

Subacute sinusitis: Are antimicrobials necessary?

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Background: The need for antimicrobials in the treatment of subacute sinusitis was evaluated in 96 afebrile children who were prescribed antimicrobial (amoxicillin, amoxicillin clavulanate potassium, or trimethoprim-sulfamethoxazole) or no antimicrobial medication in addition to a decongestant and saline nasal spray for 3 weeks.

Methods: Response was determined by complete clearing of the initial radiologic abnormalities or in the case of mucosal thickening, by a significant decrease in thickness to <6 mm within the maxillary sinuses associated with improvement of the clinical signs and symptoms of sinusitis. If there was evidence of partial clearing by radiograph, the same therapy was continued for another 3 weeks. Nonresponders demonstrated no change or worsening of clinical and radiologic findings.

Results: Sixty-seven of the 96 subjects (70%) responded: 58 (87%) in 3 weeks and 9 (13%) in 6 weeks. Fifty-five of the responders were in the antimicrobial treatment group, and 12 were prescribed no antimicrobial medication. Twenty-nine of the 96 subjects (30%) did not respond to treatment; 22 received an antimicrobial and seven received no antimicrobial medication.

Conclusions: The number of responders and nonresponders was similar in the antimicrobial- and nonantimicrobial-treated groups ($p = NS$), and no single antimicrobial medication demonstrated greater treatment effectiveness. (*J ALLERGY CLIN IMMUNOL* 1993;91:1015-23.)

Key words: Subacute sinusitis, roentgenogram, antimicrobial, decongestant, saline nasal spray

Confusion exists with regard to the criteria for diagnosis and hence the management of sinusitis in children. This occurs primarily because the radiographic findings of paranasal sinus opacification and mucosal thickening, the hallmarks of sinusitis, are also found in children who are free of symptoms.^{1,2} Despite this, there is also a relatively good correlation of these same x-ray findings with positive bacterial sinus cultures.^{3,4} Moreover, the most prominent symptoms of both acute (<3 weeks) and subacute sinusitis (3 weeks to 3 months) in the pediatric age group are nasal

Abbreviations used

ACP:	Amoxicillin clavulanate potassium
FEF _{25%-75%} :	Forced expiratory flow, mid-expiratory phase
FEV ₁ :	Forced expiratory volume in 1 second
PFT:	Pulmonary function test
TMP/SMX:	Trimethoprim-sulfamethoxazole

discharge and cough, respiratory findings that are quite common in children.^{3,5}

To date, there are a limited number of studies on the management of nonacute sinusitis with either decongestants or antihistamine-decongestant preparations alone without the prescription of antimicrobials.^{6,7} The purpose of this double-blind study was to determine whether antimicrobials are necessary in the treatment of subacute sinusitis in children or whether nonantimicrobial treatment such as the promotion of drainage of the affected sinuses by a decongestant and saline nasal spray is equally effective.

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TABLE I. Characteristics of treatment groups

Treatment group	Gender		Age (yr)	Atopic subjects	Pretreatment clinical severity score
	Female	Male			
A	9 (36%)	16 (64%)	7.50 $\pm$ 3.57	22 (92%)	17.36 $\pm$ 5.68
B	8 (31%)	18 (69%)	6.73 $\pm$ 2.42	20 (80%)	17.54 $\pm$ 6.01
C	8 (31%)	18 (69%)	6.17 $\pm$ 2.43	18 (72%)	15.62 $\pm$ 7.11
D	8 (42%)	11 (58%)	7.42 $\pm$ 2.92	17 (94%)	17.79 $\pm$ 5.79

Values for age and pretreatment clinical severity score are expressed as means $\pm$ SD.

METHODS

Patients

Patients were recruited for the study from subjects who were referred to the Pediatric Allergy Clinic of The Children's Hospital. Children 2 to 16 years old were candidates for the study if they presented with symptoms of mucoid nasal drainage, cough, or poorly controlled asthma for more than 3 weeks and less than 3 months and had radiographic evidence of sinusitis, that is, mucosal thickening of ≥ 6 mm of the maxillary sinuses or $\geq 33\%$ loss of airspace volume within the maxillary sinuses, and/or opacification or air fluid levels of any of the paranasal sinuses. Exclusion criteria included the presence of fever; the use of antimicrobials in the past 2 weeks; a history of systemic disease such as cystic fibrosis, diabetes, immotile-cilia syndrome, sickle cell disease, immunodeficiency; and a history of adverse reactions to any of the drugs used in the study.

