

# Current reviews of allergy and clinical immunology

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## The health economics of asthma and rhinitis. I. Assessing the economic impact

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As new health care strategies compete with existing ones for limited resources, the health care system and its providers are beginning to turn to health economic analyses to help inform choices in the delivery of care. This 2-part review examines the current health economic literature for asthma and rhinitis. This first installment of the review focuses on studies that characterize the economic burden of asthma and rhinitis and examines how resources are allocated to the care of persons with asthma and rhinitis. In 1998, asthma in the United States accounted for an estimated 12.7 billion dollars annually. Similarly, in 1994, allergic rhinitis was estimated to cost 1.2 billion dollars. Most of the costs for these conditions are attributed to direct medical expenditures, with medications emerging as the single largest cost component. Indirect costs also represent an important social effect. While cost-of-illness studies help to characterize the economic burden, comparative health economic studies evaluate the value of new and existing strategies for clinical care. The second part of this review will explore how comparative studies have contributed to understanding how to best diagnose and treat asthma and allergic rhinitis. (*J Allergy Clin Immunol* 2001;107:3-8.)

**Key words:** *Cost of illness, health economic evaluation, cost-effectiveness, cost-benefit*

Advances in health care appear to be increasingly tied to 2 major sources of information. The first is the ability to improve health outcomes through new or improved intervention strategies. This primary need to understand clinical efficacy and safety has been the cornerstone of evidence-based medicine for decades. The second source of information relates to society's ability and willingness to pay for intervention strategies. The field of health economics seeks to address these issues through quantitative tools designed to aid decisions of resource allocation

### Abbreviations used

CEA: Cost-effectiveness analysis  
DME: Direct medical expenditures  
ED: Emergency department

throughout the various levels of the health care system.<sup>1</sup>

The purpose of this review is to explore the health economic literature related to asthma and rhinitis. Asthma, in particular, is a disease that places a large burden on society. It is estimated that asthma affects more than 15 million persons in the United States, leading to more than 500,000 hospitalizations and over 5000 deaths annually.<sup>2</sup> Until recently, very little was known about the economic effect of asthma or the consequences of various asthma intervention strategies. Similarly, allergic rhinitis is a prevalent allergic condition, affecting at least 8%,<sup>3</sup> perhaps as high as 16%,<sup>4</sup> of the US population. Less is known about the health economic effect of rhinitis. However, together, asthma and allergic rhinitis account for most of the allergy-related morbidity associated with the respiratory system. The purpose of this review is to provide a comprehensive characterization of the health-economic literature for these 2 related conditions. This review is presented in 2 parts. Part I explores the cost-of-illness studies for asthma and allergic rhinitis. In a subsequent article, part II of this series will review the comparative economic evaluations of current strategies and technologies for care of persons with these conditions.

The articles in this review were primarily obtained through a search of the MEDLINE database, querying for the terms "asthma" and "cost" (691 articles) and "rhinitis" and "cost" (83 articles). Additional studies were identified through the reference lists of MEDLINE and by direct inquiries to an extensive number of international investigators in this field. The review includes only those studies that were written in English and that reflected original research with explicit descriptions of the methods of economic evaluation. This resulted in a total of 128 articles for review. However, it should be noted that although this review is intended to be comprehensive, it is not a formal quantitative synthesis of the literature.

This review first examines the basic methods of health economics, then explores the health-economic burden for

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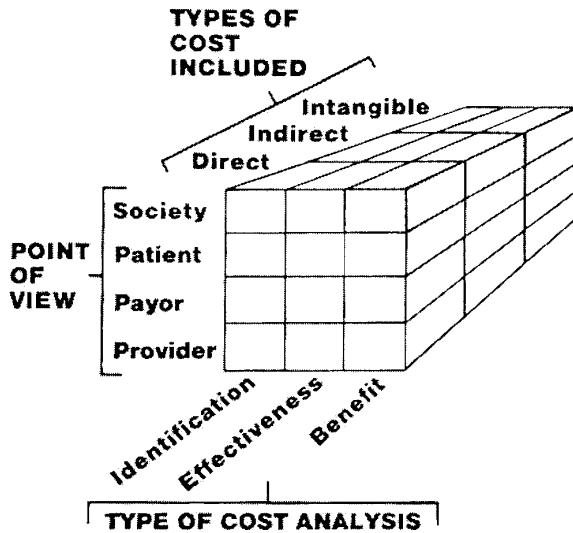


FIG 1. Three dimensions of economic evaluation of clinical care. (Reprinted with permission from Bombardier C, Eisenberg JM. *J Rheumatol* 1985;12:201-4.)

asthma and rhinitis as characterized by various cost-of-illness studies, and lastly, looks at comparative health economic studies.

