
Economic burden of rhinitis in managed care: a retrospective claims data analysis

Anand A. Dalal, PhD*; Richard Stanford, PhD*; Henk Henry†; and Bijan Borah‡

Background: Little is known about the specific cost effect of rhinitis on third-party payers. No recently reported studies have examined the economic burden of rhinitis in managed care. Furthermore, the direct costs of chronic rhinitis have not been evaluated and potential differences in health care use and costs of allergic rhinitis have not been examined.

Objective: To evaluate the economic burden of allergic rhinitis and chronic rhinitis to third-party payers in a large US managed care plan.

Methods: In a retrospective analysis using pharmacy and medical claims data from a US health plan covering approximately 15 million members, health care use and cost data were summarized for patients with allergic or chronic rhinitis (n = 301,001) for the 13-month study period (January 1, 2004, to January 31, 2005).

Results: Average rhinitis-related total costs were \$657 per patient each year (\$319 in medical costs and \$338 in pharmacy costs). Ambulatory visits were the primary contributor to rhinitis-related medical costs. Antihistamines were the most common rhinitis medication, followed by intranasal corticosteroids (INSs) and montelukast. Many patients (37% with at least 1 filled prescription for an antihistamine, an INS, or montelukast) used combination therapy. Of the 3 main pharmacotherapy categories, montelukast was associated with the highest pharmacy cost (\$353 vs \$198 for antihistamines and \$231 for INSs per patient each year for monotherapy) and drove the average annual cost of combination therapy regardless of the concomitant medication(s). The most common comorbidities were sinusitis and asthma, present in 51.1% and 27.9% of patients, respectively. Comorbidities increased rhinitis-related health care costs.

Conclusions: Allergic rhinitis and chronic rhinitis imposed a significant financial burden on third-party payers in a large US managed care plan. The presence of comorbidities further increased the rhinitis-related treatment costs.

Ann Allergy Asthma Immunol. 2008;101:23–29.

INTRODUCTION

Defined as an inflammation of the nasal membranes, severe rhinitis is characterized by nasal congestion, rhinorrhea, sneezing, and nasal itching and may be accompanied by ocular redness, tearing, and itching.¹ Rhinitis can be classified as either allergic or chronic. In *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*,² allergic rhinitis includes seasonal or nonseasonal allergic rhinitis, hay fever, and spasmodic rhinorrhea, whereas chronic rhinitis includes atrophic, granulomatous, hypertrophic, obstructive, purulent, and ulcerative rhinitis and ozena. Rhinitis is often complicated by comorbidities, including asthma, sinusitis, and otitis media with effusion.³ Empirical evidence quantifying the effect of comorbidities on rhinitis treatment and costs is lacking. Although rhinitis is not life threatening, it substantially affects patients' health-related quality of life and functional ability by impairing concentration and causing fatigue, headache, irritability, sleep disruption, and restlessness.^{4–9} Rhinitis is highly prevalent: allergic rhinitis alone affects approximately 20% of the US popula-

tion, and some studies^{10–15} suggest that its incidence is increasing worldwide. Pharmacotherapy for allergic rhinitis includes intranasal corticosteroids (INSs), antihistamines, leukotriene receptor antagonists, decongestants, and sodium cromolyn. Of the leukotriene receptor antagonists, only montelukast has been approved for treating rhinitis. Intranasal corticosteroids are the recommended class of therapy in treatment guidelines because of their effectiveness in controlling nasal symptoms.¹

Because of its prevalence and health effect, rhinitis is associated with considerable direct and indirect costs. Across studies, the annual direct cost of allergic rhinitis in the United States is estimated at \$1.6 to \$4.9 billion.¹⁶ Estimates of annual indirect costs, which vary because of factors such as heterogeneous methods of ascertaining worker productivity and difficulty in estimating lost costs of working with symptoms, range from \$0.1 to \$9.7 billion.¹⁶ Allergic rhinitis is estimated to be responsible for 3.5 million lost work days and more than 2 million missed school days per year.¹⁷ These estimates do not reflect the effect of chronic rhinitis, for which similar statistics are not available.