Study design

The protocol was approved by the Institutional Review Board of The University of Alabama at Birmingham. Written informed consent was obtained from all participants who were then randomly assigned by computer to one of four treatment programs: [A] amoxicillin (30 to 40 mg/kg/day), [B] amoxicillin clavulanate potassium (ACP) (30 to 40 mg/kg/day), [C] trimethoprim sulfamethoxazole (TMP/SMX) (TMP, 8 mg/kg/day; SMX, 40 mg/kg/day), or [D] nonantimicrobial group. Both the treating physician and the patient were blinded to the type of medication given. Medications were dispensed by a pharmacist who also gave the instructions for administration. All patients received a preparation that contained phenylephrine hydrochloride, phenylpropanolamine hydrochloride, and guaifenesin and were instructed in the use of a buffered saline nasal spray. All medications were prescribed three times a day except for TMP/SMX, which was prescribed twice a day. Although TMP/SMX was prescribed twice a day, families were unaware of the dosing frequency of any of the study drugs. The investigators were also blinded to the dosing frequency of the prescribed treatment. Each patient was treated for 3 weeks and reevaluated at the end of that time by the

same physician, who performed a physical examination and obtained a detailed interval history and a Water's view of the sinuses. If the roentgenogram demonstrated total clearing and if clinical symptoms and signs had decreased significantly, the child was designated as a *responder*, and the study drugs were terminated. If partial resolution of the sinusitis was evident on radiograph, the child was given another 3-week course of the assigned medication and again reevaluated at the end of that time both clinically and by roentgenogram (Water's view). When no change or a worsening of the clinical and radiographic findings was evident, the patient was designated as a *nonresponder*, and the study medication was discontinued. These patients were then openly given erythromycin ethylsuccinate and sulfisoxazole acetyl for 3 weeks. If a subject required 6 weeks of treatment, he or she was designated a responder only if the repeat Water's view was clear or showed a significant decrease in mucosal thickening to < 6 mm and the subject was clinically well as determined by physical examination and an improvement in clinical symptom score. Patients were contacted by the Allergy Clinic nurse on days 5 and 10 of each 3-week treatment span to assess compliance, clinical response, and adverse effects.

Clinical evaluation

Patients were evaluated initially and on each subsequent clinic visit with a history and physical examination by the same physician. A clinical severity score (0 = absent, 1 = mild, 2 = moderate, 3 = severe) was assigned initially and on each follow-up visit for each of the following parameters: the quantity of nasal discharge, the purulence of nasal secretions, nasal congestion, nasal mucosal erythema, cough and wheezing; and a total score was determined. The diagnosis of reactive airways disease was made from history in those subjects who had had recurrent episodes of wheezing that were responsive to bronchodilators. Several of the subjects on initial presentation had evidence of airway obstruction (forced expiratory volume in 1 second [FEV₁] $< 80\%$ of predicted value and/or forced expiratory flow, mid-expiratory phase [FEF_{25%-75%}] $< 60\%$ of predicted value), which improved after inhalation of a β -adrenergic agent. For this study, pulmonary func-

TABLE II. Response to treatment

Treatment	Responders	Nonresponders	Total
Antimicrobial	55 (71%)	22 (29%)	77
Nonantimicrobial	12 (63%)	7 (37%)	19

$p = \text{NS}$.

TABLE III. Response to prescribed treatment regimen

Treatment	Responders	Nonresponders	Total
Amoxicillin	18 (72%)	7 (28%)	25
ACP	19 (73%)	7 (27%)	26
TMP/SMX	18 (69%)	8 (31%)	26
Nonantimicrobial	12 (63%)	7 (37%)	19

$p = \text{NS}$.

tion testing (forced vital capacity, FEV₁, FEF_{25%-75%}, peak expiratory flow rate) was done during each visit if the child was capable of performing the maneuver. Nasal smears were obtained initially from all patients and subsequently on day 5 and on each return visit. The nasal smears on day 5 were obtained by the parents and returned to the allergy clinic in a special slide mailer. All specimens were stained with Wright's stain, and the number of eosinophils and polymorphonuclear leukocytes was determined as a percentage of the total cells present. Nasal eosinophilia was regarded as significant when >25% of the cells were eosinophils. Atopy was determined by skin prick testing to a panel of antigens or by RAST.