## HEALTH ECONOMICS: AN OVERVIEW

Bombardier and Eisenberg<sup>5</sup> have suggested a model for the economic evaluation of clinical care that includes 3 dimensions (Fig 1). One axis presents the types of costs and benefits associated with health care technology or innovation. These include direct medical expenditures (DMEs), as well as direct nonmedical costs, such as transportation expenses and child care expenses related to health care. This dimension also includes indirect costs associated with the loss of workforce participation and loss of productivity, as well as intangible costs, which reflect theoretic costs, such as the effect of scholastic achievement or career selections that may be associated with the burden of illness.

The second axis of Fig 1 reflects the various audiences that will use the information, including patient, payor, health care provider, and society as a whole. The third axis in this multidimensional model reflects the types of tools, such as cost-benefit analysis and cost-effectiveness analysis (CEA), that provide information on the most efficient or effective ways in which to allocate scarce resources.

Cost-benefit analysis is the identification and comparison of the costs associated with a new intervention and the benefits derived from its application.<sup>6</sup> Both costs and benefits are defined in monetary terms and adjusted to net present values. The ratio of monetary benefits to overall costs determines whether the value produced by the new intervention is worth the costs, and the intervention is said to be cost-beneficial if the benefits exceed the costs. The one drawback to this method is that it is often difficult to express health outcomes in monetary terms.

CEA was, to a large extent, designed to overcome the difficulty of expressing benefits in monetary terms. Of these 2 different types of economic evaluations, CEA has gained the most attention and therefore will be the focus of much of the latter portion of this review. CEA is a method designed to assess the comparative effects of different health care interventions.<sup>7</sup> It is based on the premise that for "any given level of resources available...[the goal] is to maximize the total aggregate health benefits concurred."<sup>8</sup> One of the key features of CEA is its focus on comparative design. It requires understanding of the clinical effects of interventions and their most likely alternatives as a prerequisite to generating and testing a hypothesis. Clinical effectiveness is measured in terms of outcomes that are relevant to the interested audience, whether it is society, the clinical provider, or the patient. For asthma, there are a number of potential measures of effectiveness. These include measures of symptom burden, lung function, functional status, and health-related quality of life.<sup>9</sup> The most appropriate outcomes for evaluation of rhinitis are less clear. Opportunity cost is another fundamental concept of CEA. The concept is based on the premise that the true economic cost of one intervention includes the forgone value of alternative interventions. This implies that resource allocation is a matter of choices and that an intervention should never be evaluated in isolation.

In 1992 the National Asthma Education and Prevention Program of the National Heart, Lung, and Blood Institute convened a task force to address issues surrounding the cost-effectiveness of asthma care.<sup>10</sup> This task force emphasized the need to adopt common standards for the economic evaluation of asthma care. Their recommendations included use of the symptom-free day as a standard outcome measure, the need for long study periods (a minimum of 1 year), and the need for studies that span the range of disease severity, age groups, and social economic status.<sup>11</sup> Unlike asthma, there appear to be no published recommendations for establishing standards for the CEA of rhinitis.

Much of the comparative health economic literature (eg, CEA) for asthma has focused on asthma-specific outcomes. However, the field of health economics also seeks generic measures that allow for comparison across populations, illnesses, and interventions. To date, the most commonly used measure for this type of analysis has been the quality-adjusted life years.<sup>12</sup> However, there have been many difficulties in the use of such measures for asthma and rhinitis. As a result, the literature offers little by way of comparison across other disease states.

The next section will explore the economic burden of asthma and rhinitis.

## ECONOMIC BURDEN OF ASTHMA AND RHINITIS

### Costs of asthma in the United States

The first comprehensive US study of the economics of asthma examined 1985 costs projected to 1990 esti-

**TABLE I.** Cost of asthma in 1998

	Costs (in millions of dollars)		Ratio of costs 1998 to 1994
	1994	1998	
<b>Direct medical expenditures</b>			
Hospital care			
Hospital inpatient care	1799.9	2054.6	1.14
ED care	478.6	546.3	1.14
Hospital outpatient care	633.0	722.6	1.14
Physician's services			
Physician inpatient care	96.7	110.9	1.15
Physician office visits	647.4	742.7	1.15
Prescriptions	2452.0	3188.1	1.30
All direct expenditures	6107.6	7365.3	
<b>Indirect costs</b>			
School days lost	956.7	1107.3	1.16
Loss of work			
Outside employment			
Men	365.8	415.0	1.13
Women	974.8	1128.2	1.16
Housekeeping	727.2	841.7	1.16
Mortality	1616.2	1813.9	1.12
All indirect costs	4640.6	5306.0	
<b>All costs</b>	<b>10,748.3</b>	<b>12,671.3</b>	

