoniae</i> †	3.3%	7%
Paediatric population	11-14%	56%
Intermediate penicillin-resistant <i>S pneumoniae</i> *		
Highly penicillin-resistant <i>S pneumoniae</i> †	3%	44%

*Penicillin minimum inhibitory concentration (MIC) 0.12 to 1.0 µg/mL;

†Penicillin MIC 2.0 µg/mL or greater

clinical trials using both radiological and clinical evidence (level I evidence) (122,123). In one study, patients receiving 10 days' treatment with both nasal decongestants and antibiotics (either penicillin V or lincomycin) were radiologically improved compared with controls (decongestants alone); a satisfactory clinical response rate of 84% was achieved versus 72% for controls ($P < 0.05$) (123). However, the response rate of patients receiving decongestants and antibiotics was not significantly different from that of patients receiving decongestants in combination with sinus irrigation. In a second study conducted in the paediatric population, patients receiving both three- and 10-day antibiotic therapy (either amoxicillin or amoxicillin-clavulanate) were more likely to be clinically cured than those receiving placebo (64% and 67% versus 43% at 10 days, $P < 0.05$) (122).

Two recently published studies present conflicting evidence on the value of antibiotic therapy (level I evidence) (124,125). In one study, adult patients receiving antibiotic therapy (either penicillin V or amoxicillin) were significantly more improved following 10 days of therapy than those receiving placebo (86% versus 57%, $P < 0.005$) (124). However, in a second study conducted in a primary care setting, adults with radiographic evidence of maxillary disease who received a seven-day course of antibiotic (amoxicillin) did not show a significantly different clinical improvement after two weeks from that achieved by the control group (83% versus 77%, $P = 0.2$) (125). Note that all patients received steam inhalation with 0.1% xylometazoline before randomization; thus, the control group was not a true placebo control. While antibiotics have proven to be of benefit in three of these four controlled studies, it is clear that many patients with radiographic evidence of sinusitis improve without any therapeutic intervention at all or with decongestants alone (level I evidence).

Evidence for the use of mucocleaners and corticosteroids is largely anecdotal (level III evidence). Few randomized, controlled clinical trials have been conducted to investigate the use of these agents in sinusitis. Rather, their inherent value in

treating this disease has been extrapolated from the large body of clinical trial evidence establishing the efficacy of these agents in the treatment of allergic rhinitis.

Antimicrobial therapy: The choice of antibiotic to target common sinus bacteria is empirical because the causative pathogen is seldom known. In addition, no agent is available that combines a full range of in vitro antimicrobial activity with minimal side effects and low cost. Selection is typically made based on the known pattern of bacterial resistance in the community, the relative effectiveness of various agents against common pathogens and the relative adverse event profiles and costs of these agents. Compliance issues, as well as medication allergies and drug interactions, may also play a role in antibiotic selection.

Bacterial resistance: Antibiotic therapy for the treatment of sinusitis has changed considerably over the past 15 years. Resistant strains of bacteria have emerged, rendering older agents such as amoxicillin and erythromycin less effective at resolving infection caused by such strains. In Canada, 28.4% of *H influenzae* isolates (126) and approximately 90% of *M catarrhalis* isolates (personal communication) were reported to be beta-lactamase positive. Similarly, in the United States, 30% of *H influenzae* isolates and 92% of *M catarrhalis* isolates were reported to be beta-lactamase positive (Table 6) (127,128).

More recently and most importantly, *S pneumoniae*, which is a common cause of morbidity and mortality in North America, has become increasingly resistant to first-line antimicrobial agents (127-135). Not only penicillin-resistant but also multidrug-resistant strains of *S pneumoniae* have emerged (127-135). In the 1990s, there has been an alarming increase in both intermediate-resistant and highly resistant strains of *S pneumoniae* (127-135). Worldwide, it is anticipated that the prevalence of resistant strains, as well as the reported incidence of cross-resistance, will continue to increase.

In Canada, reduced susceptibility to penicillin has recently been detected in approximately 12% of *S pneumoniae* isolates (8.4% had intermediate resistance, 3.3% had high-level resistance) (135). Of the data collected in the United States in the early 1990s, incidence rates of 6.6%, 18% and 22% were reported for penicillin-resistant *S pneumoniae* isolates (127, 128,130). By 1994, incidence rates of 25% had been reported—18% of isolates had intermediate resistance, and 7% had high-level resistance (131).

