Long-Term Outcomes in Sinus Surgery: A New Tool for Measuring Health-Related Quality of Life
Aaron K. Remenschneider, Laura D'Amico, Jamie R. Litvack, Stacey T. Gray, Eric H. Holbrook, Richard Gliklich and Ralph Metson

Otolaryngology -- Head and Neck Surgery 2014 151: 164 originally published online 4 April 2014
DOI: 10.1177/0194599814529536

The online version of this article can be found at:
http://oto.sagepub.com/content/151/1/164

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
AMERICAN ACADEMY OF
OTOLARYNGOLOGY--
HEAD AND NECK SURGERY
F O U N D A T I O N
American Academy of Otolaryngology- Head and Neck Surgery

Additional services and information for Otolaryngology -- Head and Neck Surgery can be found at:

Email Alerts: http://oto.sagepub.com/cgi/alerts
Subscriptions: http://oto.sagepub.com/subscriptions
Reprints: http://www.sagepub.com/journalsReprints.nav
Permissions: http://www.sagepub.com/journalsPermissions.nav

>> Version of Record - Jun 23, 2014
OnlineFirst Version of Record - Apr 4, 2014

What is This?
Long-Term Outcomes in Sinus Surgery: A New Tool for Measuring Health-Related Quality of Life

Aaron K. Remenschneider, MD, MPH1,2, Laura D’Amico1, Jamie R. Litvack, MD, MS3, Stacey T. Gray, MD1,2, Eric H. Holbrook, MD1,2, Richard Gliklich, MD1,2, and Ralph Metson, MD1,2

Abstract

Objective. The 6-question EuroQol 5-Dimension Health Assessment (EQ-5D) is a widely used, simple instrument that monitors general health-related quality of life (HRQoL) in chronic disease. It has not previously been applied to US patients undergoing endoscopic sinus surgery (ESS).

Study Design. Prospective cohort study.

Setting. Academic Medical Center.

Subjects and Methods. The study population consisted of 267 patients with chronic rhinosinusitis (CRS) who completed 2 disease-specific instruments—the Chronic Sinusitis Survey (CSS) and the Sinonasal Outcomes Test-22 (SNOT-22)—and 1 general health-related quality-of-life instrument—the EQ-5D—before and after ESS for CRS. Baseline scores were compared to those collected 3 and 12 months after surgery and to the general US population.

Results. Surveys were completed at all time points by 186 patients, for a response rate of 69.7%. Patients with CRS, when compared to the US population, reported more problems in the domains of pain/discomfort (73.1% vs 40.8%, P < .01), anxiety/depression (50.5% vs 26.4%, P < .01), and usual activities (30.6% vs 15.0%, P < .01). One year following ESS, there was a significant decrease in patients who reported problems with pain/discomfort (54.3%, P < .001), anxiety/depression (30.6%, P < .001), and usual activities (21.5%, P < .01). After surgery, CRS anxiety/depression scores were no different from those of the US general population. Chronic Sinusitis Survey and SNOT-22 scores demonstrated similar postoperative improvements.

Conclusion. The EQ-5D assessment provides meaningful general health outcomes data with low patient burden. Application of this instrument demonstrated long-term improvement in the quality of life of patients who undergo sinus surgery.

Keywords
chronic rhinosinusitis, clinical outcomes, sinus surgery, EQ-5D, utility values, sinusitis

Received November 26, 2013; revised February 18, 2014; accepted March 7, 2014.

Introduction

Because rhinosinusitis is the most prevalent respiratory condition affecting US adults and because it demands annual direct costs of nearly US$6 billion, there has been keen interest in measuring its health effect on patients.1,2 The field of outcomes research in chronic rhinosinusitis (CRS) has been primarily driven by results from disease-specific questionnaires that provide information on rhinologic health. Dozens of sinonasal-specific tools exist for the study of both CRS disease burden and response to therapy, including the Chronic Sinusitis Survey (CSS), Rhinosinusitis Disability Index (RSDI), and Sinonasal Outcomes Test-22 (SNOT-22).3 Comparison of data collected using these different instruments has enhanced the field of CRS outcomes research by providing various perspectives on disease-specific health burden.

