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Productivity Outcomes Following Endoscopic Sinus Surgery for Recurrent Acute Rhinosinusitis

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Objectives/Hypothesis: We sought to evaluate preoperative and postoperative productivity losses and quality of life (QOL) impairment reported by patients with recurrent acute rhinosinusitis (RARS) as compared to patients with chronic rhinosinusitis without nasal polyposis (CRSsNP).

Study Design: Prospective, multi-institutional, nested case–control.

Methods: Participants with RARS (n = 20) and CRSsNP (n = 20) undergoing endoscopic sinus surgery (ESS) were enrolled as part of a prospective cohort study. For comparison, participants diagnosed with RARS cases were age/gender-matched to control participants diagnosed with CRSsNP using a 1:1 ratio.

Results: RARS and CRSsNP participants were followed for ~14 months postoperatively. Productivity losses were reported as the number of days missed from normal productive activities out of the previous 90 days. RARS participants reported similar baseline productivity losses (12.6 ± 27.1 [standard deviation]) as participants with CRSsNP (11.7 ± 20.9; $P = .314$). Postoperatively, improvement in productivity losses was similar between RARS participants and CRSsNP controls (−6.7 ± 20.0 vs. −9.8 ± 19.1; $P = .253$). Preoperative and postoperative disease-specific QOL measures (Sino-Nasal Outcomes Test-22 and Rhinosinusitis Disability Index) were similar between the two groups. RARS participants reported a significant decrease in days of previous antibiotic ($P = .009$) and nasal decongestant ($P = .004$) use following ESS, whereas participants with CRSsNP reported a significant decrease in antibiotic ($P = .002$) and oral corticosteroid use ($P = .002$).

Conclusions: RARS patients report baseline productivity losses and disease-specific QOL impairment to levels that parallel those with CRSsNP. Patients with RARS report improvement in QOL following ESS in all disease-specific QOL measures and in several medication measures. Productivity losses and postoperative improvements are similar between patients with RARS and CRSsNP.

Key Words: Sinusitis, outcome assessment, patient outcome assessment, case–control studies, medical therapy management.

Level of Evidence: 3b

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INTRODUCTION

Recurrent acute rhinosinusitis (RARS) is a distinct clinical entity affecting 1:3,000 adults per year in the United States.[1] In contrast to chronic rhinosinusitis (CRS), patients with RARS experience resolution of sinus-specific symptoms between episodes of acute bacterial rhinosinusitis. Despite symptom relief between disease exacerbations, it is now recognized that patients with RARS report diminished quality of life (QOL) to levels that often parallel their CRS counterparts.[2]

Current guidelines have established a threshold of four episodes of acute bacterial rhinosinusitis per year as a diagnostic indication of RARS.[3,4] These diagnostic criteria are used by many clinicians to determine when a patient may become a candidate for endoscopic sinus surgery (ESS). Health economic modeling investigations, however, have offered alternate criteria by reporting a cost–benefit threshold for ESS at five infections per year.[5] Given the relative paucity of treatment outcomes data following ESS for patients with RARS,[2,6,7] more information is needed to truly discern the benefit of ESS in these patients. Although direct costs (e.g., medication use, health care utilization) of RARS have been measured,[1,8] indirect costs associated with productive activities such

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as days missed from work/school/volunteering are less well described. Accurate societal cost estimates must incorporate both direct and indirect costs associated with these treatments.[9,10]

The primary objective of this study was to assess the impact of RARS on patient-reported productivity. RARS cases were matched with CRS controls to frame the results in the context of the known impact that CRS has on productivity. We hypothesized that RARS patients electing ESS would report significant improvement in daily productivity measures. A secondary goal was to evaluate preoperative and postoperative QOL and medication use to provide a broader context of the overall impact of RARS.

