The Laryngoscope

The Predictive Value of the Preoperative Sinonasal Outcome Test-22 Score in Patients Undergoing Endoscopic Sinus Surgery for Chronic Rhinosinusitis

Claire Hopkins, MA(Oxon), FRCS(ORLHNS), DM; Luke Rudmik, MD, MSc;
Valerie J. Lund, CBE, MS, FRCS, FRCSEd

Objectives/Hypothesis: With the aim of facilitating preference-sensitive decision making regarding elective endoscopic sinus surgery (ESS) for chronic rhinosinusitis (CRS), we set out to evaluate the predictive value of the 22-item Sinonasal Outcome Test (SNOT-22) patient-reported outcome measure and to compare outcomes of a UK cohort with a similar United States/Canadian–based study.

Study Design: Prospective observational cohort study,

Methods: Patients electing ESS in 87 UK hospitals were enrolled. The primary outcome was change in SNOT-22 score 3 months after surgery. Patients were categorized according to baseline SNOT-22 score, and the proportion of patients achieving a SNOT-22 minimal clinically important difference (MCID) of 8.9 was calculated, as well as the percentage change in SNOT-22 score.

Results: A total of 2,263 patients were included within this study. There was an average 40% reduction in SNOT-22 scores following surgery, and 66% of patients overall achieved the MCID. The proportion of patients achieving the MCID increased significantly with increasing baseline SNOT-22. Patients with a preoperative score of <20 failed to achieve a mean improvement greater than the MCID. Patients with a score of >30 had a greater than 70% chance of achieving the MCID. CRS patients with polyps had greater improvement than patients with CRS without polyps. The predictive value of the SNOT-22 is similar in the UK cohort, although overall patients did not benefit from surgery as much as their North American counterparts.

Conclusions: Medically recalcitrant patients with CRS considering surgery should make decisions guided by their preoperative quality-of-life impairment, as measured by the SNOT-22.

Key Words: Chronic rhinosinusitis, outcomes, endoscopic sinus surgery, Sinonasal Outcome Test-22.

Level of Evidence: 2b

***Laryngoscope*, 125:1779–1784, 2015**

INTRODUCTION

Chronic rhinosinusitis (CRS) affects as many as 11% of adults in the United Kingdom,[1] and results in impaired quality of life (QoL), comparable and sometimes greater than patients with angina or chronic respiratory disease.[2] Medical treatment is usually tried prior to considering surgical intervention, but as many as two in three patients fail to obtain a sustainable clinical benefit,[3] and in patients with refractory CRS, symptoms may deteriorate further with ongoing medical therapy.[4] This commonly creates a situation where patients are faced with a decision to either continue with repeated medical therapy options, such as oral antibiotics and corticosteroids, or elect endoscopic sinus surgery (ESS). Given that repeated courses of oral antibiotics is a major public health concern in terms of increasing antibiotic resistance and with an estimated 40,000 sinus surgery cases performed in the UK each year, it is important to identify the highest quality practices to reduce inefficient use of scarce healthcare resources.

Preference-sensitive care involves trade-offs between the patients potential benefit, risk, and cost when making treatment decision.[5] In the absence of adequate understanding of the potential outcomes from either continued medical therapy or ESS, patients with CRS often defer to the physician to make the treatment decision. Although physicians will try and act in the patient's best interest, therapeutic decisions often reflect physician preferences rather then the true preferences of the patient. This lack of informed, shared decision

From the Department of Otolaryngology (C.H.), Guy's and St. Thomas' National Health Service Trust, London, United Kingdom; Division of Otolaryngology–Head and Neck Surgery (L.R.), Richmond Road Diagnostic and Treatment Centre, University of Calgary, Calgary, Alberta, Canada; Department of Otolaryngology (V.J.L.), Royal National Throat Nose & Ear Hospital, London, United Kingdom.

Editor's Note: This Manuscript was accepted for publication March 16, 2015.

Claire Hopkins is a consultant for Acclarent Inc., Menlo Park, California.

