

Direct expenditures for the treatment of allergic rhinoconjunctivitis in 1996, including the contributions of related airway illnesses

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Background: Previous estimates of the national economic burden of allergic rhinoconjunctivitis (AR/AC) have relied on data analyses in which AR/AC was the primary International Classification of Diseases—ninth revision—Clinical Modification (ICD-9-CM)—coded diagnosis. These studies ignore the costs when AR/AC was a secondary diagnosis to other disorders such as asthma and sinusitis.

Objective: We sought to determine the national direct cost of illness for AR/AC.

Methods: An expert panel used the Delphi technique to estimate the proportion of visits coded by other primary ICD-9-CM diagnoses in which AR/AC was a significant secondary comorbid condition. The costs of this proportion were deemed to be “attributable” to AR/AC and were added to the costs when allergic rhinitis and allergic conjunctivitis were the primary diagnoses.

Results: The cost when AR/AC was the primary diagnosis was \$1.9 billion (in 1996 dollars). The cost when AR/AC was a secondary diagnosis was estimated at \$4.0 billion, giving an estimate of \$5.9 billion for the overall direct medical expenditures attributable to AR/AC. Outpatient services (63%, \$3.7 billion), medications (25%, \$1.5 billion), and inpatient services (12%, \$0.7 billion) accounted for the expenditures. Children 12 years and younger accounted for \$2.3 billion (38.0%).

Conclusion: Upper airway allergy is an expensive disease process because of its readily apparent manifestations as AR/AC and its contribution to other airway disorders. (*J Allergy Clin Immunol* 1999;103:401-7.)

Key words: Allergic rhinoconjunctivitis, allergic rhinitis, allergic conjunctivitis, cost of illness, health economics

The direct plus indirect costs of allergic rhinitis (AR) have been estimated at \$1.2 billion in 1990¹ and \$1.8 billion in 1994.² These estimates were derived from national health care surveys and included only the cost when AR was the primary diagnosis (International Classification of Diseases—ninth revision—Clinical Modification [ICD-9-CM] code 477). Neither study estimated costs for AR treatment when another comorbid condition was the primary diagnosis coded into the database. This exclusion may have reduced the overall economic impact of AR because AR is a predisposing factor for the development and exacerbation of asthma,³⁻⁶ sinusitis,^{7,8} otitis media with effusion,⁹ and nasal polyposis.¹⁰ These disorders share common pathogenic mechanisms^{3,5} and familial^{11,12} and environmental¹³ influences that may predispose or directly cause other syndromes to develop. Conversely, treatment of AR reduces the severity of asthma^{14,15} and potentially other conditions. The exact degree of overlap between AR and these other airway disorders is a matter of debate and continued study¹⁶ and is of clear relevance when assessing the overall economic impact of AR.

The objective of this prevalence-based cost-of-illness study was to estimate the direct healthcare expenditures associated with treating the combined entity of allergic rhinoconjunctivitis (AR/AC) for all persons in the United States in 1996. Standard methods were used to determine the costs when the primary diagnosis was AR/AC. In addition, costs were determined for a series of other primary airway disorders in which AR/AC could be a significant, but secondary, comorbid condition. These conditions included sinusitis, chronic rhinitis, acute upper respiratory infections, pharyngitis and tonsillitis, rhinorrhea, asthma, nonatopic conjunctivitis, and chronic otitis media and eustachian tube disorders. The degree of overlap for AR/AC and these other primary disorders is difficult to gather from current national health care survey and administrative claims data because AR/AC is dramatically underreported as a secondary medical diagnosis. In fact, secondary diagnoses are often not coded into national databases. For example, only 27.7% of all AR encounters (ICD-9-CM code 477) had any secondary diagnosis (1994 National Ambulatory Care Survey).

