

A practical guide for the diagnosis and treatment of acute sinusitis

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Abstract

Objective: To develop guidelines for the diagnosis and management of acute sinusitis.

Options: Diagnostic clinical criteria and imaging techniques, the role of antimicrobial therapy and duration of treatment, and the role of adjunct therapy, including decongestants, glucocorticosteroids and nasal irrigation.

Outcomes: Improved accuracy of clinical diagnosis, better utilization of imaging techniques and rational use of antimicrobial therapy.

Evidence: A MEDLINE search for relevant articles published from 1980 to 1996 using the MeSH terms "sinusitis," "acute sinusitis," "respiratory infections," "upper respiratory infections," "sinusitis" and "diagnosis," "sinusitis" and "therapy," "sinusitis" and "etiology," and "antimicrobial resistance" and search for additional articles from the reference lists of retrieved articles. Papers referring to chronic sinusitis, sinusitis in compromised patients and documented nonbacterial sinusitis were excluded. The evidence was evaluated by participants at the Canadian Sinusitis Symposium, held in Toronto on April 26–27, 1996.

Values: A hierarchical evaluation of the strength of evidence modified from the methods of the Canadian Task Force on the Periodic Health Examination was used. Strategies were identified to deal with problems for which no adequate clinical data were available. Recommendations arrived at by consensus of the symposium participants were included.

Benefits, harms and costs: Increased awareness of acute sinusitis, accurate diagnosis and prompt treatment should reduce costs related to unnecessary investigations, time lost from work and complications due to inappropriate treatment. As well, physicians will be better able to decide which patients will not require antimicrobial therapy, thus saving the patient the cost and potential side effects of treatment.

Recommendations: Clinical diagnosis can usually be made from the patient's history and findings on physical examination only. Five clinical findings comprising 3 symptoms (maxillary toothache, poor response to decongestants and a history of coloured nasal discharge) and 2 signs (purulent nasal secretion and abnormal transillumination result) are the best predictors of acute bacterial sinusitis (level I evidence). Transillumination is a useful technique in the hands of experienced personnel, but only negative findings are useful (level III evidence). Radiography is not warranted when the likelihood of acute sinusitis is high or low but is useful when the diagnosis is in doubt (level III evidence). First-line therapy should be a 10-day course of amoxicillin (trimethoprim-sulfamethoxazole should be given to patients allergic to penicillin) (level I evidence) and a decongestant (level III evidence). Patients allergic to amoxicillin and those not responding to first-line therapy should be switched to a second-line agent. As well, patients with recurrent episodes of acute sinusitis who have been assessed and found not to have anatomic anomalies may also benefit from second-line therapy (level III evidence).

Validation: The recommendations are based on consensus of Canadian and American experts in infectious diseases, microbiology, otolaryngology and family medicine. The guidelines were reviewed independently for the advisory committee by 2 external experts. Previous guidelines did not exist in Canada.

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Special supplement

Supplément spécial

The authors were participants at the Canadian Sinusitis Symposium. Information about the authors and the other symposium participants appears at the end of the article.

This article has been peer reviewed.

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Résumé

Objectif : Élaborer des lignes directrices sur le diagnostic et la prise en charge de la sinusite aiguë.

Options : Critères cliniques de diagnostic et techniques d'imagerie, rôle et durée du traitement antimicrobien, et rôle du traitement d'appoint, y compris les décongestionnants, les glucocorticoïdes et l'irrigation nasale.

Résultats : Diagnostic clinique plus précis, meilleure utilisation des techniques d'imagerie et utilisation rationnelle du traitement antimicrobien.

Preuves : Une recherche, dans MEDLINE, d'articles pertinents publiés entre 1980 et 1996, effectuée au moyen des expressions MeSH «sinusitis», «acute sinusitis», «respiratory infections», «upper respiratory infections», «sinusitis» et «diagnosis», «sinusitis» et «therapy», «sinusitis» et «etiology», et «antimicrobial resistance» et recherche d'articles supplémentaires à partir des listes de référence des articles extraits. On a exclu les communications portant sur la sinusite chronique, la sinusite chez les patients compromis et la sinusite non bactérienne documentée. Les données probantes ont été évaluées par les participants au Symposium canadien sur la sinusite, qui a eu lieu à Toronto les 26 et 27 avril 1996.

Valeurs : On a utilisé une évaluation hiérarchique de la solidité des données probantes, inspirée des méthodes du Groupe d'étude canadien sur l'examen médical périodique. On a défini des stratégies pour régler des problèmes à l'égard desquels on ne disposait pas de données cliniques suffisantes. On a inclus des recommandations émanant d'un consensus des participants.

Avantages, préjudices et coûts : Une sensibilisation accrue à la sinusite aiguë, un diagnostic exact et un traitement rapide devraient réduire les coûts liés aux examens inutiles, le temps de travail perdu et les complications causées par un traitement inapproprié. En outre, les médecins seront mieux placés pour décider quels patients n'auront pas besoin d'un traitement antimicrobien, ce qui évitera au patient le coût du traitement et des effets secondaires possibles.

Recommandations : On peut habituellement poser un diagnostic clinique à partir des antécédents du patient et des résultats de l'examen physique seulement. Cinq constatations cliniques comportant 3 symptômes (odontalgie maxillaire, décongestionnants ayant peu d'effets et antécédents de rinorrhée nasale colorée) et 2 signes (sécrétions nasales purulentes et résultat anormal de la transillumination) sont les meilleurs prédicteurs de la sinusite bactérienne aiguë (données probantes de niveau I). La transillumination est une technique utile lorsqu'elle est utilisée par du personnel chevronné, mais seuls les résultats négatifs sont utiles (données probantes de niveau III). Une radiographie n'est pas justifiée lorsque la probabilité de sinusite aiguë est élevée ou faible, mais elle est utile lorsque le diagnostic est douteux (données probantes de niveau III). La thérapie de premier recours devrait être un traitement de 10 jours à l'amoxicilline (il faudrait donner du triméthoprim-sulfaméthoxazole aux patients allergiques à la pénicilline) (données probantes de niveau I) et un décongestionnant (données probantes de niveau III). Les patients allergiques à l'amoxicilline et ceux qui ne réagissent pas à un traitement de choix devraient passer à un agent mineur. En outre, les patients qui ont des épisodes récurrents de sinusite aiguë, que l'on a examinés et qui ne présentent pas d'anomalie anatomique peuvent aussi bénéficier d'une thérapie mineure (données probantes de niveau III).

