Efficacy of a Stepwise Protocol That Includes Intravenous Antibiotic Therapy for the Management of Chronic Sinusitis in Children and Adolescents

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Background: Recent concern regarding interference with facial skeletal growth and the risk of complications after endoscopic sinus surgery (ESS) has led to interest in exploring other treatment options for the management of chronic sinusitis in children.

Objective: To present the use of a stepwise protocol that includes intravenous (IV) antibiotic therapy as a therapeutic alternative to pediatric ESS.

Design: Retrospective analysis of pediatric patients with chronic sinusitis treated from January 1, 1993, to July 1, 1998, with a stepwise protocol that includes the use of IV antibiotics.

Setting: Academic tertiary care children’s hospital.

Patients: Seventy patients, aged 10 months to 15 years, with the diagnosis of chronic sinusitis as defined by symptomatic disease for at least 12 weeks. All patients had persistent symptoms and radiographic evidence of sinus disease by computed tomographic scan after a minimum 3- to 4-week course of oral antibiotics.

Interventions: Patients were treated with maxillary sinus aspiration and irrigation with selective adenoidectomy, followed by a 1- to 4-week course of a culture-directed IV antibiotic. Most patients also underwent placement of a long-arm IV catheter.

Outcome Measures: Medical charts were reviewed for clinical response to IV antibiotics, complications from IV antibiotic therapy, need for ESS, and recurrent episodes of sinusitis.

Results: Of the 70 patients studied, 62 (89%) had complete resolution of symptoms following IV therapy with selective adenoidectomy. Eight patients (11%) failed IV therapy and required ESS. Thirty-seven patients (53%) underwent concurrent adenoidectomy. Patients treated with concurrent adenoidectomy had equivocal response rates compared with patients treated with IV antibiotic therapy alone. Follow-up data were available for 52 patients (range, 6-62 months; mean, 25 months). All recurrent episodes resolved with oral antibiotic therapy. Complications from IV therapy included superficial thrombophlebitis in 6 patients (9%) and dislodgement of a catheter guidewire during placement in 1 patient (1%), requiring venotomy. Antibiotic-related complications also occurred in 3 patients (4%) and included serum sickness, pseudomembranous colitis, and drug fevers.

Conclusion: A stepwise protocol that includes IV antibiotic therapy is a safe and efficacious mode of therapy for the management of chronic sinusitis in children and adolescents and may be a reasonable alternative to pediatric ESS.


Optimal management of chronic sinusitis in the pediatric patient remains a controversial issue. Recommended therapy for pediatric chronic sinusitis ranges from functional endoscopic sinus surgery (ESS) to minimal or no intervention.1 4 During the past decade, ESS has been widely used and advocated as the treatment of choice for chronic sinusitis refractory to medical management in children. However, recent concern regarding interference with facial skeletal growth and the risk of complications after ESS has led to interest in exploring other treatment options.5 7 The purpose of this study was to expand an initial preliminary report8 on the use of a stepwise protocol that includes intravenous (IV) antibiotic therapy as an alternative to pediatric ESS.

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RESULTS

Of the 70 patients studied, 47 were boys and 23 were girls. Patient age at clinical presentation ranged from 10 months to 15...
MATERIALS AND METHODS