In the paediatric population in Canada, reported incidence rates for penicillin-resistant *S pneumoniae* were similar to those of the adult population (136,137). However, in the United States, incidence rates for penicillin-resistant *S pneumoniae* in the paediatric population were much higher than in the adult population (132,133). In a 1993 study conducted in rural Kentucky, 53% of isolates were resistant, 33% were highly resistant and 50% were multidrug resistant (132). In a second study conducted in Houston, Texas in which data were collected between 1988 and 1993, 56% of isolates were intermediately resistant and 44% were highly resistant (133).

Acute and recurrent acute disease: It is thought that, between recurrent events, patients with recurrent acute disease have normal sinuses. Therefore, treatment considerations and

recommendations that are relevant to acute disease also apply to recurrent acute disease.

The common pathogens in acute sinusitis (Table 2) as well as the comparative efficacy of selected antimicrobial agents in treating this disease have been established by using sinus puncture studies (78,85-88,98,99,138-151). Given the invasive nature of sinus puncture, some of the comparative clinical studies have established efficacy using radiographic and clinical evidence of cure (122,152-155). Since the mid-1970s, several different antimicrobial agents have been investigated for use in the treatment of sinusitis (Table 7). Bacteriological cure rates as high as 95% to 100% have been reported for the following agents: amoxicillin, amoxicillin-clavulanate, azithromycin, cefuroxime axetil, ciprofloxacin and trimethoprim/sulfamethoxazole (TMP/SMX). Ciprofloxacin, which was recently approved for use in acute sinusitis in adults, was shown to be clinically equivalent to cefuroxime axetil (143,144). For patients with proven microbiological evidence of sinus infection, clinical response rates of 87% and 92% were achieved when ciprofloxacin was administered for 10 days and two to three weeks, respectively (143,144).

From an overview of the comparative data, these agents – both first-line agents such as aminopenicillins and TMP/SMX, as well as newer agents – all appear to be efficacious in the treatment of acute sinusitis (level I evidence). However, most of these studies were conducted before 1990; no weighting has been given to the earlier studies, when resistance to traditional first-line agents was presumably less common. While any of these agents may be suitable for the treatment of sinusitis, this may well change as the prevalence of resistance to first-line agents increases (level III evidence). Clearly, there is a need to conduct new trials to compare the in vitro effectiveness of these agents in today's environment. Aminopeni-

TABLE 7
Comparative efficacy of selected antimicrobial agents in acute sinusitis (references 78,86,87,122,124,125,138-155)

Antimicrobial agent	Adults		Children
	Bacteriological cure rate (%) [†]	Clinical success rate (%) [‡]	Clinical success rate (%) [‡]
Ampicillin	83	92	–
Amoxicillin	73-100	93-100	67-100
Amoxicillin-clavulanate* (500/125 mg)	84-96	78-96	64-93
Azithromycin	93-100	93-100	–
Cefaclor	71	–	87
Cefprozil*	–	80-86	–
Cefuroxime axetil*	84-100	74-85	–
Cefixime*	91	84-94	–
Ciprofloxacin*	97-100	87-92	–
Clarithromycin*	87-93	95-97	–
Erythromycin-sulfisoxazole	–	–	95
Trimethoprim/sulfamethoxazole	84-95	76-95	–

*Agents approved for use in Canada; [†]Bacteriological eradication in patients with proven microbiological evidence of sinusitis; [‡]Improved plus cure

cillins (eg, ampicillin) may be used in locations where the incidence of beta-lactamase producing strains is low. Dosing information for selected antimicrobial agents is provided in Table 8.

