

Trends in the cost of illness for asthma in the United States, 1985-1994

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Background: During the past decade, there have been notable changes in asthma prevalence, morbidity, and mortality. In this same time period, there have also been important national efforts to increase asthma awareness and improve asthma care.

Objective: The purpose of this study was to examine the changes in US cost of illness for asthma during the 10-year period from 1985-1994.

Methods: The study was a two-period (1985 and 1994), cross-sectional, cost-of-illness analysis. Cost estimates were based on US population and health care survey data available from the National Center for Health Statistics.

Results: The total US costs of asthma for 1994 were \$10.7 billion. On the basis of 1985 estimates adjusted to 1994 dollars, total asthma costs increased by 54.1% and direct medical expenditures increased by 20.4% during the 10-year period. In 1985, hospital inpatient care represented the largest component cost of direct medical expenditures (44.6%). Hospital inpatient costs decreased to 29.5% of direct medical expenditures in 1994, primarily because of shorter lengths of stay, as opposed to a decrease in the total number of admissions. In 1994, medications represented the largest component cost of direct medical expenditures (40.1%, up from 30.0% in 1985). The largest component increase in indirect costs was due to loss of work. On the basis of adjusted dollars, estimated costs per affected person with asthma declined by 3.4% (decrease of 15.5% for children and an increase of 2.9% for persons 18 years and older) during this time period.

Conclusion: Although the US costs of asthma increased during the 1985-1994 time period, estimated costs per person with asthma demonstrated a modest decline. These findings may represent a combination of reductions in hospital lengths of stay and increasing prevalence of persons with low consumption of asthma-related health care resources. In examining the component costs, it is unclear whether these changes can be attributed to the many local, regional, and national efforts aimed at controlling untoward asthma outcomes during the 1985-1994 time period. (*J Allergy Clin Immunol* 2000;106:493-9.)

Key words: Asthma, health economics, epidemiology, costs of illness, National Center for Health Statistics

Abbreviations used

ED: Emergency department

NAEPP: National Asthma Education and Prevention Program

NAMCS: National Ambulatory Medical Care Survey

NHIS: National Health Interview Survey

The 1985 cost of asthma in the United States was estimated at nearly \$4.5 billion.¹ However, there have been important changes to the burden of asthma and possibly in the care of persons with asthma that may also have affected changes in resource allocation for this condition. From an epidemiologic perspective, asthma prevalence increased from 1985-1994.² From a policy perspective, in 1991, the National Asthma Education and Prevention Program (NAEPP) of the National Institutes of Health released the first set of guidelines for asthma care, including an extensive dissemination program to promote physician awareness and use of the guidelines.³ Since this release, there is increasing evidence of physician awareness of these guidelines.⁴⁻⁶ These changes in the epidemiology and national health policy surrounding asthma have occurred during a decade of major changes to the overall organization, as well as financing of the US health care system.

Given the concurrent changes in asthma epidemiology, and national health care policy, the patterns of resource use, and morbidity-related costs for asthma are likely to have undergone changes as well. The purpose of this study was to examine changes in the cost of illness for asthma during the 10-year period from 1985-1994.

METHODS

The 1985 cost estimates were obtained from an economic evaluation of asthma published in 1992. To conduct an accurate comparison, it was essential to closely adhere to the previous analytic methods.¹ For all health care utilization data, asthma was defined as code 493 of the International Classification of Disease, ninth revision, and was based on a first-listed diagnosis unless otherwise noted. For each estimate of use, morbidity, and mortality, several years of data were averaged to obtain stable estimates (1983-1987 for the 1985 estimate and 1993-1995 for the 1994 estimate).

Estimates of health care use, morbidity, and mortality

Data on health care use, morbidity, and mortality were obtained from surveys conducted by the National Center for Health Statistics. The National Hospital Discharge Survey provided the information on asthma hospitalizations. This annual survey examines dis-

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charges from a sample of nonmilitary acute care hospitals.⁷ Estimates of ambulatory care visits were obtained from the National Ambulatory Medical Care Survey (NAMCS),^{8,9} which samples nonfederal office-based physicians. Other information obtained from the NAMCS included visit type (initial or follow-up), physician's specialty, and medications prescribed.