The National Audit of Surgery for Chronic Rhinosinusitis and Nasal Polyposis was funded by individual contributions from participating hospitals

The authors have no other funding, financial relationships, or conflicts of interest to disclose.

Send correspondence to Claire Hopkins, MA(Oxon), FRCS(ORLHNS), DM, Reader in ENT, Kings' College London, Consultant ENT Surgeon, Department of ENT, Guy's and St Thomas' NHS Trust, London SE1 9RT, United Kingdom. E-mail: claire.hopkins@gstt.nhs.uk

DOI: 10.1002/lary.25318

TABLE I.
Most Distal Extent of Surgery Performed With Mean Lund-Mackay Score for Each Group.

Most Distal Extent of Surgery	No.	Mean Lund-Mackay Score (95% CI)
Simple polypectomy	120	11.7 (10.2–13.2)
Middle meatal antrostomy	222	7.4 (6.6–8.3)
Anterior ethmoidectomy	637	8.5 (8.1–8.9)
Posterior ethmoidectomy	468	12.6 (12.1–13.2)
Frontal (not sphenoid) and full ethmoidectomy	138	11.3 (10.3–12.3)
Sphenoid (not frontal) and full ethmoidectomy	117	14.6 (13.6–15.8)
Frontal, sphenoid and full ethmoidectomy	77	17.3 (16.0–18.6)

CI = confidence interval.

making will increase the risk of unwarranted practice patterns[6] and reduce health system performance.

A recent study[7] has suggested that the 22-item Sinonasal Outcome Test (SNOT-22) QoL instrument[8] is helpful to inform CRS patients contemplating the decision to proceed with ESS. Patients in this study who elected ESS were recruited into a multicenter, prospective observational cohort from the United States and Canada in much the same way as the UK Audit of Surgery for Chronic Rhinosinusitis and Nasal Polyps[9] recruited patients. However, the US healthcare system has many differences to the UK's National Health Service (NHS), and the recruiting surgeons were largely specialist rhinologists, working in specialist centers. In contrast, the UK prospective cohort study captured patients undergoing surgery under the care of 298 different consultant surgeons in 87 NHS hospitals. More than 50% of procedures were performed by surgeons undertaking <10 procedures during the 6 month recruitment period of the study. Therefore, the outcomes from the UK CRS audit are likely more representative of current healthcare system performance, because it captures data from a more representative cohort of otolaryngologists rather than just subspecialist rhinologists.

With the goal to improve preference-sensitive care during the management of CRS, the purpose of this analysis was to determine if the SNOT-22 has the same predictive value in our UK population. When stratifying patients based on their preoperative SNOT-22 score, the primary outcomes include the mean change in SNOT-22, percentage of relative improvement in SNOT-22, percentage of revision ESS, and percentage of patients receiving a minimal clinically important difference (MCID) improvement after ESS.

MATERIALS AND METHODS

Study Design

The National Comparative Audit of Surgery for Nasal Polyposis and Chronic Rhinosinusitis—a prospective, observational cohort study of 3,128 patients undergoing sinus surgery for CRS in 87 NHS Trusts in England and Wales—has been previously described.[10] It included data of patients who underwent any surgery for CRS. This included simple polypectomy through to extensive surgery with all sinuses addressed; the most distant extent of surgery performed is described in Table I. The main outcome measure was the SNOT-22, a validated patient-reported, CRS-specific outcome measure.[8] Patients completed the SNOT-22 surveys preoperatively on the day of surgery (baseline) and at 3, 12, and 60 months after surgery.

Setting

All 156 NHS Trusts in England and Wales were invited to participate in the audit. A total of 87 centers contributed patients to the study.

