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Sino-nasal outcome test (SNOT-22): A predictor of postsurgical improvement in patients with chronic sinusitis

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ABSTRACT

Background: A number of factors are critical when considering the expected benefit of surgical intervention in patients with chronic rhinosinusitis (CRS) who have failed medical therapy.

Objective: To evaluate the Sino-nasal Outcome Test (SNOT-22) and other patient demographic characteristics as predictors of postsurgical improvement in patients with CRS.

Methods: Consecutive adult subjects presenting to the Otolaryngology Clinics at the University of Virginia with refractory CRS that required surgery were included. Patients were excluded if they had not completed both preoperative and postoperative SNOT-22 evaluations. Demographic and baseline measures, including asthma and smoking status, total immunoglobulin E (IgE), absolute eosinophil counts, and Lund-Mackay computed tomography (CT) scoring were also obtained for each subject. Regression analyses were performed.

Results: One hundred four subjects met criteria and were included. These subjects showed a 51% overall improvement in postsurgical SNOT-22 evaluations (95% confidence interval [CI]: [45, 57%], $P < .001$). Multivariate regression analysis revealed that SNOT-22 items related to “runny nose,” “cough,” and “sadness” were independent predictors of postsurgical SNOT-22 improvement ($P < .05$, for all). Although “runny nose” had a direct correlation with improvement, more severe “sadness” and “cough” scores had a negative impact on degree of improvement. Similarly, analyses indicated that questions categorized as pertaining to nasal or ear symptoms were uniquely associated with postsurgical improvement in SNOT-22 scores ($P < .001$ and $P = .015$, respectively). Neither Lund-Mackay CT scoring, total IgE, nor absolute eosinophil counts correlated with improvement in postsurgical SNOT-22 scores.

Conclusion: Physicians can use components of the SNOT-22 to predict likelihood of symptom improvement after surgical intervention in subjects with CRS.

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Introduction

Chronic rhinosinusitis (CRS) is a common and debilitating condition with significant economic impact.¹ From 1995 to 2007, this disease accounted for 4.9 medical office visits out of every 100 people, approximately 1.5% of all office visits in the United States.² Whereas estimates of cost vary, the 2007 Medical Expenditure Panel Survey, which analyzes expenditures and utilization in health

care, suggests a national spending average on CRS approaching \$8.6 billion per year.³

First-line therapy for treatment of CRS is aimed at reducing underlying inflammation and facilitating clearance of the paranasal sinuses. Antibiotics, topical steroids, systemic steroids, and nasal saline irrigation are mainstays of treatment.^{4,5} Also key to medical management is treatment of underlying disease processes, such as environmental allergies.⁶ Unfortunately, many patients are refractory to this treatment and ultimately require functional endoscopic sinus surgery (FESS) to achieve improved symptom control and quality of life. Approximately 500,000 surgeries are performed annually for treatment of CRS refractory to medical management alone.

Given the relevance and societal impact of this disease process, careful selection of patients for surgery is necessary to optimize outcomes and reduce unnecessary risk. To that end, prior studies have attempted to define patient characteristics predictive of

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surgical outcomes.^{7–11} Unfortunately, conflicting information regarding which of these characteristics are important is prevalent. For example, studies have contrastingly suggested increased rates of revision sinus surgery among smokers or that smoking had no influence on outcome.¹² Similarly, studies have variously shown positive and negative influences of polyps, aspirin sensitivity, depression, female sex, and computed tomography (CT) scores of disease severity.¹¹

The goal of this study was to analyze outcomes of FESS using prospectively collected data in a single surgeon series obtained through a symptom-based rhinosinusitis outcome measure, the Sino-nasal Outcome Test-22 (SNOT-22). Additionally, demographic and baseline measures, including asthma and smoking status, total immunoglobulin E (IgE), absolute eosinophil counts, number of prior sinus surgeries, and Lund-Mackay CT scoring, were obtained for each subject and analyzed for correlation with surgical outcomes. We wanted to define whether the additional 2 questions in the SNOT-22 as compared with the SNOT-20 (“nasal obstruction” and “loss of smell and taste”) added any predictive value to this patient-directed outcome measure. The predictive value of such correlations will be useful to the surgeon in patient selection and informative to the patient in consenting to operative intervention.