Although the national direct cost of allergic rhinitis has been estimated previously,^{16,18} little is known about the specific cost effect of rhinitis on third-party payers; no recent studies have examined the economic burden of rhinitis in managed care. Furthermore, the direct costs of chronic rhinitis have not been evaluated and potential differences in

Affiliations: * GlaxoSmithKline, Research Triangle Park, North Carolina; † i3 Innovus, Eden Prairie, Minnesota.

Disclosures: Authors have nothing to disclose.

Funding Sources: This study was supported by GlaxoSmithKline (Drs Dalal and Stanford).

Received for publication September 28, 2007; Received in revised form December 26, 2007; Accepted for publication January 28, 2008.

Table 1. Demographics, Filled Medications, and Comorbidities for 301,001 Patients With Rhinitis

Variable	Patients, %
Demographics	
Age, y	
<12	15.0
12–18	11.0
19–40	29.0
41–60	37.0
>60	8.0
Female sex	57.4
Geographic region ^a	
Northeast	9.9
Midwest	30.8
South	47.7
West	11.7
≥1 Filled medication during the 1-y follow-up	
Antihistamine	64.3
Inhaled corticosteroid	47.3
Montelukast	17.0
Decongestant	15.0
Comorbidity	
Asthma	27.9
Chronic obstructive pulmonary disease	4.7
Sinusitis	51.1
Migraine	26.3
Sleep disorder	0.6
Hypertension	23.1
Diabetes mellitus	6.3
Depression	14.1
Otitis media	23.0
Conjunctivitis	16.4
Nasal polyps	2.1

^a Percentages do not total 100 because of rounding.

health care use and costs of allergic rhinitis and chronic rhinitis have not been examined. This study was conducted to evaluate the economic burden of allergic rhinitis and chronic rhinitis in a large US managed care plan. The study examined trends in health care and prescription medication use, costs of health service use, and the influence of comorbid conditions on the economic burden of rhinitis to managed care.

METHODS

The study was a retrospective claims analysis using pharmacy and medical claims data from a large US health plan that provides fully insured coverage for physician visits, hospitalizations, and prescription drug services to approximately 15 million members geographically distributed throughout the United States. Physicians submit their claims for payment directly to the health plan. The claims database is fully deidentified and compliant with the 1996 Health Insurance Portability and Accountability Act.

The study cohort included commercial and managed Medicaid health plan members with a pharmacy benefit if they were 4 years or older; had been diagnosed as having allergic rhinitis or chronic rhinitis during the study period, defined as

between January 1, 2004, and January 31, 2005; and had been continuously enrolled in the plan for 12 months before and 12 months after the index date. The date of a patient's earliest medical or pharmacy claim during the study period for allergic or chronic rhinitis was defined as the *index date*. To be classified as being diagnosed as having allergic or chronic rhinitis, a patient had to have at least 1 claim encounter with an *ICD-9-CM* code of 477.xx (allergic rhinitis) or 472.xx (chronic rhinitis) and at least 1 pharmacy claim for an antihistamine, an INS, or montelukast or have 2 claim encounters with an *ICD-9-CM* code of 477.xx or 472.xx during the study period. Patients with comorbid asthma who were treated with montelukast were excluded from analyses to prevent potential confounding arising from montelukast being prescribed for asthma rather than rhinitis. (Montelukast is indicated for the treatment of asthma as well as allergic rhinitis.)