The medical records of 70 pediatric patients treated with IV antibiotics for symptoms of chronic sinusitis between January 1, 1993, and July 1, 1998, were studied. Each child’s medical record was examined for demographic information, presenting signs and symptoms, atopic history, immune status, past surgical history, maxillary sinus culture, computed tomographic (CT) scan findings, complications of IV therapy, need for ESS, and recurrent episodes of sinusitis following IV therapy. Inclusion criteria included (1) sinonasal symptoms of at least 12 weeks’ duration, (2) failure to respond to a minimum 3- to 4-week course of a β-lactamase stable oral antibiotic, and (3) rhinosinusitis as documented by CT scan after the oral antibiotic course. Computed tomographic scan findings considered to be consistent with sinusitis included partial or complete sinus opacification. Patients with cystic fibrosis, craniofacial anomalies, metabolic disorders, or immunodeficiencies were excluded. Patients were also excluded if they had a history of sinonasal surgery or significant anatomic abnormalities on CT scan that would require ESS or septrhaphy. All patients were treated with the following regimen: (1) nasal endoscopy, bilateral maxillary sinus aspiration and irrigation, and long-arm IV catheter placement under general anesthesia and (2) culture-directed IV antibiotics for a minimum of 1 week or until symptoms resolved. Concurrent adenoidectomy was performed at the discretion of the surgeon. Decisions were based on the finding of adenoid hypertrophy on intraoperative examination or preoperative CT scan.

Intraoperative maxillary sinus cultures were obtained through the following techniques: (1) cottonoid pledgets impregnated with povidone-iodine and oxymetazoline hydrochloride were placed in the nasal cavity for 5 to 10 minutes, (2) maxillary sinuses were entered via inferior meati punctures using a sterile 18-gauge spinal needle or trocar, and (3) sinus contents were aspirated and sent for aerobic and anaerobic culture and susceptibility studies. When no material was aspirated, irrigation with 10 mL of isotonic sodium chloride was subsequently performed. Following irrigation, the sinus contents were reaspirated and sent for microbiologic examination.

Postoperatively, IV antibiotics were administered empirically. An initial test dose of the IV antibiotic was given postoperatively in the hospital. Thereafter, patients received the antibiotic on an outpatient basis and had home nursing for assistance with their care. Follow-up visits were scheduled as needed during the IV antibiotic regimen and thereafter. Based on culture and susceptibility studies, the antibiotic agents were altered accordingly. Assessment of the presence or absence of sinonasal symptoms and an estimate of overall improvement and long-term symptom control were made at each follow-up visit. After discontinuation of the IV antibiotic, some patients were immediately prescribed a prophylactic oral antibiotic for varying durations at the discretion of their otolaryngologist.

### Table 1. Presenting Symptoms in 70 Patients Treated With Intravenous Antibiotic Therapy for Chronic Sinusitis

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Patients, No./Total No.* (%)</th>
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<tbody>
<tr>
<td>Nasal congestion</td>
<td>69/69 (100)</td>
</tr>
<tr>
<td>Rhinorrhea</td>
<td>65/67 (97)</td>
</tr>
<tr>
<td>Cough</td>
<td>59/62 (95)</td>
</tr>
<tr>
<td>Headache</td>
<td>33/37 (89)</td>
</tr>
<tr>
<td>Halitosis</td>
<td>16/24 (75)</td>
</tr>
<tr>
<td>Postnasal drainage</td>
<td>15/19 (79)</td>
</tr>
<tr>
<td>Fever</td>
<td>20/27 (74)</td>
</tr>
</tbody>
</table>

*Denominator indicates total number of patients with presence or absence of symptom.

### Table 2. Coexisting Conditions and Environment Risk Factors in 70 Patients Treated With Intravenous Antibiotic Therapy for Chronic Sinusitis

<table>
<thead>
<tr>
<th>Condition or Risk Factor</th>
<th>Patients, No./Total No.* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coexisting conditions</td>
<td></td>
</tr>
<tr>
<td>Atopic family history</td>
<td>33/38 (87)</td>
</tr>
<tr>
<td>Otitis media</td>
<td>44/69 (64)</td>
</tr>
<tr>
<td>Asthma</td>
<td>23/57 (40)</td>
</tr>
<tr>
<td>Tonsillitis</td>
<td>24/66 (36)</td>
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<tr>
<td>Environmental risk factors</td>
<td></td>
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<tr>
<td>Smoking exposure</td>
<td>18/43 (42)</td>
</tr>
<tr>
<td>Day care</td>
<td>9/53 (17)</td>
</tr>
</tbody>
</table>