Methods

A retrospective analysis of prospectively collected patient data was performed, using a protocol approved by the Human Investigation Committee at the University of Virginia, and informed consent was not required. Consecutive adult subjects presenting to the Otolaryngology Clinics at the University of Virginia with a diagnosis of CRS who remained refractory to at least 6 weeks of medical therapy were included (Table 1). In this context, CRS was diagnosed if patients met criteria as previously described elsewhere,¹³ which requires, in addition to positive objective endoscopic or CT findings, that the patients note at least 2 of the following 4 symptoms: nasal congestion, nasal drainage, facial pain/pressure, or diminished smell.¹⁴ Before and after surgical intervention, these subjects were asked to maintain maximal medical therapy with medications directed toward the specific presumed underlying triggers, such as the presence of bacterial biofilms, allergies, eosinophilic inflammation, and aspirin sensitization as part of the standard of care for patients at the University of Virginia. At a minimum, preoperative therapy included a 1- to 2-week course of oral corticosteroid, topically administered nasal steroid, isotonic saline nasal irrigations, and culture-directed antibiotic if purulent or thickened mucous was noted on examination. Patients presenting with a history of prior surgery were also prescribed budesonide irrigations as reported by us previously.⁴

Standard protocol for all patients presenting for evaluation also included completion of the SNOT-22 before and after surgical

intervention. Each subject completed the SNOT-22 during a clinic visit by answering all questions based on a 0–5 scale, where 0 signifies no problems with the given symptom and 5 indicates maximal problems (eFig 1). This is a validated patient-reported measure of outcome established to delineate the presence and severity of sino-nasal disorders.¹⁵ Patients were excluded if they had not completed both preoperative and postoperative evaluations.

Perioperative demographic and medical histories were obtained from both the patient and the medical record. This included the presence of prior diagnosis by a physician of allergic rhinitis or asthma (this was not further evaluated with repeat pulmonary function or skin testing). Post-medical therapy acquired CT scans performed preoperatively were evaluated using the Lund-Mackay CT scoring system.^{16,17} Laboratory values, specifically a complete blood count with differential to evaluate absolute eosinophil count and a total IgE, were obtained before surgery for those patients with nasal polyps. The postoperative SNOT-22 was completed between 3 and 6 months after the surgery.

Statistical Methods

Data Summarization

Categorical scaled patient demographic and patient characteristic data were summarized by frequencies and percentages, whereas total IgE concentration and total eosinophil count were summarized by the geometric mean and the arithmetic mean of the measurement distribution, respectively.

Univariate Analyses

Negative-binomial generalized estimating equation regression models were used to estimate the mean preoperative to postoperative percent change in the scores of each question of the SNOT-22 questionnaire, and to compare the mean preoperative with the postoperative percent change in the SNOT-22 composite score (ie, total score) between patient groups with different underlying baseline characteristics. The generalized estimating equation version of the Wald statistic was used as the test statistic in hypothesis testing, and a 2-sided $P \leq .05$ decision rule was established a priori as the null hypothesis rejection rule for testing the null hypothesis that the mean preoperative to postoperative change in the SNOT-22 score was equal to 0.

Multivariate Analyses

Multivariate Ordinary-Least-Squares regression was used to determine which questions of the SNOT22 independently predicted the preoperative to postoperative change in the SNOT-22 composite score. The type III, extra sum-of-squares F -test was used to determine the independent predictors of the preoperative to postoperative change. The extra-sum-of-squares F -test also determined whether specific a priori selected clusters of related questions of the SNOT-22 were *uniquely/independently* associated with the preoperative to postoperative change in the SNOT22 composite score. A $P \leq .05$ decision rule was established a priori as the null hypothesis rejection criterion for the statistical test of association.

Statistical Software

The statistical software packages, SAS version 9.2.2 (SAS Institute Inc., Cary, North Carolina), and Spotfire S-plus version 8.2 (TIBCO Inc, Palo Alto, California), were used to conduct the statistical analyses.