Patient Inclusion and Cohorts

Patient eligibility criteria and overall selection have been described previously, but included all consecutive adults undergoing elective surgery for CRS in recruiting centers over a 6-month period. Complete preoperative SNOT-22 scores were available for 2,803 patients. Postoperative SNOT-22 data were reported by 2,336 patients (83.4%) at 3 months and 2,284 patients at 12 months (81.7%). Only patients with complete data at both baseline and 3 months were included in this study (n = 2,263) (Fig. 1). The median time for completion of SNOT-22 questionnaires following surgery was 15.6 weeks and 53.0 weeks for the 3- and 12-month cohorts, respectively. Only patients with matched data have been included for analysis. Patients were also asked to report "How do you rate the results of your surgery" according to the choices of excellent, very good, good, fair, or poor.

Preoperative SNOT-22 scores were categorized into 11 groups, based on 10-point increments beginning with 0 and ending with 110. Percentage change in SNOT-22 scores were calculated for each patient using the formula ([preoperative score−postoperative score]/preoperative score × 100) before calculating population means. A larger percentage of change reflects greater benefit.

The MCID in the SNOT-22 has been shown to be 8.9. This was used to dichotomize the cohort into two groups: those with improvement in SNOT-22 >8.9 and those failing to achieve this. The percentage of patients achieving the MCID was calculated for each group. Patients were not excluded on the grounds of preoperative survey floor effects (i.e., patients undergoing ESS within the study with a preoperative score of <8.9 were

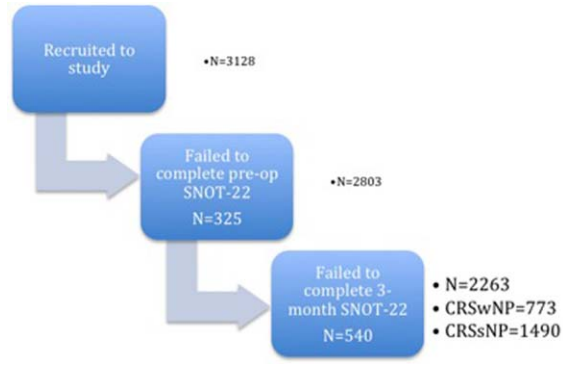

Fig. 1. Flow diagram of recruited patients. CRSsNP = chronic rhinosinusitis without nasal polyps; CRSwNP = chronic rhinosinusitis with nasal polyps; SNOT-22 = 22-item Sinonasal Outcome Test. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

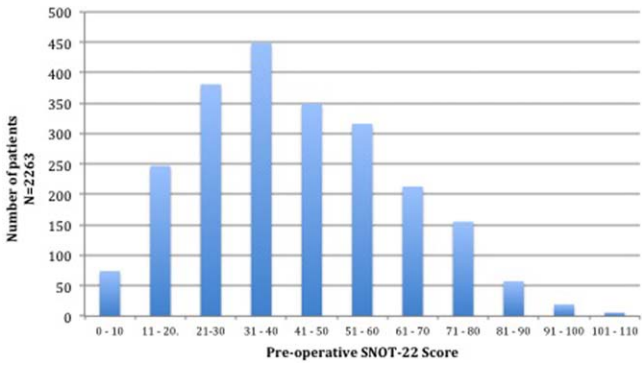

Fig. 2. Preoperative distribution of SNOT-22 scores. SNOT-22 = 22-item Sinonasal Outcome Test. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

included in this analysis even though they were unable to achieve the MCID).

Analysis

All statistical analyses were performed on Stata version 8 (StataCorp, College Station, TX). Paired t tests were used to analyze difference in pre- and postoperative scores within groups (significance $\alpha = .05$). One-way analysis of variance (unequally sized groups) was used to calculate P values for differences in absolute postoperative SNOT-22 scores, change in SNOT-22 scores, and percentage change in SNOT-22 score between baseline SNOT-22 groups. χ^2 tests of association were used to compare two categorical variables.

RESULTS

The preoperative distribution of SNOT-22 scores is shown in Figure 2. There is a near normal distribution around a mean of 42.5 (95% confidence interval: 41.6–43.3). Key patient demographics according to preoperative score are presented in Table II. There are more female patients in the groups reporting higher preoperative SNOT-22 scores.