*Denominator indicates total number of patients with presence or absence of condition.

years, with a mean and median age of 6.4 and 6.0 years, respectively, and an SD of 3.7 years. The most frequently reported presenting symptoms were nasal congestion, rhinorrhea, and cough (Table 1). The mean duration of these symptoms was 6.5 months (range, 3-120 months). The mean duration of preoperative oral antibiotic use was 4 weeks (range, 3-12 weeks). Before referral, many patients were treated with multiple antibiotic trials, with a mean of 4 courses (range, 1-10 courses).

Factors associated with chronic sinusitis were analyzed in each patient (Table 2). The most common coexisting conditions were a family history of atopy and personal history of otitis media, asthma, and tonsillitis. Environmental risk factors, such as passive smoke exposure and day care, occurred in some patients. Allergy testing was performed in 55 patients (79%), with 28 (51%) having a positive reaction to allergens. Immunologic testing was performed in 32 patients (46%), and none were identified as having immunodeficiencies.

Preoperative CT scans demonstrated varying degrees of maxillary and ethmoid sinus mucosal thickening in most patients (Table 3). Frontal and sphenoid sinus involvement was present in fewer patients. The most prevalent presenting physical findings were edematous nasal mucosa (94%) and purulent exudate within the nasal cavity (80%). Thirty-two patients (46%) had undergone prior otolaryngologic procedures. Previous ventilation tube insertion had been performed in 22 patients (31%), adenoidectomy in 24 patients (34%), and tonsil-
Maintenance doses of the oral antibiotics were taken prophylactically and was used in 18 patients (38%). Amoxicillin-clavulanate was the most common antibiotic combination of trimethoprim and sulfamethoxazole. Cefuroxime, azithromycin, cefpodoxime proxetil, and a combination amoxicillin, amoxicillin with clavulanate, cefprozil, cefuroxime, azithromycin, cefpodoxime, and a combination of trimethoprim and sulfamethoxazole. Amoxicillin-clavulanate was the most common antibiotic administered and was used in 18 patients (38%). Maintenance doses of the oral antibiotics were taken prophylactically by patients for a mean of 8 weeks (range, 4-16 weeks). Following the completion of the treatment protocol, 12 (17%) and 7 (10%) patients were also maintained on intranasal steroids and systemic antibiotics, respectively. Systemic steroids were not administered to any of the patients.

Fifty-one (73%) of 70 patients and 76 (59%) of 129 aspirates were culture positive for at least 1 organism (Table 4). Thirty patients (43%) had multiple organisms cultured, and 21 patients (30%) had the same organism cultured bilaterally. The organism most frequently isolated was Haemophilus influenzae, which was found in 32 (42%) of the aspirates. Other commonly identified bacteria were α-hemolytic streptococci, Moraxella catarrhalis, S pneumoniae, and coagulase-negative staphylococci. Thirty-four (24%) of 142 organisms were found to have penicillin resistance after susceptibility testing. Anaerobic bacteria were identified in 13 aspirates (17%).

Ten patients (14%) developed complications. Catheter-related thrombophlebitis occurred in 6 patients (9%) and was successfully treated in all cases with catheter removal and local wound care. In 1 patient (1%), a guidewire became lodged during catheter insertion, requiring venotomy for removal. Three patients developed antibiotic-related complications, including drug fevers (1%), serum sickness (1%), and pseudomembranous colitis (1%). These complications resolved with discontinuation of the antibiotics and appropriate medical therapy.