MATERIALS AND METHODS

Patient Population and Inclusion Criteria

Patients were recruited and prospectively enrolled into a continuing, multisite, observational, cohort study of adult patients with RARS and CRS. Preliminary findings from this investigation have been previously published.[11–13] The institutional review board (IRB) at each enrollment location governed all investigational protocols and adult informed consent procedures. Enrollment sites consisted of sinus and skull base surgery centers within academic, tertiary hospital systems including Oregon Health & Science University (OHSU; Portland, OR, eIRB #7198), Stanford University (Palo Alto, CA, IRB #4947), the Medical University of South Carolina (Charleston, SC, IRB #12409), and the University of Calgary (Calgary, Alberta, Canada, IRB #E-24208), with central coordination conducted at OHSU. All study patients were reminded that study consent was voluntary, and the standard of care surrounding ESS was unchanged by study participation.

All study participants elected adjunctive ESS as the subsequent treatment option for alleviation of symptoms after failure of previous medical management including, but not limited to, at least one course ($\geq$14 days) of broad spectrum or culture-directed antibiotic therapy (CRS without nasal polyposis [CRSsNP] cohort) and at least one course of either topical corticosteroids ($\geq$21 days) or a 5-day course of oral corticosteroid therapy. For comparison, case participants diagnosed with RARS were age-matched (within 2 years) and gender-matched to control participants diagnosed with CRSsNP using a 1:1 ratio for the nested case–control design. Case subjects were selected from CRSsNP subjects (n = 337) enrolled within the same prospective cohort. Both case and control participants were prospectively diagnosed with RARS and CRSsNP, respectively, as defined by criteria outlined by the 2007 and 2015 Adult Sinusitis guidelines published by the American Academy of Otolaryngology.[3,4]

During the initial preoperative enrollment appointment, study participants were asked to provide detailed demographic information, as well as social and medical history cofactors including, but not limited to: age, gender, race, asthma, nasal polyposis, depression, allergy, aspirin sensitivity, current tobacco and alcohol use, ciliary dyskinesia, corticosteroid dependency, immunodeficiency, autoimmunity, and diabetes mellitus. Participants were followed up to 18 months after ESS and completed survey evaluations postoperatively at 6-month intervals, either during physician-directed clinical appointments or via follow-up mailings.

Clinical Measures of Disease Severity

Computed tomography. High-resolution computed tomographic (CT) imaging was utilized to evaluate preoperative sinonasal disease severity using images in both sagittal and coronal planes. Images were also staged by the enrolling physician in accordance with the Lund-Mackay bilateral scoring system (score range = 0–24) which quantifies the severity of image opacification in the maxillary, ethmoidal, sphenoidal, ostiomeatal complex, and frontal sinus regions.[14]

Nasal endoscopy. Paranasal sinuses were evaluated at baseline and following ESS using rigid fiberoptic endoscopes (SCB Xenon 175; Karl Storz, Tuttlingen, Germany). Endoscopic examinations were staged by the enrolling physician at each site using the bilateral Lund-Kennedy scoring system (score range = 0–20), which quantifies visualized pathologic states within the paranasal sinuses including the severity of polyposis, discharge, edema, scarring, and crusting.[15] Higher scores on both staging systems indicate worse disease severity.

Olfactory function. Preoperative and postoperative olfactory function was evaluated using the Brief Smell Identification Test (BSIT). The BSIT is a validated 12-item, noninvasive test of olfactory function that uses microencapsulated odorant strips, which are activated with a standard #2 pencil in a "scratch 'n sniff" format.[16] Participants are instructed to identify each odorant using a method of forced choice (score range = 0–12). Scoring of all BSIT evaluations was completed by a study coordinator at each site. Higher total scores represent better olfactory status, whereas both male and females can be categorized as having "normal" (score $\geq$ 9) or "abnormal" (score $<$ 9) olfactory function.

ESS

Surgical extent was directed by the discretion of each enrolling physician and reflected sinus disease progression on an individual patient basis. ESS consisted of either unilateral or bilateral maxillary antrostomy, partial or total ethmoidectomy, sphenoidotomy, frontal sinusotomy (Draf I, IIa, IIb, or III), or partial or complete middle turbinate resections, with septoplasty and/or inferior turbinate reductions. Image guidance was used when deemed appropriate. All surgical cases were followed with postoperative therapeutic regimens including daily nasal saline rinses and subsequent medical therapy as necessary.