TABLE 8
Selected antimicrobial agents used in the treatment of acute sinusitis

Antimicrobial agent	Adult dosage	Paediatric dosage (years)
Amoxicillin	250 to 500 mg every 8 h	20 to 40 mg/kg/day [†] every 8 h
Amoxicillin-clavulanate*	1 tablet (Clavulin-250 or Clavulin-500F, SmithKline Beecham) every 8 h	40 mg/kg/day amoxicillin plus 10 mg/kg/day clavulanic acid [†] every 8 h
Azithromycin	500 mg every 24 h day 1; 250 mg every 24 h days 2 to 5	–
Cefaclor	250 mg every 8 to 12 h	20 mg/kg/day [†] every 12 h
Cefprozil*	250 or 500 mg every 24 h	7.5 to 15 mg/kg every 12 h
Cefuroxime axetil*	250 mg every 12 h	10 to 15 mg/kg/day [†] every 12 h
Cefixime*	400 mg every 24 h or 200 mg every 12 h	8 mg/kg/day every 24 h or 4 mg/kg/day every 12 h
Ciprofloxacin*	500 mg every 12 h	–
Clarithromycin*	500 mg every 12 h	15 mg/kg/day [†] every 12 h
Erythromycin-sulfisoxazole	–	40 mg/kg/day [†] every 12 h
Trimethoprim-sulfamethoxazole DS (160/800)	1 to 1.5 tablets every 12 h	3 mg trimethoprim/kg plus 15 mg sulfamethoxazole/kg every 12 h

*Agents approved for use in Canada; [†]In three equally divided doses; [‡]In two equally divided doses

In cases where higher levels of resistance are suspected, some agents may be preferable to others because they have proven to be more effective in in vitro testing (level II evidence). Cefixime and ciprofloxacin were particularly effective against isolates of *H influenzae*, regardless of beta-lactamase production (127). Ciprofloxacin was also effective against *M catarrhalis* (127). As resistance to beta-lactamase producing strains of *H influenzae* and *M catarrhalis* increases, agents that retain their effectiveness may prove to be particularly beneficial.

The increase in pneumococcal resistance to penicillin and the subsequent increase in the incidence of cross-resistance to other antimicrobial agents present a serious challenge to the practitioner in selecting an optimal therapy. Penicillin-resistant strains of *S pneumoniae* that were relatively resistant to amoxicillin, cephalosporins and other beta-lactam antibiotics are now more likely to be resistant to several of the non-beta-lactam antibiotics including macrolides (erythromycin), TMP/SMX, chloramphenicol and tetracyclines (127-135). The degree of cross-resistance varies by agent but generally increases with the level of penicillin resistance. Incidence rates ranging from 26% to 90% have been reported for cross-resistance to TMP/SMX (127,131,133).

In one surveillance study, cefprozil and cefuroxime axetil were found to be more active against all penicillin-resistant strains of *S pneumoniae* than either cefaclor or cefixime at the minimum inhibitory concentration (MIC) of 50% of isolates, though none of the cephalosporins tested were susceptible at the MIC of 90% of isolates (128). In another study, 100% of strains with high-level penicillin resistance were resistant to cefuroxime axetil, but only 28% and 22% of strains were resistant to cefotaxime and ceftriaxone, respectively (135). While there are limited comparative clinical trial data in this area, management guidelines for the treatment of pneumococcal infections are increasingly needed (135).

A treatment course of sufficient duration is as critical to effective treatment of sinus infection as appropriate antibiotic selection. In several clinical studies of acute sinusitis, 95% to 100% cure rates have been achieved with antimicrobial regimens of three, seven and 10 days' duration, although most studies have been conducted with 10-day regimens (78,87,88,122,139-153). In one 80-patient study, similar clinical cure rates were observed regardless of whether patients received three days' or 10 days' treatment with TMP/SMX in combination with a nasal decongestant (153). This result may prove to be anomalous because resistance to *S pneumoniae* has risen substantively since the time that this study was conducted. At this time, no other published direct comparative data on the duration of antimicrobial therapy have been published. While further study is still required to establish the optimal treatment regimen, a 10-day regimen (level I evidence) is recommended by this committee to ensure eradication of the pathogen and avoid recurrence of infection.

Chronic disease: While several antimicrobial agents are under investigation for the treatment of chronic sinusitis, none has been approved in Canada for this indication. Agents used to treat this disease should have an antibiotic profile that in-

cludes anaerobic activity because anaerobes are more common than aerobes in chronic sinusitis. Antibiotics are usually given for much longer periods of time in chronic disease ranging from three to six weeks; however, adverse effects such as diarrhea and vaginitis are common with longer term therapy (156).