Radiographic assessment

Sinus radiographs including anteroposterior, occipitomental (Water's view), and lateral views were obtained on the first visit; a Water's view was obtained on return visits on all patients. The roentgenograms were evaluated by a staff radiologist as being normal or abnormal on the basis of the presence of air fluid levels, maxillary opacification or maxillary mucosal thickening of ≥ 6 mm or $\geq 33\%$ loss of airspace volume within the maxillary sinuses. The attending radiologist was unaware of the patient's participation in the study and treatment regimen.

Statistical analysis

Categorical data were analyzed with chi square analysis or in the case of small sample size, Fisher's exact test. Comparisons of means were done with analysis of variance and post hoc procedures. Logistic regression analysis was also used to correlate relevant factors with responses. Power was calculated to detect 25% to 30% difference in response of antimicrobial treatment versus nonantimicrobial treatment groups, $\alpha = 0.05$ and power = 0.80 (i.e., four cases to one control or 70 to 80 cases required vs 20 to 25 controls).

RESULTS

From March 1987 to March 1990, 123 patients with chronic upper respiratory symptoms of more than three weeks' and less than three months' duration, with or without lower respiratory involvement such as coughing or wheezing, and radiologic evidence of sinusitis were enrolled in the study. The characteristics of the study population by treatment group are described in Table I. Subjects within each treatment group were similar in terms of sex and age distribution, atopic status, and pretreatment clinical severity score. Of the 123 patients, 96 completed the study. Sixty-seven of the 96 subjects (70%) responded to their respective treatments as defined by a clearing of the roentgenogram or significant decrease of mucosal thickening to <6 mm associated with clinical improvement on the basis of interval history and physical examination: 58 subjects (87%) responded in 3 weeks, and the remaining nine (13%) in 6 weeks (Table II). Of the 67 responders, 55 received an antimicrobial and 12 received no antimicrobial medication. Twenty-nine of the 96 subjects (30%) did not respond to treatment as determined by no change or a worsening of clinical status and sinus radiograph at 3 weeks or lack of complete clearing after 6 weeks of treatment. Of the 29 nonresponders, 22 received an antimicrobial and seven received no antimicrobial. The percentage of responders and nonresponders was similar in the antimicrobial-treated group compared with the nonantimicrobial-treated group ($p = \text{NS}$). Moreover, none of the three antimicrobials used demonstrated a statistical superiority with regard to treatment response (Table III). The respective response rates were amoxicillin,

TABLE IV. Characteristics of study population

	Responders	Nonresponders	Total
Age			
2-6 yr	32 (71%)	13 (29%)	45
> 6-12 yr	32 (71%)	13 (29%)	45
> 12 yr	3 (50%)	3 (50%)	6
Sex			
Male	42 (67%)	21 (33%)	63
Female	26 (79%)	7 (21%)	33
Diagnosis			
AR	16 (76%)	5 (24%)	21
RAD	2 (50%)	2 (50%)	4
AR + RAD	38 (67%)	19 (33%)	57
VMR	2 (67%)	1 (33%)	3
RRI	9 (82%)	2 (18%)	11
Atopy*			
Positive	54 (70%)	23 (30%)	77
Negative	10 (67%)	5 (33%)	15

AR, Allergic rhinitis; RAD, reactive airways disease; VMR, vasomotor rhinitis; RRI, recurrent respiratory infection.

*Atopic status determined in 92 of 96 subjects.

72%; ACP, 73%; TMP/SMX, 69%; and no antimicrobial, 63%.