Disease-Specific QOL

Study participants completed two patient-based QOL surveys both during preoperative evaluation and at all subsequent follow-up time points, as part of a larger total battery of evaluative instruments.

Sino-Nasal Outcome Test. The 22-item Sino-Nasal Outcome Test (SNOT-22) is a validated survey developed to evaluate symptom severity in CRS (©2006, Washington University, St Louis, MO).[17,18] Individual item scores are measured using patient-selected responses on a Likert scale where higher scores indicate worse symptom severity as follows: 0 = no problem, 1 = very mild problem, 2 = mild or slight problem, 3 = moderate problem, 4 = severe problem, and 5 = problem as bad as it can be. Previous exploratory factor analysis of SNOT-22 scores, using this cohort, identified five distinct subdomains.[19] Subdomains include rhinologic symptoms (score range = 0–30), extranasal rhinologic symptoms (score range = 0–15), ear and/or facial symptoms (score range = 0–25), psychological dysfunction (score range = 0–35), and sleep dysfunction (score range = 0–

25). Higher subdomain and SNOT-22 scores (score range = 0–110) represent worse QOL and symptom severity.

Rhinosinusitis Disability Index. The Rhinosinusitis Disability Index (RSDI) is a 30-item survey instrument comprised of three subdomains to assess the impacts of rhinosinusitis on a participant's physical (score range = 0–44), functional (score range = 0–36), and emotional (score range = 0–40) status.[20] Higher subdomain and total RSDI scores (score range = 0–120) represent worse QOL and greater impact of rhinosinusitis symptoms on patients' daily function.

Measures of Medication Utilization and Lost Productivity

Preoperative and postoperative outcome evaluations also included questions of past days of medication use (days out of the previous 90) including antibiotics, systemic corticosteroids, topical corticosteroid drops, topical corticosteroid sprays, antihistamines, decongestants, leukotriene modifiers, and saline irrigations. Lost productivity was operationalized in both cases and controls as participants were asked to recall the number of days (out of the previous 90 days) that were missed or impacted due to sinus-related symptoms (e.g., missed workdays, school days, or volunteer time).

Exclusion Criteria

Patients with immunodeficiency, ciliary dysfunction, and autoimmune disease were excluded due to potential heterogeneity of disease processes and variations in subsequent treatment. Patients with steroid-dependent diseases were excluded due to potential confounding of reported postoperative medication use following endoscopic sinus surgery. Patients were excluded if <6 months had elapsed since ESS procedures, and any participants failing to provide study-related QOL evaluations within the preceding 18 months were considered lost to follow-up and were also excluded from the final analyses.

Data Management and Statistical Analyses

Study data were stripped of all protected health information and coded using a unique study identification number to ensure confidentiality before being transferred to OHSU. All study data were manually entered into a relational database (Access; Microsoft, Redmond, WA), and statistical analyses were conducted using commercially available software (SPSS v22; IBM, Armonk, NY). Preoperative cofactors, clinical measures of disease severity, measures of surgical extent, QOL scores, and days of medication use and lost productivity were evaluated descriptively, and data normality was verified for all continuous measures. Last available RSDI and SNOT-22 item scores were used to operationalize each postoperative evaluation due to previously reported stability of postoperative scores between 6-, 12-, and 18-month follow-up.[12,21] Mann-Whitney U and χ^2 testing was utilized to compare all independent continuous measures and prevalence measures between cases and controls when appropriate. Wilcoxon signed rank testing was used to evaluate matched pairings over time. All statistical comparisons assumed a 0.050 error probability.