Comparative clinical trial data are available for each of ciprofloxacin, amoxicillin-clavulanate, clarithromycin and erythromycin; these agents have been shown to be effective in the treatment of chronic disease (level I evidence). Of patients with bacteriologically documented sinusitis, eradication of the causative pathogen was achieved in 81% to 100% of patients receiving ciprofloxacin for acute and chronic disease and for acute exacerbations of chronic disease (143,144,157-159). When reassessed four weeks after completion of treatment, this level of bacterial eradication was maintained (157). Ciprofloxacin was shown to be comparable in clinical efficacy to cefuroxime axetil, amoxicillin-clavulanate and clarithromycin in the treatment of adult patients with either acute sinusitis or acute exacerbation of chronic sinusitis (143; data on file, Bayer Inc). In the treatment of patients with chronic disease alone, nine days' treatment with ciprofloxacin was at least as effective as amoxicillin-clavulanate - clinical cure was achieved in 58.6% and 51.2% of patients, respectively ($P>0.05$); bacteriological eradication was achieved in 88.9% and 90.5% of patients, respectively ($P>0.05$) (158). In addition, ciprofloxacin was better tolerated ($P=0.012$). Gastrointestinal disturbances were the most frequently reported adverse effects, in 7% and 28% of patients, respectively.

Clarithromycin, administered over a period of eight to 12 weeks, has also been studied in chronic disease (159). Clinical efficacy was dependent on the length of treatment; after 12 weeks, 70.6% of patients had a clinical assessment that was at least rated as 'good'. Similar results have been shown with erythromycin (160), although neither of these studies had a placebo control or comparator group.

Paediatric disease: It is particularly important that the clinician identify and deal with any modifiable predisposing factors of paediatric disease. For example, sinusitis can often be prevented in children with allergic rhinitis through aggressive control of the allergic disease by using both allergy avoidance and pharmacological management (66,80). Interestingly, almost 80% of asthmatic children with sinusitis were able to discontinue use of bronchodilators following resolution of their sinusitis with appropriate antimicrobial therapy (72). Nonetheless, the presence of predisposing risk factors and concomitant diseases should not preclude antimicrobial treatment for sinus disease in the acute setting. For example, while a history of immune deficiency may require specific management, acute sinusitis still requires treatment with a course of antibiotics.

Amoxicillin, amoxicillin-clavulanate and cefuroxime axetil have all been shown to be effective in the treatment of acute sinusitis in children (level I evidence) (78,122,161). Amoxicillin was shown to be more effective than cefaclor in clinical trial (78), while clinical cure rates of 67% and 64% for amoxicillin and amoxicillin-clavulanate, respectively, indicate that these agents are clinically equivalent (122). For patients who

failed to recover during placebo treatment, erythromycin-sulfisoxazole was effective at resolving acute disease (122). In addition, 92% of children receiving cefuroxime axetil for the treatment of acute sinusitis showed evidence of clinical improvement (161). Alternative antibiotics include TMP/SMX, cefaclor and cefixime, though amoxicillin-clavulanate, erythromycin-sulfisoxazole and cefuroxime axetil have the most comprehensive antibacterial spectra. Amoxicillin can be used for uncomplicated acute paediatric sinusitis where the incidence of beta-lactamase producing organisms is low. Ciprofloxacin is not indicated for use in prepubertal patients, although in a recently published surveillance study of approximately 1700 patients aged 17 years and under, only one patient was identified with a potential ciprofloxacin-induced adverse event (hemolytic-uremic syndrome) (162). From this retrospective analysis, the authors concluded that no drug-related serious, or unusually high rates of, adverse events were seen in the paediatric population.

The addition of a decongestant-antihistamine to antimicrobial therapy in acute paediatric sinusitis did not prove to be of benefit and is not recommended (level I evidence) (163). Antihistamines should be used only for patients with recognized allergic disease (level III evidence) (164).