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TABLE I. Estimated proportion of each airway disorder with concomitant allergic rhinoconjunctivitis by age

Airway disorder	ICD-9-CM code	Children ≤ 12 years			Adults ≥ 13 years		
		%	SD	Validity rank	%	SD	Validity rank
Atopic conjunctivitis	372.05, 372.13, 372.14	100	24.5	1.0	100	24.5	1.0
Chronic otitis media and eustachian tube disorders	381.1-381.9, 382.1-382.9	30	6.8	2.0	30	6.3	1.8
Sinusitis	461, 473	30	6.3	1.8	30	8.7	1.8
Asthma	493	20	8.1	2.2	15	12.1	2.2
Acute upper respiratory infections	465	5	2.4	2.0	5	2.4	2.0
Pharyngitis and tonsillitis	462, 463	5	3.7	1.4	5	3.7	1.4
All other conjunctivitis	Remainder of 372	10	4.0	1.6	10	4.0	1.6
Chronic rhinitis	472.0	15	6.8	1.8	15	9.7	2.0
Rhinorrhea	478.1	25	7.5	1.8	25	10.7	1.8
Acute otitis media	381.0, 382.0	10	5.8	1.8	10	4.5	1.8
Nasal polyps	471	10	9.7	1.8	20	7.3	1.8

Ranges for validity ranks are 1 ($\pm 5\%$ error); 2 ($\pm 10\%$ error); 3 ($\pm 20\%$ error); and 4 ($> 20\%$ error).
%, Percent attributable to AR/AC.

Abbreviation used

AR:	Allergic rhinitis
AC:	Allergic conjunctivitis
AR/AC:	Allergic rhinoconjunctivitis
ICD-9-CM:	International Classification of Diseases—ninth revision—Clinical Modification
NCHS:	National Center for Health Statistics

Chronic sinusitis (6.2%), acute sinusitis (0.6%), and asthma (0.5%) were infrequently coded during AR visits.

As an alternative method, the degree of overlap between AR/AC and the other disorders was estimated by an expert panel using the Delphi consensus-building technique.¹⁷⁻¹⁹ This method has evolved as an expedient and effective mechanism to address complex health care questions and issues when empiric data are absent. The technique has been frequently applied and validated in health care research.¹⁷⁻²⁶ This technique allowed us to estimate the costs devoted to evaluation and treatment of AR/AC but assigned to other airway disorders. Addition of this sum to the direct costs when AR/AC was the primary diagnosis yields an estimate of the overall direct costs for AR/AC.

METHODS

Delphi procedure

An expert panel of 4 practicing physicians (JNB, MK, SJ, and Y-HP) and an epidemiologist (PJG) were recruited on the basis of their clinical and research expertise in allergy, immunology, otolaryngology, and pulmonary medicine, and they represented academic, private practice, and government affiliations. The following ICD-9-CM codes²⁷ covering major airway disorders were identified by extensive literature reviews and the expert panel: AR (477), atopic conjunctivitis (372.05, 372.13, 372.14), chronic rhinitis (472), sinusitis (461, 473), nasal polyps (471), acute upper respiratory infection (465), pharyngitis and tonsillitis (462, 463), rhinorrhea

(478.1), asthma (493), nonatopic conjunctivitis (remainder of 372), and chronic otitis media and eustachian tube disorders (381.1-381.9, 382.1-382.9). Because differences by sex and race were not deemed to be critical, the panelists estimated the proportional estimates by age for the following 2 groups: patients 12 years or younger ("children") and patients 13 years or older ("adults").

A 3-round modified consensus Delphi procedure was used to develop a group judgment on the proportion of patients with a related airway disorder and comorbid AR/AC.^{18,22} Round I was conducted by mail to permit an initial independent assessment by each panelist of the relationship of AR/AC to each of the other disorders. The original question to be investigated was as follows: "What is the percentage of patients with each of the following airway disorders who also have allergic rhinitis?" Proportional estimates were reported in 5% increments and were analyzed in advance of the expert panel meeting. To attribute the greatest weight to the most common responses, the mode and range of the proportion estimates were calculated for each airway disorder by age group.