As a complement to disease-specific surveys, health-related quality of life (HRQoL) may be measured using instruments that capture aspects of general health. Such

1Department of Otolaryngology, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts, USA
2Department of Otology and Laryngology, Harvard Medical School, Boston, Massachusetts, USA
3Department of Surgery, Washington Veterans Affairs Medical Center, Department of Otolaryngology, MedStar Washington Hospital Center, Washington, DC, USA

This article was presented at the 2013 AAO-HNSF Annual Meeting & OTO EXPO; September 29–October 3, 2013; Vancouver, British Columbia, Canada.

Corresponding Author:
Aaron K. Remenschneider, MD, MPH, Department of Otolaryngology, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, MA 02114, USA.
Email: aaron_remenschneider@meei.harvard.edu
instruments allow a general picture of a population’s health status and provide data for comparisons between chronic diseases. In the field of CRS outcomes, the Medical Outcomes Study Short-Form 36 (SF-36) has fulfilled this role over the past 20 years. The SF-36 and modified versions of the SF-36 remain the only general HRQoL instruments in use among researchers in chronic rhinosinusitis.\(^4\)\(^-\)\(^7\) In contrast, general health outcomes research across other conditions have used a variety of instruments, including the EuroQol 5-Dimension Health Assessment (EQ-5D), Index of Well-Being (QWB), and Health Utilities Index (HUI-3).\(^5\)\(^,\)\(^9\) Obtaining general health outcomes data using multiple instruments is critical to mature the field of outcomes research in CRS.

The EQ-5D is a simple survey with minimal patient burden. It consists of 6 questions related to general health and takes less than 2 minutes to complete.\(^10\) In general HRQoL research, it has demonstrated reliability as well as convergent and discriminant validity.\(^11\) The EQ-5D quantifies problems in 5 separate domains and allows for the direct translation of scores into health utility values—a key building block for calculating quality adjusted life years (QALYs). Cost-utility analysis is the association of treatment costs with QALYs and represents the ultimate goal of most general HRQoL research.

The Department of Health and Human Services has used the EQ-5D to collect a database of health information on the US population.\(^8\)\(^,\)\(^12\) This resource is the largest publicly available dataset for cost-effectiveness and cost-utility research in the country. For this reason, there has been a significant trend toward the adoption of the EQ-5D for general health outcomes research, with more than 2600 articles published to date. Only 1 US publication delineates estimated health burden for sinusitis using the EQ-5D, and it was analyzed along with 18 other self-reported conditions in a study by Ko and Coons.\(^13\) Unfortunately diagnoses were self-reported, all forms of sinusitis were included, and patients were assessed at only 1 point in time.

Patients with CRS undergoing endoscopic sinus surgery (ESS) have not been previously evaluated using the EQ-5D in the United States. The purpose of this study is to report EQ-5D derived baseline health status in patients with chronic rhinosinusitis and report long-term EQ-5D outcomes in CRS patients who underwent sinus surgery.

**Methods**

**Subjects**

The study population consisted of patients with CRS refractory to medical therapy who were scheduled for sinus surgery at the Massachusetts Eye and Ear Infirmary between February 2011 and May 2012. Subjects were recruited from 11 different otolaryngologic practices (4 academic and 7 community-based private) and were enrolled on the day of surgery in a consecutive fashion. Smoking history and comorbidity data were extracted from the medical record. The diagnosis of nasal polyposis was made by the surgeon based on preoperative endoscopic examination. Allergy diagnosis was confirmed by quantitative testing.

Inclusion criteria included age greater than 18 years and a diagnosis of CRS as defined by the American Academy of Otolaryngology.\(^14\) Subjects were excluded if they had a diagnosis of neoplasm, trauma, or cerebrospinal fluid leak, if surgery included the performance of frontal sinus obliteration, or if a preoperative computed tomography scan was not available for review. Patients with preoperative data who did not complete 3- or 12-month follow-up surveys were analyzed as nonresponders.