Health care use and cost data (medical costs, pharmacy costs, and total [medical plus pharmacy] costs) were summarized for all patients with rhinitis for the 12-month period after the index date. Postindex outcomes included health care use (numbers of hospitalizations, emergency department visits, rhinitis-related specialist office visits, and other outpatient visits), health care costs (total medical cost and costs of hospitalizations, emergency department visits, ambulatory visits [office plus outpatient], office visits, rhinitis-related specialist office visits, and other outpatient visits), prescription drug use (average number of filled prescriptions), and prescription drug costs for antihistamines, INSs, and montelukast. The study captured overall health care use and costs (termed *all use and costs*) and rhinitis-related health care use and costs (termed *rhinitis-related use and costs*) during the 1-year follow-up. Cost and use of health care services were evaluated using univariate analyses.

The incremental burden of the following prespecified comorbid conditions (*ICD-9-CM* codes in parentheses) on the medical, pharmacy, and total costs of treating rhinitis was determined: asthma (493.xx), chronic obstructive pulmonary disease (491.xx, 492.x, or 496), sinusitis (461.xx or 473.xx), migraine and headache not otherwise specified (346.xx or 784.0), sleep disorder (327.xx or 307.4), hypertension (401.xx–405.xx), diabetes mellitus (250.xx), depression (296.xx, 298.0, 300.4, 309.1, and 311.xx), otitis media (381.xx or 382.xx), conjunctivitis (372.0x–372.3x), and nasal polyps (471.xx). The 10 most frequently occurring conditions in conjunction with rhinitis as the primary diagnosis code were selected as comorbidities. In addition, nasal polyps were chosen as a comorbidity based on their inclusion in previous research.¹⁹ The comorbid conditions could have been preexisting (ie, identified during a 12-month prestudy baseline period) or concurrent with rhinitis (ie, diagnosed during the 12-month postindex period). Regression analyses incorporating a generalized linear model framework were used to predict the rhinitis-related costs for patients with rhinitis and the comorbid condition and for patients with rhinitis and without the comorbid condition. The generalized linear model framework was used to avoid the problems of retransformation of

cost.^{20,21} A 1-part model was used because it captures the prominent feature of average health care costs, which are positive after controlling for patient characteristics. The models included an indicator for the presence of the comorbidity and controlled for age, sex, insurance type, and geographic region. Using similar analysis methods, the effect of topical ocular medication use on rhinitis-related medical, pharmacy, and total health care costs was also determined.

RESULTS

Cohorts

The number of patients identified as having rhinitis and meeting the other eligibility criteria was 301,001, of whom 286,202 had allergic rhinitis and 46,140 had chronic rhinitis (Table 1). These categories were not mutually exclusive: 31,341 patients had both allergic rhinitis and chronic rhinitis. The mean age of the patients was 36 years.

Health Care Use and Costs

Annual rhinitis-related total medical and prescription drug costs averaged \$657 per patient per year (Table 2). Medical costs (\$319 per patient per year) and drug prescription costs (\$338 per patient per year) contributed approximately equally to the total rhinitis-related health care cost.

Office visits accounted for most rhinitis-related medical costs (Table 2). The study cohort had an average of 1.50 rhinitis-related office visits and 0.47 rhinitis-related specialist office visit per patient per year. As expected for rhinitis, hospitalizations and emergency department visits attributed to rhinitis were infrequent (Table 2).

Prescription Drug Use and Costs

The most common class of medications for rhinitis was antihistamines, followed by INSs and leukotriene modifiers. At least 1 filled prescription medication during the study period was documented for 64.3% of patients for an antihistamine, 47.3% of patients for an INS, and 17.0% of patients for montelukast (Table 1). Of the patients with at least 1 filled prescription for an antihistamine, an INS, or montelukast, more than one-third (37%) used more than 1 class of prescription rhinitis medication during the study period.

Among those receiving monotherapy, the mean number of annual filled prescriptions per patient was highest for antihistamines, followed by montelukast and INSs. Among those receiving combination therapies, the mean number of annual filled prescriptions per patient was higher for those receiving 3 classes of medication vs those receiving 2 classes (Table 3).