Results

The data for a total of 104 subjects that met the defined criteria were included. The baseline characteristics for the subjects are

Table 1
Patient demographics and characteristics

Variable (n = 104)	n (%)
Sex (male)	60 (58)
Asthma	42 (40)
ASA intolerance	15 (14)
Allergies	51 (49)
Smoking history	20 (19)
Prior FESS	
0	40 (39)
1	31 (30)
>1	33 (32)
Total IgE - geometric mean (IU/mL) [95% CI] ^a	113 [75, 171]
Total eosinophil counts - mean ($\times 10^9/L$) [95% CI] ^b	440 [400, 576]
Lund Mackay score - mean [95% CI]	13 [12, 15]

^an = 51.

^bn = 44.

summarized in Table 1. Total IgE and absolute eosinophil counts were obtained on the subset of these patients with nasal polyps ($n = 51$).

Our results indicated that all patients showed some level of improvement postoperatively, with an average improvement in the total symptom score (reduction in SNOT-22 composite score) of 51% (95% CI: [45, 57%]) of baseline, preoperative values. However, when we examined the least severely symptomatic patients (those with the lowest quartile of SNOT-22 symptoms), there was a flooring effect with a reduction of only 35% (95% CI: [17, 49%]) (Table 2). Those patients who had never undergone FESS before their presentation at the University of Virginia did significantly better than those who had previously undergone 1 or more surgeries ($n = 40$ for 0 surgeries with 63.4% improvement (95% CI: [54.38, 70.63]), $n = 31$ for 1 prior surgery with 48.4% improvement (95% CI: [33.74, 59.83]), and $n = 22$ for more than 1 prior surgeries with 54.5% improvement (95% CI: [42.27, 64.22]) ($P = .05$ [for no surgery vs 1 or more]) (Table 3).

Each question from the SNOT-22 was initially evaluated using univariate analysis. Individual questions improved significantly from the preoperative scores, with a range of 72% (95% CI: [47, 85%]) for “embarrassment” to 33% (95% CI: [21, 43%]) for “loss of smell/taste” (Fig 1). Because each parameter improved, we evaluated which questions were uniquely and independently associated with postoperative improvement. For instance, because “embarrassment” improved, we posited whether this was simply an indicator that people reported that they were embarrassed because they had a “runny nose” or whether this was uniquely associated with postoperative improvement. Using multivariate regression analysis, we were able to establish which components of the SNOT-22 were “hinge-pin” questions that *independently* predicted postoperative improvement. “Runny nose” directly correlated with improved postoperative SNOT-22 scores ($P < .01$). “Ear fullness” and “nasal obstruction” trended toward significance as well ($P = .07$ and $P = .09$, respectively). In contrast, questions concerning “cough” and “sadness” independently had negative impacts on the degree of improvement ($P < .05$ for both) (Fig 2 and eTable 1).

Because many of the questions in the SNOT-22 cluster together, we conducted hypothesis tests related to determine which clusters of questions provided *uniquely/independently* predictive information about postoperative improvement. For these analyses, we grouped questions into 4 main categories: nasal related (“need to blow nose,” “sneezing,” “runny nose,” “nasal obstruction,” “loss of smell/taste,” and “postnasal drip”); ear and facial related (“ear fullness,” “dizziness,” “ear pain,” “facial pain and pressure”); quality of life related (“difficulty falling asleep,” “wake up at night,” “wake up tired,” “fatigue,” “reduced productivity,” “reduced concentration”); and psychologically related (“frustrated/restless/irritable,” “sad,” “embarrassed”). Those clusters that related to nasal and to ear and facial symptoms were significantly associated with postoperative improvement ($P < .001$, and $P = .015$, respectively).

We next evaluated whether the additional questions in the SNOT-22 improve the ability of this test to predict postsurgical outcomes. Using multivariate regression analyses, we determined that even though the question related to nasal obstruction trended toward significance, the 2 questions that make the SNOT-22 unique, “nasal obstruction” and “loss of smell and taste,” were not

Table 3

Comparison of prior surgeries and absolute improvement in SNOT-22 Scores

Prior surgeries (PS)	Absolute improvement (units)	Percent improvement (%)	Lower 95% CI	Upper 95% CI
0	27.26	63.39	54.38	70.63
1	20.81	48.41	33.74	59.83
>1	23.46	54.55	42.27	64.22

independent predictors of postoperative improvement when clustered together ($P = .114$), nor did their removal from the “nasal-related group” decrease its significance ($P = .002$).