The study population was also analyzed with regard to age, sex, diagnosis, presence of atopy, and pretreatment clinical severity score. No factor was found to be a statistically significant predictor of response to treatment (Tables IV and V). This was confirmed by multivariate logistic regression analysis. There was a wide range of pretreatment clinical severity scores for all subjects. However, the mean score of responders and nonresponders was comparable, 16.64 and 17.89, respectively (Table V), and the mean pretreatment clinical severity score of the subjects assigned to one of the antimicrobial treatment groups was similar to that of subjects who were not prescribed an antimicrobial medication, 16.83 and 17.79, respectively (Table VI). As determined by telephone interview on days 5 and 10 of treatment, more subjects in the antimicrobial-treated group reported a moderate or significant clinical improvement on day 5 than subjects in the nonantimicrobial-treated group. However, on day 10, this difference in improvement was less marked between the two treatment groups. Furthermore, by the end of 3 weeks of treatment, the mean clinical severity scores of subjects in the antimicrobial- and nonantimicrobial-treated groups were similar, and this comparable finding in clinical symptoms was evident as well in the subjects who required 6 weeks of treatment (Table VI). As expected,

responders had fewer symptoms as reflected by lower clinical severity scores at the end of both the 3-week and the 6-week treatment periods (Table V).

On sinus radiographs, all 96 subjects showed maxillary sinus involvement. There was one adolescent subject with maxillary mucosal thickening and minimal mucosal thickening of the sphenoid sinuses. There were no subjects with either frontal or ethmoid sinus involvement alone. Specific radiologic findings were not predictive of outcome. Nineteen of the 25 subjects (76%) with mucosal thickening who were treated with an antimicrobial responded (Table VII). However, all four children who were treated with no antimicrobial also responded compared with only 76% of those who received antimicrobial treatment ($p = \text{NS}$). Opacification of one or more sinuses was found in 65 subjects. Fifty of these 65 subjects were assigned to the antimicrobial treatment group. Of the 50, 35 (70%) responded, and 8 (53%) who received no antimicrobial treatment responded ($p = \text{NS}$). Fifteen subjects with sinus opacification did not receive an antimicrobial; 8 (53%) responded to the assigned treatment and 7 (47%) did not. Forty of the 65 subjects with opacification had mucosal thickening of one or more of the sinuses as well. Two subjects had air fluid levels on sinus radiographs; both received ACP. One responded to treatment and one did not.

Pulmonary function was assessed in 60 subjects

TABLE V. Clinical severity scores by treatment groups

Treatment group	Responders	Nonresponders	Total
Before treatment*			
A	17.78 ± 5.57	16.28 ± 6.29	17.36 ± 5.68
B	16.10 ± 5.73	21.43 ± 5.26	17.54 ± 6.01
C	15.00 ± 6.69	17.00 ± 8.28	15.62 ± 7.11
D	18.25 ± 5.59	17.00 ± 6.48	17.79 ± 5.79
Total	16.64 ± 5.94	17.89 ± 6.69	
Treatment week 3*			
A	4.44 ± 2.55	12.57 ± 7.02	6.72 ± 5.55
B	4.10 ± 2.16	12.57 ± 4.89	6.38 ± 4.88
C	5.17 ± 4.20	14.00 ± 3.85	7.88 ± 5.78
D	5.92 ± 2.61	14.14 ± 8.59	8.95 ± 6.74
Total	4.80 ± 3.01	13.34 ± 5.98	
Treatment week 6*			
A	2.50 ± 2.12	9.80 ± 5.97	7.71 ± 6.10
B	4.33 ± 1.53	11.33 ± 5.77	7.83 ± 5.38
C	5.50 ± 2.12	14.40 ± 7.02	11.86 ± 7.24
D	1.00 ± 0.00	10.20 ± 6.53	8.67 ± 6.95
Total	3.75 ± 2.12	11.44 ± 6.14	

Values are expressed as means ± SD.

**p* = NS.

by spirometry. Before treatment, 39 subjects (65%) had normal and 21 (35%) had abnormal pulmonary function test (PFT) results. The PFT results of 11 of the 21 (53%) subjects with abnormal initial PFT results normalized after treatment. Nine responded and two did not. Of the 21 subjects with abnormal PFT results, 16 were responders and five were nonresponders to the assigned treatment. Of the 10 whose PFT results remained abnormal, nine responded to the assigned treatment and one did not; there were eight subjects assigned to the antimicrobial group and two to the nonantimicrobial group. In this study the posttreatment PFT results did not correlate with response to treatment (*p* = NS). The medical management of all subjects with asthma was optimized at the beginning of the study, and the same medications were maintained throughout the study period.