In the case of chronic disease, although limited clinical data are available, amoxicillin, TMP/SMX and clindamycin have all been shown to be of benefit (level I and II evidence). In one study of paediatric patients with chronic sinusitis and respiratory allergy, amoxicillin was the most effective agent for treating the sinus infection, although TMP/SMX was an adequate alternative (163). In a second study, clindamycin proved to be the most effective agent for treating chronic sinusitis in children, followed by amoxicillin or ampicillin and erythromycin (165). Amoxicillin-clavulanate is recommended as first-line treatment for refractory acute infections and chronic sinusitis in children because it is effective against most of the suspected pathogens, including anaerobes and beta-lactamase producing organisms (level III evidence) (80).

Decongestants and mucoevacuants: Decongestants and mucoevacuants may help to achieve and maintain ostial patency and, therefore, are thought to be of benefit in the treatment of sinusitis (level III evidence). Topical decongestants cause local vasoconstriction in the nasal mucosa, thereby reducing tissue edema in the nasal cavity, while mucoevacuants cause thinning of the nasal secretions, thereby facilitating nasal drainage. The value of decongestants in the treatment of acute sinusitis can be inferred from a comparative study in which patients with acute sinusitis treated with decongestants only served as the control (123). By using both radiological and symptomological evidence, a satisfactory clinical response was observed in 71% of patients randomized to 10 days' treatment with decongestants alone, and there was a 28% improvement in the radiological gradation of the sinus state (123). Topical decongestants (nose drops and sprays) are recommended for short term use only, not exceeding three days because continuous use can lead to rebound vasodilation and reduction in efficacy. Oral decongestants may be of benefit should longer term decongestant therapy be required (166,167).

Topical decongestants that can be used in this indication include naphazoline, phenylephrine and oxymetazoline. Oral agents for longer term use include ephedrine, phenylephrine, pseudoephedrine and phenylpropanolamine. Some are also available in combination with guaifenesin, which is the most frequently used mucoevacuant/expectorant. Both topical and oral agents are widely available as over-the-counter medications. Decongestants are contraindicated in uncontrolled high blood pressure, coronary artery disease, glaucoma and urinary retention.

Based on anecdotal evidence, a number of nonpharmacological approaches may be of benefit in temporarily relieving symptoms of acute sinusitis (15). These strategies include steam inhalation techniques with or without astringents, saline nasal spray or nasal lavage between steam treatments, adequate home humidification, consumption of spicy foods or breathing hot, dry air (level III evidence).

Anti-inflammatory agents: Corticosteroids are not recommended for use in acute sinusitis (2,17). However, they may have a role in reducing tissue inflammation, edema and hyper-reactivity in patients who have not improved despite a comprehensive regimen including antimicrobial, decongestant and mucoevacuant therapy (level III evidence).

The value of glucocorticoids in chronic sinusitis can be inferred from laboratory evidence involving markers for the inflammatory response. Both allergic and nonallergic patients with chronic sinusitis had increased expression of interleukin (IL)-5R and IL-13 compared with normal controls; treatment with topical steroids downregulated receptors for IL-5R and IL-13 (168,169). The value of reducing the inflammatory response can also be inferred from the following clinical study. In 50 patients with chronic sinusitis, similar clinical response rates were experienced by those randomized to treatment with antibiotic (neomycin), glucocorticoid (dexamethasone) and decongestant (tramazoline), and those randomized to active treatment without the antibiotic; both active treatments were superior to placebo (response rates of 62%, 60% and 12%, respectively) (170).

Newer, topically administered glucocorticoids are preferred because they have a longer duration of action than older agents and systemic absorption of the swallowed portion is minimal. However, their onset of effect is not evident for at least four to seven days. These newer agents include beclomethasone dipropionate, budesonide, flunisolide, fluticasone propionate and triamcinolone acetonide. Older, faster-acting glucocorticoids, such as dexamethasone, may be of value when rapid onset of action is required.

Oral steroids are less desirable given the significant systemic adverse effects that are associated with their long term use. However, they may be of benefit should topical intranasal preparations not be sufficient to reduce inflammation. Surgery may be the only recourse for patients whose sinusitis has not resolved with medical treatment.

Other treatments: It is now known that allergy plays only a minor role in the pathogenesis of sinusitis. Antihistamines have not proven to be effective and, thus, are not recommended for the treatment of sinusitis (level III evidence).