Estimates of emergency department (ED) and hospital outpatient care were obtained from the National Health Interview Survey (NHIS), a home interview of a sample of the noninstitutionalized civilian population of the United States.¹⁰ The survey is a self-report, with proxies responding on behalf of persons under 19 years of age. Persons with asthma are defined as those who reported having asthma in the past 12 months. The NHIS also provides information on the burden of illness related to time lost from either school or work (defined to include both outside work and housekeeping).

US vital records provided information on asthma mortality.^{11,12} Asthma mortality was defined on the basis of underlying cause of death.

Cost estimates

Cost-of-illness estimates were derived for both direct medical expenditures and indirect costs.¹³ Direct medical expenditures include charges for inpatient and outpatient hospital services, ED services, physician services, and medications. Indirect costs include the value of time lost from school and work as a result of asthma morbidity and mortality. As noted below, all estimates reflect average costs or charges because national estimates of disease-specific costs were not available.

Data from the 1987 National Medical Expenditure Survey 2 were used to estimate the 1994 charges for selected health care resources.¹⁴ The 1985 cost estimates were derived from estimates provided by the 1980-1981 National Medical Care Utilization and Expenditure Survey.¹⁵ Both of these surveys estimate charges-expenditures rather than actual costs of care.

Expenditures for health care use. For hospital inpatient care for both 1985 and 1994, the number of asthma-related hospitalization days was multiplied by adjusted expenses per inpatient day reported by the American Hospital Association (nonfederal hospitals).^{16,17}

ED services expenditures for 1994 were estimated by multiplying the number of ED visits by the average charge per visit, as obtained from the National Medical Expenditure Survey. For 1985 costs, ED visit data were multiplied by the average charge per visit obtained from the National Medical Care Utilization and Expenditure Survey.¹

The 1994 hospital outpatient care estimates were obtained by multiplying the number of visits by the average charge per visit on the basis of the National Medical Expenditure Survey. The 1985 estimates of hospital outpatient expenditures were obtained by multiplying the number of visits by the average charge obtained from the National Medical Care Utilization and Expenditure Survey.¹

For both 1985 and 1994, physician office visit estimates were obtained by multiplying the number of asthma visits by the charge per new or established patient visit (per physician specialty) on the basis of data from the American Medical Association survey of physicians (1985 and 1994).¹⁸

Expenditures for physician inpatient services were calculated by multiplying the number of visit days by the charge per initial or follow-up hospital visit on the basis of data from the American Medical Association survey of physicians (1985 and 1994).^{18,19}

Using methods previously described,¹ medication expenditures were calculated for each class of asthma drugs by multiplying the average wholesale prescription price, as reported in the Drug Topics Red Book,^{20,21} by an average annual dose on the basis of prescription mentions in the NAMCS.

Indirect costs. Because NHIS data are not sex specific, each child's mother was assumed to be the caretaker for purposes of calculating costs related to loss of school days. The number of school days lost was equated with the number of days lost from work for the caretaker. Costs were derived as the value of time lost from either outside employment (on the basis of average annual earnings) or housekeeping (on the basis of the imputed value of housework)^{22,23} by using methods previously described.¹

NHIS data were used to calculate the estimated annual number of work days lost.¹ Costs were derived as the value of time lost from either outside employment (on the basis of average annual earnings) or housekeeping (on the basis of the imputed value of housework; personal communication, D. Rice, 11-22-97)²² by using methods previously described.¹

Mortality costs were calculated by multiplying the number of asthma deaths by the age- and sex-specific current values of estimated lifetime earnings discounted to current value (ie, 4% for the 1985 estimates²³ and 3% for the 1994 estimates).²⁴

Comparison of costs between 1985 and 1994. To compare the change in costs between the two time periods, 1985 data were adjusted to reflect 1994 dollars. This adjustment was calculated for direct medical care costs by using selected medical care items from the Consumer Price Index²⁵ and for indirect costs by using the seasonally adjusted employment cost index for the civilian workforce.²⁶