Validation : Les recommandations sont fondées sur un consensus d'experts canadiens et américains en maladies infectieuses, microbiologie, otorhinolaryngologie et médecine familiale. Deux experts de l'extérieur ont procédé à une étude indépendante des lignes directrices pour le compte du comité consultatif. Il n'y avait pas de lignes directrices auparavant au Canada.

Commanditaire : Le Symposium canadien sur la sinusite et l'aide et l'appui techniques de Core Health Inc. dans la préparation du présent manuscrit ont été financés par une subvention de recherche sans restriction des Laboratoires Abbott du Canada. Le comité consultatif du symposium contrôle entièrement le contenu des lignes directrices.

Acute sinusitis is one of the most common conditions treated in the outpatient setting in North America. Of Americans surveyed about current health problems, 14% reported a diagnosis of sinusitis.^{1,2} Acute sinusitis accounts for 4.6% of physician visits by young adults.³ In the 1992 National Ambulatory Medical Survey, sinusitis was the fifth most common diagnosis for which an antibiotic was prescribed in the United States (J.W.W.: personal communication).

About 0.5% of common colds are complicated by signs or symptoms of paranasal sinusitis, most often localized to or involving the maxillary sinus.⁴⁻⁸ Each year, on average, adults have 2 to 3 colds and children 6 to 8; thus, the absolute number of people with signs and symptoms compatible with sinusitis annually is high.⁴⁻⁶

This consensus statement was designed to provide a framework to guide primary care physicians in the cost-effective diagnosis and management of this common

problem. Previous Canadian guidelines do not exist. To the best of our knowledge, the only other document to mention the diagnosis and treatment of sinusitis was published as the proceedings of a meeting in Florida in 1990.⁹

Literature review

A MEDLINE search was performed for relevant articles published from 1980 to 1996 using the MeSH terms "sinusitis," "acute sinusitis," "respiratory infections," "upper respiratory infections," "sinusitis" and "diagnosis," "sinusitis" and "therapy," "sinusitis" and "etiology," and "antimicrobial resistance." The reference lists of retrieved articles were reviewed for additional articles. Papers referring to chronic sinusitis, sinusitis in compromised patients and documented nonbacterial sinusitis were excluded.

The evidence was discussed at the Canadian Sinusitis Symposium, a consensus conference held in Toronto April 26–27, 1996. Participants at the symposium included experts in microbiology, infectious diseases, otolaryngology and family practice. The focus was on the difficulties of diagnosis and the appropriate treatment of acute sinusitis.

The symposium participants used a hierarchical evaluation of the strength of evidence modified from the methods of the Canadian Task Force on the Periodic Health Examination.¹⁰ Emphasis was placed on randomized, placebo-controlled clinical trials (level I evidence) and well-designed controlled trials without randomization (level II evidence) when available. Opinions of respected authorities based on clinical experience, descriptive studies and reports of expert committees (level III evidence) were assigned a lower weight. Strategies to deal with problems for which no adequate clinical data were available were identified at the symposium. Recommendations arrived at by consensus of the symposium participants (level III evidence) were added to this final report.

This document is limited to acute sinusitis in otherwise healthy people and does not address disease in patients who are immunocompromised or have underlying medical conditions or chronic sinusitis.

Classification of sinusitis

Sinusitis is classified as acute or chronic primarily on the basis of pathological findings and the duration of infection. Kern¹¹ defined acute sinusitis as any infectious process in the sinus that lasts from 1 day to 3 weeks. Epithelial changes in the sinuses are usually reversible in the acute phase. If the disease persists for 3 months it is classified as chronic and may involve irreversible mucosal damage. As well, patients who experience more than 3 or 4 episodes annually or who repeatedly fail to respond to

medical therapy may be considered to have chronic disease. Acute sinusitis can also occur in patients with chronic sinusitis.¹²

The gold standard for diagnosing acute bacterial sinusitis is the culture of infected secretions obtained by direct sinus puncture.^{13–17} A 4-view radiographic series of the sinuses may be considered a pragmatic alternative reference standard in patients with signs and symptoms consistent with sinusitis. It is considered to be about 75% as accurate as sinus aspiration and culture in diagnosing maxillary sinusitis.¹⁸ Since direct sinus puncture is not routinely performed in a primary care setting, the cause is assumed to be bacterial when acute sinusitis is diagnosed.

In this article "acute bacterial sinusitis" is used only to describe cases in which bacterial infection has been documented by antral puncture. Sinusitis diagnosed clinically or with the aid of radiographs is termed "acute sinusitis."

The paranasal sinuses

The paranasal sinuses comprise 4 paired air-filled cavities: the frontal, maxillary, ethmoid and sphenoid sinuses (Fig. 1).^{19,20} Each cavity is lined with ciliated pseudostratified columnar epithelium and has a narrow ostium that opens into the nasal cavity. The size and shape of the sinus cavities vary between age groups and people, and even within individuals.²¹ The posterior ethmoid sinus opens into the superior meatus, and the sphenoid sinuses open into the sphenoethmoid recess. The ostia of the frontal, maxillary and anterior ethmoid sinuses open into the os-

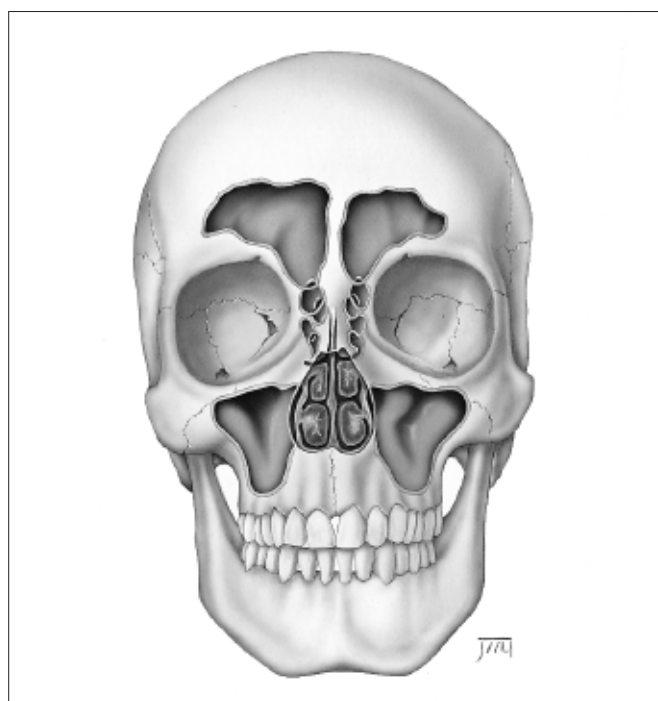


Fig. 1: The paranasal sinuses.

tiomeatal complex. Any blockage of this region will lead to obstruction of sinus drainage and potential development of sinusitis.