Among patients receiving rhinitis monotherapy, the average prescription medication cost for rhinitis treatment was highest for the montelukast group, followed by the antihistamine group and the INS group (Table 3). Among patients receiving combination therapy, the average prescription medication cost for rhinitis treatment was highest for regimens including montelukast (Table 3). Among patients receiving bicomination therapy, those receiving INS plus antihistamines had lower average annual prescription costs than those receiving montelukast plus antihistamines. In the bicomination group of INS plus montelukast, the average annual prescription cost was \$183 for INS and \$339 for montelukast. Among patients receiving tricombination therapy, monte-

Table 2. Health Care Use and Costs per Person per Year During the 1-Year Follow-up for 301,000 Patients^a

Variable	Overall	Rhinitis related
Health care services		
No. of hospitalizations	0.07 (0.34)	0 (0.05)
No. of emergency department visits	0.63 (3.04)	0.02 (0.56)
No. of office visits ^b	7.1 (5.9)	1.5 (1.7)
No. of rhinitis-related specialist office visits ^{b,c}	NA	0.47 (1.20)
No. of office visits (any type) ^d	13.43 (14.08)	4.17 (8.60)
Cost, US \$		
Hospitalizations	762 (6886.2)	25 (833.1)
Emergency department visits	67 (387.6)	2 (43.8)
Ambulatory visits (office plus outpatient)	2,635 (5,569.9)	285 (663.4)
Office visits	1,326 (2,681.3)	268 (593.7)
Rhinitis-related specialist office visits ^c	NA	144 (519.6)
Other office visits ^e	1,309 (4,299.0)	17 (290.5)
Total medical cost	3,693 (10,919.3)	319 (1,072.9)
Total prescription cost	1,523 (2,405.3)	338 (405.1)
Total cost (medical plus prescription)	5,216 (11,695.1)	657 (1,169.3)

Abbreviation: NA, data not applicable.

^a Data are given as mean (SD).

^b Visit count restricted to encounters with a physician-billed evaluation and management code (*Current Procedural Terminology* 4 code 99,000–994,999), by site of service of office or clinic, and to 1 encounter per physician per day.

^c Allergist or pulmonologist.

^d Visit count restricted to encounters with site of service of office or clinic and to 1 encounter per physician per day.

^e Excludes physician office visits.

Table 3. Data for Filled Prescriptions and Medical, Prescription, and Total Costs per Person per Year^a

Drug	No. of filled prescriptions	Medical cost, US \$	Prescription cost, US \$	Total cost (medical plus prescription), US \$
Antihistamine (n = 90,703)	3.3 (3.2)	215 (828)	194 (226)	409 (872)
INS (n = 47,451)	2.6 (2.3)	213 (669)	188 (173)	401 (701)
Montelukast ^b (n = 3,648)	3.2 (3.1)	188 (683)	302 (292)	490 (751)
Antihistamine plus INS (n = 70,185)	4.0 (2.2) plus 2.6 (2.2)	339 (246)	253 (169) plus 186 (169)	777 (189)
Antihistamine plus montelukast ^b (n = 5,366)	4.0 (3.7) plus 3.3 (3.1)	308 (964)	234 (251) plus 315 (295)	857 (1082)
INS plus montelukast ^b (n = 2,917)	2.5 (2.2) plus 3.6 (3.2)	294 (590)	183 (166) plus 339 (307)	816 (728)
Antihistamine plus INS plus montelukast ^b (n = 6,628)	4.5 (3.7) plus 2.9 (2.5) plus 3.6 (3.1)	484 (827)	282 (263) plus 211 (189) plus 348 (301)	1,325 (1039)

Abbreviation: INS, inhaled corticosteroid.

^a Data are given as mean (SD).

^b Montelukast users do not include patients with asthma.

lukast was the biggest component of prescription costs, followed by antihistamines and INS (Table 3).