The expert panel convened in a face-to-face meeting to discuss the results of Round I. It was decided that the original question implied a close pathophysiologic connection of AR and allergic conjunctivitis (AC), and therefore the 2 were amalgamated into 1 category of allergic rhinoconjunctivitis (AR/AC). Because this was an economic analysis, the panel decided that the presence of a single common pathogenic mechanism (ie, atopy) should not be the sole criteria for disease association. Hence other atopic diseases, such as atopic dermatitis, were not assessed for their overlap with AR/AC. Such an "epidemiologic" approach could overestimate the morbidity if a clear distinction was not made between the atopic diathesis and each ICD-9-CM-coded disease grouping. A more concrete and discernible focus was honed: "For each primary ICD-9-CM-coded airway disorder, determine the percentage of encounters in which AR/AC was a secondary diagnosis evaluated, treated, and contributing to the primary disorder." This fraction was felt to estimate the "hidden" or uncoded contribution of AR/AC to the cost of the primary disorders. This can be restated to be the costs attributed to one of the primary diagnoses (eg, sinusitis) in the health economics databases that were actually caused by AR/AC. This modification was used for Rounds II and III.

The panel reviewed the responses of Round I and provided a second series of proportional estimates (Round II). The modal probabilities and associated ranges were again calculated. Another discussion ensued regarding the areas of greatest disagreement for the

TABLE II. Sources of data for rhinitis health resource use and expenditure estimates (in 1996 dollars)

Type of service	Source of use data	Unit price per encounter*
Institutional care		
Hospital discharges and inpatient days	<i>1994 National Hospital Discharge Survey.</i> An ongoing survey of noninstitutional general and short-stay hospitals (hospitals with an average length of stay of fewer than 30 days), exclusive of Federal, military, and Veterans Administration hospitals, located in the 50 states and the District of Columbia. In 1994, 276,533 discharges were obtained from the 478 hospitals that participated in this survey.	\$1881
Outpatient care		
Office-based physician encounters and prescriptions	<i>1994 National Ambulatory Medical Care Survey.</i> A national sample of office-based nonfederal physicians, excluding anesthesiology, pathology, and radiology. In 1994, 35,598 patient record forms were received from the 1704 physicians who participated in this survey.	\$95
Hospital outpatient encounters and prescriptions	<i>1994 National Hospital Ambulatory Medical Care Survey.</i> A national sample of hospital outpatient departments of noninstitutional general and short-stay hospitals, exclusive of Federal, military, and Veterans Administration hospitals, located in the 50 states and the District of Columbia. In 1994, 29,095 patient records were obtained from the 260 hospital outpatient departments participating in this survey.	\$547
Free-standing ambulatory surgery center encounters	<i>1994 National Survey of Ambulatory Surgery.</i> A national sample of ambulatory surgery procedures performed in hospitals and free-standing ambulatory surgery centers in the United States. The hospital universe includes noninstitutional general and short-stay hospitals, exclusive of Federal, military, and Veterans Administration hospitals, located in the 50 states and the District of Columbia. In 1994, 117,861 patient records were obtained from the 491 hospitals and centers participating in this survey.	\$547
Emergency department encounters	<i>1994 National Hospital Ambulatory Medical Care Survey.</i> A national sample of hospital outpatient departments of noninstitutional general and short-stay hospitals, exclusive of Federal, military, and Veterans Administration hospitals, located in the 50 states and the District of Columbia. In 1994, 29,547 patient records were obtained from the 418 emergency departments participating in this survey.	\$350
Outpatient medication	<i>1994 National Ambulatory Medical Care; 1994 National Hospital Ambulatory Medical Care.</i>	\$32

*Extrapolated from 1987 National Medical Expenditure Survey.

attribution of AR/AC to the other disorders. Round III then commenced, with each panelist assigning a final proportional estimate for each airway disorder. In this final stage of consensus building, median proportional estimates were calculated. These final estimates were mailed to each panel member, who then ranked their level of confidence in the final result according to the following numeric validity scale: 1 = certain, proportion estimate is dependable within $\pm 5\%$; 2 = reliable, dependable within $\pm 10\%$; 3 = risky, dependable within $\pm 20\%$; or 4 = unreliable, undependable by more than $\pm 20\%$ (Table I).