RESULTS

Study Cohort and Sinus Surgery Characteristics

A total of 20 participants, meeting all inclusion and exclusion criteria, undergoing ESS for RARS were enrolled between July 2011 and June 2014. Patients were subsequently matched to 20 participants undergoing ESS for CRSsNP between May 2011 and March 2014. Participants with RARS were followed for an average of 14.0 ± 6.1 (standard deviation) months compared to an average of 14.4 ± 5.3 months for control subjects with CRSsNP (P = .779). Both RARS cases and CRSsNP controls had a mean age of 35.3 ± 9.1 years and were comprised of six males (30%) and 14 females (70%). Further comparisons of participant characteristics, comorbid conditions, and clinical measures of disease severity are described in Table I, and the prevalence of unilateral and bilateral surgical procedures is described in Table II.

Subjects with RARS were found to have a significantly higher prevalence of septal deviation and turbinate hypertrophy, whereas control participants with CRSsNP had significantly worse CT scores. No other differences in patient characteristics or average clinical measures of disease severity were found between RARS and CRSsNP groups. Subjects with RARS were found to have significantly fewer previous sinus surgeries, fewer overall total ethmoidectomies, sphenoidotomies, and frontal sinusotomies, and less image guidance use (Table II) compared to subjects with CRSsNP. Conversely, subjects with RARS were found to undergo greater frequencies of maxillary antrostomy, partial ethmoidectomy, inferior turbinate reduction, and septoplasty procedures as part of their surgical treatment.

Preoperative QOL Outcome Measures

Differences between preoperative mean SNOT-22 and RSDI total and domain scores were compared between the RARS and CRSsNP groups (Table III). No significant differences were reported between matched participants with RARS and CRSsNP for any preoperative QOL outcome measure ($P \geq .086$).

Preoperative Medication Use and Lost Productivity

Differences between preoperative mean days of medication usage and lost productivity days were compared between the RARS and CRSsNP groups (Table IV). Case participants with RARS were only found to report significantly more average days of antihistamine use compared to CRSsNP controls. Days of lost productivity were comparable between subjects with RARS and CRSsNP.

Postoperative Medication Use and Lost Productivity

Differences between postoperative mean days of medication usage and lost productivity days were compared between subjects with RARS and those with CRSsNP (Table V). Subjects with RARS were found to report significantly higher mean days on oral steroids than patients with CRSsNP. No differences were found for the remaining classes of medication use or lost productivity days.

TABLE I.
Characteristics, Comorbid Conditions, and Clinical Measures of Disease Severity of Matched RARS Cases and CRSsNP Control Subjects (n = 40).

Characteristic	RARS, n = 20		CRSsNP, n = 20		P
	Mean (SD)	No. [%]	Mean (SD)	No. [%]	
Caucasian/white		19 [95]		16 [80]	.151
Asian		1 [5]		1 [5]	>.999
Hispanic/Latino		0 [0]		1 [5]	>.999
Asthma		4 [20]		2 [10]	.661
Allergy, mRAST/skin prick		11 [55]		7 [35]	.204
Nasal polyposis		0 [0]		0 [0]	>.999
Aspirin sensitivity		0 [0]		1 [5]	>.999
Septal deviation		17 [85]		8 [40]	.008
Turbinate hypertrophy		12 [60]		3 [15]	.008
Depression		3 [15]		5 [25]	.695
Tobacco use		0 [0]		2 [10]	.487
Alcohol use		14 [70]		8 [40]	.057
Diabetes mellitus, type I/II		1 [5]		0 [0]	>.999
Clinical measures of disease severity					
Lund-Mackay CT scores	4.8 (4.2)		8.5 (5.7)		.030
Lund-Kennedy endoscopy scores	2.5 (1.7)		4.3 (3.5)		.108
BSIT olfactory scores	10.2 (1.5)		9.6 (1.7)		.421

BSIT = Brief Smell Identification Test; CRSsNP = chronic rhinosinusitis without nasal polyposis; CT = computed tomography; mRAST = modified radioallergosorbent testing; RARS = recurrent acute rhinosinusitis; SD = standard deviation.

Following ESS, patients with RARS were found to have a significant decrease in reported days of previous antibiotic and decongestant use. Although there was average improvement in lost productivity days, this improvement did not reach statistical significance ($P = .064$). In the CRSsNP cohort, significant reductions in average days of antibiotic use ($P = .001$), systemic corticosteroid use ($P = .001$), and lost productivity days ($P = .002$) were reported (Table VI).

