

REVIEW

The value of endoscopic sinus surgery in chronic rhinosinusitis

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Abstract

Objectives: Chronic rhinosinusitis (CRS) is a disease with significant impacts at both a societal and personal level. There has been an increase in emphasis on patient-centered care and patient outcomes, with value becoming a commonplace concept in health care systems. This review seeks to better define the value that endoscopic sinus surgery (ESS) provides in the treatment of CRS.

Data Sources: PubMed literature review.

Review Methods: A review of published literature related to ESS and its effects on CRS patients from multiple perspectives (quality outcomes, patient satisfaction, cost-effectiveness) was integrated and analyzed through the viewpoint of a value equation.

Results: ESS provides long-term quality outcomes in both patient-reported outcome measures (PROMs) as well as in objective metrics for patients refractory to medical therapy. The vast majority undergoing ESS are satisfied both in the short and long-term with their decision to pursue surgery. Treatment of CRS with ESS is generally more cost-effective than continued medical therapy (CMT), especially in refractory patients. Taken together, the combination of improved outcomes as well as patient satisfaction after ESS in relation to the costs of surgery provides significant quantifiable value to CRS patients.

Conclusion: ESS clearly provides value in the treatment of CRS. Understanding both quality and outcome metrics along with patient expectations and priorities will assist providers in generating a more personalized and value-based approach to patients with CRS.

Level of Evidence: 5.

KEYWORDS

cost, outcomes, patient satisfaction, quality

1 | INTRODUCTION

It is well known that the United States spends almost twice as much on health care compared to any other country, however with poorer

performance on overall health outcomes.¹ Subsequently there has been an increase in emphasis on patient-centered care and patient outcomes, with value as a key concept becoming commonplace in health care systems. This progressive shift from traditional

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volume-based health care, or fee-for-service, to value-based medicine with reimbursements and compensation increasingly tied to quality metrics is placing significant importance on critically evaluating and understanding factors that contribute to increased patient satisfaction and outcomes.

Chronic rhinosinusitis (CRS) is a condition with a substantial personal and societal burden comparable to other more common chronic medical conditions. Endoscopic sinus surgery (ESS) is a frequently utilized treatment in the management of CRS. The aim of this review is to assess the value that ESS provides when treating patients with CRS, or perhaps to put more colloquially, is sinus surgery “worth it?”

2 | DEFINING VALUE

To answer this question, it is important to first define the term “value” in medicine. This has proven to be a source of great disconnect, as the definition of value can vary widely between patients, providers, and employers. Physicians tend to equate value with providing quality care, whereas patients and employers provide a more mixed response with increased emphasis on both cost and customer service.²

A commonly cited definition for value in health care was initially proposed by Porter in 2010, defining value (V) as quality outcomes (Q) relative to costs (C), or simplified to an equation, $V = Q/C$.³ This approach is skewed more towards an economic perspective, and does not recognize the importance of shared clinical decision-making and patient empowerment which are progressively being recognized as fundamental features of value.⁴ Adding service (S), or patient satisfaction, to this equation provides the patient with an equal voice in determining value, and provides consideration to the relationship between these three primary concepts as advocated by University of Utah Health and others.⁵ This approach in turn allows for equal consideration to both physical outcomes as well as psychological outcomes. A final value equation of $V = (Q + S)/C$ will be used in this manuscript as a paradigm to ascertain the value that ESS provides in the management of CRS, with the understanding that this is but one method of many of conceptually defining value.