Finally, we evaluated whether the presence of asthma, allergy, smoking history, or aspirin sensitivity, as well as baseline total IgE, absolute eosinophil count, and Lund-MacKay scores, predicted postoperative improvement. Neither patient-reported allergy nor asthma was associated with significant postoperative improvement in our cohort. Consistent with this, we were unable to show any predictive value of either total IgE or absolute eosinophil counts (Fig 3A–D). Surprisingly, aspirin sensitivity, smoking status, and Lund-MacKay scores were also *not* predictive of improvement in this patient population.

Discussion

In this study, we have provided further corroboration of previously identified prognostic factors and identified additional factors that inform the optimal selection of patients for FESS. The value of the overall SNOT-22 score was apparent, with patients with the highest symptom scores experiencing the greatest degree of symptom improvement (Table 2). This corresponds with previous studies, which have cited the relatively greater improvement among more severely affected patients.^{9,10} Even the patients with the lowest preoperative symptoms scores did experience improvement, although the magnitude of the change was limited by the associated flooring effect (Table 2).

Multivariate analysis showed which individual components of the SNOT-22 provided unique information predictive of surgical outcomes. “Runny nose,” “cough,” and “sadness” each provided independent information, and “ear fullness” and “nasal obstruction” approached significance (Fig 2). Multiple regression analysis of the significant factors yielded the interesting observation that “runny nose” predicted *greater* improvement in symptoms, whereas “sadness” and “cough” were significantly predictive of *lesser* improvement.

Conflicting reports have been made regarding the effect of depression on quality of life and surgical outcomes in the CRS patient population.^{7,8,10,11,18,19} Depressed patients generally have greater subjective symptom scores than their nondepressed counterparts. Litvack and colleagues⁸ demonstrated that while patients with higher depression scores have worse disease-specific quality of life than nondepressed patients, they seem to experience comparable objective improvement with FESS. In the Litvack study, depressed patients experienced a significant improvement in their depression. Our study confirmed the ability of FESS to improve the overall symptom score in patients who identify “sadness” as a significant symptom. However, multiple regression analysis revealed that these scores correlated with *less* improvement in overall score after surgery. Given this finding in the greater context of the literature, it is advisable to address these considerations with the depressed patient.

“Cough” was associated with less improvement in total SNOT-22 scores. We hypothesized that this would be related to an underlying diagnosis of asthma and, therefore, not amenable to improvement through FESS. However, on further analysis, clinical diagnosis of asthma and “cough” scores on the survey were apparently *not* associated. Furthermore, asthma was not predictive of outcomes (Fig 3B), as has also been noted in other studies.^{10,11} An alternative

Table 2

Postoperative SNOT-22 improvement as a function of preoperative SNOT-22

Preoperative score	Absolute improvement units [95% CI]	Percent improvement % [95% CI]
15	5.3 [2.6, 7.4]	35.0 [17.1, 49.1]
30	16.1 [13.6, 18.3]	53.7 [45.2, 60.9]
45	25.2 [22.3, 27.8]	56.1 [49.6, 61.7]
60	31.9 [26.4, 36.4]	53.1 [44.0, 60.7]