Initial clinical improvement following IV therapy was achieved in 62 patients (89%). Eight patients (11%) had no response to IV therapy and required ESS. Of those patients with initial clinical improvement following IV antibiotic therapy, long-term follow-up (defined as >6 months from IV therapy) information was available on 52 (74%). The mean follow-up in this group of patients was 25 months (range, 6-62 months). Of these 52 pa-
Pediatric chronic sinusitis is a complex disease whose natural history and pathogenesis are poorly understood. Primarily because of its multifactorial etiology, management of chronic sinusitis in children is complicated, and there is uncertainty about the best method of treatment. Most otolaryngologists who treat pediatric chronic sinusitis agree that a prolonged course of a broad-spectrum, β-lactamase stable oral antibiotic is the cornerstone of medical therapy. Additional measures, such as topical and systemic steroid therapy, systemic antihistamine and decongestant use, nasal irrigation, and immunotherapy, may also be beneficial. After optimal medical therapy, the disease can often be recalcitrant and, as a consequence, surgical intervention may be considered.

Several surgical options are available for the treatment of chronic sinusitis in children. Endoscopic sinus surgery has been most widely used for the treatment of refractory sinusitis in children. The reported success rates for pediatric ESS range from 80% to 93%.3,2 Despite its apparent benefits, pediatric ESS carries serious risks and, because of the smaller anatomy, requires greater technical skill and more meticulous surgery than in adults. In addition, interference with sinus development and midfacial growth after ESS has been well documented in animal studies and in anecdotal clinical reports.2,7 Because of these recent concerns, an increasing number of clinicians stress the medical nature of pediatric chronic sinusitis and urge conservative use of ESS.3,4

As an alternative to ESS, we advocate a stepwise protocol for the treatment of pediatric chronic sinusitis (Figure). In our patient population, patients referred with chronic sinusitis (defined as >3 months’ duration) are initially treated with at least a 3- to 4-week course of a β-lactamase stable oral antibiotic. Concurrently, most patients also undergo an allergy and immunology evaluation. If a child’s workup is noncontributory and medical therapy, including allergy management, is not effective,
a CT scan of the paranasal sinuses is performed. This imaging study allows us to determine the presence or absence of sinus disease and to assess adenoid size. The CT scan also permits an identification of any significant anatomic abnormalities that would be more amenable to ESS. Based on these findings, IV antibiotic therapy with selective adenoidectomy is offered to appropriate patients as an alternative to ESS. In the event that patients fail to respond to the IV antibiotics, they subsequently undergo ESS.

Our results suggest that this stepwise protocol that includes the use of IV antibiotic therapy is a reasonable therapeutic option for patients with refractory chronic sinusitis. Patients treated with IV antibiotics have clinical response rates similar to those undergoing ESS. Of the 70 patients treated, 62 (89%) had complete resolution of symptoms following IV therapy. In addition, the IV antibiotic therapy demonstrated minimal complications and was well tolerated by most patients. Many families also reported that care of the catheter and administration of the IV antibiotic were easily learned and feasible tasks.

This report differs from a previous series in that a larger number of patients were studied for longer periods. Patients demonstrated equivalent initial clinical response rates (89%) in both studies. In regards to their long-term outcomes, 45 patients (87%) in the present study continued to maintain clinical improvement, despite occasional episodes of acute sinusitis. All of the recurrent sinus infections in these patients resolved with oral antibiotic therapy.

An analysis of the patients who did not experience or maintain initial clinical improvement following IV antibiotic therapy revealed certain prognostic factors. The patients who did not achieve long-term clinical cure were older than those who responded to treatment. Similarly, patients who failed to sustain clinical improvement had a longer duration of preoperative symptoms than responders, suggesting that chronicity of disease may also be a predictive factor. The patients who subsequently underwent ESS after a failure to respond to the stepwise protocol did not experience superior resolution of symptoms. In fact, only 3 (43%) of 7 patients after ESS were judged by their parents to have had long-term clinical improvement, which suggests that these patients had more significant manifestations of disease. Other data examined in patients who did not respond to the stepwise protocol included isolation of antibiotic-resistant bacteria, history of atopy or asthma, use of prophylactic antibiotic, topical nasal steroid or antihistamine therapy, and presence of environmental factors, such as passive smoke exposure or day care. A thorough analysis of these factors failed to reveal other conditions that could predict a response to treatment. In this retrospective study, patients were not stratified by severity of sinonasal symptoms or CT scan findings. Such stratification may be beneficial for future prospective studies to assist with identifying those children and adolescents who would be most likely to respond to the stepwise protocol. Ideally, this would require the use of a CT staging system and a patient-based symptom instrument.