The use of topical ocular medication increased rhinitis-related health care costs. The increase in rhinitis-related health care costs per patient per year between those using ocular medication and those not using ocular medication was \$37.91 for medical costs, \$134.51 for prescription costs, and \$215.65 for total costs.

Comorbidities and Their Effect on Cost

The most common comorbidities were sinusitis and asthma (Table 1). The presence of a comorbid condition generally increased the rhinitis-related cost burden (Table 4 and Figure 1). Asthma, chronic obstructive pulmonary disease, sinusitis, migraine, depression, conjunctivitis, and nasal polyps increased rhinitis-related medical, pharmacy, and total costs (Table 4 and Figure 1). Asthma had the greatest effect on predicted rhinitis-related pharmacy costs, and nasal polyps had the greatest effect on predicted rhinitis-related medical costs. Sleep disorder, hypertension, diabetes mellitus, and otitis media did not appreciably affect rhinitis-related medical, pharmacy, or total costs.

DISCUSSION

The results of this study involving pharmacy and medical claims data from more than 300,000 patients with rhinitis show that rhinitis-related medical and pharmacy costs constitute a substantial financial burden to a managed health plan. Rhinitis prescription pharmacy costs were the major contributors to average rhinitis-related total costs. Office visits (any type) were the primary component of rhinitis-related medical costs. The number and costs of rhinitis-related hospitalizations and emergency department visits were low to nil.

Antihistamines were the most common rhinitis medication, followed by INSs and montelukast. (INSs are endorsed as the

preferred treatment for allergic rhinitis in treatment guidelines¹). Many patients (37% of those with at least 1 filled prescription for an antihistamine, an INS, or montelukast) used combination therapy. Of the 3 main categories of pharmacotherapy, montelukast was associated with the highest pharmacy cost (\$353 vs \$198 for antihistamines and \$231 for INSs per patient per year for monotherapy) and drove the average annual prescription medication costs of combination therapy regardless of the concomitant medication(s). Among combination therapies involving montelukast and INSs, montelukast costs drove the total pharmacy costs for the combination therapy. Combination therapies involving montelukast were more expensive than those involving INSs. Sinus and asthma treatments were excluded from the analyses. Among the patients with and without allergic rhinitis, there were age and region differences ($P < .01$).

The most common comorbidities in patients with rhinitis were sinusitis and asthma, a result of corroborating previous findings.³ Both of these comorbidities and other less common comorbidities (chronic obstructive pulmonary disease, migraine, depression, conjunctivitis, and nasal polyps) increased the direct rhinitis-related health care costs. Comorbid asthma was particularly costly, with incremental total rhinitis-related health care costs of \$456 per patient per year in patients with rhinitis who had asthma vs those who did not have asthma. Nasal polyps, although not highly prevalent in the sample, substantially increased total rhinitis-related health care costs—by \$583 per patient per year for those with nasal polyps vs those without nasal polyps. The results underscore the importance of considering the costs of comorbidities in estimating the economic burden of rhinitis. Rhinitis is usually accompanied by several comorbid conditions.^{3,6} Comorbid conditions increase the cost of treating rhinitis and, therefore, contribute to overall economic effect. Analyses that examine the relative costs of interventions for rhinitis and comorbid-

Table 4. Incremental Average Annual Rhinitis-Related Health Care Costs for Comorbid Conditions