3 | COSTS VS CHARGES

The value equation's denominator—“cost”—requires further definition, specifically clarifying the difference between “cost” and “charges” when considering any economic perspective in medicine. Costs typically refer to the expense incurred to deliver health services, whereas charges refer to the amount requested as compensation for those services.⁶ Most health systems outside the US and in some U.S. integrated systems (eg, Veteran Affairs Health System), costs and charges are equal. More commonly in the U.S., charges exceed costs. Charges tend to represent the dollar amount of health care bills in the United States. Both definitions of expenditure can be useful in health economics, while there are limitations to be aware of. It is particularly important to ensure charges are compared to charges,

and costs compared to costs, due to the inflation of charges relative to costs. If charges and costs are compared for two different services, the charge-based service will appear inappropriately more expensive in comparison. This is also important when assessing the value of particular services. If charges are used when determining value, the overall value will generally be reduced compared to the value based on true costs. This may undervalue services, which can affect policy decisions and treatment implementation. While costs are generally considered to be a more accurate determination of expenditure, they can be difficult to calculate. In the case of supplies, these costs are sometimes not available due to contracts between vendors and hospitals requiring that pricing information not be disclosed. In the case of labor costs, it can be challenging to correctly attribute all the labor involved in a unit of service. Due to these difficulties, it is tempting to use the more easily obtained value of charges rather than costs. Sometimes costs are instead measured as what is paid for a service, rather than what is charged, better approximating the individual and societal impact of a service. So, while both costs and charges can be used when assessing the economics in health care, it is important to explicitly state which metric is used. This review will focus on costs rather than charges.

4 | CHRONIC RHINOSINUSITIS IS COSTLY

The European and U.S. prevalence of CRS is variously estimated at 10% to 12%.⁷ The Centers for Disease Control and Prevention (CDC) reports 28.9 million adults diagnosed with sinusitis in the U.S., and 4.1 million visits to physician offices with CRS as the primary diagnosis.⁸ The economic impact of CRS can be described at both the societal level as well as the individual level.

At the societal level, CRS costs can be further divided into direct costs and indirect costs. Direct costs are directly attributable to patient care, and for CRS primarily consist of three main areas; outpatient physician visits, prescription medicines, and surgery. A systematic review in 2015 estimated these costs to be between \$6.9 to 9.9 billion USD per year,⁹ with a review in 2017 updating the estimated number to be between \$10 and 13 billion USD per year.¹⁰ Analysis of incremental direct costs attribute approximately \$500 USD/patient/year for outpatient visits, approximately \$400 USD/patient/year for prescription medicines, and sinus surgery costs in the U.S. falling between \$8500 to \$11 000 USD per case.¹¹

Indirect costs on the other hand are defined as expenses incurred due to lost work productivity secondary to the morbidity of a given disease. The morbidity of CRS is subtle but substantial. At an individual level, the impacts of CRS on quality of life (QOL) extend beyond the direct symptoms of nasal congestion, facial pain and pressure, decreased sense of taste and smell, and nasal drainage. Studies evaluating the health utility values of patients suffering from CRS found worse quality-of-life scores when compared to patients suffering from moderate chronic obstructive pulmonary disease (COPD), angina, and asthma.¹² This is likely attributable to multiple central behavioral dysfunctions that have been found to have a strong correlation with

those suffering from CRS, including chronic pain, depression, loss of sleep, fatigue, and cognitive impairment.¹³

A prospective study by Rudmik et al found that the mean work days lost due to absenteeism (missed work days) and presenteeism (reduced work productivity) were 25 and 39 days per year respectively, roughly translating to about \$10 000 USD per patient based on mean U.S. annual wage rates.¹⁴ Another prospective study by Smith et al specifically evaluated facial pain and productivity, identifying a strong correlation of CRS-related pain with presenteeism, the main driver of productivity losses.¹⁵ Cumulatively these studies estimate the indirect societal costs to total around \$13 billion USD per year,⁹ with an updated number in 2017 increasing the estimate to \$20 billion USD.¹⁰

Clearly a potential trade-off can be seen between the direct and indirect costs of CRS. The expenditure of direct costs associated with treatment can improve a patient's QOL and reduce the burden of CRS, with the potential to reduce productivity losses associated with CRS.¹⁶ Extrapolated across the millions of individuals with CRS, one can clearly see that balancing these expenditures and benefits at a societal level is at the essence of examining value.