APPENDIX 1
Summary of grades of evidence and the
classification of recommendations for clinical practice guidelines

Quality of evidence*

- | | |
|---|---|
| <p>I Evidence obtained from at least one properly randomized controlled trial</p> <p>II-1 Evidence obtained from well-designed controlled trials without randomization</p> <p>II-2 Evidence obtained from well-designed cohort or case-control analytical studies, preferably from more than one centre or research group</p> | <p>II-3 Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) may also be included in this category</p> <p>III Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees</p> |
|---|---|

*Adapted from reference 11

APPENDIX 2
Glossary of key terms

Acute-on-chronic sinusitis: Multiple acute exacerbations of chronic sinusitis with complete resolution of acute but not chronic symptoms between episodes

Allergic fungal sinusitis: Benign, noninvasive disease due to a hypersensitivity reaction to a fungal allergen. There is allergic mucus production and recurring nasal polyposis. This diagnosis should be suspected in patients with an atopic nasal polyp or recurrent nasal polyps in whom the computed tomography scan shows bony erosion and/or heterogeneity of the contents of the paranasal sinuses

Invasive fungal sinusitis: A rare, potentially fatal sinus infection in an immunocompromised host in which the fungal elements spread through the walls of the sinus and invade the surrounding tissues. Rapid diagnosis and treatment is critical, because patients are more likely to die than to survive the infection

Mucocele: Expansion of a paranasal sinus by retained mucus secretion secondary to blockage of the natural ostium

Mucopyocele: A mucocele that contains infected mucus

Nasal polyposis: A chronic disease resulting in swelling of the mucous membrane into the cavities of the nose and sinuses

Noninvasive fungal sinusitis: A fungal infection within a paranasal sinus in an immunocompetent host including the following forms: mycetoma, chronic indolent fungal sinusitis and allergic sinusitis

Orbital cellulitis: Inflammation or infection of the cellular tissue within the orbit. Orbital cellulitis can be a complication of acute ethmoid sinusitis if the infection extends laterally into the orbit through the lamina papyracea; less frequently, it occurs as a complication of frontal and maxillary sinusitis

Osteomyelitis: Inflammation of the bone caused by a pyogenic (pus-producing) organism or by a fungus

Ostiomeatal complex: The region of the nose between the middle and lateral nasal wall, which contains the ostial openings of the frontal, maxillary and ethmoid sinuses

Pansinusitis: Inflammation or infection involving all the paranasal sinuses

Proptosis: Abnormal protrusion of the eyeball (171)

Rhinitis: Inflammation of the mucous membrane of the nose (171)

Rhinotomy: Examination of the nasal passages either through the anterior nares or through the nasopharynx (171)

Rhinosinusitis: Inflammation of the nose and accessory sinuses

Sinusitis: Inflammation of a sinus, which can be purulent or nonpurulent, or acute or chronic (171)

Subdural empyema: Intracranial collection of pus between the dura and the arachnoid matter

Unilateral pansinusitis: Inflammation or infection involving all the paranasal sinuses on one side

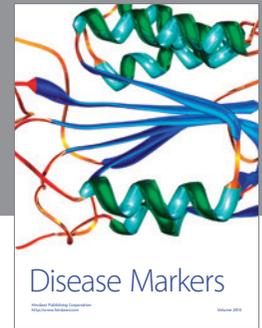
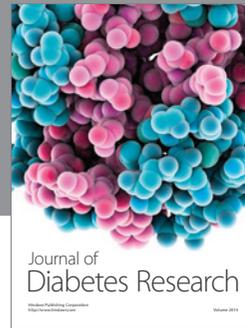
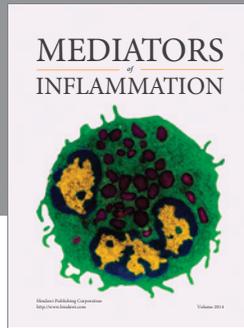
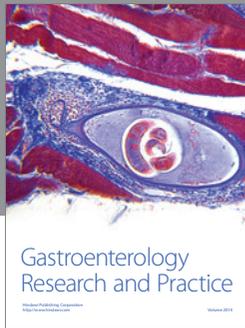
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