A protective blanket of mucus covers the respiratory cilia of the sinus and is moved constantly along predetermined pathways to the ostia. The mucous blanket exists in two layers, which act independently of one another. The first, deeper layer surrounds the cilia and seems to lubricate them as they beat through it. The cilia project slightly beyond this layer into the second, superficial layer, where inhaled particles are captured. The superficial layer floats on the first layer and is transported by the cilia. In the maxillary sinus, mucus is moved from the floor of the sinus radially up the walls and superiorly to the ostium. In the frontal sinus, mucus moves along the intersinus septum, across the roof of the sinus and across the sinus floor to the frontal recess and the middle meatus.²²

Pathogenesis of acute bacterial sinusitis

Obstruction of sinus drainage and retention of secretions are the fundamental events in sinus infection. In the absence of obstruction, inoculation of a sinus cavity with bacteria commonly associated with acute sinusitis is insufficient to produce sinusitis.²³ Several factors may contribute to obstruction: mucosal swelling leading to diminished patency of the ostia, abnormalities of the cilia, structural abnormalities and overproduction of secretions.^{4-6,23} Preceding viral infection or epithelial damage weakens mucosal defenses and facilitates penetration of bacteria into the sinus mucosa.^{13,24-26} Although nasal allergies also contribute to edema and swelling of the nasal mucosa, little information is available concerning their role in acute sinusitis.^{24,27-29}

Diagnosis

History and physical examination

Many symptoms of acute sinusitis are nonspecific and may be difficult to differentiate from symptoms of upper respiratory tract infection or allergic rhinitis. Nasal congestion, purulent nasal drainage, facial pain (particularly unilateral), maxillary toothache and a poor response to decongestants increase the likelihood of sinusitis.^{1,30,31}

The nostrils may be examined using a short, wide speculum mounted on a handheld otoscope.^{31,32} Purulent secretion from the middle meatus is highly predictive of maxillary sinusitis;^{14,30,33} however, this may be difficult to visualize unless a topical vasoconstrictive agent is used to shrink the nasal mucosa.³⁴ Direct inspection of the posterior pharynx or use of a pharyngeal mirror may reveal posteriorly draining purulent secretions.³⁵

Facial tenderness is best assessed by applying digital pressure over the maxillary and frontal sinuses. Because 5% to 10% of cases of bacterial maxillary sinusitis are secondary to dental root infection, the maxillary teeth can be tapped with a tongue depressor to check for tenderness.³⁰ The ethmoid and sphenoid sinuses cannot be adequately evaluated during the physical examination.³¹

There have been few attempts to assess the accuracy of the history and physical examination in diagnosing acute sinusitis. Axelsson and Runze³⁶ evaluated 69 items historically thought to be associated with sinusitis among 164 consecutive patients with acute sinusitis. Six symptoms were found to be significantly more common ($p < 0.01$) in patients with abnormal radiographs than in those with normal radiographs: preceding upper respiratory tract infection, nasal discharge (purulent or not), painful mastication, malaise, cough and hyposmia.³⁶ However, no single finding was found to be highly predictive of sinusitis.

Using paranasal sinus radiographs Williams and Sime³¹ compared the symptoms of 247 consecutive male patients who had rhinorrhea, facial pain unrelated to trauma or self-suspected sinusitis. Radiologists blinded to the clinical findings interpreted each radiograph. Coloured nasal discharge, cough and sneezing had the greatest sensitivity (72%, 70% and 70% respectively) but were not specific (52%, 44% and 34%). Maxillary toothache was highly specific (93%), but only 11% of the patients reported it. Symptoms historically thought to make sinusitis less likely, such as sore throat (sensitivity 52%, specificity 56%), itchy eyes (sensitivity 52%, specificity 43%) and constitutional symptoms (sensitivity 56%, specificity 47%), were not discriminatory. The one potential weakness of this study was its exclusion of women.

Berg and Carefelt³⁷ examined 155 patients admitted to an emergency department with symptoms in the paranasal region. Patients were selected for the study regardless of the intensity of their symptoms; however, they could not have been symptomatic for longer than 3 months. Nasal discharge alone did not qualify the patient for the study unless examination revealed pus from the middle meatus. Clinical impression of acute bacterial sinusitis was confirmed by sinus puncture and culture. Purulent nasal discharge and facial discomfort, predominately on 1 side, were found to be the 2 most reliable indicators of sinusitis, with an overall sensitivity of 85%.

Hansen and associates³⁸ evaluated the symptoms, signs, erythrocyte sedimentation rate and C-reactive protein concentration in 174 adults suspected of having acute bacterial maxillary sinusitis by their primary care physician. Sinus puncture and culture were used as the diagnostic gold standard. Only the erythrocyte sedimentation rate and the C-reactive protein concentration were found to be independently associated with the diagnosis

of acute bacterial sinusitis. The combination of the 2 variables had a sensitivity of 82% and a specificity of 57%. None of the generally accepted signs and symptoms was independently associated with bacterial sinusitis; however, this study illustrates the relative accuracy of the primary care physician in diagnosing acute sinusitis.

Several studies have involved children.^{14,39,40} Wald and collaborators¹⁴ correlated clinical findings with both radiographic and bacteriologic findings. Clear or purulent discharge (sensitivity 76% to 84%) and cough (sensitivity 48% to 80%) were found to be the most sensitive, but the discriminating power of these findings is not known.³¹

Predictive value of signs and symptoms

Combinations of signs and symptoms that best predict sinusitis have been identified using logistic regression analysis.³⁰ A 4-view radiographic series served as the gold standard in this study. Three symptoms (maxillary toothache, poor response to decongestants and history of coloured nasal discharge) and 2 signs (purulent nasal secretion and abnormal transillumination) were found to be the best predictors of sinusitis (Table 1).^{30,31} When none of these findings was present sinusitis could be ruled out; however, when 4 or more were present, the likelihood ratio was 6.4 (Table 2).^{30,31} The patients selected for the study were enrolled from a primary care walk-in clinic. Unlike a specialist clinic, where the prevalence of sinusitis is expected to be high, a walk-in clinic is likely to have a prevalence similar to that in the general population. Thus, the predictive values obtained were not skewed by an unrepresentative population.