The SNOT-22 score at 3 months, the mean change in score, and the percentage change in score are shown in Table III. Importantly, both the absolute change in score ($F[10,2252] = 63.9$, $P < .001$) and percentage change ($F[10,2252] = 8.16$, $P < .001$) increase with greater preoperative severity. Figure 3 shows a scatter plot of change in the SNOT-22 mapped against the preoperative baseline. Only those with a score of more than 21 to 30 had a mean change greater or equivalent to the MCID. It is interesting that although there was a small increase in the percentage change in score with increasing baseline severity, those with the highest scores preoperatively still remained more symptomatic after surgery ($F[10,2252] = 81.6$, $P < .001$). There was a slight decline in SNOT-22 scores between 3 and 12 months, but the difference did not reach statistical significance in any of the cohorts.

Overall, 66.2% of patients achieved a reduction in SNOT-22 scores greater than the MCID at 3 months (Table IV). When looking at the proportion of patients achieving the MCID, this increased with increasing preoperative SNOT-22 score ($F[10,2252] = 25.07$, $P < .001$), ranging from 8% to 100%. Those with a preoperative score above 31 had a >70% chance of achieving the MCID. We found the percentage of CRS with polyps patients achieved the MCID; 68.9% was statistically higher than for the CRS without polyps patients (60.9%) ($\chi^2 = 14.53$, $P < .001$).

When comparing the percentage of patients achieving the MCID ($F[5,2257] = 90.7$, $P < .001$), the mean postoperative SNOT-22 score ($F[5,2257] = 221.8$, $P < .001$) and the change in SNOT-22 scores from baseline to 3 months ($F[5,2257] = 108.7$, $P < .001$) according to the patients' categorical rating of results of surgery (Table V), there was a significant difference between groups. A greater percentage of those rating the results of surgery as excellent or very good achieved the MCID; this group had significantly lower postoperative scores at 3 months and greater change in score from baseline. However, when looking at the rating of results by preoperative SNOT-22 score (Table IV), the percentage of those rating the results as excellent or very good actually declined slightly as baseline severity increased ($\chi^2 = 34.1$, $P < .001$).

Finally, looking at revision rates at 5 years, there was a progressive increase with increasing preoperative

TABLE II.
Key Demographics Based on Preoperative SNOT-22 Group.

Preoperative SNOT-22	Mean Age, yr	% Male	Mean LM Score	% Polyps	% Asthma	% Previous Surgery
0–9	51.8	71.3	8.8	67.6	19.4	31.5
10–19	52.9	76.9	10.1	68.7	22.2	38.9
20–29	51.3	68.5	10.6	69.3	31.9	40.4
30–39	49.4	63.2	10.9	68.8	33.8	45.8
40–49	47.6	59.3	10.4	61.7	27.9	45.7
50–59	48.9	53.4	10.7	62.7	35.5	47.9
60–69	48.1	49.3	11.4	64.7	38.4	57.1
70–79	46.3	39.4	10.4	59.0	43.1	55.3
80–89	45.4	32.9	10.6	61.4	42.0	60.0
90–99	49.7	38.1	14.6	61.9	52.4	61.9
100–110	53.7	0	15.5	16.7	33.3	33.3

LM = Lund-Mackay; SNOT-22 = 22-item Sinonasal Outcome Test.

TABLE III.
Postoperative SNOT-22 at 3 and 12 Months, Absolute and Percentage Change in SNOT-22 at 3 Months, and Revision Surgery Rates at 5 Years by Preoperative SNOT-22 Score.