The efficacy of adenoidectomy is widely debated, but preliminary studies suggest a positive effect on pediatric chronic sinusitis. It is thought that adenoidectomy improves sinonasal symptoms by eliminating nasal airway obstruction and stasis of secretions. Removing the adenoid pad as a potential nidus for bacterial colonization is also considered important for improving sinus disease. In this study, the effect of adenoidectomy remains uncertain, because all patients were concomitantly treated with IV antibiotics. An interesting point, nonetheless, is that IV antibiotics appear to play an independent role from adenoidectomy in affecting the sinuses, because patients treated with only IV antibiotic therapy had clinical response rates similar to those of patients who underwent concurrent adenoidectomy. This is more apparent when one considers that more than half of the patients treated with only IV antibiotic therapy had previous adenoidectomy performed and presumably had no adenoid tissue in the nasopharynx. Some authors have also reported improvement in sinus disease after maxillary sinus lavage. Because this procedure addresses only the maxillary sinus, other authors are not convinced that it can produce a long-lasting benefit in children. Therefore, although it is possible that maxillary sinus lavage contributed to the initial clinical improvement seen in our patients, it is questionable whether this intervention had an effect on our patients’ long-term clinical outcome.

There is limited information regarding the microbial pathogenesis of chronic sinusitis in children. Moreover, the data are complicated in many studies by the use of various definitions of chronic sinusitis, concurrent antibiotic administration, and lack of aseptic culture technique. Because of these issues, the etiologic role of bacterial agents in chronic sinusitis has been viewed with skepticism by some authors. They believe that microorganisms play a minor part in the pathogenesis of chronic sinusitis and emphasize possible structural
damage of the sinus mucosa with loss of its normal state. In the present study, 51 (73%) patients had microorganisms present in their maxillary sinuses. Because only 34 (24%) of the organisms demonstrated drug resistance, these results represent for the most part susceptible bacteria that are persistent after a prolonged course of a β-lactamase stable oral antibiotic. These microbial pathogenic data are similar to what have been reported in other studies and indicate that bacterial infection may be an important factor in chronic sinusitis. Sinonasal symptoms improved in most patients following IV antibiotic therapy, which further supports a bacteriologic cause and suggests that poor sinus penetration of the oral agent may have led to initial failures.

We also propose that IV antibiotics may be efficacious in the treatment of chronic sinusitis by interrupting an infectious and inflammatory process localized within the sinus mucosa and underlying bone. Recent evidence suggests that active inflammation in the ethmoid bone may be a significant factor in the persistence of mucosal disease. It is therefore conceivable that prolonged IV antibiotic therapy, with increased blood concentrations, more effectively penetrates bone and alleviates this condition. The concept of a chronic “osteitis” and the efficacy of IV antibiotics for this type of disease process have been previously addressed and demonstrated in patients with chronic suppurative otitis media. Further studies are required to definitively establish a causal relationship in patients with chronic sinusitis.

Although the results of the present study are encouraging, a retrospective study design has inherent limitations, with possible bias. Because a comparison with children and adolescents who did not receive treatment was not performed, it is difficult to distinguish whether the natural course of the disease may have affected clinical outcomes. The use of multiple interventions (sinus irrigations, adenoidectomy, and IV antibiotics) also makes it difficult to separate their individual effects. Despite these deficiencies, this study suggests that a stepwise protocol that includes the use of IV antibiotic therapy is a safe and effective alternative to ESS for children and adolescents with chronic sinusitis.

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REFERENCES