Recommendations

- Sinus puncture, with aspiration and culture of sinus secretions, remains the gold standard for diagnosis; however, this technique is invasive and impractical in most situations (level I evidence).
- No single clinical finding is predictive of acute sinusitis (level I evidence).
- Three symptoms (maxillary toothache, poor response to decongestants and history of coloured nasal discharge) and 2 signs (purulent nasal secretion and abnormal transillumination) are the best clinical predictors of acute sinusitis (level I evidence).
- When fewer than 2 of the above signs or symptoms are present acute sinusitis can be ruled out (level I evidence).
- A diagnosis of acute sinusitis may be unclear in patients with 2 or 3 of the above signs and symptoms. In this situation, sinus radiography would be helpful (level III evidence).

- When 4 or more of the signs and symptoms are present the likelihood of acute sinusitis is very high (likelihood ratio 6.4) (level I evidence).

Transillumination

Transillumination may be used to evaluate the maxillary and frontal sinuses, but its value is controversial.^{13,15,39,41,42} It may be even less useful in children than in adults and is completely unreliable in children under 9 years of age,¹⁸ primarily because of the thickness of both the soft tissues and the bony vault, the differential rates of paranasal sinus development in children and the lack of aeration of the sinuses. Sensitivity of transillumination in children has ranged from 48% to 76%.⁴³⁻⁴⁵

The examination must be conducted in complete darkness. A transilluminator is placed directly against the infraorbital rim of the patient. With the patient's mouth open, the examiner judges the amount of light transmitted through the maxilla. Results are usually interpreted as opaque (no light transmission), dull (reduced light transmission) or normal. Alternatively, the transilluminator is placed in the patient's mouth, and the patient makes a tight seal around it. The examiner judges the amount of light transmitted through the maxillary sinuses. To transilluminate the frontal sinus, the light source must be placed inferior to the medial border

Table 1: Independent predictors of acute sinusitis*

Symptom or sign	Likelihood ratio (and 95% CI†)	
	Positive	Negative
Maxillary toothache	2.5 (1.2-5.0)	0.9 (0.8-1.0)
Purulent secretion	2.1 (1.5-3.0)	0.7 (0.5-0.8)
Poor response to decongestants	2.1 (1.4-3.1)	0.7 (0.6-0.9)
Abnormal transillumination result	1.6 (1.3-2.0)	0.5 (0.4-0.7)
History of coloured nasal discharge	1.5 (1.2-1.9)	0.5 (0.4-0.8)

*Data adapted from Williams and Simel.³¹

†CI = confidence interval.

Table 2: Likelihood of acute sinusitis as determined by number of signs and symptoms present*

No. of signs/ symptoms	No. of patients		Likelihood ratio
	With sinusitis	Without sinusitis	
4	16	4	6.4
3	29	18	2.6
2	27	39	1.1
1	14	48	0.5
0	2	32	0.1
Total	88	141	

*Data adapted from Williams and Simel.³¹

of the supraorbital ridge. Interpretation is difficult because the frontal sinuses are naturally asymmetrical.

Williams and colleagues³⁰ compared the findings of transillumination with those of paranasal radiography in 247 patients. They reported that transillumination did little to change the post-test probability of sinusitis. It generated a likelihood ratio of only 1.6 if the result was dull or opaque for either maxillary sinus, and 0.5 if it was normal for both maxillary sinuses. The authors concluded that, as a single finding, transillumination was unreliable. In contrast, Gwaltney and coworkers¹⁵ found that transillumination was highly useful when the result was either opaque (likelihood ratio 4.0) or normal (likelihood ratio 0.04). Dull transillumination findings were less useful (likelihood ratio 0.41). The apparent differences between these two trials may be the result of different patient populations. In the first study³⁰ patients were recruited from a primary care walk-in clinic, whereas in the second study¹⁵ patients were selected from an otolaryngology clinic.

Recommendations

- Transillumination should be performed only by experienced personnel (level III evidence).
- Only negative findings (no loss of transmitted light) are useful (level III evidence).
- Transillumination must be performed in complete darkness (level III evidence).
- Only maxillary sinuses can be adequately evaluated (level III evidence).
- Patients must remove dental plates before the procedure (level III evidence).

Diagnostic imaging

Radiography

Radiographic studies can improve the diagnostic accuracy of acute sinusitis and correlate well with sinus aspiration.¹³ However, many issues remain unresolved, especially the question of when to order radiographs and which view to order (1 view v. 3 or 4 views). Some specialists routinely order radiography for patients with suspected sinusitis, yet it is unclear how primary care physicians should use radiography.^{18,35}

Air–fluid levels and complete opacification of the sinus are useful features when present on radiographs, with positive predictive values of 80% to 100% in most studies.^{1,13,16} Sensitivity is low: only about 60% of patients with sinusitis will have opacification or air–fluid levels.¹ The sensitivity of sinus mucosal thickening is high (greater than 90%), but it is nonspecific in symptomatic patients.^{1,15,16,44,45} Mucosal thickening of at least 5 mm has

been used as a threshold in an attempt to optimize predictive values; however, specificities from 36% to 76% have been observed in symptomatic patients using this cutoff point.^{13,15,16} Radiographs of sinuses in children 1 year of age or less are not useful because of false opacification due to facial asymmetry and redundant mucosa.¹⁴ However, in older children, without a current upper respiratory tract infection, an abnormal radiograph of the maxillary sinus combined with fever and rhinorrhea correctly predicts acute sinusitis in 75% of cases.¹⁴

Basic radiographic examination of the paranasal sinuses includes 4 views: the Waters view (occipitomeatal), to evaluate the maxillary sinuses; the Caldwell view (angled posteroanterior), to evaluate the ethmoid and frontal sinuses; the lateral view, to evaluate the sphenoid sinuses and to confirm disease in the paired maxillary, ethmoid and frontal sinuses; and the submentovertex view, to evaluate the sphenoid and ethmoid sinuses.^{46,47} This last view is also useful for examining the lateral walls of the maxillary sinuses. All radiographs are done with the patient erect in order to evaluate air–fluid levels.