Postoperative QOL Outcome Measures

Differences between preoperative mean SNOT-22 and RSDI total and domain scores over time were compared between subjects with RARS and those with CRSsNP (Table VII). Participants with RARS were found to have significant improvements across all mean QOL measures including SNOT-22 and RSDI scores. Similarly, patients with CRSsNP were found to exhibit significant improvement in all mean

TABLE II.
Prevalence of Unilateral and Bilateral Surgical Procedures.

Surgical Procedures	RARS, n = 20, No. (%)		CRSsNP, n = 20, No. (%)		P
	Left Side	Right Side	Left Side	Right Side	
Previous [revision] sinus surgery	0 (0)		11 (55)		<.001
Maxillary antrostomy	20 (100)	19 (95)	16 (80)	16 (80)	.029
Partial ethmoidectomy	16 (80)	15 (75)	5 (25)	4 (20)	<.001
Total ethmoidectomy	3 (15)	3 (15)	12 (60)	11 (55)	<.001
Sphenoidotomy	2 (10)	1 (5)	12 (60)	11 (55)	<.001
Middle turbinate resection	0 (0)	1 (5)	3 (15)	4 (20)	.057
Inferior turbinate reduction	12 (60)	12 (60)	4 (20)	4 (20)	<.001
Septoplasty	18 (90)		8 (40)		.002
Frontal sinusotomy Draf I	1 (5)	0 (0)	1 (5)	1 (5)	>.999
Frontal sinusotomy Draf IIa	0 (0)	0 (0)	7 (35)	8 (40)	<.001
Frontal sinusotomy Draf IIb	0 (0)	0 (0)	2 (10)	1 (5)	.241
Frontal sinusotomy Draf III*	0 (0)		0 (0)		>.999
Image guidance	1 (5)		9 (45)		.008

Right and left side frequencies are reported separately; probability values reflect differences between summarized total sides for RARS and CRSsNP.
*Indicates bilateral surgical procedure by definition.
CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis.

TABLE III.
Comparisons Between Preoperative Mean SNOT-22 and RSDI Scores Between RARS Case and CRSsNP Control Subjects (n = 40).

	RARS, n = 20		CRSsNP, n = 20		
Outcome Measures	Mean (SD)	Range	Mean (SD)	Range	*P*
SNOT-22 total scores	49.1 (19.0)	17–89	52.4 (17.8)	21–79	.583
Rhinologic symptoms	14.3 (5.1)	5–25	14.6 (5.7)	6–27	>.999
Extranasal rhinologic symptoms	7.9 (3.4)	2–14	7.6 (2.7)	0–12	.820
Ear and/or facial symptoms	9.6 (4.7)	2–19	9.6 (5.2)	0–21	.968
Psychological dysfunction	14.4 (7.7)	1–31	17.3 (8.3)	0–27	.114
Sleep dysfunction	13.4 (6.8)	3–25	13.4 (7.5)	0–25	>.999
RSDI total score	41.1 (22.7)	4–104	49.4 (19.0)	10–81	.127
Physical subdomain	17.6 (9.2)	0–39	19.6 (6.0)	6–27	.327
Functional subdomain	14.1 (7.8)	1–35	16.5 (7.4)	4–30	.301
Emotional subdomain	9.4 (7.3)	0–30	13.4 (8.5)	0–26	.086

CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis; RSDI = Rhinosinusitis Disability Index; SD = standard deviation; SNOT-22 = 22-item Sino-Nasal Outcome Test.

QOL measures. Neither group was found to exhibit improvement in Lund-Kennedy endoscopy scores (RARS, $P = .248$; CRSsNP, $P = .119$) or BSIT olfaction scores (RARS, $P = .831$; CRSsNP, $P = .811$). When comparing patients with RARS to matched CRSsNP controls, both groups improved significantly over time and to approximately the same average magnitude in all QOL measures, endoscopy scores, and BSIT scores (all $P \geq .301$).