After enrollment, patients were followed prospectively, completing the EQ-5D, the CSS, and the SNOT-22 on the day of surgery (baseline) and at 3 and 12 months postoperatively. Data collection was performed by mail, phone, or electronic survey in a Health Insurance Portability and Accountability Act (HIPAA) compliant manner and is discussed in a recent publication from our institution by Meier et al.\(^15\) An online survey firm (DataStar, Waltham, Massachusetts, USA) was employed to create and administer a web-based, HIPAA compliant system for patients to securely enter their responses to each questionnaire. Emails were sent at 3- and 12-month intervals, which allowed patients to complete all aspects of each survey remotely. Visual Analog Scale (VAS) scores were reproduced at an appropriate length with a slide bar for selection.

Institutional review board approval was obtained from the Human Studies Committee of the Massachusetts Eye and Ear Infirmary. There was no risk of harm or adverse events as a result of participation in the study. Subjects participating did so voluntarily and without compensation.

**EuroQol 5-Dimension Health Assessment**

The EQ-5D is a general quality-of-life instrument that collects information from 5 health domains: mobility, self-care, usual activity, pain/discomfort, and anxiety/depression. A sixth question asks about the patient’s “health today” along a 0 to 100 VAS. Patients report whether they have problems with each health domain in order to provide a general view of their overall health. Scores can be translated into utility values to determine the benefit of treatment in QALYs or as part of a cost-utility analysis. The 3-level original version (EQ-5D-3L) assessed each domain along 3 degrees: no problems, moderate problems, or severe problems. In 2010, a new 5-level version (EQ-5D-5L) was introduced and has been shown to increase discriminatory power and reduce the ceiling effect for summation scores.\(^16\)\(^-\)\(^18\)

**Statistical Analyses**

EuroQol 5-Dimension Health Assessment scores were recorded as the percentage of patients reporting problems in each domain. The conversion of EQ-5D domain scores into categorical values (problems vs no problems) has been previously described\(^19\)\(^,\)\(^20\) and is recommended by the EuroQol group when there are few patients reporting significant problems in each domain and when comparison of domain scores between groups is performed.\(^21\) In the postoperative period, it allows for a clear delineation of patients who moved from a “problem” to a “no-problem” state.
Using the chi-square test, baseline and 12-month postoperative EQ-5D domain scores were compared to US population norms of similar age and sex distribution taken from a representative national study.20 Chronic rhinosinusitis patient baseline and 12-month postoperative EQ-5D VAS scores were also compared to US norms using 2-tailed unpaired t tests.

Values at baseline and 3 and 12 months following surgery were compared using both the chi-square test and the Cochran–Armitage test for trend. Pre- and postoperative EQ-5D VAS scores (0 = the worst health imaginable, 100 = best possible health) and CSS and SNOT-22 scores (0 = no symptoms, 110 = maximal symptoms) were compared using paired t tests. Minimal clinically important difference (MCID) for the EQ-5D VAS has been estimated in other diseases via anchor-based or distribution-based approaches with results that consistently reflect a 0.5 standard deviation of the mean baseline VAS score; thus, this value was prospectively assigned as the MCID in this study.22–24 To facilitate intersurvey comparison, CSS scores were normalized to a 0 to 100 scale, where 0 is the worst possible score (maximal symptoms/medication usage) and 100 the best (no symptoms or medication usage), as has been previously described.25 The threshold for clinical success using the CSS was set at a 40% improvement, as was defined by Witsell et al.26 Baseline EQ-5D, CSS, and SNOT-22 scores for patients lost to follow-up were compared to those with both 3- and 12-month responses using chi-square and t tests to assess for the possibility of response bias. Demographic and comorbid characteristics were also compared.

Given the lack of published data on EQ-5D scores in patients with CRS, an a priori power analysis was performed using meaningful clinical change in SNOT-22 scores (9 point change in total score), as has been previously reported.27 Using an alpha of .05, a sample size of 182 was necessary to obtain greater than 80% power to detect significant change in health status following surgery.

**Results**

Baseline surveys were completed by 267 patients deemed eligible for study inclusion. Two hundred two patients responded to 3-month surveys for a response rate of 75.8%. One hundred eighty-six patients completed surveys at both 3 and 12 months for a final response rate of 69.7%. Male patients made up 44.1% of the study population and the mean age (SD) was 49.9 (15.6) years. Forty-eight percent of CRS patients had nasal polyposis at surgery. Patient comorbidities included aspirin sensitivity (5.9%), asthma (32.6%), chronic obstructive pulmonary disease (1.6%), diabetes mellitus (4.3%), environmental allergies (55.1%), gastroesophageal reflux (14.0%), hypertension (20.4%), immunodeficiency (1.6%), and migraine (6.5%). Only 4.3% of patients were current smokers. Forty-three percent of patients had undergone prior sinus surgery.