The number and types of views that should be ordered have been examined by several investigators.^{46–48} Hayward and associates⁴⁸ compared the Waters view alone with a 3-view series (Waters, occipitofrontal and lateral) and found 99% agreement. They concluded that a single Waters view is sufficient for diagnosis. Williams and collaborators⁴⁷ compared a single Waters view and a 4-view series and also found a high rate of agreement. However, after correcting for chance agreement they found that the results varied depending on which sinus was involved. Agreement for the maxillary sinuses was almost perfect but was poor for the remaining sinuses. The authors pointed out that maxillary sinusitis is much more prevalent than other forms. Most studies have demonstrated that about 90% of cases of sinusitis involve the maxillary sinuses.^{12,47} Therefore, most cases of sinusitis would be diagnosed using only the Waters view. A third study compared the Waters view with a 3-view series in children (mean age 9 years).⁴⁹ The single Waters view had a sensitivity of 89%, a specificity of 83%, a positive predictive value of 87% and a negative predictive value of 87%. The overall accuracy of the Waters view in diagnosing acute sinusitis in children was 87%.⁴⁶

When should primary care physicians order radiographs? Several studies^{30,48,49} have shown that physicians can accurately distinguish between patients with low and high probabilities of sinusitis based on the number of clinical findings (Table 1). When 4 or more signs and symptoms are present (Table 2) the probability of sinusitis is high and further testing is unwarranted.³⁰ When less than 2 signs or symptoms are present, there is a low probability of sinusitis, and again further testing is unwarranted.

However, with 2 or 3 signs or symptoms the probability of sinusitis is intermediate, and radiographs are warranted to aid in the diagnosis.

Patients with pronounced frontal headaches should have a radiograph series performed to rule out frontal sinusitis. The posterior wall of the frontal sinus provides a relatively thin barrier to infection of the central nervous system; therefore, diagnosis and appropriate treatment is crucial in these patients.⁵⁰ Patients with proven frontal sinusitis should be monitored closely.

Computerized tomography

Computerized tomography (CT) provides greater definition of the sinus cavity contents than radiography.⁵¹ On the basis of clinical and endoscopic criterion standards, CT appears to be more sensitive than plain radiography for detecting sinus abnormalities, particularly in the sphenoid and ethmoid sinuses.⁵² However, more than 40% of adults and children undergoing CT for reasons unrelated to sinus disease show some mucosal abnormality.^{53,54} In addition, Gwaltney and colleagues⁵⁵ described a high incidence of significant abnormalities found on CT scans of young otherwise healthy adults with fresh colds.

Recommendations

- In patients with fewer than 2 signs or symptoms the likelihood of acute sinusitis is low, and therefore radiographs are not required (level III evidence).
- In patients with 4 or more signs or symptoms the likelihood of acute sinusitis is high, and therefore radiographs are not required (level III evidence).
- A diagnosis of acute sinusitis may be unclear in patients with 2 or 3 associated signs and symptoms. In such cases radiography would be helpful in determining the diagnosis (level III evidence).
- Patients with frontal headaches and findings suggestive of sinusitis should have a radiograph performed to rule out frontal sinusitis (level III evidence).
- If radiography is warranted the Waters view alone should be sufficient. The Caldwell, lateral and submentovertex views can be added if the Waters view is inconclusive (level III evidence).
- Radiography should not be performed in children 1 year of age or less (level III evidence).
- CT scans are not cost-effective and should not be used routinely to diagnose acute sinusitis (level II evidence).

Causes

The most accurate information about the causes of acute bacterial sinusitis comes from studies in which cul-

ture specimens were obtained by direct puncture and aspiration of the sinus cavity. Several studies have shown that no correlation exists between nasal and sinus cultures in acute bacterial sinusitis.^{13-15,17}

Most information is limited to the maxillary sinus because of its accessibility. There is no information to correlate bacterial infection in the frontal, ethmoid and sphenoid sinuses with that in the maxillary sinus.⁵⁶ In general, the culture results of sinus puncture from different studies have been concordant (Table 3).^{6,14,17,18,56-59}

Gwaltney and coworkers⁵⁶ conducted a study between 1975 and 1989 to determine the causative pathogens in community-acquired acute bacterial sinusitis. They demonstrated, through sinus puncture and direct surgical exposure, that *Streptococcus pneumoniae* and *Haemophilus influenzae* were the most common (in 41% and 35% of cases respectively). The relative incidence of these pathogens did not change significantly over the 15-year period; however, the number of strains of β -lactamase-producing *H. influenzae* increased dramatically. None of the *H. influenzae* strains isolated between 1975 and 1985 were β -lactamase producing, whereas 52% of those isolated between 1985 and 1989 were. Anaerobes and other streptococci were each isolated from 7% of sinus aspirates. *Moraxella catarrhalis* was isolated from 4% of sinus specimens and *Staphylococcus aureus* from another 3%.

H. influenzae and *S. pneumoniae* are most often isolated in pure culture (72% of cases) but are occasionally found together or in combination with other organisms.⁵⁷ *H. influenzae* strains isolated through sinus puncture are almost exclusively unencapsulated and cannot be typed.

The bacteriologic characteristics of acute maxillary sinusitis in children are similar to those of sinusitis in adults.^{6,58-61} As in adults, *S. pneumoniae* and *H. influenzae* are the most common pathogens, representing 70% of all bacterial species isolated. However, the prevalence of sinusitis due to *M. catarrhalis* is significantly greater among children than among adults. About 25% of sinus specimens obtained from symptomatic children yield *M. catarrhalis*.^{6,17,58,59,65,66}

Table 3: Microbial causes of community-acquired acute bacterial sinusitis^{14,17,56-59}

Organism	Mean % (and range) of cases	
	Adults	Children
<i>Streptococcus pneumoniae</i>	34 (23-54)	41 (36-47)
<i>Haemophilus influenzae</i>	35 (19-60)	29 (27-32)
Anaerobes	6 (0-10)	0
<i>Staphylococcus aureus</i>	4 (0-8)	0
<i>Streptococcus pyogenes</i>	2 (1-3)	2 (2)
<i>Moraxella catarrhalis</i>	2 (0-8)	26 (23-27)
Gram-negative bacteria	4 (0-11)	2 (2)

Treatment

Antimicrobial therapy

Only 3 randomized controlled trials provided evidence for the usefulness of antimicrobial agents. Axelsson and associates⁶⁷ compared the use of a nasal decongestant, a decongestant plus sinus irrigation, and a decongestant plus an 8- to 10-day course of antibiotic therapy in 156 patients with acute maxillary sinusitis. Patients were selected on the basis of both clinical and radiographic findings suggestive of acute maxillary sinusitis. Patients receiving the decongestant and antibiotic therapy showed significant clinical improvement compared with those given only the decongestant ($p < 0.05$). No significant difference was observed between patients receiving the antibiotic therapy or those treated with sinus irrigation. Radiographic evidence of improvement, however, was significantly more prevalent in the group treated with antibiotics than in the other 2 groups ($p < 0.05$). In the second study Wald and colleagues¹⁹ compared the effectiveness of a 10-day course of amoxicillin, amoxicillin-clavulanate potassium and placebo in 93 children. Children were eligible if they had nasal discharge of any quality or cough, or both, that had been present for at least 10 but no longer than 30 days by their parents' estimation. Clinical improvement was seen in 79% of the children in the 2 treatment groups, but in only 60% of those in the placebo group. The overall 10-day cure rate was 67% among those in the treatment groups, compared with only 43% among those in the placebo group. Clinical assessments on day 3 and 10 of therapy showed that children in the treatment groups were significantly more likely to be cured at 3 days ($p < 0.01$) and at 10 days ($p < 0.05$) than the children in the placebo group. Lindbaek and coworkers⁶⁸ recently compared the effectiveness of amoxicillin and penicillin V against placebo in the treatment of acute sinusitis in adults. They found that the drugs were significantly more effective than placebo alone ($p < 0.0001$).