5 | COMPONENTS OF ESS VALUE

5.1 | Evaluating quality outcomes (Q)

ESS has been established as an effective treatment for CRS patients who are refractory to medical management. One validated and widely utilized instrument to determine CRS specific health-related QOL is the 22-Item Sinonasal Outcome Test (SNOT-22) as it provides the highest quality disease-specific patient reported outcome measures (PROMs) compared to other validated CRS instruments.¹⁷ Soler et al evaluated the mean change in SNOT-22 scores following ESS and found an average 24-point change at an average follow up of 10 months, a number which is markedly greater than the widely utilized minimal clinically important difference (MCID) in the SNOT-22 of 9.¹⁸ Of note, even for patients who do not reach the MCID change in their total SNOT-22 scores after ESS, those who have significant improvement in their nasal symptoms still report improvement of their global CRS symptoms.¹⁹ A systematic review comparing ESS to continued medical therapy (CMT) found ESS to significantly improve QOL scores as well as objective nasal endoscopy scores in patients refractory to medical therapy.²⁰

ESS has also been shown to be effective in improving QOL regardless of time at intervention, either from a disease longevity standpoint or from a patient age standpoint. While the best timing for ESS in CRS remains a topic of investigation, all studies show that patients derive substantial benefit from ESS, regardless of preoperative symptom duration.²¹⁻²⁶ Moreover, Crosby et al did not find any significant differences in SNOT-22 scores post-ESS when comparing patients younger than 50 and those 50 years and above.²⁷

Studies utilizing PROMs other than the SNOT-22 have found ESS to be associated with improvements in cognitive dysfunction,²⁸

fatigue,²⁹ and sleep,³⁰ thus indicating the broader QOL impacts ESS can have on patients suffering from CRS outside of nose-related clinical symptoms.

These improvements in QOL that are seen 6 months postoperatively are typically sustained over the long term, with 75% of patients reporting clinically significant QOL improvement over an average of 10 years. In addition, health utility values in these patients continued to improve over time, with the mean long-term utility level after ESS reverting close to US population norms.³¹

Another method of assessing the impact of ESS on outcomes is to focus on its effect on CRS-related productivity losses. Beswick et al found ESS to be substantially more effective at reducing productivity losses than continued medical therapy (CMT), with \$200 USD improvement for CMT vs \$5015 USD for ESS.³² Smith et al found pain-related presenteeism to be the largest driver of productivity loss with CRS, with a mean number of workdays lost at 63 days per year, or a \$20 321 USD per patient per year monetary loss.¹⁵

5.2 | Evaluating patient satisfaction (S)

Most outcomes research evaluating the role of ESS have focused on health-related quality-of-life or current health state. Patient satisfaction is a much less studied topic given the inherent subjective nature of the measurement. Satisfaction can be defined differently by different people, and survey results can vary widely depending on the population surveyed, timing, type of questionnaire, and rating methodology. It is a complex concept that relates to many factors including personal and societal standards, lifestyle, past experiences, and future expectations.³³

Information provided to patients during the perioperative period has a significant effect on outpatient surgery-related satisfaction. The importance of clinical information both pre- and post-operatively was identified in a study surveying 7899 outpatients, with informed consent and information about home care after discharge having the greatest influence on satisfaction.³⁴ Rhinologic surgeons can play a greater role in increasing satisfaction in this area, as most patients obtain information about ESS from peers as well as the internet prior to their preoperative visit.³⁵ Additional counseling alone may not be sufficient however, as education level, disease severity, procedure specificity, and postoperative care all have impacts on ESS-related satisfaction scores.³⁶

In addition, patients' areas of greatest concern may not align with those of the physician, thus highlighting the need for effective communication prior to proceeding with ESS.³⁷ Mattos et al identified the symptoms of nasal obstruction, smell/taste, nasal discharge, and sleep to be considered most important by patients undergoing ESS. Interestingly only the fulfillment of preoperative expectations and the resolution of the symptoms most important to patients were associated with satisfaction at least 3 months or longer postoperatively. Of patients that did not achieve a minimal clinically important difference (MCID) in their SNOT-22 scores, 86% still reported overall satisfaction in their outcomes, highlighting that ESS provides subjective value to

patients even when significant health-related QOL improvement is lacking.³⁸

Regarding long-term patient expectations surrounding ESS, Smith et al performed a follow up survey of 59 patients (from 154 total, 38% response rate) who had undergone ESS an average of 10 years prior. Greater than 85% of respondents reported satisfaction with their decision to pursue surgery and that ESS improved symptoms most important to them. A similarly high percentage of patients would pursue ESS again if needed and would recommend the procedure to someone else.³¹