**Comparison of CRS Patients to the US Population**

In comparison to the general US population, patients with CRS reported more problems in the area of pain/discomfort, anxiety/depression, and usual activities (P < .01), as shown in Figure 1 and Table 1. This finding is in contrast with the domains of mobility and self-care, where CRS patients appeared to have fewer problems. Mean age and sex were comparable between the 2 groups (44 years and 51% female for US population vs 49 years and 55% female in the current study). The general US population reports higher mean EQ-5D VAS scores than patients with CRS (Table 2).

**Long-Term Effect of Sinus Surgery on Quality of Life**

EuroQol 5-Dimension Health Assessment scores demonstrated significant improvement across 3 of the 5 domains following sinus surgery (Figure 2). The percentage of patients reporting problems with pain/discomfort decreased from 73.1% to 44.1% at 3 months. By 12 months, 10% of patients had recurrence of pain/discomfort; however, the trend from baseline to 3 and 12 months remained significant using the Cochrane–Armitage test for trend (P = .02).

Problems with anxiety/depression were reported in 50.5% of patients preoperatively, and this proportion improved to 31.7% by 3 months after surgery. This effect was durable out to 12 months with 30.6% of patients reporting problems (P < .01). The percentage of patients having problems with the performance of usual activities dropped from 30.6% before surgery to 21.5% at 12 months (P = .02).

Patients reported few problems with mobility or self-care (9.7% and 0.5%, respectively). Although there was a slight increase in the percentage of patients reporting problems in these domains at 12 months, these changes were not found to be statistically significant (P = .08, P = .41, respectively). As seen in Figure 3, mean (SD) EQ-5D VAS scores demonstrated improvement following sinus surgery, 73.9 (16.2) to 80.4 (16.8), P < .01. Although this change was statistically significant, it did not reach the MCID.

Postoperative CRS patients have continued problems with pain/discomfort and usual activities when compared to the general population. Anxiety/depression scores, however,
were no longer significantly different from the general US cohort 12 months after ESS (Table 1). After 12 months, sinus surgery does appear to partially close the gap in VAS, but patients with CRS still report inferior scores ($P = .03$).

Mean (SD) SNOT-22 scores improved from 48.1 (21.3) preoperatively to 22.5 (19.6) at 3 months ($P < .001$). At 12 months, scores remained improved at 25.6 (20.1). This 22.5 point difference from baseline is both statistically ($P < .01$) and clinically significant (Figure 4). Mean CSS scores similarly improved from a preoperative 47.1 (20.1) to 71.92 (19.9) at 3 months. At 12 months, scores remained essentially unchanged at 70.7 (21.5). This 50% improvement was statistically and clinically significant at both 3 and 12 months ($P < .01$), as shown in Figure 5.

### Table 1. EuroQol 5-Dimension Health Assessment (EQ-5D) Domain Scores in Chronic Rhinosinusitis (CRS) Patients and the General US Population.\(^a\)

<table>
<thead>
<tr>
<th>EQ-SD Domain</th>
<th>CRS (n = 186), %</th>
<th>General US Population (n = 3773), %(^{20})</th>
<th>$\chi^2$ Statistic</th>
<th>$\chi^2$ P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>9.7</td>
<td>18.2</td>
<td>9.214</td>
<td>.002</td>
</tr>
<tr>
<td>1 year postop</td>
<td>15.1</td>
<td></td>
<td>1.296</td>
<td>.255</td>
</tr>
<tr>
<td>Self-care</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>0.5</td>
<td>3.7</td>
<td>5.344</td>
<td>.021</td>
</tr>
<tr>
<td>1 year postop</td>
<td>2.2</td>
<td></td>
<td>1.336</td>
<td>.248</td>
</tr>
<tr>
<td>Usual activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>30.6</td>
<td>15.0</td>
<td>35.358</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>1 year postop</td>
<td>21.5</td>
<td></td>
<td>6.054</td>
<td>.014</td>
</tr>
<tr>
<td>Pain/discomfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>73.1</td>
<td>40.8</td>
<td>80.096</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>1 year postop</td>
<td>54.3</td>
<td></td>
<td>13.906</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Anxiety/depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>50.5</td>
<td>26.4</td>
<td>56.108</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>1 year postop</td>
<td>30.6</td>
<td></td>
<td>1.773</td>
<td>.183</td>
</tr>
</tbody>
</table>