Comorbid condition	Cost type	Rhinitis-related health care cost, US \$			
		Adjusted ^a		Unadjusted	
		With comorbidity	Without comorbidity	With comorbidity	Without comorbidity
Asthma	Medical	512.04	332.46	467.27	274.77
	Prescription	595.95	322.32	515.88	285.83
	Total	1,012.42	556.56	983.15	560.60
Chronic obstructive pulmonary disease	Medical	426.89	374.68	381.95	316.48
	Prescription	463.11	380.52	448.65	334.52
	Total	796.13	652.43	830.60	651.00
Sinusitis	Medical	430.56	340.21	390.46	275.57
	Prescription	415.94	363.51	372.52	317.67
	Total	763.47	593.70	762.98	593.24
Migraine	Medical	456.35	358.34	405.35	300.04
	Prescription	387.74	382.51	344.10	336.95
	Total	745.77	638.22	749.45	636.99
Sleep disorder	Medical	384.24	376.44	331.39	318.55
	Prescription	382.01	383.44	355.69	338.15
	Total	673.46	657.22	687.08	656.70
Hypertension	Medical	369.49	378.29	326.68	316.61
	Prescription	403.58	377.98	386.42	326.37
	Total	673.54	652.98	713.10	642.98
Diabetes mellitus	Medical	368.81	376.91	318.29	318.61
	Prescription	391.07	382.98	372.65	336.29
	Total	655.18	657.40	690.94	654.90
Depression	Medical	431.39	370.05	371.56	312.53
	Prescription	400.62	381.34	374.54	334.05
	Total	728.45	648.90	746.10	646.58
Otitis media	Medical	379.11	376.00	333.93	315.97
	Prescription	394.15	381.71	330.30	339.57
	Total	692.52	651.52	664.23	655.54
Conjunctivitis	Medical	509.63	359.89	468.85	301.54
	Prescription	434.74	377.81	371.56	334.42
	Total	853.08	635.41	840.41	635.96
Nasal polyps	Medical	776.92	369.83	750.50	312.35
	Prescription	535.89	381.05	511.29	335.71
	Total	1231.40	648.74	1261.79	648.06

^a Adjusted medical and prescription costs do not sum to the total because they are predicted costs.

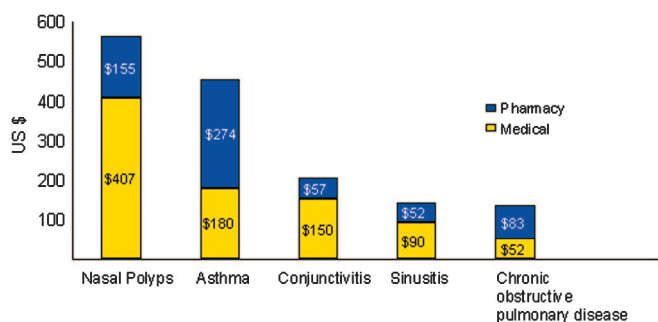


Figure 1. Selected incremental costs of rhinitis comorbidities, per patient per year.

ties will be misspecified if the joint cost effect of rhinitis and the comorbidities is not considered. Furthermore, failure to

recognize comorbidities may reduce the effectiveness of any intervention and misdirect cost-effective disease management strategies. Interventions that improve common pathophysiological features or measures that modify common risk factors have the potential to improve both diseases and may have additive or synergistic clinical and cost-saving benefits. The potential that strategies used to treat a comorbidity may improve or worsen comorbid illness should be considered. For example, several studies^{22,23} demonstrate that treatment of concomitant allergic rhinitis in patients with asthma significantly reduces asthma-attributed health care use, including emergency department treatment and hospitalization. This study did not include sinus or asthma treatment. The purpose of this study was to understand the direct costs of rhinitis; therefore, patients with asthma were excluded.

The data from this investigation should be interpreted in the context of its strengths and limitations. The strengths of

this investigation include the national representativeness of the sample, the generalizability of the results to clinical practice, and the maximization of data capture by conducting the study in an integrated health care delivery system. A limitation of this investigation is the retrospective observational design, which allows for the possibilities of confounding and the introduction of biases that may not be detectable because of the lack of linked clinical data and unrecognized confounders. In addition, this study did not capture indirect costs (ie, those attributable to lost productivity or poor quality of life) and, therefore, underestimates the full economic burden of rhinitis. Also, several limitations apply to the use of claims data. First, the presence of a claim for a filled prescription does not indicate that the medication was taken as prescribed. Second, the presence of a diagnosis code on a medical claim is not proof of disease because the diagnosis may be incorrectly coded or included on the claim as an exclusion criterion rather than be a reflection of a diagnosis. However, this study included the criterion of at least 2 diagnosis codes to identify and account for any exclusionary diagnoses. Finally, certain information, such as clinical and disease-specific variables, that could shed light on study outcomes is not readily available in claims data.