Columns may not add up to 100% because of rounding. Adapted from Weiss et al.<sup>15</sup> Other sources include the following: Table 778 in "CPI for all urban consumers (CPI) for selected items and groups 1980-1998" accessed at <http://www.census.gov/prod/99pubs/99statab/sec15.pdf>; Tables 164 (1980-1997) and 171 (1980-2005) found in "National health expenditures by object" accessed at <http://www.census.gov/prod/99pubs/99statab/sec03.pdf>; and Table 702 found in the US Bureau of Labor Statistics "Bulletin 2307 and employment and earnings" accessed at <http://www.census.gov/prod/99pubs/99statab/sec13.pdf>. The source for statistical abstracts was <http://www.census.gov/prod/www/statistical-abstract-us.html>.

**TABLE II.** Comparison of 5 studies on direct and indirect costs of asthma adjusted to 1991 US dollars

Country and year of data	Costs (in millions of dollars)			Estimate per asthma patient costs (\$)
	DMEs	Indirect costs	Total costs	
Australia (1991) <sup>19</sup>	250.0	207.0	457.0	326
New South Wales (1989) <sup>16</sup>	125.8	37.5	163.3	513
Sweden (1975) <sup>18</sup>	90.8	257.5	348.3	1315
United Kingdom (1988) <sup>17</sup>	722.5	1070.0	1792.5	522
United States (1990) <sup>13</sup>	3700.0	2700.0	6400.0	640

Adapted from NIH publication No. 95-3659.<sup>24</sup>

mates.<sup>13</sup> For 1990, these costs were an estimated 6.2 billion dollars, approximately 1% of all US health expenditures. Subsequent to that publication, there have been 2 additional studies of the US costs of asthma.<sup>14,15</sup> Table I displays 1994 costs projected to 1998 estimates by using previously published methods for this type of data projection.<sup>13</sup> The 1998 projections reflect a total of 12.7 billion dollars in US costs of asthma. Fifty-eight percent of these costs were DMEs, and 42% were indirect costs.

The most notable change in asthma costs during the 1985 to 1994 period was a decrease in hospitalization costs as a percentage of total DMEs. This was due to a notable decrease in length of stay and not to a decrease in the total number of hospitalizations. Also, medication costs have now replaced hospital costs as the largest component of DMEs. The average estimated annual cost per adult (18 years and older) with asthma increased as well during this time period, although costs per child decreased.<sup>15</sup>

## Costs of asthma internationally

Worldwide, there is considerable interest in the economic effect of asthma, as evidenced by numerous cost-of-illness studies.<sup>13,16-23</sup> These studies are difficult to compare because of differences in definitions of costs and sources of unit costs and differing time periods and exchange rates. Mindful of these difficulties, the Global Initiative for Asthma conducted a review of 6 asthma cost-of-illness studies (Table II).<sup>24</sup> That review of asthma costs in developed countries suggested an average annual societal burden ranging from \$326 to \$1315 per afflicted person (1991 US dollars). Approximately 40% to 50% of the total asthma costs were attributed to DMEs.

There are also several studies of asthma costs in less-developed countries<sup>24-26</sup>; however, they are limited to small, select population samples. Although these studies play an important role in local policy, they are of limited value for the purpose of international comparison.

There appears to be only one non-US study examining trends in the costs of asthma.<sup>27</sup> It was conducted in Sweden between 1980 and 1991. The results suggest a nearly 37% increase in total asthma costs, with a 41.1% increase in DMEs and a 34.2% increase in indirect costs.

### Special characteristics of the costs of asthma

The costs of asthma have also been examined from the perspective of the individual and his or her family. Most of these reports followed families for an extended period of time, asking them to keep diaries of their asthma-related expenditures. The earliest of these was conducted in the United States in 1968. It followed 21 families for a period of 1 year and resulted in an annual mean cost of \$1245, with poorer families contributing a larger proportion of their total family income toward asthma services. A second study of US families, conducted from 1977 to 1980, showed average annual costs of \$1087 per child with asthma ( $n = 25$ ).<sup>28</sup> A more recent study from Australia, with similar methods and a much larger sample of children with milder asthma ( $n = 193$ ), showed a mean annual cost per child of 212.48 Australian dollars, increasing to 884 Australian dollars for children who had been hospitalized.<sup>29</sup> Canadian investigators found that the annual costs per patient in South Central Ontario varied greatly on the basis of disease severity, age, smoking status, drug coverage, health plan, and retirement status.<sup>30</sup> One study of particular interest characterized asthma costs in lesser developed countries.<sup>31</sup> The investigators conducted a mail survey of health care providers in 24 countries throughout Africa and Asia; many of the countries had a limited supply of asthma-related drugs. The results indicated the estimated costs of asthma drugs ranged from 3.8% to 25% of the patient's monthly income. Another study of 8 low- and middle-income countries found that costs and availability of asthma medications varied widely, representing a potentially important barrier to care.<sup>32</sup>