\(^a\)Values shown reflect the proportion of patients reporting problems in each domain.

### Table 2. Pre- and Postoperative EuroQol 5-Dimension Health Assessment (EQ-5D) Visual Analog Scale Scores for Chronic Rhinosinusitis (CRS) Patients and Members of the General US Population.\(^a\)

<table>
<thead>
<tr>
<th>EQ-SD Visual Analog Scale Score</th>
<th>CRS (n = 186), mean (SD)</th>
<th>General US Population (n = 3773), mean (SD)(^{20})</th>
<th>95% Confidence Interval</th>
<th>$t$ Test</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>73.9 (16.2)</td>
<td>84.3 (23.8)</td>
<td>$-13.87, -6.93$</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>1 year postop</td>
<td>80.4 (16.8)</td>
<td></td>
<td>$-7.37, -0.43$</td>
<td>.027</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Higher scores imply better health.

### Analysis of Patients with Missing Follow-up Data

Demographic, comorbidity, and all baseline health assessments were not statistically different between patients who made up the study cohort and those who were lost to follow-up with 3 exceptions. Patients lost to follow-up were found to have higher rates of smoking (16% vs 4%, $P < .01$), diabetes (8.6% vs 4.3%, $P < .04$), and gastroesophageal reflux (25.6% vs 14.0%, $P < .01$), when compared to patients completing all surveys.

### Discussion

General health outcomes measures are an increasingly important part of patient-centered research for individuals undergoing surgical treatments. Information on expected changes in general health-related quality of life (HRQoL) is of interest to patients, care providers, and payers. With the recent passage of the Affordable Care Act, new mandates are expanding research and documentation of patient-centered outcomes.\(^{28,29}\) Coupled with the dramatic level of health care spending in the United States, these changes are already increasing interest in cost-effectiveness and cost-utility analysis for certain diagnoses and their treatments. When performed correctly, these studies rely on high-quality, representative HRQoL outcomes data. To gather these results, the 2 most frequently employed instruments are the EQ-5D and the SF-36 and its derivatives.\(^{30,31}\) To date, the SF-36 or SF-12 has been the primary instrument used in CRS outcomes research. This study represents the first large-scale report of the EQ-5D in the United States to...
measure HRQoL in patients with CRS undergoing sinus surgery.

In this multipractice, prospective cohort study, patients with CRS experienced improvement in general HRQoL as measured by the EQ-5D. Affected EQ-5D domains were improved at both 3 and 12 months after surgery, with limited deterioration between time points. Similarly improved were the disease-specific quality-of-life measures, the SNOT-22 and the CSS. Patient VAS scores did improve following surgery and nearly reached the minimal clinically important difference.

One strength of general health outcomes data is the ability to compare findings to both general population data and to other chronic diseases. These data are important for understanding the relative burden of illness and may have a future role in prioritizing health care spending. Based on prior work in the United States and abroad, a rich amount of literature using the EQ-5D is currently available. In this study, patients with CRS experienced impaired quality of life when compared to the general US population. Although EQ-5D scores improved after surgery, patients with CRS still experienced more pain, discomfort, and the inability to perform usual activities. Documenting the health burden of CRS is an important first step to including CRS outcomes in large-scale studies on the burden of chronic disease. Furthermore, when EQ-5D data are paired with a disease-specific instrument such as the CSS or SNOT-22, providers can expect to obtain a comprehensive view of their patient’s health that may be of interest to payers for medical care.