Several factors may have led to underestimation of the health care use and costs of treating rhinitis in this study. Enrollees were considered to have treated rhinitis only if a diagnosis for them was recorded during 2004 (ie, from January 1, 2004, through January 31, 2005). Patients in the database with rhinitis who were diagnosed as having rhinitis before January 1, 2004, were not identified as having rhinitis. Therefore, the study did not capture rhinitis-attributed health care use of costs incurred in 2004 by enrollees who received ongoing treatment for rhinitis but whose 2004 records did not include a rhinitis diagnosis. The exclusion from the analyses of patients with comorbid asthma treated with montelukast (because of the possibility that montelukast was prescribed for asthma rather than rhinitis) may have contributed to underestimation of the costs of treating rhinitis.

There are no recently published studies detailing the burden of rhinitis in managed care. This burden is often perceived as trivial compared with other chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease. This study documents the drivers of rhinitis care and costs. The cost burden of rhinitis literature is dated and is, as summarized by Reed et al,¹⁶ based on mostly survey-reported information. There have been studies^{16,18,24–29} that either summarize literature or use population-based self-reported patient surveys to document the economic burden of rhinitis. The advantages of claims data are based on being able to examine “real-world” reimbursed amounts and, therefore, are an accurate reflection of outcomes compared with self-reported numbers. The burden of comorbid conditions to rhinitis cost has not been reported elsewhere.

In summary, data from this retrospective claims analysis demonstrate that allergic rhinitis and chronic rhinitis are associated with financial burden to managed care. Medical

costs and drug prescription costs contributed approximately equally to the total rhinitis-related health care cost. Comorbidities, particularly asthma and nasal polyps, increased the direct rhinitis-related health care costs of patients with rhinitis.

ACKNOWLEDGMENTS

We thank Jane Saiers, PhD, for her assistance with writing the manuscript (GlaxoSmithKline funded her work).