Accuracy and reliability of the data. Other studies have reported on the appropriateness of the design and estimate procedures used to obtain the National Center for Health Statistics data. Data for both costs and prices were obtained from national sources thought to be most reliable and commonly used for this type of economic analysis. However, most of the published data provide only point estimates and include no method for determining confidence intervals. Without measures of standard error for the cost estimates, it is not possible to assess error quantitatively. Therefore as is the convention in this type of economic analysis, wherever possible, each assumption is explicitly stated to provide the reader with a means of evaluating the quality of the estimates.

RESULTS

Direct medical expenditures

In 1994, there were an estimated 477,000 hospitalizations for asthma in the United States, resulting in 1.93 million bed days with an average length of stay of 4.06 days. The resulting inpatient expenditures for asthma are estimated at \$1.8 billion (Table I). There were an estimated 1.6 million ED visits at a cost of \$478.6 million.

There were an estimated 10.8 million asthma-related visits to private physician's offices in 1994 at a cost of \$647.4 million (Table I). The majority (61.5%) of these visits were to primary care specialists (family medicine, general practice, general pediatrics, or internal medicine) as opposed to asthma specialists (allergists and pulmonary physicians).

Short-acting β -agonists were the most frequently prescribed category of asthma medication, accounting for more than 6.9 million prescriptions in 1994. Inhaled steroids and cromolyn accounted for the next most frequent categories of prescribed asthma medications at nearly 3.7 million prescriptions. Of less frequent use were theophylline and long-acting β -agonists. There were an estimated 1.4 million allergy shots reported as well. The 1994 total estimated cost of prescription medications for asthma (excluding allergy shots) was \$2.45 billion.

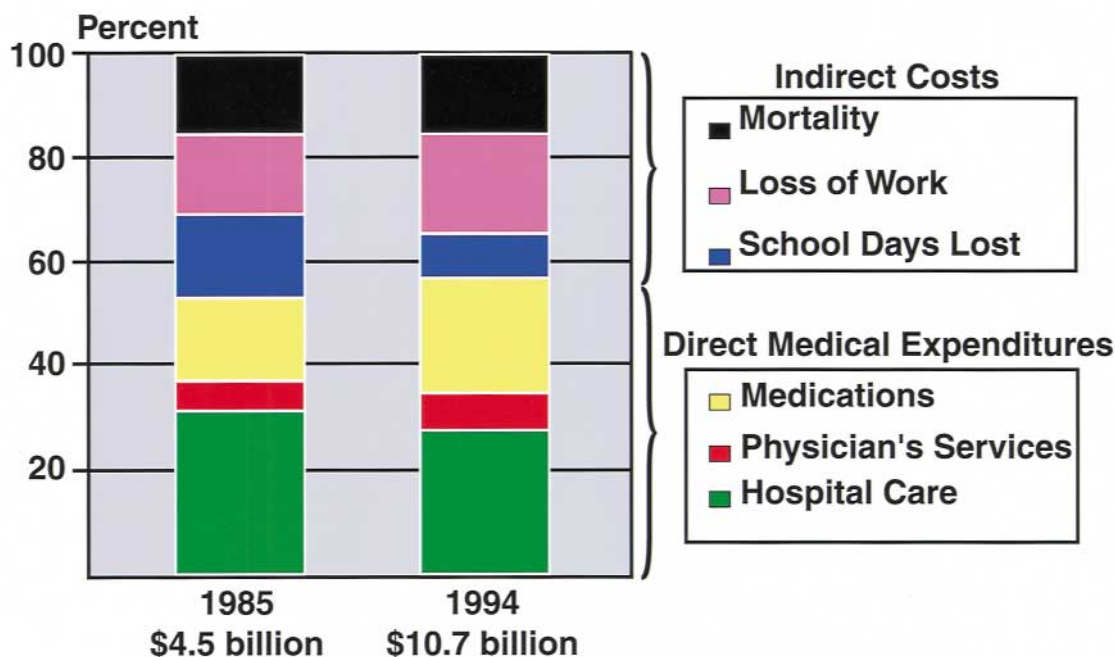


FIG 1. Change in distribution of US cost of illness for asthma from 1985-1994.