Estimating health resource use and expenditures attributable to AR/AC

National health care survey data from the National Center for Health Statistics (NCHS) were analyzed (Table II).²⁸ Encounters for each primary diagnosis were extracted from each survey. All encounters

for AR and atopic conjunctivitis were attributed to AR/AC. For the remaining disorders, the panel's final proportional estimates were multiplied by the total number of inpatient and outpatient encounters for each airway disorder to estimate healthcare resource use attributable to AR/AC (Table III). Data from these 1994 surveys were extrapolated to 1996 values by using standard epidemiologic techniques.²⁹

The unit price per encounter was determined for each type of service (Table II) on the basis of the 1987 National Medical Expenditure Survey of the Agency for Health Care Policy and Research and was inflated to 1996 dollars.³⁰ These average expenditures were based on payments from Medicare, Medicaid, private third-party payers, and other sources. The cost per inpatient hospital day represents the sum of facility and physician expenses. Expenditures for each ICD-9-CM code were calculated by multiplying encounters (Table III) by unit price per encounter (Table II) to yield that cost for each type of resource use, disease, and the total attributable cost of AR/AC (Table IV). Data were further disaggregated by age (<12

TABLE III. Resource use attributable to AR/AC in the United States by type of service and airway disorder, 1996

Airway disorder	Inpatient hospital		Outpatient encounters				Prescriptions
	Discharges	Days	Physician office	Hospital outpatient	Ambulatory surgery center	Emergency department	
AR/AC	*	*	9,864,529	476,207	*	207,436	18,536,685
Chronic otitis media and eustachian tube disorder	11,114	26,374	5,685,463	425,334	26,948	932,480	10,001,288
Sinusitis	13,532	46,878	4,589,939	214,087	5544	223,756	9,205,377
Asthma	69,005	278,282	1,645,076	154,378	*	245,829	4,891,229
Acute upper respiratory infection	2220	6795	871,739	56,203	*	104,112	1,533,460
Pharyngitis and tonsillitis	1478	4159	670,601	39,093	192	105,176	1,122,249
Other conjunctivitis	*	*	349,319	29,276	592	57,953	567,298
Chronic rhinitis	*	*	316,453	16,201	*	10,706	613,292
Rhinorrhea	*	*	207,064	*	1743	*	356,012
Total	97,349	362,488	24,200,183	1,410,779	35,019	1,887,448	46,862,890

Prescriptions included prescription and nonprescription medications ordered or prescribed during physician office-based, hospital outpatient department, and emergency department encounters.

*Data could not be reported because the weighted estimates were of small magnitude, had standard errors >30%, and were not statistically valid by NCHS criteria.

TABLE IV. Medical expenditures attributable to AR/AC in the United States by type of service and airway disorder, 1996 (in millions of dollars)

Airway disorder	Hospital encounters		Outpatient encounters				Total
	Discharges	Physician office	Hospital outpatient	Ambulatory surgery center	Emergency department	Prescriptions	
AR/AC	*	937.1	260.5	*	72.6	593.2	1863.4
Chronic otitis media and eustachian tube disorders	49.6	540.1	232.76	14.7	326.4	320.0	1483.5
Sinusitis	88.2	436.0	117.1	3.0	78.3	294.6	1017.3
Asthma	523.4	156.3	84.4	*	86.0	156.5	1006.7
Acute upper respiratory infection	12.8	82.8	30.7	*	36.4	49.1	211.8
Pharyngitis and tonsillitis	7.8	63.7	21.4	0.1	36.8	35.9	165.7
Other conjunctivitis	*	33.21	16.0	0.3	20.3	18.2	88.0
Chronic rhinitis	*	30.1	8.92	*	3.7	19.6	62.3
Rhinorrhea	*	19.7	*	1.0	—	11.4	32.0
Total	681.8	2299.0	771.7	19.2	660.6	1498.5	5930.8

Prescriptions include prescription and nonprescription medications prescribed during physician office, hospital outpatient department, and emergency department encounters; costs for refill were not included.

*Nonsignificant expenditures according to NCHS criteria.

years and >13 years) to assess costs for childhood and adult AR/AC (Table V).

RESULTS

Consensus panel conclusions

The proportions of patients with other primary airway disorders that were estimated to have comorbid AR/AC were relatively modest, ranging from 5% for acute upper respiratory infection and pharyngitis/tonsillitis, 10% for nasal polyps, 20% for asthma, and 30% for sinusitis and chronic otitis media and eustachian tube disorders (Table I). For nearly all airway disorders, the panel estimated that there were no differences according to age in the proportion of patients first seen with comorbid AR/AC. The only exceptions were nasal polyps (10% for patients ≤12 years vs 20% for patients ≥13 years) and asthma (20% for patients ≤12 years vs 15% for patients ≥13 years). The expert panel members were fairly confident

in the percentage estimates, with no validity rank higher than 2.2 (±12% error). The standard deviation for all estimates was relatively small, suggesting little disparity among the panel members for individual estimates.