Preoperative SNOT-22	No.	SNOT-22 at 3 Months Postoperative	Change in SNOT-22 Score	% Change	% Revision Surgery at 5 Years	SNOT-22 Score at 12 Months
0–10	74	7.0 (4.9–9.1)	0.2 (−2.0–2.3)	11.0	4.3	10.5
11–20	247	11.4 (10.1–12.8)	4.2 (2.9–5.6)	25.1	6.9	11.8
21–30	381	16.4 (15.1–17.8)	8.9 (7.6–10.3)	35.0	13.4	17.6
31–40	449	21.6 (20.2–23.0)	13.9 (12.5–15.3)	38.9	9.8	22.6
41–50	349	26.9 (25.0–28.8)	18.5 (16.6–20.5)	40.6	12.1	28.2
51–60	316	31.9 (29.7–34.2)	23.5 (21.3–25.7)	42.5	13.4	34.6
61–70	213	39.0 (35.7–42.3)	26.1 (22.8–29.4)	39.9	19.4	43.4
71–80	155	40.9 (37.2–44.6)	34.3 (30.6–38.1)	45.6	26.3	48.6
81–90	57	54.9 (47.5–62.4)	30.1 (22.8–37.4)	35.5	25.8	60.8
91–100	19	43.9 (30.1–57.7)	50.3 (36.7–64.0)	53.6	33.3	60.6
101–110	6	52.9 (29.9–75.9)	49.3 (25.9–72.7)	48.2	25.0	73.6

SNOT-22 = 22-item Sinonasal Outcome Test.

baseline severity ($\chi^2 = 38.4$, $P < .001$). The revision surgery rate was lower in those who achieved the MCID (11.3%) compared with those who did not (18.0%) ($\chi^2 = 12.5$, $P < .001$).

DISCUSSION

The outcomes from this study have demonstrated that the preoperative SNOT-22 score is an excellent predictor of both the reduction in SNOT-22 score after ESS and the chance of achieving a clinically significant improvement in symptoms. Furthermore, the outcomes from this UK-based adult CRS cohort are largely similar to the outcomes from the previous United States/Canadian–based study, which externally validates using the preoperative SNOT-22 to guide preoperative discussions and help inform patients to their probable outcomes after ESS. For example, physicians can inform those patients starting with the highest SNOT-22 scores preoperatively that they will remain most symptomatic after surgery, and have the highest rates of revision surgery at 5 years. For simplicity, explaining to a patient that they are likely to receive a 50% reduction in their symptom load will aid informed consent and optimize patient preference-based decisions.

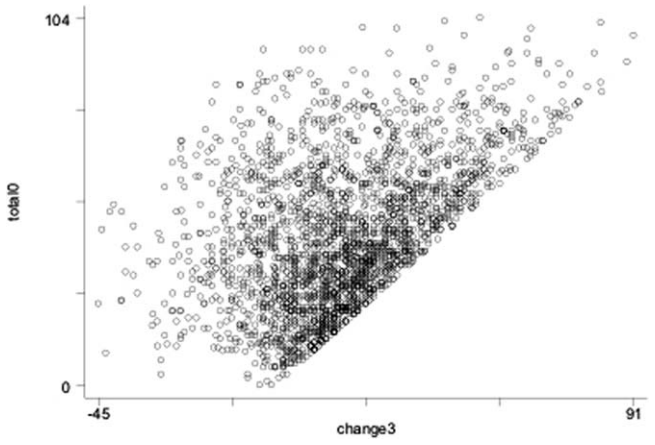

Fig. 3. Change in SNOT-22 scores at 3 months plotted against preoperative SNOT-22 score. SNOT-22 = 22-item Sinonasal Outcome Test.

Seventy-four patients underwent surgery with scores of 10 or less; by definition, those with a score of <9 would be unable to achieve an improvement greater than the MCID. Although exploring the individual circumstances leading to surgery in this group is beyond the scope of this article, the importance of careful selection is highlighted. The possibility of a significant placebo effect is raised, as over 40% of these patients rated the results of surgery as "excellent" or "very good."

None of the groups (except for the group that started with a mean SNOT-22 score below that of the normal population) achieved postoperative scores below the normal mean of 9.2.[11] These persistent symptoms are likely to explain why, although achieving improved absolute changes in SNOT-22 scores, those with higher preoperative scores are no more likely to rate the results of surgery as excellent or very good as those with lower scores. Using repeated patient-reported outcome measures such as the SNOT-22 may also be useful in counseling patients after ESS if they are dissatisfied with the outcome of surgery.