As determined from initial nasal smears available for evaluation, there was an increased number of polymorphonuclear leukocytes and few or no eosinophils. Initial polymorphonuclear leukocyte counts of responder and nonresponder groups were similar, and presence or absence of polymorphonuclear leukocytes did not determine sinusitis treatment success in either the antimicrobial- or the nonantimicrobial-treated groups.

TABLE VI. Clinical severity scores of antimicrobial- versus nonantimicrobial-treated groups

	Clinical severity score
Before treatment*	
Antimicrobial	16.83 ± 6.28
Nonantimicrobial	17.79 ± 5.79
Treatment week 3*	
Antimicrobial	7.00 ± 5.38
Nonantimicrobial	8.95 ± 6.74
Treatment week 6*	
Antimicrobial	9.20 ± 6.32
Nonantimicrobial	8.67 ± 6.95

Values are expressed as means ± SD.

**p* = NS.

Twenty-seven subjects did not complete the study: eleven were noncompliant with follow-up, nine had a worsening of clinical status, five experienced intolerance to treatment regimen, one had an initial erroneous reading of radiographs, and one was a case of treatment assignment error (Table VIII). Of these 27 subjects, 15 were assigned to the antimicrobial treatment group (six

TABLE VII. Correlation of response with radiologic findings in antimicrobial versus nonantimicrobial groups

	Responders	Nonresponders	Total
Mucosal thickening*			
Antimicrobial-treated group	19 (76%)	6 (24%)	25
Nonantimicrobial-treated group	4 (100%)	0	4
Opacification ± mucosal thickening*			
Antimicrobial-treated group	35 (70%)	15 (30%)	50
Nonantimicrobial-treated group	8 (53%)	7 (47%)	15
Air fluid level			
Antimicrobial-treated group	1 (50%)	1 (50%)	2
Nonantimicrobial-treated group	0	0	0

p* = NS.TABLE VIII.** Reasons subjects did not complete study

Reason	No. of subjects		
	Antimicrobial	Nonantimicrobial	Total
No follow-up	7	4	11
Worsening of clinical status	4	5	9
Medication intolerance	4	1	5
Medication assignment error	0	1	1
Initial misinterpretation of radiograph	0	1	1

amoxicillin, five ACP, and four TMP/SMX). Four of these 15 individuals experienced a worsening of symptoms as indicated by an increase in body temperature, more coughing or wheezing, or complaint of headache. Two were assigned amoxicillin and two were assigned TMP/SMX. Five subjects experienced adverse effects to their assigned medication; in one subject who was receiving amoxicillin a rash developed, and in two who were assigned ACP gastrointestinal upset developed. One subject could not swallow the TMP/SMX tablet, and one subject who was receiving no antimicrobial medication complained of vomiting after taking the nonantimicrobial medication. Seven subjects in the antimicrobial treatment group did not return for follow-up. In the group that did not receive antimicrobial medication, five of the 13 subjects had an increase in respiratory symptoms, four did not return for follow-up, one subject was incorrectly prescribed an antimicrobial medication that was not part of the study protocol, and one had a cyst in the maxillary sinus (which was initially deemed to be mucosal thickening) and was dropped from the study.

DISCUSSION

The clinical significance of radiographic abnormalities of the paranasal sinuses in children remains controversial.^{1,8,9} However, the presence of air fluid levels, opacification, and/or mucosal thickening in the face of respiratory symptoms is usually an indication for treatment, primarily with an antimicrobial. Other treatment modalities such as antihistamines and decongestants or nasal sprays are prescribed inconsistently, and their uses have not been well studied. This double-blind controlled study compared the three antimicrobials that are most commonly used to treat sinusitis with a nonantimicrobial treatment. All subjects also received an oral decongestant and used a topical saline nasal spray. The results indicate that the use of an antimicrobial may not always be necessary in the treatment of subacute sinusitis because the subjects responded equally well to the use of a decongestant plus a buffered saline nasal spray. Both clinical and radiographic improvement were evident. No factor such as sinus radiographic findings, severity of presenting clinical symptoms, atopy, age, or sex that en-

hanced the probability of which subjects would respond to treatment could be identified. Also, none of the antimicrobial agents used proved to be more effective.