Health resource use attributable to AR/AC

A total of 27.5 million outpatient physician, outpatient hospital, and emergency department examinations were attributed to AR/AC in 1996 (Table III). Of this total, 38.4% were for the primary treatment of AR/AC. The remaining encounters were for chronic otitis media and eustachian tube disorders (25.6%), acute and chronic sinusitis (18.3%), and asthma (7.4%). The remaining conditions constituted less than 5% of all attributable outpatient encounters. Allergy testing was reported during 7.1% and 15.6% of AR/AC outpatient office-based physician and outpatient hospital department encounters, respectively (data not shown). Outpatient office-based physician care for AR/AC was most frequently delivered

TABLE V. Medical expenditures attributable to AR/AC in the United States by age and airway disorder, 1996 (in millions of dollars)

Airway disorder	≤12 years	≥13 years	Total
AR/AC	356.6	1506.8	1863.4
Chronic otitis media and eustachian tube disorders	1173.5	310.0	1483.5
Sinusitis	176.0	841.2	1017.3
Asthma	255.3	751.4	1006.7
Acute upper respiratory infection	114.3	97.6	211.8
Pharyngitis and tonsillitis	76.5	89.3	165.7
Other conjunctivitis	41.6	46.3	88.0
Chronic rhinitis	30.3	32.0	62.3
Rhinorrhea	26.8	5.3	32.0
Total	2250.9	3679.9	5930.8

by allergists and pulmonary physicians (38.3%) followed by pediatricians (20.8%) and the primary care specialties of family medicine and general medicine (16.2%). Approximately 46.8 million prescription and nonprescription medications were prescribed or ordered during these outpatient examinations for an average of 1.7 per encounter. A total of 35,019 ambulatory surgical center encounters were attributed to AR/AC, principally for the treatment of chronic otitis media and eustachian tube disorders (77.0%). Inpatient costs were due to the equivalent of 97,349 hospital stays and 362,488 hospital days, with an average of 3.7 days per stay. Asthma was the primary diagnosis for 70.1% of the attributed discharges, with 25% caused by sinusitis, chronic otitis media, and eustachian tube disorders. Hospitalizations accounted for 11.9% of the overall cost.

Expenditures attributable to AR/AC

Expenditures attributable to AR/AC total \$5.93 billion in 1996, of which 31.4% was for treatment of AR/AC as the primary medical diagnosis, 25.0% for comorbid chronic otitis media and eustachian tube disorders, and 17% each for comorbid sinusitis and asthma (Table IV). The remaining airway conditions constituted less than 5% of total attributable medical expenditures. By type of service, outpatient office-based physician encounters were associated with 38.8% of total attributable medical expenditures followed by outpatient medication (25.3%), hospital outpatient (13.0%), hospital inpatient (11.5%), and emergency department (11.1%) expenditures. Ambulatory surgical centers accounted for less than 1% of total attributable expenditures.

Overall, 38% of total attributable expenditures were for children 12 years and younger, whereas 62.0% were for teens and adults (Table V). Not surprisingly, the distribution of expenditures by age differed between the 9 airway disorders. Children's costs were due to chronic otitis media and eustachian tube disorders (52.1%), AR/AC (15.8%), and asthma (11.3%). For teens and adults, AR/AC accounted for 41.0% of total attributable medical expenditures followed by sinusitis (22.9%) and asthma (20.4%). Costs for comorbid chronic rhinitis, acute upper respiratory infections, pharyngitis and tonsil-

litis, and other conjunctivitis were evenly distributed in the 2 groups.

DISCUSSION

The results of our Delphi consensus process indicate that the healthcare expenditures for AR and AC were \$5.93 billion (in 1996 dollars). Outpatient care accounted for 63%, medicines 25%, and inpatient care of associated disorders 12% of the cost. Treatment for children 12 years or younger amounted to 38% of all attributable medical expenditures.