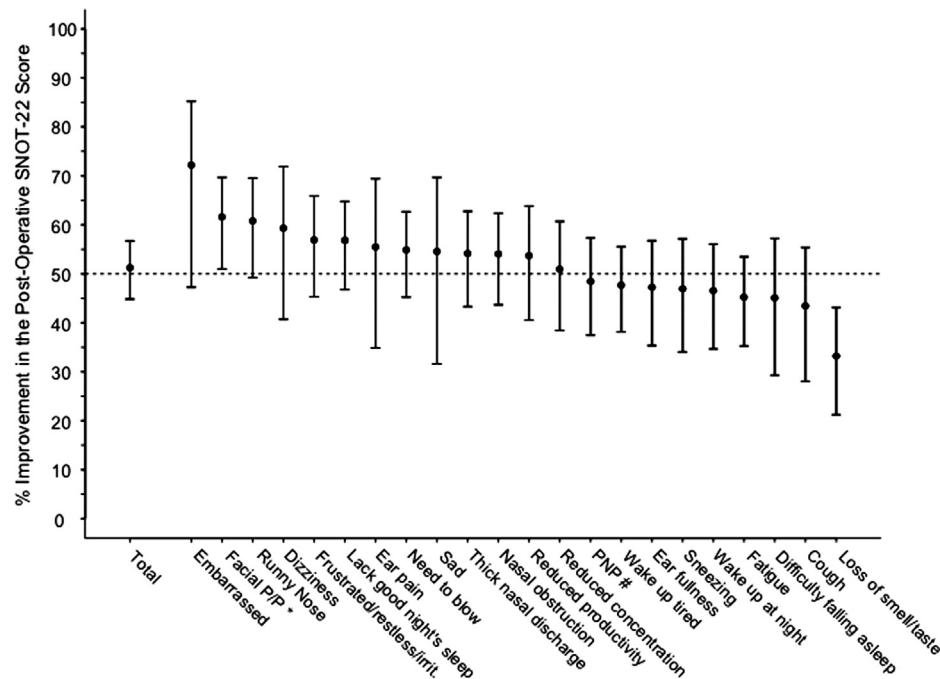


Figure 1. Univariate analysis of postoperative improvement in SNOT-22 scores by question. Abbreviations: PP, pain/pressure (*); PND, postnasal drip (#).

explanation may be that the presence of cough served as a surrogate marker of laryngopharyngeal reflux in this subgroup of our population. Further study of this phenomenon is warranted.

Given the established negative impact of tobacco smoke on innate and humoral immunity,^{20,21} smoking is regarded as having a negative prognostic indicator in sinus disease. Whereas smoking has previously been associated with the need for revision surgery

and inferior surgical outcomes,^{22,23} more recent trials designed specifically to investigate the relationship of smoking with postoperative outcomes demonstrated *comparable* subjective outcomes to nonsmokers, whereas endoscopy scores remain poor in both cohorts.¹² The current study revealed no significant relationship between smoking status and FESS outcomes. This finding lends further support to the mounting evidence that although smoking

