Published in final edited form as:

Int Forum Allergy Rhinol. 2015 June ; 5(6): 498–505. doi:10.1002/alr.21482.

The impact of endoscopic sinus surgery on total direct health care costs among patients with chronic rhinosinusitis

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Abstract

Background—This study investigates how endoscopic sinus surgery (ESS) impacts total direct health care costs, medication usage and frequency of imaging among patients with chronic rhinosinusitis (CRS).

Methods—Data were obtained from Marketscan Commercial Claims and Encounters databases; patients who underwent ESS for CRS in 2008 were identified. Health care costs, days of antibiotic & oral steroid usage and number of computed tomography & magnetic resonance imaging studies were collected for 12 months prior to and 36 months after surgery and compared in one-year intervals.

Results—8963 surgical patients were included. Median total direct costs fell from \$4750 at preoperative baseline, 95% CI [\$4661 - 4838], to \$4212 by Year 3 after surgery, 95% CI [\$4078 - 4346]. Disease-specific costs related to conditions commonly associated with CRS – asthma, allergy, depression and headache – all decreased in years after surgery; the reduction was significant for all conditions but asthma. Mean days of antibiotic usage per year decreased from 28.2 days before surgery to 15.9 days by Year 3 after surgery, p-value <0.001. Days of oral corticosteroid usage remained stable at just over 7 days. Mean number of imaging studies fell from an average of 1.6 in the year before surgery to 0.2 by Year 3 after surgery, p-value <0.001.

Conclusion—Among patients who underwent ESS for CRS, total direct health care costs, antibiotic usage and number of imaging studies improved after surgery, remaining below preoperative levels throughout all three years of follow-up. Oral corticosteroid usage remained stable.

Keywords

sinusitis; endoscopic surgical procedure; antibiotics; computed tomography; health services

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Financial disclosures: None to report

Conflicts of Interest: None to report

Introduction

Chronic rhinosinusitis (CRS) is a common disease with a large impact on the U.S. health care system. It is one of the top 20 diagnoses treated in ambulatory care, generating an estimated 11 million office visits per year¹. Management of CRS is estimated to cost the U.S. about \$8.6 billion per year²; compared to national averages, patients with CRS will have twice as many ambulatory office visits and fill five times as many prescriptions per year³.

It is estimated that over 250,000 patients undergo sinus surgery each year⁴. There have been long-term prospective studies supporting a quality of life benefit to surgery^{5,6}, along with a reduction in antibiotic usage⁷. However, the impact of surgery on total health care utilization is less clear. Previous investigations with cross-sectional and prospective cohort designs have suggested that sinus surgery may reduce health care utilization^{8,9}.

Commercial claims databases provide a population-based method for evaluating health care costs among large numbers of patients. Previous investigations have evaluated commercial claims data for CRS-related expenditures before and after ESS, finding a decrease in CRS-related costs following ESS^{10,11}. Because these studies evaluated costs linked to diagnostic codes for CRS-related diagnoses, the question could be raised as to whether an evaluation of total, rather than just CRS-related, health care costs might find different results.

The objective of this investigation was to use employer-based claims data to determine how total direct health care expenditures changed among patients with CRS following surgery, and to investigate whether costs associated with comorbid conditions commonly associated with CRS would also improve following ESS. In addition, the investigation considers the impact of surgery on three other areas of concern for patients with CRS: total days of antibiotic usage per year, total days of oral corticosteroid usage per year and number of computed tomography (CT) & magnetic resonance imaging (MRI) scans per year.

Methods

This study used health care claims data contained within Truven Health Analytics MarketScan® Commercial Databases¹². The MarketScan data are adjudicated claims data, which directly include the value paid by the payer(s). The MarketScan databases include comprehensive claim-level data on inpatient, outpatient, and prescription drug claims for over 100 million employed individuals and their dependents in the US. Claims data are also matched to administrative records, which provide demographic information and monthly insurance coverage status, allowing for longitudinal tracking of individuals. Because MarketScan databases are a deidentified dataset, the University of Washington Human Subjects Division determined that this study was exempt from requiring Institutional Review Board approval.

The surgical cohort was defined by identifying all patients ages 18 to 65 within MarketScan with at least one Current Procedural Terminology (CPT) code in 2008 for ESS, see Table 1, in association with International Classification of Diseases-9 (ICD-9) code for chronic rhinosinusitis, 473.x. Patients who had a previous claim for ESS, who did not have

continuous enrollment in MarketScan throughout the time period of interest, or who had a diagnosis of cystic fibrosis (ICD-9 277.x) or malignant nasal neoplasm (ICD-9 160.x) were excluded. Demographic information, including age and gender, were collected for all cohort members and descriptive univariate analysis was performed to define cohort characteristics.