DISCUSSION

Recurrent acute rhinosinusitis represents an important subset of patients with rhinosinusitis, yet this disease entity remains relatively understudied and poorly understood. The overall burden of disease in RARS has been primarily measured by CRS disease-specific QOL outcomes, although recent studies have incorporated measures of health care utilization, medication use, and productivity into this paradigm.[5,22] Productivity is a measure of indirect cost and commonly reported as days missed from work or reduced work performance due to a health condition.[9] This study was designed to specifically evaluate these measures of disease burden at baseline and to quantify the improvement following ESS.

Productivity was compared between RARS patients and CRSsNP controls due to the known substantial detrimental effects CRS has on patient productivity levels. Recent investigation performed by Rudmik et al. characterized productivity losses in patients with CRS and found an average annual absenteeism of 24.6 workdays missed per year, resulting in an annual productivity cost of $10,077.07 per patient.[9] ESS may help negate some of these costs for CRS patients, as several studies have reported significant improvements in time missed from productive activities following surgical intervention.[23,24] However, there are limited data examining productivity in patients with RARS. Bhattacharyya was the first to report significant improvement in missed workdays following ESS in a cohort of 19 patients who failed maintenance medical management.[7] In the current study, patients with RARS were found to have measures of preoperative productivity loss comparable to patients with CRSsNP, indicating no greater level of productivity loss

TABLE IV.
Comparisons Between Preoperative Days of Medication Use and Lost Productivity Between RARS Case and CRSsNP Control Subjects (n = 40).

	RARS, n = 20*		CRSsNP, n = 20*		
Medication/Lost Productivity	Mean (SD)	Range	Mean (SD)	Range	*P*
Antibiotics	15.3 (17.4)	0–56	19.3 (16.6)	0–60	.314
Systemic corticosteroids	5.1 (9.0)	0–30	9.0 (10.5)	0–40	.086
Topical corticosteroid drops	4.5 (20.1)	0–90	19.3 (36.3)	0–90	.301
Topical corticosteroid sprays	45.9 (38.5)	0–90	32.3 (40.0)	0–90	.331
Antihistamines	38.2 (42.2)	0–90	11.9 (27.9)	0–90	.040
Decongestants	33.9 (35.1)	0–90	16.9 (29.1)	0–90	.072
Leukotriene modifiers	5.5 (20.4)	0–90	3.0 (10.4)	0–45	.989
Saline irrigations	50.1 (38.8)	0–90	44.2 (36.5)	0–90	.640
Lost productivity days out of previous 90	12.6 (27.1)	0–90	11.7 (20.9)	0–80	.314

*Medication days out of previous 90 days.
CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis; SD = standard deviation.

TABLE V.
Comparison of Mean Improvements in Medication Use and Lost Productivity Days Between RARS Cases and CRSsNP Controls.

Medication/Lost Productivity	RARS, Mean (SD)	CRSsNP, Mean (SD)	*P*
Antibiotics	−11.7 (17.0)	−15.2 (17.4)	.445
Systemic corticosteroids	−2.9 (7.9)	−8.4 (10.1)	.020
Topical corticosteroid drops	4.5 (35.5)	2.1 (49.4)	.678
Topical corticosteroid sprays	−5.4 (35.2)	−7.7 (25.0)	.659
Antihistamines	−5.8 (26.5)	6.7 (27.4)	.231
Decongestants	−21.1 (29.8)	−6.5 (21.4)	.114
Leukotriene modifiers	9.2 (40.7)	3.8 (14.4)	.779
Saline irrigations	−6.6 (43.8)	−13.3 (41.3)	.758
Lost productivity days	−6.7 (20.0)	−9.8 (19.1)	.253

CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis; SD = standard deviation.

burden in patients with RARS attributable to their disease process. Similarly, productivity gains following ESS were not statistically different between patients with RARS and CRSsNP controls ($P = .253$). Whereas improvement in mean lost days of productivity did not reach statistical significance following ESS ($P = .064$), there was >50% reduction in mean time missed from productive activities for RARS patients.