TABLE I. US costs of asthma in 1994 among selected age groups in millions of dollars

Category*	Age group (y)		All
	≤17	≥18	
Direct medical expenditures			
Hospital care			
Inpatient	514.3	1285.6	1799.9
ED	228.7	250	478.6
Outpatient	243.9	389.1	633.0
Physicians' services			
Inpatient	27.6	69.1	96.7
Outpatient	191.0	456.4	647.4
Medications	752.6	1699.3	2452.0
All direct expenditures	1958.2	4149.4	6107.6
Indirect costs			
School days lost	956.7	—	956.7
Loss of work			
Outside employment	—	1340.6	1340.6
Housekeeping only	—	727.2	727.2
Mortality	258.8	1357.3	1616.2
All indirect costs	1215.5	3425.1	4640.6
All costs	3173.7	7574.5	10,748.3

*Loss of work (outside employment and housekeeping) was calculated only for persons age 18 or older, and school days lost were estimated only for persons age 17 or younger. For mortality, the groups studied were age 19 or under and 20 or over. Columns may not add up to totals because of rounding. Mortality loss was discounted by 3% (see the "Methods" section).

Indirect costs of asthma

For children age 5 to 17 years, in 1994, there were an estimated 11.8 million school days missed because of asthma. This school loss accounted for an estimated \$957 million dollars in caretakers' time lost from work (both outside employment and housekeeping). For persons with asthma who were 18 years or older, there were an estimated 8 million work days lost (employment outside the home) at an

estimated cost of \$1.3 billion. For women keeping house, restrictions caused by asthma accounted for an additional \$727.2 million in indirect costs during 1994.

Death from asthma remains an infrequent event in the United States. In 1994, asthma was reported as the underlying cause of death for 5486 persons. The estimated cost, as measured by lifetime earnings for these individuals, is \$1.62 billion.

TABLE II. Ten year changes in US costs of asthma from 1985-1994

	No. of events (in thousands)†	1985* total costs (in millions of dollars)	1985 estimates adjusted to 1994 dollars (in millions of dollars)	No. of events (in thousands)†
Direct medical expenditures				
Hospital care				
Inpatient‡	2318	1058.8	2351.1	1934
ED	1810	200.3	444.8	1592
Outpatient	1500	129.2	286.9	1708
Physicians' services				
Inpatient	2318	81.3	149.8	1934
Outpatient	6500	193.3	356.2	10,757
Medications§	7440	712.7	1394.5	15,116
All direct expenditures		2375.6	4983.3	
Indirect costs				
School days lost	7182	726.1	690.6	11,754
Work days lost				
Outside employment	4428	284.7	270.8	7989
Housekeeping only	10,208	406.0	386.1	15,388
Mortality	3880	676.3	643.2	5486
All indirect costs		2093.1	1990.7	
All costs		4468.7	6974.0	

*Data adapted from *N Engl J Med.* 1992;326:862-6.

†Data in thousands, except where noted otherwise.

‡Number of bed days.

§Number of medications prescribed.

||Number of actual deaths.

TABLE III. Estimated average costs of asthma per reported person with asthma in 1985 and 1994 in the United States

	1985	1985 costs adjusted to 1994 dollars	1994
Estimated No. of persons with asthma* (in millions)			
All ages	8.9	NA	14.2
≤17 y	3.0	NA	5.0
≥18 y	5.9	NA	9.2
Estimated total costs of illness (in billions of dollars)			
All ages	4.47	6.97	10.75
≤17 y	1.50	2.25	3.17
≥18 y	2.97	4.72	7.57
Estimated per capita costs of illness (in dollars per reported person with asthma)			
All ages	502.2	783.6	756.9
≤17 y	513.3	751.5	634.8
≥18 y	496.6	799.9	823.3

NA, Not applicable.

*Prevalence estimates are based on 3-year averages of NHIS data. Note that age-specific estimates may not add up to totals because of rounding.