Total Health Care Costs

Total costs were tabulated from a payer perspective and included all costs related to inpatient services, outpatient services, emergency department visits, and prescription medications. Disease-specific costs were tabulated from all claims associated with the ICD-9 code of interest, see Table 2.

Each patient was tracked over a period of 12 months prior to surgery and 36 months following surgery in order to collect claims data regarding total inpatient, outpatient and prescription costs that were incurred. Costs that occurred within 7 days prior to or 30 days following the date of surgery were rolled into the cost of surgery itself. Median total direct costs were calculated annually, adjusted for inflation and expressed in 2011 dollar amounts. Disease-specific costs of common comorbid conditions were quantified in similar fashion. Bootstrapping was used to determine 95% confidence intervals (CI) and to compare median total and disease-specific health care costs in the year before surgery, and each year following surgery. In addition, to better clarify utilization patterns in close proximity to the time of surgery, total direct costs that were incurred within 12 months before or after surgery were also evaluated in 3-month intervals.

Antibiotics and imaging

Antibiotic and oral corticosteroid data were obtained using national drug codes based upon therapeutic class as defined by pharmaceutical claims dictionary. Because prescriptions for CRS can range in duration from weeks to months, the decision was made to evaluate the total number of days of antibiotics and oral corticosteroids prescribed per year, rather than total number of prescriptions filled. Claims data for CT and MRI imaging were compiled using CPT codes for imaging procedures as listed in Table 1.

Similarly to cost data, medication usage and imaging data were collected for a period of 12 months prior to and 36 months after surgery and grouped into one-year intervals for analysis. Mean numbers of days of medication usage and imaging studies were calculated for the year prior to surgery and each year after surgery. Comparisons between years were made using one-way analysis of variance with statistical significance set at $P < 0.05$. All analysis was performed using STATA version 13.1 (STATA, Inc, College Station, Texas).

Results

Case selection and cohort characteristics

The initial query identified 45,471 individuals within MarketScan databases who underwent endoscopic sinus surgery in 2008. Of these, 8963 individuals had continuous enrollment over the time period of interest and met all criteria for inclusion in the surgical cohort, see Figure 1. The majority of individuals were excluded due to lack of continuous enrollment.

The cohort was 52.9% female. Mean age was 44.8 (SD=10.6). In general, the patients were relatively healthy, with 8562 (95.5%) having a Charlson Comorbidity Index score of 0 or 1. We compared demographic characteristics and comorbid conditions among patients with continuous enrollment over the time of the study to a group of patients who only had 12 months of continuous enrollment prior to surgery.

The patients with only 12 months of preoperative enrollment had similar demographic characteristics, but did have a higher burden of comorbid disease, see Table 3. Some ICD-9 codes appeared to be under-reported; for example, no patients had a diagnosis of mycoses (fungal sinusitis) among those with only 12 months of enrollment.

Total health care costs

Figure 2 presents median annual total direct health care costs for 12 months before and 36 months after surgery among patients who had continuous enrollment. After adjustment for inflation, median total health care costs, including outpatient, inpatient and prescriptions costs, among the cohort equaled \$4750 at preoperative baseline, 95% CI [\$4661 - 4838]. Direct surgical costs, which were calculated as all costs that occurred 7 days prior to and 30 days after surgery, totaled median \$7728 for the cohort, 95% CI [7629 – 7826].

Median total direct health care costs decreased modestly to \$4572 by Year 1 after surgery, 95% CI [\$4426 – 4717] and continued to trend downward to \$4385, 95% CI [\$4247 – 4523] by Year 2 and \$4212 by Year 3, 95% CI [\$4078 - 4346].

Median CRS-related costs associated with diagnostic code 473.x and otolaryngology provider were also calculated. In the 12 months before surgery, inflation-adjusted median costs equaled \$558, 95% CI [\$546 – 570], decreasing to \$372 by Year 1 after surgery, 95% CI [\$355 – 389]. By Year 2 and Year 3 after surgery, CRS-related costs incurred with otolaryngology provider equaled zero for more than half the cohort.