Patients enrolled in the current study were matched by age and gender to examine for any potential differences in productivity and QOL between the two groups while controlling for those two patient factors. Given the chronicity of CRS as compared to the intermittent nature of RARS, we suspected that average reported productivity losses would be greater in the CRS cohort. Both baseline and postoperative QOL and productivity measures were similar between cases and controls, suggesting a greater daily impact of the RARS disease process on productivity than initially thought.

Using both the RSDI and SNOT-22 survey instruments, the current study found significant improvement in QOL in patients with RARS following ESS. These data both support and augment the literature regarding postoperative QOL outcomes in patients with RARS. Poetker et al. evaluated postoperative QOL using the RSDI in 14 patients with RARS and found significant postoperative improvement in the RSDI total scores and within the physical and functional subdomains with an average of 8 months of follow-up.[2] In their study, no improvement was found in the emotional subdomain. With a larger sample size and a longer follow-up period, the current study identified postoperative improvement in the total RSDI score as well as in all subdomains. Bhattacharyya noted a statistically significant improvement in the rhinosinusitis symptom inventory with a minimum of 12 months of follow-up data.[7] Our data complement these findings with a similar length of postoperative follow-up using a different set of well-validated and widely used QOL indices that measure additional aspects of the patients' experience.

Patients with RARS are commonly prescribed antibiotics for episodes of acute sinusitis, resulting in increased health care costs. The reduction in

TABLE VI.
Improvement in the Mean Days of Medication Use and Lost Productivity (Out of Previous 90 Days) for Both Independent RARS Case (n = 20) and CRSsNP Control (n = 20) Groups.

Medication/Lost Productivity	Preoperative, Mean (SD)	Postoperative, Mean (SD)	*P*
RARS			
Antibiotics	15.3 (17.4)	3.6 (9.0)	.009
Systemic corticosteroids	5.1 (9.0)	2.1 (6.9)	.113
Topical corticosteroid drops	4.5 (20.1)	9.0 (27.7)	.564
Topical corticosteroid sprays	45.9 (38.5)	40.5 (42.4)	.574
Antihistamines	38.2 (42.2)	32.4 (40.5)	.326
Decongestants	33.9 (35.1)	12.8 (27.3)	.004
Leukotriene modifiers	5.5 (20.4)	14.7 (32.8)	.281
Saline irrigations	50.1 (38.8)	43.9 (41.1)	.414
Lost productivity days	12.6 (27.1)	5.9 (20.0)	.064
CRSsNP			
Antibiotics	19.3 (16.6)	4.1 (11.3)	.001
Systemic corticosteroids	9.0 (10.5)	0.6 (1.8)	.001
Topical corticosteroid drops	19.3 (36.3)	21.3 (37.4)	.953
Topical corticosteroid sprays	32.3 (40.0)	21.4 (35.9)	.137
Antihistamines	11.9 (27.9)	18.5 (35.7)	.416
Decongestants	16.9 (29.1)	10.4 (27.4)	.182
Leukotriene modifiers	3.0 (10.4)	6.8 (22.0)	.276
Saline irrigations	44.2 (36.5)	30.9 (33.8)	.152
Lost productivity days	11.7 (20.9)	1.9 (4.8)	.002

CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis; SD = standard deviation.

TABLE VII.
Comparison of Mean Preoperative and Postoperative Quality of Life and Clinical Measure of Disease Severity Scores Over Time for Both Independent RARS Case (n = 20) and CRSsNP Control (n = 20) Groups.