There are many variables that may influence the outcome of surgery; patient-related factors include the baseline SNOT-22, as discussed here; the extent of radiological disease, polyp status, asthma and coexisting conditions, patient gender, and previous surgery may be important. In terms of operative variables, the experience of the surgeon, extent of surgery performed, timing of surgery, and post-operative management may influence outcome. However, when multivariate linear regression was used to build a case-mix adjusted model of outcomes measured in terms of the postoperative SNOT-22, the preoperative SNOT-22 was found to be the most important (coefficient 0.49, $P < .01$ at 3 months; 0.59, $P < .01$ at 12 months).[10] Other factors to predict outcomes after ESS included older age; male gender;

TABLE IV.
Percentage of Patients Achieving the MCID by Preoperative SNOT-22 Score.

Preoperative SNOT-22	% Achieving MCID	% CRSwNP Patients Achieving MCID	% CRSsNP Patients Achieving MCID	% Patients Rating Operation as Excellent/Very Good
0–10	8.4	6.1	13.6	41.9
11–20	45.3	49.7	35.9	51.7
21–30	57.7	59.6	52.9	49.1
31–40	70.2	74.8	60.4	48.9
41–50	72.2	74.9	67.7	43.3
51–60	75.0	76.0	73.3	42.6
61–70	75.1	80.9	64.9	38.0
71–80	85.2	92.9	74.6	40.0
81–90	72.0	77.1	63.6	23.9
91–100	89.5	100	75.0	52.3
101–110	100	100	100	33.3

CRSsNP = chronic rhinosinusitis without polyps; CRSwNP = chronic rhinosinusitis with polyps; MCID = minimal clinically important difference; SNOT-22 = 22-item Sinonasal Outcome Test.

shorter symptom duration prior to surgery; the presence of polyps, which were associated with greater benefit in terms of change in SNOT-22 scores; and previous surgery and asthma, which were adversely associated.

Limitations of the MCID are, as a population-derived mean, that it assumes the same amount of change is the smallest detectable change at an individual level. Of course, what might represent a clinically important change will vary from one individual to another. Therefore, it is not intended that baseline SNOT-22 scores or the chance of achieving the MCID should be used as absolute thresholds for eligibility for surgery. Nonetheless, our results suggest that a patient with a preoperative score of 20 or lower might be less likely to benefit from surgery, and there should be caution when operating on patients with a score of <10. This must be interpreted in light of the clinical history and findings.

Given current financial constraints within the NHS, a number of Clinical Commissioning Groups have restricted access to secondary care for patients with CRS according to a number of criteria. One draft policy circulated for consultation suggested a minimum SNOT-22 score of 66 prior to referral to secondary care. ENT surgeons in that area robustly opposed this, and although surgery for rhinosinusitis remains on a list of procedures with restricted referral criteria, patients with moderate to severe symptoms of CRS are eligible for referral.[12,13] Certainly, if thresholds are introduced, they must be evidence based.

A detailed comparison of the North American and UK cohorts discussed herein is beyond the scope of this current article. However, in the former study, 80% patients achieved the MCID, with a mean reduction in SNOT-22 score of 46.4%, compared with only 66.2% achieving the MCID in the UK cohort and a mean reduction 40% in SNOT-22 scores. The possibility of poorer patient selection in the UK study has been raised above; in addition, Rudmik et al. excluded three out of 330 patients in their cohort with preoperative scores of <10 due to preoperative survey floor effects, whereas this cohort was included in the present study. Surgeons in the US study were specialist rhinologists, whereas in the United Kingdom more than 50% of cases were seen by surgeons performing a relatively low number of surgeries (<10 in 6 months) as part of a general ear, nose, and throat practice. There are key differences in access to secondary care between both healthcare systems. Nonetheless, both studies highlight the value of using the SNOT-22 for assessment of patients with CRS.