5.3 | Evaluating costs (C)

The reported costs of ESS range widely from approximately \$3600,^{9,39} to over \$10 500 USD.⁹ Prior literature generally describes the cost of ESS as a single procedure, though ESS is really a combination of discrete component procedures.⁴⁰⁻⁴³ Accordingly, operative time, which is the main driver of costs (as opposed to charges), varies significantly in ESS. Due to this wide variation that exists, accurately determining operative time and thus cost in ESS is challenging. Thomas et al performed a systematic evaluation of true ESS costs—not charges—to identify sources of variance. Cost and time were extracted from 1739 ESS cases and three bilateral groupings were examined: (a) Full ESS (all sinuses); (b) Intermediate ESS (total ethmoid, maxillary); and (c) Anterior ESS (anterior ethmoid, maxillary). The median costs for Full, Intermediate, and Anterior ESS were \$4281, \$3716, and \$2549 ($P < .001$). Median durations were 87, 60, and 58 minutes respectively ($P < .001$). Full ESS duration, total cost, and supply costs were 1.37, 1.52, and 2.40 times greater than anterior ESS respectively ($P < .001$), demonstrating that cost and operative time increased with surgical extent.⁴⁴ When breaking down the data further into individual discrete procedures and combinations of procedures comprising bilateral ESS, among 1477 bilateral ESS cases with 19 different procedure combinations, sphenoidotomy had the lowest total and supply costs of \$2112 and \$636, respectively. Total cost was highest at \$4640 for full ESS with maxillary tissue removal, and supply cost was highest for full ESS with maxillary and sphenoid tissue removal at \$2191.⁴⁵ This evidence suggests the importance of understanding and delineating costs of individual ESS components as well as all ESS procedure combinations when evaluating the overall costs of ESS.

6 | PUTTING IT TOGETHER: THE VALUE OF ESS IN CRS

6.1 | Evaluating cost-effectiveness (Q/C)

From an economic perspective, value can be framed in the context of cost-effectiveness, where certain weights are assigned to outcomes, and the goal is to determine if the cost expense is worth the change in outcomes. A commonly utilized threshold, albeit somewhat

arbitrary, for assessing the cost-effectiveness of an intervention in the United States is \$50 000 USD per quality-adjusted life-year (QALY) gained.⁴⁶ The incremental cost-effectiveness ratio (ICER) is also a frequently utilized statistic, defined by the difference in cost between two interventions divided by the difference in effect. An ICER below a given threshold is deemed cost-effective whereas an ICER above the threshold is considered too expensive.

Rudmik et al in 2014 performed an economic evaluation utilizing a Markov decision-tree model comparing ESS followed by appropriate medical therapy to continued medical therapy (CMT) alone. The reference case managed a cohort of patients with refractory CRS for 30 years, with the cost-effectiveness acceptability curve demonstrating a 74% certainty that the ESS strategy is the most cost-effective decision for any willingness to pay (WTP) threshold greater than \$25 000 per QALY. The ICER for ESS vs medical therapy alone was \$5900.⁴⁰ Scangas et al performed a similar analysis with different assumptions for the model, while also incorporating the impact of revision surgery rates. They found an ICER of \$13 850/QALY with an 86% certainty for WTP threshold greater than \$25 000/QALY, and a 99% certainty for any WTP threshold greater than \$50 000/QALY.⁴³ The same group then evaluated CRS with nasal polyps (CRSwNP) vs without (CRSsNP), finding a 95% certainty that ESS was more cost-effective for any WTP threshold greater than \$20 000/QALY for both cohorts. Economic evaluation found an ICER of \$5687/QALY and \$5404/QALY for CRSwNP and CRSsNP respectively, with the improvement in the long-term cost-effectiveness of ESS attributed to the introduction of multiple years of utility data into the model.⁴² These numbers are similar to the initial ICER of \$5900 proposed by Rudmik et al. In summary, the data indicate that treatment of CRS with ESS is more cost-effective 74-99% of the time, depending on willingness-to-pay and specific outcome measure utilized.