Our study differs from previous analyses of national databases because we included both the costs accrued when AR was the primary diagnosis (31% of expenditures, \$1.86 billion) plus the costs attributable to AR/AC but classified to other primary diagnoses. These diagnoses included inner ear-related disorders (25%, \$1.48 billion), acute and chronic sinusitis (17%, \$1.01 billion), and asthma (17%, \$1.01 billion). Inclusion of these additional attributable costs increased the total direct cost of illness by 3.7 to 4.9 times the previous estimates. Exclusion of these costs would significantly underestimate the economic impact of AR/AC because AR/AC is underreported as a secondary medical diagnosis by coding physicians and in national databases and is often underappreciated as a contributing cause of these other airway complaints.

Our estimate for the direct cost of AR alone was similar to that of Malone et al (\$1.2 billion)¹ and McMennamin (\$1.6 billion)² once their figures were inflated (36) to 1996 dollars. There is reasonable agreement despite differences in methodology, data sources, and specific medical services studied. Malone et al¹ used the 1987 National Medical Expenditure Survey (Table II) to estimate expenditures for visits to outpatient offices, clinics, hospital offices, or emergency departments and for patients who received a medication. McMennamin² used the 1985 National Ambulatory Medical Care Survey (Table II)²⁸ to assess outpatient office-based physician encounters and medication costs. Our study provided a more comprehensive assessment of attributable health resource use by examining care provided at physician

offices, hospital outpatient departments, emergency departments, ambulatory surgical centers, and inpatient hospital facilities. Indirect costs could not be estimated from our databases.

The course and outcomes of the Delphi process were shaped in several critical ways by the expert panel. The original question posed to the panel was felt to be too closely related to the underlying prevalence of atopy in each disorder. Debate after the first round led to a more concrete question that better reflected the intention of the study.

The expert panel's estimates of economic overlap were lower than published rates for disease coexistence. For example, the prevalence of AR in children with otitis media and eustachian tube dysfunction ranges from 22% to 50%, whereas 23% of children with AR had secretory otitis media.^{9,16,31} The expert panel estimated that 30% ($\pm 10\%$ error) of the cost of middle ear disease was attributable to AR/AC. This estimate was contentious because many children have only single episodes, treatment with "antiallergy" drugs such as antihistamines and decongestants are largely ineffective, and a large proportion of the total cost is associated with chronic recurrent disease.³¹ This estimate should be reevaluated in future studies in which comorbidity data are more highly refined. Nasal polyps are another case in point because 29% of patients with nasal polyps may have AR/AC, yet the panel estimated that only 10% to 20% of the cost of care was attributable to AR/AC.¹⁰ The panel decided that disease associations did not necessarily lead to simultaneous treatment. For example, 17% to 21% of subjects with AR have asthma, and 28% to 80% of patients with asthma have AR.^{3-6,12,13,16} The Delphi process estimated that AR/AC was treated as a secondary diagnosis in only 15% to 20% of patients who are first seen with asthma.

Significant limitations that could influence the total cost of AR/AC are noteworthy. Because up to 88% of persons self-reporting hay fever symptoms were self-treated or untreated, current estimates may still grossly underrepresent the total cost of the disease. The costs of over-the-counter medications for self-treatment were not available. NCHS and the Agency for Health Care Policy and Research surveys do not include the federal, military, and Department of Veterans Affairs populations. The costs among residents of nursing homes and other institutions were also excluded. Costs of diagnostic services (blood tests, pulmonary-function testing, radiology procedures not associated with a physician encounter), related medical equipment (peak-flow meters, nebulizer equipment), and avoidance measures (dust mite, cockroach and dander elimination, encasings, high-efficiency particulate air filters) could not be determined.

The costs of prescription medications were low because the most recent large-scale data source was an updated (1994) survey from 1987 that was extrapolated to 1996 dollars.³⁰ National prescription costs were estimated at \$577 million for AR/AC and \$1.48 billion for the overall attributable expenditures. However, actual sales figures for the upper airway allergy market in 1996 show that nonsedating antihistamines cost \$1.483 billion,

nasal steroid sprays \$0.723 billion, and other drugs \$0.260 billion for a total of \$2.467 billion (IMS American Combined Retail Provider Perspective, personal communication from Michael Sheehy). Actual sales were 5 times higher than the estimate for AC/AR obtained from the national databases. Substitution of these actual costs into Table IV would add \$1 billion to the total expenditure. These figures suggest that the average cost of an allergy prescription was \$53 in 1996 compared with \$32 for all drug prescriptions (Table II). These sales figures do not include the costs of antibiotics, bronchodilators, and other drugs that would have been prescribed for each of the comorbid conditions. The costs of allergy shots and medication refills could not be determined.