Outcome Measure	Preoperative, Mean (SD)	Postoperative, Mean (SD)	*P*
RARS			
SNOT-22 total scores	49.1 (19.0)	23.9 (16.6)	.001
Rhinologic symptoms	14.3 (5.1)	7.1 (5.6)	.002
Extranasal rhinologic symptoms	7.9 (3.4)	4.1 (3.8)	.003
Ear and/or facial symptoms	9.6 (4.7)	4.9 (3.6)	.003
Psychological dysfunction	14.4 (7.7)	6.5 (6.1)	.002
Sleep dysfunction	13.4 (6.8)	6.8 (5.3)	.004
RSDI total score	41.1 (22.7)	17.9 (18.1)	.001
Physical subdomain	17.6 (9.2)	8.1 (8.0)	.001
Functional subdomain	14.1 (7.8)	5.8 (6.9)	.001
Emotional subdomain	9.4 (7.3)	4.0 (5.5)	.008
Lund-Kennedy endoscopy scores	2.5 (1.7)	2.3 (2.2)	.248
BSIT olfactory scores	10.2 (1.5)	10.2 (2.5)	.831
CRSsNP			
SNOT-22 total scores	52.4 (17.8)	24.7 (20.2)	<.001
Rhinologic symptoms	14.6 (5.7)	7.6 (6.2)	.001
Extranasal rhinologic symptoms	7.6 (2.7)	3.2 (3.1)	<.001
Ear and/or facial symptoms	9.6 (5.2)	5.4 (4.8)	.004
Psychological dysfunction	17.3 (8.3)	7.4 (7.6)	<.001
Sleep dysfunction	13.4 (7.5)	6.1 (6.1)	.001
RSDI total score	49.4 (19.0)	21.1 (21.2)	<.001
Physical subdomain	19.6 (6.0)	9.2 (8.9)	<.001
Functional subdomain	16.5 (7.4)	7.2 (8.7)	.001
Emotional subdomain	13.4 (8.5)	4.8 (7.0)	.001
Lund-Kennedy endoscopy scores	4.3 (3.5)	3.5 (3.2)	.119
BSIT olfactory scores	9.6 (1.7)	9.9 (1.3)	.811

BSIT = Brief Smell Identification Test; CRSsNP = chronic rhinosinusitis without nasal polyposis; RARS = recurrent acute rhinosinusitis; RSDI = Rhinosinusitis Disability Index; SD = standard deviation; SNOT-22 = 22-item Sino-Nasal Outcome Test.

postoperative antibiotic use found in the current study suggests that over time there may be an economic benefit via reduced health care utilization.[8] It is important to note, however, that the use of oral antibiotics for patients with RARS has recently been called into question. Kaper et al.'s 2013 systematic review of RARS literature found no evidence available to support the effectiveness of short-course antibiotic therapy for recurrent acute episodes of sinusitis.[25] Future study will be needed to further delineate the role of antibiotic therapy in RARS patients.

To accurately assess the economic burden of chronic illness, both direct (e.g., medication use/health care use/surgical costs) and indirect costs (e.g., productivity, lost wages, travel costs) should be accounted for. Previous economic analysis has integrated variations of these measures, albeit with limited data, as few published studies have incorporated these measures. The results presented in the current study encompass both of these domains and may help to support future economic analysis.

Several limitations must be considered when interpreting the results of this study. Literature surrounding treatment outcomes for RARS is frequently limited by sample size, and the current study is no exception. This is a reflection of the challenges associated with studying RARS patients, as they do not necessarily require tertiary rhinology care or strict long-term follow-up. Future study should include prospective analysis of a larger cohort to verify findings from the current study. In this study, productivity and medication use were measured by patient recall over the past 90 days. Given that RARS is an episodic disease process, there are inherent limitations in the form of recall bias, as patients may have been asymptomatic during the period in which follow-up evaluations took place and may have been unable to accurately recall missed days of work, exact medication use, or normal productivity. We feel this risk is minimized, as current recall recommendations support 3 month evaluations.[10,26,27] Despite these factors, this study is strengthened by its prospective, case-controlled, multi-institutional nature and provides a measure of insight into productivity losses associated with refractory RARS.

CONCLUSION

Baseline productivity and QOL are diminished in patients with RARS to severity levels that parallel their CRSsNP counterparts. Patients with RARS report

improvement in QOL following ESS in all disease-specific QOL measures and in several medication measures. Productivity losses and postoperative gains are similar between patients with RARS and CRSsNP.

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