Figure 3 depicts median total direct health care costs in 3-month intervals in the year before and after surgery. In the interval 10-12 months prior to surgery, median total direct costs equaled \$627, 95% CI [\$606 – 647]. A substantial increase in total direct costs is noted in the 3 months prior to surgery, rising to a peak of \$1402, 95% CI [\$1376 – 1428]. Excluding the cost of surgery, total direct costs then quickly fell off and reached \$808 by 10-12 months after surgery, 95% CI [\$777 – 841].

There were 2758 patients (30.1%) with diagnosis of nasal polyposis at any point during the four years of enrollment, and 1101 patients (12.3%) with diagnosis during the preoperative year. CRS-associated costs were not significantly different among patients with and without nasal polyps. During the preoperative year, annual CRS associated costs were \$541 among patients with nasal polyps, 95% CI [\$508 – 574]. Similarly to patients without nasal polyps, less than 50% of patients with polyps filed a CRS-associated claim in Year 2 & Year 3 after surgery, resulting in median cost of \$0.

We also investigated expenditures for treatment of comorbid conditions commonly associated with CRS. Disease-specific claims for allergic rhinitis, headache/migraine, depression and asthma all showed a downward trend after ESS, see Table 4. Asthma showed

the most modest decrease from median \$195 per year preoperatively, 95% CI [\$143-272], to \$132 per year by Year 2 after surgery, 95% CI [\$82-245]. Allergic rhinitis costs decreased from \$275 per year preoperatively, 95% CI [\$258 – 292] to \$18 per year, 95% CI [\$0 - \$55]. Among patients who had a diagnosis of headache/migraine or depression during the preoperative year, less than 50% filed a claim for these conditions in postoperative Year 2.

Antibiotic & oral corticosteroid usage

Figure 4 depicts the pattern of antibiotic usage. Among the cohort, the mean number of days of antibiotics taken in the 12 months prior to surgery equaled 28.2 days (SD=33.7). Days of usage dropped to 22.2 days (SD=31.6) by Year 1 after surgery, which was significantly lower than mean usage in the 12 months prior to surgery, p-value <0.001. Antibiotic usage then stabilized at about 16 days per year in Year 2 and Year 3 after surgery.

Among patients without asthma, mean days of total oral corticosteroid usage in the preoperative year equaled 7.6 days per year (SD=22.3), which increased slightly but significantly to 9.8 days per year in Year 1, p-value <0.001. The 9.8 days includes any oral corticosteroids prescribed on the date of or immediately after ESS. Use of oral corticosteroids then fell back to preoperative levels of just over one week per year by Year 2 and Year 3 after surgery, see Figure 5. There was not a significant difference in days of corticosteroid usage when comparing preoperative year to postoperative Year 3, p-value 0.49.

The average number of CT and MRI scans obtained in the 12 months prior to surgery equaled 1.6 studies (SD=1.2). As shown in Figure 6, frequency of imaging fell to an average of 0.5 studies (SD=1) per year by Year 1 after surgery, which is significantly lower than preoperative levels, p-value <0.001. The average number of CT scans obtained by cohort members fell even further to 0.2 scans per year by Year 2 and Year 3 after surgery.

Discussion

Previously, investigators have used MarketScan databases to characterize the pattern of CRS-related health care costs among patients before and after ESS. In 2011, Bhattacharyya et al. first noted a substantial spike in CRS-associated health care utilization in the months just prior to ESS. Recently, Benninger and Holy again noted a linear increase in CRS-related utilization in the 6 months leading up to surgery, and further characterized this relationship among a subset of patients with respiratory comorbidities¹³. These well-designed studies evaluated CRS-associated costs and utilization, raising the question as to whether total direct health care costs would display a similar trend, and whether disease-specific costs associated with comorbid conditions commonly associated with CRS would also decrease following ESS.

Detected patterns in total health care utilization may behave differently than those of CRS-related spending for several reasons. For example, claims may not be diagnosed or coded correctly. A recent study found a large disparity between patients whose claims records contained ICD-9 code 473.x and those confirmed to have a true diagnosis of CRS¹⁴. It can be difficult to determine an appropriate algorithm for defining a cohort based on diagnostic

code, and the selection of which diagnostic codes to include will certainly affect results. For example, Benninger and Holy noted that patients underwent an average of 0.83 CRS-associated CT scans in the 6 months prior to surgery; however, the current study found an average of 1.4 sinus imaging studies in the 6 months prior to surgery. This difference may be explained by the diagnostic code attached to the imaging order. Benninger's study required an ICD-9 code for CRS-related diagnosis, whereas this current study included all maxillofacial CT or MRI scans regardless of the diagnostic code associated with them. It could be argued that a decrease in total direct costs is the finding of greatest interest when determining the impact of endoscopic surgery on costs and utilization. If CRS-associated costs decreased, but overall expenditures did not respond similarly, then it would be more difficult to interpret the benefits of ESS.