These findings are at variance in several respects with the relatively few published studies on the treatment of nonacute sinusitis in children. Rachelefsky et al.⁶ reported a double-blind study of 84 atopic children who had abnormal sinus radiographs and symptoms comparable to those of the subjects in our study. They found the lowest response both clinically and on radiographs in the group treated with a 2-week course of an antihistamine decongestant alone (44%) and the highest rate in those who received amoxicillin (90%). Treatment with TMP/SMX was also effective, whereas treatment with erythromycin was not (a 78% and 48% response rate, respectively).

Rachelefsky et al.⁶ and Businco et al.⁷ have also suggested that opacification as compared with mucosal thickening on sinus radiographs is a better indicator of the need for antimicrobial treatment. In our study the percentage of responders and nonresponders in the antimicrobial-treated groups was similar irrespective of the radiographic findings of mucosal thickening or opacification (Table VII). However, for the nonantimicrobial-treated group, the percentage of responders was lower among those subjects with opacification than among those with mucosal thickening (53% vs 100%), and the percentage of nonresponders was higher (47% vs 0%). Although this suggests that opacification may be a better clinical indicator for the use of antimicrobials, the difference was not statistically significant because the numbers in these groups were too small.

The comparable responses of the subjects in the antimicrobial-treated group and those who received no antimicrobial medication in our study are thought-provoking. It further raises the question of how often the findings of mucosal edema or opacification of the paranasal sinuses on roentgenographic examination are but indicators of inflammation from either an infectious or a non-infectious cause.

In nonatopic children with respiratory symptoms of subacute sinusitis, Wald et al.³ demonstrated a good correlation between sinus opacification and mucosal thickening of >4 mm with the presence of bacteria in the affected sinus. A significant bacterial colony count was found in 30 of the 52 sinuses (58%) aspirated from 26 children (65%). *Streptococcus pneumoniae*, *Hemophi-*

lus influenzae, and *Moraxella catarrhalis* were the most common isolates.

Arruda et al.¹⁰ aspirated the maxillary sinuses of 33 children who underwent tonsillectomy and adenoidectomy, who had no previous diagnosis of sinusitis, and who were not screened for atopy. Twelve had complete opacification of one or both maxillary sinuses, and 21 had clear roentgenograms defined as <20% of mucosal thickening relative to the total sinus area. Sinus aspirate cultures from eight of the 12 children (67%) who had abnormal maxillary sinus radiographs grew *S. pneumoniae*. Positive cultures were found in only six of the 21 subjects (28%) with clear radiographs ($p < 0.05$). Complete opacification of the maxillary sinus was more frequently seen with a history of asthma, the presence of nasal purulent secretions, peripheral eosinophilia, and an elevated level of serum IgE. However, a specific correlation of these factors with positive bacteriologic cultures was not made.

Businco et al.⁷ in an open study treated 42 children with asthma who had allergic sinusitis, which was defined as abnormal sinus radiographs but lack of purulent posterior nasal drip, with an intranasal steroid and an antihistamine decongestant (phenylephrine and tripolidine) without an antibiotic for 10 days. Twenty-eight of the 42 children (67%) demonstrated an improvement in their asthma symptoms and on sinus radiograph. In this study the intranasal steroid spray may have contributed to the clinical and radiologic improvement by its local antiinflammatory effect and secondarily by promoting drainage.

Although the incidence of abnormal sinus radiographs in children with atopic asthma has been reported to range from 40% to 52%^{11, 12} a variable occurrence of abnormal sinus radiographs has also been demonstrated in children without apparent respiratory symptoms. Diamant et al.¹³ reported that approximately one half of the 137 children evaluated by computed tomographic scan for reasons unrelated to sinusitis had maxillary and/or ethmoid opacification to some degree. Kovatch et al.¹⁴ examined 112 children who had skull radiographs performed for reasons unrelated to infection. With the use of more rigorous criteria for the diagnosis of a recent respiratory infection (i.e., a history of respiratory symptoms within 2 weeks of the study and a physical examination of the nasopharynx), abnormal maxillary sinus films were noted in only 2 of 31 subjects (7%) who were older than 1 year of age. Eight of 14 (57%) had

abnormal maxillary radiographs if signs and symptoms of a respiratory infection were present. Because most upper respiratory infections in children are viral, the study by Kovatch et al.¹⁴ suggests that even minor respiratory infections may be associated with inflammatory changes in the sinuses.