The population of CRS patients in this study appears demographically similar to that of other large outcomes

**Figure 2.** EuroQol 5-Dimension Health Assessment (EQ-5D) domain scores before and following sinus surgery. *P < .01.

**Figure 3.** Mean EuroQol 5-Dimension Health Assessment (EQ-5D) Visual Analog Scale (VAS) scores improve at 3 and 12 months following sinus surgery. Higher scores imply better health. *P < .01.

**Figure 4.** Sinonasal Outcomes Test-22 (SNOT-22) scores demonstrate significant decreased symptom burden after sinus surgery. Lower scores imply better health. *P < .001.

**Figure 5.** Chronic Sinusitis Survey (CSS) scores reveal decreased symptom burden and medication usage following sinus surgery. Higher scores imply better health. *P < .001.
studies. Scores reported using the CSS and SNOT-22 both pre- and postoperatively were similar to cohorts in both the United States and Britain. An earlier study from this institution measured HRQoL using the SF-36 and found significant improvements in the subscales of bodily pain, social functioning, mental health, and physical functioning. These subscales are similar to the EQ-5D domains found to be impaired in this study’s CRS patients. Given the similarity in patient demographics and disease-specific results between the current study and prior reports, EQ-5D outcomes reported here should have broad external validity across the CRS patient population.

The EQ-5D has been used successfully in other surgical fields to measure HRQoL before and after surgery. Outcomes for orthopedic procedures have been reported, with relevant quality-of-life gains quantified. These data have been used for preoperative patient counseling and in European resource allocation decisions.

One small German study in patients with CRS used both the SF-36 and the EQ-5D VAS before and after sinus surgery to assess for the effect that gender imparts on general HRQoL. The authors used the EQ-5D VAS for comparisons but did not report or compare domain scores. It is important that the EQ-5D was found to confirm data recorded with the SF-36.

Because the comparison of general HRQoL data across instruments has been shown to be unreliable and is not recommended, the data presented here represent an important first step toward establishing a literature base of EQ-5D values that can assist in the design of future studies for comparative effectiveness and cost-utility research. These data also corroborate existing evidence that patients who undergo sinus surgery for CRS have a significant improvement in general HRQoL by documenting findings with a second validated general health outcomes instrument.

One primary concern with questionnaire-based follow-up studies is the potential for bias resulting from a lack of comparability of patients who are lost to follow-up with those included in the analysis. In this study, 30% of patients did not complete follow-up questionnaires after surgery. Aside from smoking status, diabetes, and gastroesophageal reflux, patient characteristics were not different between responders and nonresponders. Although response bias is possible, baseline survey results were not significantly different from those patients who completed 3- and 12-month questionnaires. Furthermore, pre- and postoperative SNOT-22 and CSS scores from the cohort of 186 mirror other large trials, suggesting that the captured patient data are reflective of the CRS population as a whole.

A weakness in the design of this study was the collection of general HRQoL data using only the EQ-5D. If patients had completed both the EQ-5D and the SF-36, a direct comparison of patient information could have been possible; however, the increased burden would have likely led to challenges with enrollment and follow-up. Furthermore, several publications already report SF-36 measured health burden in CRS, including changes following sinus surgery. Baumann and Blumenstock’s study from Germany suggests that responses to both surveys may be similar and reliable.

Conclusion
Patients scheduled to undergo sinus surgery for CRS have impaired quality of life when compared to the general US population. These patients do experience improvement in their long-term general HRQoL following surgery as measured by the EQ-5D. This survey was easy to administer and had a limited respondent burden. The use of the EQ-5D in patient cohorts with CRS represents an important step toward comprehensive quantification of the health benefits of sinus surgery.

Author Contributions
Aaron K. Remenschneider, study design, data collection and analysis, manuscript preparation; Laura D’Amico, data acquisition and interpretation, review of manuscript; Jamie R. Litvack, study design, data acquisition and analysis, manuscript review; Stacey T. Gray, study design, data acquisition, manuscript review; Eric H. Holbrook, study design, data acquisition, manuscript review; Richard Gliklich, study conception, data analysis and review, manuscript revision; Ralph Metson, study design, data acquisition and analysis, manuscript drafting and review.

Disclosures
Competing interests: None.
Funding source: The Board Committee on Quality of the Massachusetts Eye and Ear Infirmary provided financial and clerical support for data collection.

References