6.2 | Evaluating value $([Q + S]/C)$

From the above discussion, one can see that introducing patient satisfaction into the value equation increases the challenge in measuring value, beyond solely economic considerations. Nonetheless, the patient's perspective in improved health could be argued to hold equal importance in the equation. Rarely does a patient present to a health care provider to improve their productivity or a score on a PROM. The patient presents because she wants to feel better. Recent work has examined which components of a patient's illness drive decision making toward CMT or ESS, with prior surgical procedures, severity of symptoms, polyp status, and effectiveness of medical treatments all contributing to this process.^{47,48} These two options look significantly different from a patient's perspective, underscoring the need for the counseling surgeon to be able to define their relative value.

ESS is associated with significantly higher up-front direct costs than continued medical therapy (CMT) for CRS.⁴⁰ However, at a certain point, some patients with CRS become refractory to CMT and tend to experience a progressive decline in their QOL.⁴⁹ In these patients, despite the significant direct costs of ESS, the significant

improvement in symptoms and QOL experienced by patients who elect ESS is more valuable than that provided by CMT alone.⁴⁰ It is also worth noting that patients with refractory CRS experience significant productivity losses associated with their disease, and that CMT does not significantly reduce these losses, whereas following ESS these productivity losses improve.^{14,16,50} The combination of the lack of response to CMT, improvement in symptoms and QOL following surgery and improvement in productivity losses following ESS contribute to the overall value of ESS in refractory CRS patients. However, not all CRS patients elect to pursue ESS. These patients typically have less QOL impairment than their refractory counterparts and achieve stability on CMT over time. In these patients, CMT is more cost-effective than ESS.¹⁰

Patient satisfaction is arguably both a more subtle and more subjective component in the value equation. Adding it to the numerator, while challenging, better encompasses the foundational purpose of medicine, relieving an individual's suffering however that person individually experiences and perceives that suffering. Clearly more work must be done in this area to expand upon our field's advances in PROMs.

6.3 | New horizons in the value of CRS treatments

Emerging literature is identifying that not all CRS patients are the same, and this condition is more nuanced and varied than previously thought. As the importance of precision medicine becomes more apparent as it pertains to CRS, it is vital to understand the value of various treatment options for CRS and how that relates to patient expectations and outcome metrics.⁵¹

Some of the more recent medical therapies that are being developed for the treatment of CRS have the potential to more accurately target its varied manifestations. Notably, these advances fall outside of these previous cost-effectiveness analyses. Perhaps the best example is biologic therapies, such as omalizumab, mepolizumab, and dupilumab, which are associated with significant costs that dramatically exceed the costs of traditional CMT and ESS (\$10 000-\$40 000 USD annually).⁵² The value of these therapies is currently under investigation and it will be critically important to assess their value in comparison to more traditional medical treatments and ESS. A recent paper has suggested that these biologics are not cost-effective in patients with CRS who have not undergone ESS.⁵³ While additional research is needed, the cost of these medications is restrictive for many patients and health care providers at this time, underscoring the need to establish their relative value in a CRS treatment paradigm.

7 | CONCLUSION

ESS clearly provides value in the treatment of CRS when viewed through the perspective of quality outcomes, patient satisfaction, and cost-effectiveness, especially in patients who are refractory to CMT. With recent advances in PROMs, cost analysis, and understanding the

elements of individual patient satisfiers, the value of ESS can be compared to alternative interventions, whether continuing traditional medical therapy or embarking upon biologic therapy. Understanding both quality and outcome metrics along with patient expectations and priorities will assist providers in generating a more personalized and value-based approach to patients with CRS.

CONFLICT OF INTEREST

The author declares no conflicts of interest.

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