TABLE V.
Percentage of Patients Achieving the MCID, Postoperative SNOT-22 Score at 3 Months, and Change in SNOT-22 Score From Baseline to 3 Months by Patients' Rating of the Results of Surgery.

Patient Rating of Results of Surgery	% Achieving MCID	Postoperative SNOT-22 Score at 3 Months	Change in SNOT-22 Score at 3 Months
Excellent	85.4	12.6 (11.5–13.7)	26.6 (25.1–28.1)
Very good	77.1	19.9 (18.6–21.5)	21.3 (19.7–22.7)
Good	65.7	27.6 (26.0–29.2)	15.1 (13.5–16.7)
Fair	45.2	41.4 (39.2–43.6)	6.2 (4.4–8.0)
Poor	22.4	49.5 (46.5–52.5)	−2.0 (−4.4–0.4)

MCID = minimal clinically important difference; SNOT-22 = 22-item Sinonasal Outcome Test.

CONCLUSION

Our study confirms that medically recalcitrant patients with CRS considering surgery should make decisions guided by their preoperative QoL impairment, as measured using the SNOT-22. Patients with scores of <20 typically fail to receive a clinically meaningful benefit, whereas those with scores over 30 have a greater than 70% chance of achieving an MCID. There is remarkable consistency in findings of prospective cohort studies undertaken in two very diverse healthcare settings (United States and United Kingdom), further strengthening our conclusions.

BIBLIOGRAPHY

1. Hastan D, Fokkens WJ, Bachert C, et al. Chronic rhinosinusitis in Europe—an underestimated disease. A GA(2)LEN study. *Allergy* 2011; 66:1216–1223.
2. Soler ZM, Wittenberg E, Schlosser RJ, Mace JC, Smith TL. Health state utility values in patients undergoing endoscopic sinus surgery. *Laryngoscope* 2011;121:2672–2678.
3. Baguley C, Brownlow A, Yeung K, Pratt E, Sacks R, Harvey R. The fate of chronic rhinosinusitis sufferers after maximal medical therapy. *Int Forum Allergy Rhinol* 2014;4:525–532.
4. Smith KA, Rudmik L. Impact of continued medical therapy in patients with refractory chronic rhinosinusitis. *Int Forum Allergy Rhinol* 2014;4: 34–38.
5. Wennberg JE. Practice variation: implications for our health care system. *Managed care* 2004;13(9 suppl):3–7.
6. Wennberg JE. Time to tackle unwarranted variations in practice. *BMJ* 2011;342:d1513.
7. Rudmik L, Soler Z, Mace J, DeConde A, Schlosser R, Smith T. Using preoperative SNOT-22 score to inform patient decision for endoscopic sinus surgery. *Laryngoscope.* 2014 Dec 29. doi: 10.1002/lary.25108.
8. Hopkins C, Gillett S, Slack R, Lund VJ, Browne JP. Psychometric validity of the 22-item Sinonasal Outcome Test. *Clin Otolaryngol* 2009;34: 447–454.
9. Hopkins C, Slack R, Lund V, Brown P, Copley L, Browne J. Long-term outcomes from the English national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. *Laryngoscope* 2009;119:2459–2465.
10. Hopkins C, Browne JP, Slack R, et al. The national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. *Clin Otolaryngol* 2006;31:390–398.
11. Gillett S, Hopkins C, Slack R, Browne JP. A pilot study of the SNOT 22 score in adults with no sinonasal disease. *Clin Otolaryngol* 2009;34: 467–469.
12. UK National Health Service. Procedures of limited clinical value 2013–2014. Section 2: evidence based advice to GPs 2013. Available at: http://www.newhamccg.nhs.uk/Downloads/About Us/papers/10 April 2013/3.2 Draft POLCV 201314 Section 2 Advice to GPs but no prior approval.pdf. Accessed January 27, 2015.
13. UK National Health Service. Milton Keynes Clinical Commissioning Group referral policies. Available at: http://www.miltonkeynesccg.nhs.uk/documentlist/clinical-prioritisation-policies. Accessed January 27, 2015.