Another important consideration is the fact that CRS has been associated with other chronic conditions, such as depression, asthma, allergy, migraine, sleep disturbance and olfactory dysfunction^{15,16,17}. Previous studies have noted improvement in these conditions following ESS^{18,19,20}. Patients who undergo ESS may experience improvement in other areas of health that would not be captured by only evaluating CRS-associated costs. The current study found a significant decrease in expenditures related to allergic rhinitis, headache/migraine and depression following ESS. There was also a decrease in asthma-related expenditures, although this did not reach significance. We did not notice a significant difference in the level of CRS-associated costs among patients with or without nasal polyps. Because this is a claims-based study, we are limited by diagnostic codes in categorizing patients. For example, we attempted to identify those patients with ICD-9 code for mycoses to identify fungal sinusitis cases, but found such a low frequency, that it did not seem to be reliable enough to incorporate into our analysis.

The current study has the benefit of an additional year of postoperative follow-up compared to the previous Marketscan studies. When considered in annual intervals over the 3 years after surgery, total health care costs display a modest, but consistent, downward trend that persists throughout the time of the study. This trend seems to indicate that ESS was of benefit in controlling symptoms.

As further evidence of improvement after surgery, the current study found significant decrease in antibiotic usage and imaging studies by Year 1 after surgery. In the years after surgery, patients appeared to establish a chronic baseline of 16 days of antibiotics per year for all causes, while few required additional CT or MRI imaging. On average, patients continued to require just over a week of oral steroid medication per year. Such information can be useful when counseling patients on long-term expectations after surgery.

A limitation of this study is that it can only evaluate subjects with continuous insurance claim records. Subjects who benefitted from ESS, but who did not have continuous enrollment may be less likely to seek additional medical care after the immediate post-operative time period. As a claims-based study, the current study is unable to describe a pattern of utilization for patients with less stability in their health-care coverage. We noted a difference in the frequency of comorbid conditions between patients included in the study and those who only had 12 months of insurance coverage preoperatively. It is possible that

cost and utilization patterns may differ among patients with and without insurance coverage, and, though it is beyond the scope of this study, such a comparison may be a worthwhile consideration for future investigation. Patients who have continuous enrollment through Marketscan are not required to have longitudinal follow-up at providers; they are only required to have continuous insurance coverage. If the patients did not visit a provider, they will still be present in the database with no claims reported for total costs. Therefore, patients included in this study did not necessarily visit their provider more frequently than patients who were excluded.

This study has several other limitations. Though it is a resource for claims data, Marketscan databases do not include clinical records. Total direct costs and health care utilization are therefore being considered as proxies for severity of disease. Patients who undergo ESS are likely to have more severe disease than patients who are successfully managed medically; therefore, the patterns of utilization observed in the surgical cohort may be higher than those of patients who did not elect surgery. In addition, available claims data are limited to a finite time window, so it is possible that some patients may have undergone sinus surgery at a more distant point in the past. More than 1100 patients had a diagnosis of nasal polypsis preoperatively, so these patients are at greater risk of requiring multiple surgeries. However, even if the cohort includes patients who underwent a revision procedure, it still seems reasonable to compare trends in preoperative and postoperative utilization

The investigation also does not include data on indirect costs of illness, such as decreased productivity or absenteeism, which are important considerations when determining total direct costs associated with CRS²⁰. Investigations into indirect costs should provide an area for future research. Finally, this study is limited by the lack of a control cohort of patients with CRS who did not undergo surgery. With any chronic condition, there may be a “regression toward the mean” over time, so that patients’ symptoms, and health care utilization, may improve as symptoms wane, with or without treatment. The trend of decreasing total health care costs does persist over three years of follow-up, which seems to suggest that the trend is not due to transient fluctuations in utilization patterns.

Conclusion

This study used an employer-based claims database to demonstrate that total direct health care costs, antibiotic usage, and frequency of CT/MRI imaging decreased significantly in the years following ESS among patient with CRS. Oral corticosteroid usage remained stable. In addition, disease-specific costs for comorbid conditions commonly associated with CRS – asthma, allergic rhinitis, headache, and depression – also decreased in the years after ESS. This investigation provides further evidence that ESS is of value to patients with CRS who meet indications for surgery.