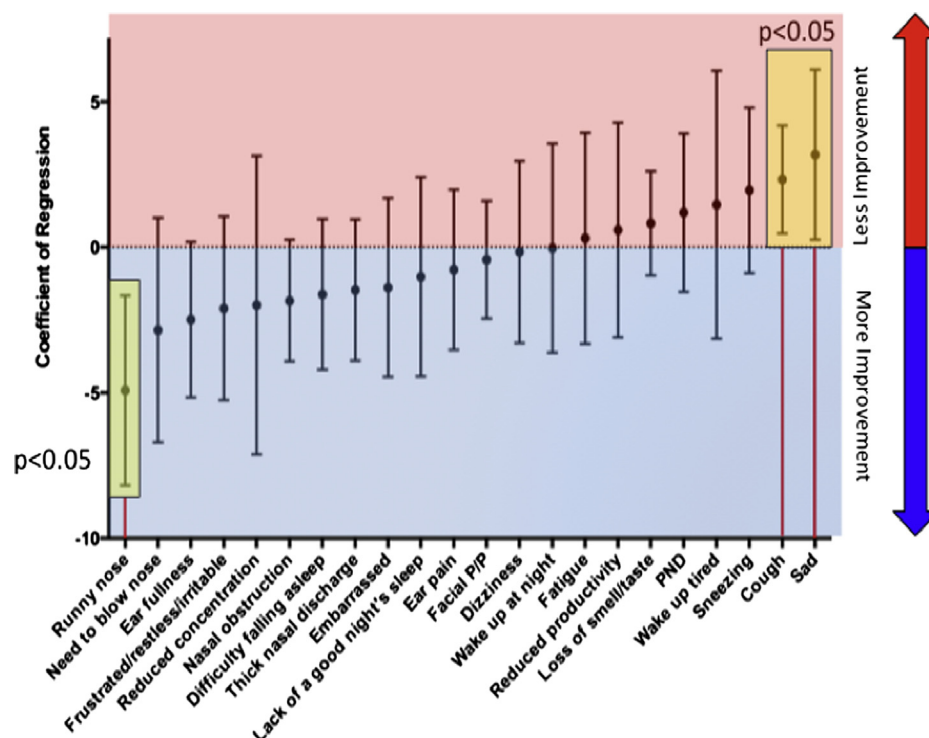


Figure 2. Multivariate regression analysis comparing presurgical and postsurgical SNOT-22 questions. “Runny nose” directly correlated with postoperative SNOT-22 improvement ($P < .05$), whereas “cough” and “sadness” predicted less improvement overall ($P < .05$, respectively). “Ear fullness” and “nasal obstruction” trended toward significance ($P = .07$ and $.09$, respectively).

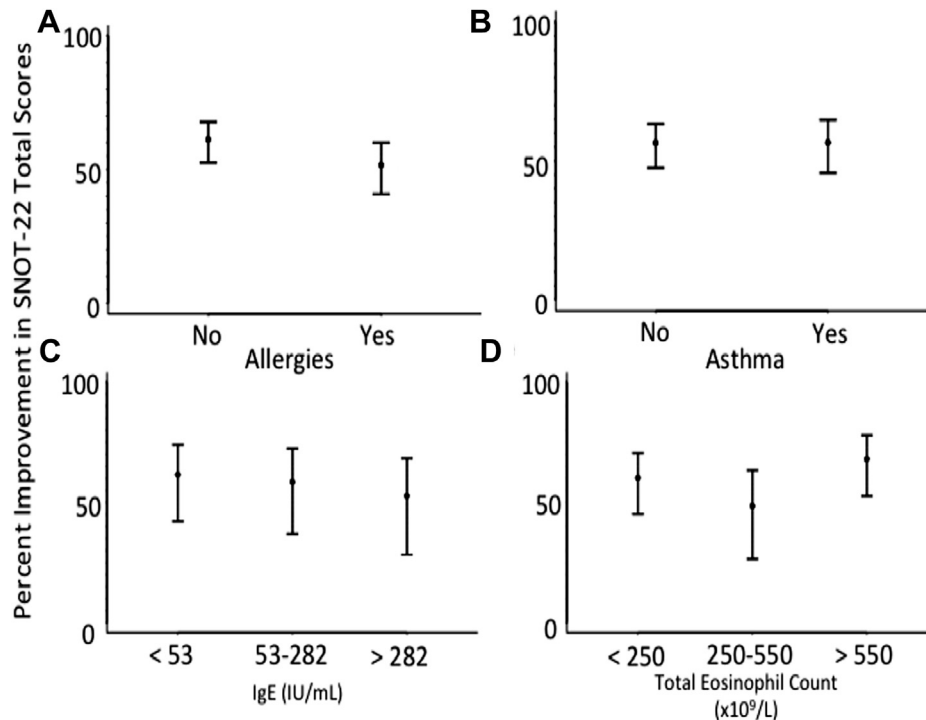


Figure 3. Improvement in total SNOT-22 scores as a function of baseline measures. (A) Physician-diagnosed allergy did not predict postoperative improvement in SNOT-22 scores ($P = .12$). (B) Physician-diagnosed asthma did not predict postoperative improvement in SNOT-22 scores ($P = .98$). (C) Total IgE (IU/mL) scores did not predict postoperative improvement in SNOT-22 scores [$53\text{--}282\text{ IU/mL}$ vs. 53 IU/mL [$P = .78$]; $>282\text{ IU/mL}$ vs. $<53\text{ IU/mL}$ [$P = .49$]; $>282\text{ IU/mL}$ vs. [$53\text{--}282\text{ IU/mL}$] [$P = .67$]]. (D) Absolute eosinophil count did not predict postoperative improvement in SNOT-22 scores [$250\text{--}550 \times 10^9/\text{L}$ vs. $<250 \times 10^9/\text{L}$ [$P = .28$]; $>550 \times 10^9/\text{L}$ vs. $<250 \times 10^9/\text{L}$ [$P = .39$]; $>550 \times 10^9/\text{L}$ vs. [$250\text{--}550 \times 10^9/\text{L}$] [$P = .07$]].

cessation should be encouraged, active smoking should not be regarded as a contraindication to FESS.