The indirect costs associated with lost productivity were not estimated because we believe that the available data sources do not accurately measure the productivity losses associated with AR/AC. By using data from the 1994 National Health Interview Survey, the estimated number of work-loss days of persons who self-reported having hay fever was not statistically valid by NCHS criteria. For example, persons self-reporting hay fever had fewer restricted activity days (1.2 days per person) than persons not reporting hay fever (5.1 days per person). We believe that the productivity losses are underestimated because this data source is based solely on self-reports and calculations of the productivity losses associated with persons with asthma and hay fever, sinusitis and hay fever, otitis media and hay fever, or other combinations of comorbidities may not be valid.

ICD-9-CM introduces inherent problems of disease classification into secondary data sources. Cost-of-illness studies based solely on the primary or first-coded diagnosis may not be valid descriptions of the cost of care. The specific conditions and the sequence of these conditions reported on medical face sheets depend on interpretation and therefore may not be consistent between medical personnel. ICD-9-CM coding does not reflect clinical or pathologic classifications of airway diseases, nor does this coding system presume that the physician has explored the essential links between sinusitis, asthma, and underlying AR/AC. The assessment of symptoms such as cough (786.2), wheezing (786.09), dyspnea (786.0), recurrent respiratory infection (519.8), and acute rhinitis (460) were not examined because of the wide differential diagnoses evoked, the low percentages of each that would be attributed to AR/AC (0% or 5% as per the Methods section), and the unreliability of the estimates for these small numbers of encounters (standard error $>30\%$ with NCHS criteria).

National prevalence-based cost-of-illness studies, including this analysis, do not assess costs on a per patient basis. This is because the numbers of encounters for each ICD-9-CM code per year for each individual are not captured in the databases. An estimate of the average 1996 cost per patient was derived by dividing the total expenditures for AR/AC by the total population self-reporting hay fever (1994 National Health Interview Sur-

vey)²⁸ and inflating to represent the 1996 US civilian noninstitutionalized population (26.7 million persons, including 24.1 million persons 13 years or older).³² Children represented 9.7% of this population but accounted for 38% of the expenditures (Table V), although the estimate for the number of children was not statistically valid by NCHS criteria. By using these assumptions and limitations, the overall direct cost was \$222 per patient with hay fever, \$153 per adult, and an implied cost of \$902 per child. However, Malone et al¹ estimated that only 12.3% of persons self-reporting hay fever actually sought medical care. If so, then the medical databases and expenditures may have captured only 3.28 million persons, leading to average total costs of \$1807 per person treated by a physician for AR/AC, including \$1244 per adult and \$7333 per child. Clearly, new study methods are required to reconcile these figures.

In conclusion, the economic burden of AR/AC in the United States is substantial and disproportionate to the number of affected persons. The direct cost of care for AR/AC (\$1.9 billion) was less than that for the comorbid disorders, such as asthma (\$6.7 billion), chronic otitis media (\$4.9 billion), and sinusitis (\$3.4 billion), but the overall cost attributable to AR/AC was estimated at \$5.93 billion. These costs are likely to escalate given the rising prevalence of atopic diseases over the past several decades. Earlier evaluation and treatment of the allergic component may substantially reduce long term-expenditures by arresting the progression from rhinitis to disorders with greater morbidity and cost. This hypothesis is supported by the demonstration that an allergy evaluation for patients with asthma resulted in fewer outpatient, emergency department, and hospital inpatient encounters.³³ Broadly based interventions aimed at decreasing allergic sensitization and progression of atopic airway disorders from rhinitis to asthma,^{14,15} sinusitis, and chronic middle ear disease may have even greater long-term financial effects. Testing these hypotheses will require newer epidemiologic tools, including longitudinal studies with healthcare and prescription service databases to assess yearly costs per patient for each diagnosis.

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