Acknowledgements

This study was supported by Grant# 2T32DC000018, Institutional National Research Service Award for Research Training in Otolaryngology from the National Institute on Deafness and Other Communication Disorders.

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Figure 1.
Flow diagram depicting selection of surgical cohort

Figure 2.

Bar chart of median annual health care costs. CRS-related costs are costs associated with both an ICD-9 code for CRS (473.x) and encounter with otolaryngology provider. Cost of surgery includes all costs incurred 7 days prior to and 30 days after date of surgery. Costs have been adjusted for inflation and are expressed in 2011 dollar amounts.

Figure 3. Bar chart of median total health care costs divided into 3-month intervals within the 12 months before and after surgery. Cost of surgery is not depicted.

Figure 4.
Mean number of days of antibiotic usage per year before and after sinus surgery.

Figure 5.

Mean number of days of oral corticosteroid usage per year before and after sinus surgery. Postoperative Year 1 includes oral corticosteroids prescribed on the date of or immediately after ESS. Patients who also had a diagnosis of asthma have been excluded.

Figure 6.
Mean number of CT and MRI studies performed per year before and after sinus surgery.

Table 1

CPT codes for surgical and CT/MRI claims

CPT codes	Procedure
ESS procedures	
31254	Anterior ethmoidectomy
31255	Anterior/posterior ethmoidectomy
31256	Maxillary antrostomy
31267	Maxillary antrostomy/tissue removal
31276	Frontal sinus exploration
31287	Sphenoidotomy
31288	Sphenoidotomy/tissue removal
Imaging	
70450	CT head without contrast
70460	CT head with contrast
70486	CT maxillofacial without contrast
70487	CT maxillofacial with contrast
70488	CT maxillofacial with/without contrast
70540	MRI orbit, face & neck without contrast
70542	MRI orbit, face & neck with contrast
70543	MRI orbit, face & neck with/without contrast

Table 2

ICD-9 codes used to define cohort and identify disease-specific claims

Diagnosis	ICD-9 code
Chronic rhinosinusitis	473.x
Fungal sinusitis (mycoses)	117.9
Nasal polyposis	471.x
Asthma	493.x
Headache	784.0 339.x, 307.81, 346.x, 350.2
Depression	296.2x, 296.3x, 296.82, 311.x, 300.4
Allergic rhinitis	477.x, 784.91
Cystic fibrosis	277.x
Malignant sinonasal neoplasm	160.x

Table 3

Characteristics of subjects by length of insurance enrollment

	Patients with 4 years of continuous enrollment	Patients with 12 months of enrollment prior to surgery	p-value
Number	8963	13156	
Female (%)	52.9	53.9	.1573
Mean Age (Range)	44.8 (18-62)	44.5 (18-64)	.0184
CCI (SD)	.316 (0.59)	0.281 (0.61)	<.0001
Forms of CRS			
Nasal polyps (%)	12.3%	15.0%	<.0001
Fungal (%)	2.2%	0%	<.0001
Neither polyps nor fungal (%)	85.9%	85.0%	.0600
Comorbid conditions			
Depression (%)	4.8%	5.6%	<.0001
Allergy (%)	28.7%	39.4%	<.0001
Headache/Migraine (%)	14.7%	21.4%	<.0001
Asthma (%)	9.2%	14.8%	<.0001
Both Asthma & Polyps (%)	2.02	3.3%	<.0001
Diabetes (%)	12.3%	15.0%	<.0001

CCI = Charlson Comorbidity Index

Table 4

Health care costs for comorbid conditions associated with chronic rhinosinusitis

Diagnosis	Year prior to surgery		Year 1 after surgery		Year 2 after surgery	
	Total number with claims	Median costs [95% CI]	Number with claims (% of total)	Median costs [95% CI]	Number with claims (% of total)	Median costs [95% CI]
Asthma	827	\$195 [\$143-272]	551 (67%)	\$150 [\$72-213]	532 (64%)	\$132 [\$82-245]
Allergy	2571	\$275 [\$258 - 292]	1599 (62%)	\$160 [\$132 - 188]	1293 (50%)	\$18 [\$0 - \$55]
Headache/Migraine	1318	\$301 [\$280 - 322]	584 (44%)	\$0	461 (35%)	\$0
Depression	428	\$187 [\$163 - \$210]	268 (63%)	\$140 [\$85 - 195]	212 (50%)	\$0 [\$0 - 65]