As noted, allergy status, eosinophilia, and IgE levels were not related to improvement in symptom scores on the SNOT-22, although these factors are limited in confirming the presence of allergic disease.^{24–26} We chose to include physician-diagnosed allergy as recalled by the subjects primarily because of the high rate of false-positive tests afforded to skin prick tests in this situation. The symptoms of sinus disease and allergy are similar, and history alone will not distinguish which disease is leading to the pathologic conditions, rendering positive skin tests difficult to interpret. We improved our diagnostic abilities by ensuring that those patients with physician-diagnosed allergy and asthma were receiving treatment at the time of enrollment.

Of all the evaluated demographic factors, only prior surgery was predictive of the magnitude of improvement, with the greatest absolute improvement seen in those with no prior surgery. This finding suggests that the first attempt at surgical intervention is extremely important. Alternatively, multiple revision surgeries may be a surrogate for the refractoriness of the disease process. Those requiring multiple surgeries likely had more complex disease that was difficult or impossible to treat with conventional therapies, including surgical intervention. Importantly, FESS provides the opportunity to open windows into the sinuses that did not previously exist, thereby improving the application of postoperative medical treatments, including steroids.^{27,28} The addition of these windows might explain the differences in postoperative improvement in those patients with no prior surgeries, although, as was the practice of the surgeon in this study, only a small number of patients with prior surgery started budesonide rinses (for the first time) postoperatively.

In this large, single-surgeon series, subjective symptom reporting through the SNOT-22 survey and demographic factors

were evaluated for influence on postsurgical outcomes. Although it is encouraging that all patients in the series noted improvement in symptoms, this universal improvement limits the power of the statistical model to identify patient features predictive of outcomes. Additionally, the aggressive medical management employed postoperatively may not reflect national practice trends, thereby potentially decreasing the general applicability of these findings. Lastly, outcomes were measured at 6 months in this study, and it is possible that the markers we found are not representative of longer-term outcomes after intervention. However, other studies in CRS have shown that 6-month outcomes are comparable to data at 2 years postintervention.²⁹

In conclusion, our study showed that, with optimal surgical intervention (and postoperative medical management), FESS is an extremely effective treatment of CRS. Patient-based outcome measures, such as the SNOT-22, are helpful tools for quantifying changes in symptoms and can be used to predict extent of postoperative improvement. Although all of the components of the SNOT-22 significantly improved after surgery, only “runny nose” (associated with greater improvement), as well as “cough” and “sadness” (both associated with less improvement), were independent predictors of postsurgical SNOT-22 improvement. Although further work is needed in this area, this study begins to define important questions that must be asked before surgical intervention.

Supplementary Data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.anai.2013.06.033>

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A: Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how 'bad' it is by circling the number that corresponds with how you feel using this scale →

	No problem	Very mild problem	Mild or slight problem	Moderate problem	Severe problem	Problem as bad as it can be	
1. Need to blow nose	0	1	2	3	4	5	
2. Sneezing	0	1	2	3	4	5	
3. Runny nose	0	1	2	3	4	5	
4. Cough	0	1	2	3	4	5	
5. Post nasal discharge (dripping at the back of your nose)	0	1	2	3	4	5	
6. Thick nasal discharge	0	1	2	3	4	5	
7. Ear fullness	0	1	2	3	4	5	
8. Dizziness	0	1	2	3	4	5	
9. Ear pain	0	1	2	3	4	5	
10. Facial pain/pressure	0	1	2	3	4	5	
11. Difficulty falling asleep	0	1	2	3	4	5	
12. Waking up at night	0	1	2	3	4	5	
13. Lack of a good night's sleep	0	1	2	3	4	5	
14. Waking up tired	0	1	2	3	4	5	
15. Fatigue	0	1	2	3	4	5	
16. Reduced productivity	0	1	2	3	4	5	
17. Reduced concentration	0	1	2	3	4	5	
18. Frustrated/restless/irritable	0	1	2	3	4	5	
19. Sad	0	1	2	3	4	5	
20. Embarrassed	0	1	2	3	4	5	
21. Sense of taste/smell	0	1	2	3	4	5	
22. Blockage/congestion of nose	0	1	2	3	4	5	