Total economic effect of asthma in 1994

The total estimated costs of asthma in 1994 were \$10.7 billion (Table I). Direct medical expenditures accounted for \$6.1 billion (56.8%) of the total costs. Prescriptions were the single largest direct medical expenditure (\$2.45 billion). Indirect costs of asthma in 1994 were estimated at \$4.6 billion, with 45% of costs (\$2.07 billion) attributable to loss of work productivity through disability.

Ten-year trends in asthma costs of illness from 1985-1994

Table II presents the changes in estimated health care use, morbidity, and costs during the 10-year period from 1985-1994.

From 1985-1994, annual asthma-related inpatient care decreased from 2.3 to 1.9 million bed days, a 23.4% decline in adjusted expenditures. The decrease in total

1994 total costs (in millions of dollars)	1985 adjusted to 1994 change in total costs (%)
1799.9	-23.4
478.6	7.6
633.0	120.7
91.0	-35.5
647.4	81.7
2452.0	75.8
6107.6	22.6
956.7	38.5
1340.6	395.1
727.2	88.3
1616.2	151.3
4640.6	133.1
10,748.3	54.1

bed days was principally caused by a 23.2% decrease in asthma-specific length of stay, rather than a negligible 2.8% decrease in the number of hospitalizations for asthma. On the basis of National Hospital Discharge Survey data during this same time period, hospitalization events for all conditions decreased by 15.5%, average length of stay decreased by 10.9%, and annual total bed days decreased by nearly 24.7%.

As seen in Table II, annual asthma-related expenditures for ED care increased by 7.6% (from 1985-1994, adjusted), and outpatient care increased by 120.6% (from 1985-1994, adjusted). These increases in costs occurred during a period of time when there was a decrease in the total number of ED visits, suggesting that the difference was due to increases in ED charges. Similar to ED charges, much of the increase in total expenditure for hospital outpatient visits was due to a large increase in the estimated average charge per visit.

Total estimated annual asthma-related physicians' office visits increased during this 10-year period. This increase, combined with an increase in the average charge per visit, accounted for an 81.8% relative increase in office visit expenditures. Similar to hospital inpatient expenditures, total asthma expenditures for physician inpatient services decreased during this period, primarily because of the above-noted decrease in total hospitalization bed days.

Of the different components of direct costs, the greatest absolute change occurred in asthma-related medications. The annual estimates increased from approximately \$1.4 billion (1985 adjusted dollars) to \$2.5 billion.

During the 10-year period, total expenditures for asthma medications increased by 75.8%. This increase was due to an estimated 103.2% increase in the total number of prescribed medications and an estimated 169.3% increase in average unit cost per medication.

Estimated total annual adjusted asthma-related indirect costs increased by 133.1% (Table II). This was partly because of a 38.5% increase in the costs associated with caregiver lost time from work attributed to lost school days. However, most of the increase in indirect costs was due to an adjusted 395.1% increase in costs associated with lost time from work caused by adult asthma. There was an 80.4% increase in the total number of days lost from work caused by asthma. Asthma mortality also increased by 41.4%, and related costs increased by approximately 151.3% during this time period.

On the basis of 1985 estimates of the cost of illness adjusted to 1994 dollars, there was an overall 54.1% increase in asthma costs during the 1985-1994 time period. As seen in Fig 1, direct medical expenditures as a proportion of the total costs during this time increased slightly (ie, 53.2% in 1985 vs 56.8% in 1994). The change in allocation among the direct medical expenditure components was principally caused by increased expenditures for asthma-related medications.

Table III presents the actual and adjusted per capita costs of illness during both time periods as determined by the total estimated numbers of US persons with self-reported asthma. These data suggest a 54.1% increase in nominal per capita expenditures and a 3.4% decrease in real expenditures. This decrease in adjusted expenditures was attributed to children (age 17 and younger), who demonstrated a 15.5% decrease in costs that was mostly driven by decreasing length of hospital stays, versus adults (18 years and older), who had a 2.9% increase in costs.