REFERENCES

1. Dykewicz MS, Fineman S. Executive summary of Joint Task Force Practice Parameters on Diagnosis and Management of Rhinitis. *Ann Allergy Asthma Immunol*. 1998;81:463–468.
2. National Center for Health Statistics, Centers for Disease Control and Prevention, US Department of Health and Human Services. *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. Available at: <http://www.cdc.gov/nchs/about/otheract/icd9/abctcd9.htm>. Accessed June 21, 2007.
3. Skoner DP. Complications of allergic rhinitis. *J Allergy Clin Immunol*. 2000;105(pt 2):S605–S609.
4. Juniper EF. Measuring health-related quality of life in rhinitis. *J Allergy Clin Immunol*. 1997;99:S742–S749.
5. Kremer B. Quality of life scales in allergic rhinitis. *Curr Opin Allergy Clin Immunol*. 2004;4:171–176.
6. Nathan RA. The burden of allergic rhinitis. *Allergy Asthma Proc*. 2007;28:3–9.
7. Bousquet J, Bullinger M, Fayol C, Marquis P, Valentin B, Burtin B. Assessment of quality of life in patients with perennial allergic rhinitis with the French version of the SF-36 Health Status Questionnaire. *J Allergy Clin Immunol*. 1994;94:182–188.
8. Meltzer EO, Nathan RA, Seiner JC, Storms W. Quality of life and rhinitic symptoms: results of a nationwide survey with the SF-36 and RQLQ questionnaires. *J Allergy Clin Immunol*. 1997;99(suppl 2):S815–S819.
9. Ferguson BJ. Influences of allergic rhinitis on sleep. *Otolaryngol Head Neck Surg*. 2004;130:617–629.
10. Nathan RA, Meltzer EO, Seiner JC, Storms W. Prevalence of allergic rhinitis in the United States. *J Allergy Clin Immunol*. 1997;99(suppl 2):S808–S814.
11. Fleming DM, Crombie DL. Prevalence of asthma and hay fever in England and Wales. *BMJ*. 1987;294:279–283.
12. Åberg N. Asthma and allergic rhinitis in Swedish conscripts. *Clin Exp Allergy*. 1989;19:59–63.
13. Hopper JL, Jenkins MA, Carlin JB, Giles GG. Increase in the self-reported prevalence of asthma and hay fever in adults over the last generation: a matched parent-offspring study. *Aust J Public Health*. 1995;19:120–124.
14. Bauchau V, Durham SR. Prevalence and rate of diagnosis of allergic rhinitis in Europe. *Eur Respir J*. 2004;24:758–764.
15. Huurree TM, Aro HM, Jaakkola JJ. Incidence and prevalence of asthma and allergic rhinitis: a cohort study of Finnish adolescents. *J Asthma*. 2004;41:311–317.
16. Reed SD, Lee TA, McCrory DC. The economic burden of allergic rhinitis: a critical evaluation of the literature. *Pharmacoeconomics*. 2004;22:345–361.
17. Virant FS. Allergic rhinitis. *Immunol Allergy Clin North Am*. 2000;20:265–282.
18. Ray NF, Baraniuk JN, Thamer M, et al. Direct expenditures for the treatment of allergic rhinoconjunctivitis in 1996, including the contributions of related airway illnesses. *J Allergy Clin Immunol*. 1999;103:401–407.
19. Schoenwetter WF, Dupclay L Jr, Appajosyula S, et al. Economic impact and quality-of-life burden of allergic rhinitis. *Curr Med Res Opin*. 2004;20:305–317.

-
20. Duan A. Smear estimate: a nonparametric retransformation method. *J Am Stat Assoc.* 1983;78:605–610.
 21. Manning WG, Mullahy J. Estimating log models: to transform or not to transform. *J Health Econ.* 2001;20:461–494.
 22. Corren J, Manning BE, Thompson SF, Hennessey S, Strom BL. Rhinitis therapy and the prevention of hospital care for asthma: a case control study. *J Allergy Clin Immunol.* 2004;113:415–419.
 23. Fuhlbrigge AL, Adams RJ. The effect of treatment of allergic rhinitis on asthma morbidity, including emergency department visits. *Curr Opin Allergy Clin Immunol.* 2003;3:29–32.
 24. McMenamin P. Costs of hay fever in the United States in 1990. *Ann Allergy.* 1994;73:35–39.
 25. Malone DC, Lawson KA, Smith DH, Arrighi HM, Battista C. A cost of illness study of allergic rhinitis in the United States. *J Allergy Clin Immunol.* 1997;99(pt 1):22–27.
 26. Mackowiak JI. The health and economic impact of rhinitis. *Am J Manag Care.* 1997;3(suppl II):S8–S18.
 27. Baraniuk JM, Meltzer EO, Spector SL. Impact of allergic rhinitis and related airway disorders. *J Respir Dis.* 1996;17(suppl):511–523.
 28. Storms W, Meltzer EO, Nathan RA, et al. The economic impact of allergic rhinitis. *J Allergy Clin Immunol.* 1997;99(suppl 2):S820–S824.
 29. Law AW, Reed SD, Sundry J, et al. Direct costs of allergic rhinitis in the United States: estimates from the 1996 Medical Expenditure Panel Survey. *J Allergy Clin Immunol.* 2003;111:296–300.
- Requests for reprints should be addressed to:*
Anand A. Dalal, PhD
GlaxoSmithKline
5 Moore Dr
Research Triangle Park, NC 27708
E-mail: anand.a.dalal@gsk.com
-