TOTAL: _____

GRAND TOTAL:

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eFigure 1. SNOT-22 questionnaire. Reproduced with permission from: Piccirillo JF, Merritt MG, Richards ML. Psychometric and clinimetric validity of the 20-item Sino-Nasal Outcome Test (SNOT-20). *Otolaryngol Head Neck Surg.* 2002;126:41–47.

eTable 1

Summary for the postoperative improvement in the mean SNOT-22 questionnaire score unadjusted for the baseline score

Question	Estimate % improvement in mean score	Lower 95% confidence limit	Upper 95% confidence limit
Total	51.1	44.8	56.7
Embarrassed	72.1	47.3	85.2
Facial P/P	61.4	51.0	69.7
Runny nose	60.6	49.2	69.5
Nasal obstruction	59.2	40.7	71.9
Frustrated/restless/irritable	56.8	45.3	65.9
Lack of a good night's sleep	56.7	46.8	64.8
Ear pain	55.4	34.9	69.4
Need to blow nose	54.8	45.2	62.7
Sad	54.4	31.6	69.7
Thick nasal discharge	54.0	43.3	62.7
Loss of smell/taste	53.9	43.7	62.3
Reduced productivity	53.6	40.5	63.8
Reduced concentration	50.8	38.5	60.7
PND	48.3	37.5	57.3
Wake up tired	47.5	38.1	55.5
Ear fullness	47.1	35.4	56.7
Sneezing	46.8	34.0	57.1
Wake up at night	46.4	34.7	56.1
Fatigue	45.1	35.2	53.5
Difficulty falling asleep	45.0	29.3	57.2
Cough	43.3	28.0	55.4
Loss of smell/taste	33.1	21.2	43.1

A: Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how 'bad' it is by circling the number that corresponds with how you feel using this scale →

	No problem	Very mild problem	Mild or slight problem	Moderate problem	Severe problem	Problem as bad as it can be	
1. Need to blow nose	0	1	2	3	4	5	
2. Sneezing	0	1	2	3	4	5	
3. Runny nose	0	1	2	3	4	5	
4. Cough	0	1	2	3	4	5	
5. Post nasal discharge (dripping at the back of your nose)	0	1	2	3	4	5	
6. Thick nasal discharge	0	1	2	3	4	5	
7. Ear fullness	0	1	2	3	4	5	
8. Dizziness	0	1	2	3	4	5	
9. Ear pain	0	1	2	3	4	5	
10. Facial pain/pressure	0	1	2	3	4	5	
11. Difficulty falling asleep	0	1	2	3	4	5	
12. Waking up at night	0	1	2	3	4	5	
13. Lack of a good night's sleep	0	1	2	3	4	5	
14. Waking up tired	0	1	2	3	4	5	
15. Fatigue	0	1	2	3	4	5	
16. Reduced productivity	0	1	2	3	4	5	
17. Reduced concentration	0	1	2	3	4	5	
18. Frustrated/restless/irritable	0	1	2	3	4	5	
19. Sad	0	1	2	3	4	5	
20. Embarrassed	0	1	2	3	4	5	
21. Sense of taste/smell	0	1	2	3	4	5	
22. Blockage/congestion of nose	0	1	2	3	4	5	
TOTAL:	_____	_____	_____	_____	_____	_____	
_____ Copyright Washington University							GRAND TOTAL:

eFigure 1 SNOT-22 questionnaire. Reproduced with permission from: Piccirillo JF, Merritt MG, Richards ML. Psychometric and clinimetric validity of the 20-item Sino-Nasal Outcome Test (SNOT-20). Otolaryngol Head Neck Surg . 2002;126:41-47.

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