Table 4 lists the antimicrobial agents appropriate for the treatment of acute bacterial sinusitis in Canada. Tables 5 and 6 list trials that have compared the efficacy of various antimicrobial regimens. Virtually all involved patients with acute maxillary sinusitis. The β -lactam antimicrobial agents amoxicillin and amoxicillin-clavulanate have been studied extensively,^{43,69-77} as have the cephalosporins cefaclor, cefuroxime and cefixime,^{75,77-79} the macrolides azithromycin and clarithromycin^{71-74,80} and trimethoprim-sulfamethoxazole (TMP-SMX).^{18,50} Early studies evaluated the use of erythromycin alone.⁸¹

Amoxicillin therapy is considered to be the first-line treatment of acute bacterial sinusitis. Three studies, using a standard regimen of 500 mg of amoxicillin 3 times daily

for 10 days, reported cure rates based on clinical outcome of 73%,⁷¹ 72%⁷² and 74%.⁷⁴ Of the patients not deemed to have complete resolution of symptoms, clinical improvement was seen in 27%, 26% and 17% respectively. The mean bacteriologic cure rate in all 3 studies, based on culture of sinus aspirates before and after treatment in all or a subgroup of patients, was greater than 90%.

Clinical cure rates for amoxicillin-clavulanate did not differ significantly from those for other antimicrobial Neilsen⁷⁰ compared the effectiveness of amoxicillin-clavulanate and loracarbef in acute sinusitis. Patients were assigned randomly to receive either 500/125 mg of amoxicillin-clavulanate 3 times daily for 10 days or 400 mg of loracarbef twice daily for 7-10 days. Clinical response, determined within 72 hours after the completion of drug therapy, was considered to be successful if there was improvement or clinical cure. A positive clinical response occurred in 96% of the patients given amoxicillin-clavulanate and in 92% of those given loracarbef.

Cefaclor, cefuroxime axetil and cefixime have been evaluated in both adults and children.^{75,77-79} Camacho and associates⁷⁵ compared the efficacy of cefuroxime axetil (250 mg twice daily) and amoxicillin-clavulanate (500/125 mg 3 times daily). The bacteriologic cure rates were 84% and 87% respectively. No significant difference was observed in the clinical cure rate. In a similar trial, the clinical outcomes of patients treated with cefixime or amoxicillin were evaluated.⁷⁷ Again, no significant difference was observed between the 2 groups. When compared with cefaclor, however, cefuroxime was significantly better at eradicating the bacteria (bacteriologic cure rates 95% v. 71%; $p < 0.05$, Fisher's exact test).⁷⁹

Several trials have examined the effectiveness of clarithromycin and azithromycin.^{71-74,80} Both of these drugs have been shown to be as effective as amoxicillin and amoxicillin-clavulanate.⁷¹⁻⁷⁴ Although the approved dose of clarithromycin for treating acute sinusitis is 500 mg twice daily,

Table 4: Oral antimicrobial therapy for acute bacterial sinusitis approved for use in Canada

Drug	Adult dosage	Pediatric dosage
Amoxicillin	500 mg q8h	40 mg/kg daily, in 3 doses
Amoxicillin-clavulanate	500/125 mg q8h	45/6.4 mg/kg daily, in 2 doses
Clarithromycin	500 mg bid	15 mg/kg daily, in 2 doses
Cefuroxime axetil	250 mg bid	30 mg/kg daily, in 2 doses
Cefaclor	250 mg q8h	20-40 mg/kg daily, divided q8h-q12h
Cefixime	400 mg bid	9 mg/kg daily
TMP-SMX*	160/800 mg q12h	8/40 mg/kg daily, in 2 doses
Erythromycin-sulfisoxazole	-	40 mg/kg daily, in 3 doses

*TMP-SMX = trimethoprim-sulfamethoxazole.

several trials have used 250 mg twice daily and have shown clinical and bacteriologic cure rates exceeding 90%.^{73,74,80}

Duration of antimicrobial therapy

Clinical trials have used 10- to 14-day courses of therapy. However, few have been designed to determine the optimal length of treatment for acute sinusitis. Wald and collaborators¹⁴ provided evidence that a shorter duration of therapy may be efficient in children. Children receiving a 10-day course of amoxicillin or amoxicillin-clavulanate showed clinical cure or significant improvement by day 3 ($p < 0.01$). Although a greater proportion were cured by day 10, the overall clinical success rate (cure or improvement) was no greater after 7 additional days of therapy.

Williams and collaborators⁵⁰ compared the outcomes of patients receiving either a 3- or 10-day course of TMP-SMX and a decongestant (oxymetazoline). Subjects received either 1 tablet of TMP-SMX twice daily for 10

days or 1 tablet twice daily for 3 days followed by 7 days of placebo. They were assessed clinically on days 0, 7, 14, 30 and 60, and radiographs were taken on days 0 and 14. Bacteriologic studies using secretions obtained by sinus puncture were not done. At 14 days a similar proportion of patients in the 3- and 10-day treatment groups rated their symptoms as cured or much improved (77% and 76% respectively). The median number of days to cure or improvement were 5.0 and 4.5 respectively. Radiographic evidence of improvement did not differ significantly between the groups. The investigators concluded that a 3-day course of TMP-SMX was as effective as a 10-day course. These results, however, cannot be generalized to other antimicrobial agents. Antibiotics with shorter half-lives, lower tissue penetration or narrower antimicrobial spectrums may not be as efficacious if used for only 3 days.⁵⁰ As well, since completion of the study by Williams and collaborators, resistance of *S. pneumoniae* to TMP-SMX has increased dramatically.