A recent study by Pelikan and Pelikan-Filipek¹⁵ reported the maxillary sinus changes of mucosal thickening >3 mm and/or opacification that occurred in 37 adult subjects with chronic maxillary sinusitis after nasal allergen challenge. These changes were transient (lasting 24 to 48 hours) and occurred in the maxillary sinuses ipsilateral to the nasal challenge. These findings lend credence to the supposition that mucosal thickening and/or opacification of the paranasal sinuses as seen on roentgenogram may represent inflammation of a noninfectious etiology.

Our study suggests that nonantimicrobial modalities may be reasonable in the management of nonacute sinusitis. Although the use of an oral decongestant and a saline nasal spray in this study appears to have been beneficial, the real effects of these cannot be separated from the effects of "time alone" in this study because there was no true placebo-treated group. A controlled study of this type would in fact have been impossible to design because any solution applied to the nasal mucosa would facilitate drainage.¹⁶

When to use antimicrobials in the treatment of nonacute sinusitis remains a difficult question and one not answered by our study. Our investigation supports the hypothesis that the radiographic changes of mucosal thickening and/or opacification are not necessarily diagnostic of an infectious etiology and that we may indeed be overtreating nonacute sinusitis with antimicrobial medication. The increased incidence of abnormal sinus radiographs in the atopic individual has long been recognized. However, the clinical significance of these findings remains questionable because of the complexity of the pathophysiology involved. It is possible that the observed inflammatory response may be secondary to persistent allergen exposure alone in that the nasal mucosal edema and consequent sinus ostia obstruction that occur predispose to infection. The patient population of our study most closely resembles this group, since 80% were atopic.

In addition to atopy, other noninfectious causes of sinus inflammation also need to be considered such as the respiratory tract irritants of passive tobacco smoke or air pollution. Subjects with

vasomotor rhinitis may also experience inflammatory changes in the sinuses that are similar to those seen in the nasal mucosa.

From the above cited studies, it appears that the radiographic changes of sinus mucosal thickening and/or opacification must be considered in conjunction with the patient's history before treatment is determined. The practical diagnosis and treatment of children with suspected sinusitis relies on a detailed review of history of present illness and evaluation of existing clinical symptoms and signs. Other clues to guide treatment include specific history-taking with regard to atopy, exposure to environmental irritants such as tobacco smoke and wood-burning stoves, and enrollment in day care. Imaging techniques may be used to confirm the clinical impression of sinusitis in children.¹⁷⁻¹⁹ However, no diagnostic gold standard exists for the pediatric population. Plain radiographs were used in this study as an objective, cost-effective, and less invasive technique to gauge response to treatment in conjunction with clinical findings.

The presence of mucopurulent nasal secretions also does not appear to be a reliable indication for treatment with antibiotics. Thus in the absence of fever and other systemic symptoms, a 10- to 14-day trial with an oral decongestant and a saline nasal spray would appear to be logical in suspected cases of subacute sinusitis. Ideally, sinus aspirates can be performed to rule out infection of the affected sinuses. However, this is not clinically practiced. In our study sinus aspirates were not done because the morbidity associated with the procedure could not be justified in subjects who were not acutely ill.

The dilemma of whether to treat or not to treat with an antimicrobial remains a significant one because a variety of complications can result from sinusitis. In the orbital area cellulitis, abscesses, and cavernous venous thrombosis may develop. In addition, infection can extend intracranially and result in meningitis, brain abscesses, and extradural or subdural abscesses. Patients with a history of sinusitis complications or evidence of systemic disease should be aggressively treated. Antimicrobials may also be indicated in less reliable patients who may not return for follow-up care because the complications of sinusitis can be life-threatening.

The treatment period in this study was prolonged (a minimum of 3 weeks). Although there are no previous studies to suggest an optimal interval of treatment time before reevaluation,

most investigators' experience has been that the traditional 10-day antimicrobial course is inadequate.^{20, 21} Future comparative studies on multiple aspects of sinusitis are warranted in the areas of pathogenesis, epidemiology, prevention, diagnosis, and treatment.¹⁹ The role of ancillary therapy with decongestants, saline nasal spray, and topical antiinflammatory agents spanning various treatment intervals in the same type of subjects has yet to be determined in the treatment of sinusitis.

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