Emergency department (ED) visits and hospitalizations are key cost components of asthma care. Several studies have attempted to better quantify these costs.<sup>33-35</sup> One of these studies examined the costs of 214 persons with asthma-related ED visits not resulting in hospitalization. The ED costs for these individuals ranged from an average of \$248 for children 5 years and younger to \$457 for adults 18 years and older.<sup>34</sup> These costs were similar to those described in another study of more than 3000 adults who had an average ED cost of \$234 per visit.<sup>35</sup> In this same study average hospitalization costs for asthma were \$3103; however, they ranged from approximately \$2000 for patients classified as having mild asthma on admission to more than \$15,000 per hospitalization for patients defined as having the most severe disease.<sup>35</sup>

There has been at least one population-based study of the cost of asthma for patients with very severe disease. This was based on an analysis of the National Medical Expenditure Survey, a national survey based on a sample of the US population.<sup>36</sup> The results suggest that less than 20% of the persons with asthma in the sample were responsible for more than 80% of the total direct costs.

Also, perhaps not unexpectedly, persons using more medications had higher costs. Studies from other countries have also described similar findings of cost increases in accordance with disease severity.<sup>37-39</sup> High use of short-acting  $\beta$ -agonists has also been shown to be predictive of high asthma costs.<sup>40</sup>

There are now 2 economic studies of children with asthma, one conducted within a single health care organization and the other based on a national population sample; both explore the marginal cost of asthma above other health care costs.<sup>41,42</sup> These studies conclude that for children with asthma, there seem to be additional nonasthma-related costs associated with comorbid upper and lower respiratory conditions. One of these studies examined a low-income Medicaid population and found that asthma costs for African American children were 24% higher than the costs for white children, primarily because of higher costs associated with hospitalizations and ED visits.<sup>41</sup>

It should be noted that indirect costs are seldom included in cost-of-illness studies for asthma. This is likely the result of the lack of standardized approaches for deriving such costs. Hopefully, the early work in this field of measurement will lead to improved understanding and more frequent reporting of these important costs.<sup>43</sup>

### Costs of rhinitis

Relative to asthma, the literature surrounding the cost of illness for rhinitis is rather modest. The direct costs of hay fever in the United States were estimated to be \$1.16 billion in 1990.<sup>44</sup> More recently, data from the National Medical Expenditures Survey was used to estimate the costs of allergic rhinitis; 1987 costs projected to 1994 dollars resulted in an estimate of \$1.23 billion annually.<sup>4</sup> These figures are most likely underestimates because most persons with allergic rhinitis do not seek health care, and many use over-the-counter pharmacotherapy. These studies were also conducted before the introduction of newer classes of prescription antihistamines. The use of diagnostic testing and immunotherapy may also represent a significant economic cost,<sup>45</sup> and there is evidence to suggest that the costs are substantially higher when allergic rhinitis is concomitant with asthma.<sup>41,12</sup> Using a population-based asthma cohort, one study found that yearly medical charges were on average 46% higher for persons with asthma and concomitant allergic rhinitis than for persons with asthma alone.<sup>46</sup>

It has been proposed that indirect costs in terms of loss of work productivity are also an important component cost of allergic rhinitis.<sup>47</sup> Although these indirect costs are most likely substantial, attempts at measurement have been hampered by suboptimal study designs.<sup>48,49</sup>

There is almost no information on the societal costs of rhinitis outside the United States. There is one study reporting on the costs of rhinitis in Japan. In this study the 1994 total costs (both direct and indirect, including over-the-counter medications) were estimated at 1.15 billion US dollars, with an average annual expenditure of \$118 per affected patient.<sup>50</sup>

## CONCLUSION

Cost-of-illness studies of asthma and allergic rhinitis suggest that these conditions represent a large burden to society, both nationally and internationally. Studies of the trends in costs suggest that medications are the largest cost component of DMEs. Indirect costs also represent an important effect. With the costs of illness for these conditions now becoming well defined, the field of health economics is starting to shift toward understanding how to best use resources and therapeutic strategies to improve care for these conditions. Part 2 of this series will review the comparative health economic literature for asthma and allergic rhinitis.

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