DISCUSSION

The total adjusted and unadjusted costs of asthma in the United States increased during the 10-year period from 1985-1994. The total costs of illness increased less among children (age 17 and younger) than among adults. The per person cost of asthma for children decreased during the 10-year period while increasing slightly for adults.

Changes in the costs of asthma during the 10-year period must be interpreted in view of the changes in asthma morbidity and the secular trends in health care use during this same time period. From 1985-1994, there were reported increases in US asthma prevalence and less dramatic increases in asthma mortality rates for certain age groups.²⁷ Asthma hospitalization rates remained relatively stable, although overall hospitalization rates declined during this time period. When viewed together, these trends seem to portray an increase in the burden of asthma in the United States. Yet how might these general epidemiologic trends aid in interpreting the trends in costs? One possible explanation is that the increase in total costs is due, at least in part, to the general increase in preva-

lence. However, the epidemiologic trends do not explain either the decrease in costs per affected child (age 17 and younger) or even the slight increase in costs per affected adult. It is also unclear how increases in diagnostic awareness may have contributed to these trends.

For adults, the increased total costs and increased costs per affected person are primarily related to an increase in medication-related expenditures and indirect costs. This suggests that either the severity of asthma has increased in this population or there has been a decrease in the use of effective health care resources. Yet the lack of increase in hospitalizations, the declining lengths of stay, and the relatively stable mortality rates in this adult population do not support the concept of increased severity as an explanation for the increases in costs.

Perhaps more interesting is the finding that although the total cost of asthma for children has increased, the estimated real cost per affected child has decreased. This finding suggests either more efficient use of health care resources for children with asthma or perhaps much of the apparent increase in asthma prevalence is due to an increase in the number of children and young adults with mild asthma and therefore much lower requirements for health care resources.

It might be anticipated that the national efforts in asthma education and the promotion of asthma care guidelines would have a positive effect on the burden of asthma. This expectation stems primarily from the enormous efforts to disseminate asthma management information—especially the NAEPP asthma practice guidelines—as well as the emerging evidence of physician awareness of the guidelines during the period under study.^{4,6} The finding that asthma hospitalization events remained relatively stable and lengths of stay decreased at a time of increasing prevalence might provide comforting assurance if it were not for the decrease in hospitalization rates and length of stay for all causes seen during this same time period. Therefore in light of the secular changes in hospitalizations for all causes, there is little evidence to support the premise that the NAEPP guidelines have had a major effect on asthma-specific hospitalizations. Alternatively, the NAEPP guidelines stress the importance of ambulatory care and use of anti-inflammatory medications. The study data show large increases in the use of both of these components of care during the period from 1985–1994, and this finding does suggest that there have been improvements in care consistent with the NAEPP guidelines. However, as seen in this study, 1994 use of anti-inflammatory medications remained low.

As is true of any study, there are limitations to this type of economic analysis, requiring caution in interpretation. In most economic evaluations, it can be argued that estimates of the costs per unit of service or the value assigned to the resources could be more accurate. However, no such national data are available. Although every attempt was made to address the major component costs of care, it is not possible to estimate some asthma-related expenditures, such as diagnostic services, medical devices (peak flowmeters and spacer devices), costs of transportation, costs of asthma education, and costs of

decreased output at work caused by reduced efficiency. Indirect costs relating to the care of very young children (under 5 years) were not available.

Respective of its many limitations, the study results suggest that the proportion of asthma care delivered in the ambulatory care setting is increasing and that medication-prescribing patterns are becoming consistent with the national guideline recommendations. However, it is disquieting that along with these positive changes in care, asthma hospitalizations and asthma mortality rates have not decreased substantially. Rather, asthma morbidity, as measured by school and work loss, has actually increased. Perhaps in a few years another look at the costs of asthma may demonstrate the types of improvements in health care resource use and population outcomes that we expect from our national efforts to improve asthma care.

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Trends in US asthma costs Web site

Visit the Asthma and Allergy Foundation of America Web site at www.aafa.org/highcost for a breakdown of asthma costs by state, county, and major metropolitan area.