Table 5: Results of clinical trials assessing the efficacy of antimicrobial therapy for acute bacterial sinusitis in adults

Trial	Drug regimen	% of patients with clinical cure or improvement		% of patients with proven bacteriologic cure*
		Cure	Improvement	
Williams et al ⁵⁰	TMP-SMX 1 tablet (double strength) bid × 3 d	31	46	ND
	× 10 d	19	57	ND
Mattucci et al ⁶⁹	Amoxicillin 250 mg tid	50	45	95
	Minocycline 100 mg bid	40	60	100
Nielsen ⁷⁰	Amoxicillin-clavulanate 500/125 mg tid	96	96	96
	Loracarbef 400 mg bid	92	92	88
Casiano ⁷¹	Amoxicillin 500 mg tid	73	27	100
	Azithromycin 500 mg × 1 d, 250 mg × 5 d	74	26	100
Dubois et al ⁷³	Amoxicillin-clavulanate 500/125 mg tid	67	26	90
	Clarithromycin 500 mg bid	64	33	87
Camacho et al ⁷⁵	Amoxicillin-clavulanate 500/125 mg tid	67	18	84
	Cefuroxime axetil 250 mg bid	63	19	87
Edelstein et al ⁷⁷	Amoxicillin 500 mg tid	47	49	ND
	Cefixime 400 mg × 10 d	51	43	ND
Gehanno et al ⁷⁸	Cefixime 400 mg × 10 d	82	2.7	84
Sydnor et al ⁷⁹	Cefuroxime axetil 250 mg bid	–	–	95+
	Cefaclor 500 mg tid	–	–	71+
Muller ⁸⁰	Azithromycin 500 mg × 3 d	66	27	92
	Clarithromycin 250 mg × 10 d	68	27	93

*ND = no data.

+ $p < 0.05$.

Summary

For patients with acute sinusitis, about 40% of whom will recover spontaneously, issues such as cost and safety of empirical therapy are paramount. Amoxicillin therapy is considered to be the first-line treatment of acute bacterial sinusitis. TMP-SMX can be considered for first-line therapy in patients allergic to penicillin. A 10-day course of amoxicillin has been shown to be as effective as any comparative agent.^{69,71-75,77} Although some studies support the use of a shorter course of therapy, the data are limited.^{15,50} Strong evidence exists, however, to support the use of a 10-day course of antimicrobial therapy.^{69,71-75,77} β -lactamase-resistant agents do not offer a significant advantage for first-line therapy. Many patients, even with a proven β -lactamase-producing organism, will respond to amoxicillin alone.¹⁵

Second-line therapy can be used if a patient is allergic or has not responded to first-line therapy. For second-line therapy, any agent with an approved indication for acute bacterial sinusitis other than amoxicillin and TMP-SMX may be used. Although patients with a proven β -lactamase-producing pathogen will often respond to first-line therapy, treatment failures do occur, and second-line therapy is warranted. Patients with recurrent episodes of acute sinusitis who have been found not

to have anatomic anomalies may benefit from second-line therapy.

Recommendations

- Antimicrobial therapy for acute bacterial sinusitis is beneficial (level II evidence).
- Amoxicillin therapy should be the first-line treatment of acute bacterial sinusitis (level I evidence).
- The duration of therapy should be 10 days (level I evidence).
- Patients who are allergic to amoxicillin or do not respond to amoxicillin therapy should be treated with a second-line antimicrobial agent (level III evidence).

Antimicrobial resistance

Before 1972 *H. influenzae* was almost uniformly susceptible to ampicillin. Since then, however, β -lactamase-producing strains resistant to ampicillin have become common.⁸⁵⁻⁸⁸ The presence of penicillin-binding proteins with decreased affinity for the β -lactam antimicrobials have also been shown to confer resistance to the penicillins and cephalosporins.^{89,90}

In 1994 a nation-wide surveillance study of *H. influenzae* showed that 37% of strains were β -lactamase producing (ranging from 20% in Manitoba to 62% in Prince Edward Island).⁹¹ The prevalence of these strains was higher in children than in adults (45% v. 30%). Of the β -lactamase-negative isolates, 1.5% were found to be resistant to ampicillin.

Although *M. catarrhalis* was once uniformly susceptible to virtually all agents used to treat respiratory tract infections, this organism has quickly developed resistance. In 1989 Wallace and colleagues⁹² reported that rates of resistance to the penicillins had increased to more than 75%.

Penicillin-resistant *S. pneumoniae* was first described in Australia in 1967,⁹³ and the first high-level resistant strains were reported in South Africa in 1977.⁹⁴ The first case of infection from penicillin-resistant *S. pneumoniae* in the United States was reported in 1974 and the first isolates in Canada were described in the 1970s.^{95,96} During the 1980s surveillance studies in Canada revealed that fewer than 1.5% of strains were of intermediate resistance and none was highly resistant.^{97,98} However, in 1994, 7.1% of strains collected in Ontario were of intermediate resistance and 2.9% were highly resistant.

In summary, rates of antimicrobial resistance have slowly been increasing in both the community and hospital settings and are causing mounting concern that treatment failure of first-line agents could become common. This trend will require close monitoring.

Table 6: Results of clinical trials assessing antimicrobial therapy for acute maxillary sinusitis in children

Trial	Drug (dosage)	% of children with clinical cure
Wald et al ⁴³	Amoxicillin 40 mg/kg daily, in 3 doses	67
	Amoxicillin-clavulanate 40 mg/kg daily, in 3 doses	64
Wald et al ⁶¹	Amoxicillin 40 mg/kg daily, in 3 doses	81
	Cefaclor 40 mg/kg daily, in 3 doses	78
Wald et al ⁸²	Cefaclor 40 mg/kg daily, in 3 doses	92
	Amoxicillin-clavulanate 40 mg/kg daily, in 3 doses	93
Rodriguez ⁸³	Amoxicillin 50 mg/kg daily, in 4 doses	100
	Erythromycin-sulfisoxazole 50/150 mg daily, in 4 doses	95
Rachelefsky et al ⁸⁴	Amoxicillin 40 mg/kg daily, in 3 doses	77
	Erythromycin-ethylsuccinate 30/40 mg/kg daily, in 4 doses	36
	TMP-SMX 40/8 mg/kg daily, in 2 doses	62

Adjunct therapy

Decongestants

Although there are no published placebo-controlled studies of decongestants, these medications are often included in the treatment of acute sinusitis.^{2,99,100}

The nasal spray decongestants phenylephrine hydrochloride (0.5%) and oxymetazoline hydrochloride (0.05%) are frequently used to treat acute sinusitis. Phenylephrine spray should be used 3 or 4 times daily for 3 days, but no longer than 1 week.¹² Oxymetazoline spray should be used 2 or 3 times a day, but no longer than 3 to 4 days. Patients who use either agent more frequently or for longer periods than recommended are at risk of rebound vasodilation.

Oral decongestants (pseudoephedrine and phenylpropranolamine) are α -adrenergic agonists that reduce nasal blood flow. Theoretically, oral preparations can penetrate the ostiomeatal complex, where topical agents may not penetrate effectively.¹² The use of oral decongestants has been shown to improve nasal patency.¹⁰¹ As well, Melen and coworkers³³ have demonstrated that these agents can increase the functional diameter of the maxillary ostium. Some oral decongestants are available in combination with mucosolvents, which may help to thin secretions and facilitate drainage.

Antihistamines

Antihistamines have not proven to be effective in the management of acute sinusitis and theoretically may be harmful. Because of their anticholinergic action, antihistamines can cause dryness of mucosal membranes and may interfere with the clearance of purulent mucous secretions.¹² Although no controlled studies have examined the role of antihistamines in the treatment of sinusitis, the participants of the Canadian Sinusitis Symposium have recommended that antihistamines not be used to treat acute sinusitis (level III evidence).

Glucocorticosteroids

There have been no controlled clinical trials of systemic glucocorticosteroid therapy for acute sinusitis. There are, however, several trials of topical glucocorticosteroid preparations: in one the drug was administered into the maxillary sinus and in three it was given intranasally.¹⁰²⁻¹⁰⁵ In the first trial,¹⁰² the group given a glucocorticosteroid and an antibiotic had a higher prevalence of ostia patency than the group given only an antibiotic; however, there was no difference in symptom reduction between the 2 groups. Only 1 of the other 3 trials found

inclusion of glucocorticosteroids with antibiotics to be useful.¹⁰⁵ Since glucocorticosteroids take a long time to act, an episode of acute sinusitis may resolve before their beneficial effects are noticed.

Irrigation of the nasal cavity

Irrigation and drainage of the nasal cavity may result in dramatic relief of pain and prevent otherwise irreversible mucosal damage.¹⁰⁶ Although saline solutions of roughly physiologic proportions can be prepared by patients for this purpose, the most convenient means is through the use of a commercial product available in squeeze spray bottles.

Recommendations

- Decongestants, along with antimicrobial therapy, are useful in treating acute sinusitis (level III evidence).
- Antihistamines are contraindicated in the management of acute sinusitis (level III evidence).
- Glucocorticosteroids have not been shown to be of any notable benefit in treating acute sinusitis. Little evidence is available to support their use (level III evidence).
- Irrigation of the nasal cavity may provide symptomatic relief (level III evidence).

Surgery

Surgery may be necessary to facilitate drainage of the involved sinus and to remove diseased mucosa. For acute bacterial sinusitis, this should be considered only if complications are threatening, the pain is severe or the patient is not responding to medical treatment.

The introduction of functional endoscopic sinus surgery (FESS) has revolutionized the surgical approach to sinus disease. FESS is a functional rather than an enterative or ablative procedure. The affected tissue is removed and the normal tissue is left in place. FESS can surgically correct anatomic obstructions and re-establish conditions that enhance normal mucociliary clearance. Case series have shown that 80% to 90% of patients who undergo FESS experience moderate to complete relief of symptoms.^{107,108}

Complications of sinusitis

Local complications

Mucocele or mucopyoceles are chronic cystic lesions of the paranasal sinuses.^{4,109} The most common location of clinically significant lesions are the frontal sinuses; the next most common the anterior ethmoid sinus. Frontal

headaches, proptosis and diplopia secondary to downward and outward displacement of the globe are the most common initial complaints.^{106,110}

Orbital complications

Orbital complications are the most common complications of sinusitis, particularly in children. Direct extension can occur through neurovascular foramina, through congenital or acquired dehiscence, or through thin bone such as the lamina papyracea.⁴

Intracranial complications

Meningitis is the most common intracranial complication; others include epidural abscess, subdural empyema, venous sinus thrombosis and cerebral abscess.¹¹¹ They can result from direct extension, septic thrombophlebitis and hematogenous spread.

Sinusitis and asthma

Sinusitis and asthma have been linked for over a century, yet proving a casual relation between them has remained difficult. Unrecognized sinusitis has frequently been cited as a stimulus for poorly controlled asthma; some studies have reported as many as 47% of patients with asthma having radiographic evidence of sinusitis during exacerbations of their airway disease.¹¹² Sinus aspirates rarely show evidence of overt infection. However, 2 clinical observations suggest that infection may play a role: bacterial infection is more readily demonstrated in aspirates from sinuses with significant mucosal thickening, and mucosal thickening regresses after antibiotic therapy.¹¹³

The mechanisms by which sinusitis worsens asthma remain speculative. A sinobronchial reflex mediated through the vagus nerve may allow stimulation of nasal receptors to produce bronchoconstriction. Similar pathological features, mediators and cytokines have been found in bronchial and nasal biopsy specimens and lavage fluid, which suggests a common pathogenic mechanism. The finding that topical nasal corticosteroids may reduce bronchial hyperreactivity and asthma symptoms has supported both of these potential mechanisms.¹¹⁴ The third possible mechanism is through post-nasal drip, with leakage of inflammatory mediators from the upper to the lower airways. This has been demonstrated in animal models but not in humans.¹¹⁵

The strongest evidence linking chronic sinusitis and asthma comes from clinical case studies showing that medical^{113,116} or surgical^{117,118} therapies for sinusitis lead to improved asthma symptoms and a reduction in the need for asthma medications. Occult sinusitis should be sought

in patients with poorly controlled asthma. Effective treatment of sinusitis may alleviate asthma symptoms and greatly reduce the need for systemic steroid therapy, thereby reducing morbidity.

Indications for referral to a specialist

Most patients with acute sinusitis can be diagnosed and managed by primary care physicians. Indications for referral include the development of complications, the failure of second-line therapy and recurrent disease (more than 3 episodes per year).

Validation

Previous guidelines for the diagnosis and treatment of acute sinusitis do not exist in Canada. The recommendations in this article are based on consensus of Canadian and American experts in infectious diseases, microbiology, otolaryngology and family medicine who participated in the Canadian Sinusitis Symposium. The guidelines were reviewed independently for the advisory committee of the symposium by 2 external experts.

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