Chapter 19
The Cost of Asthma

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Introduction

Asthma is one of the most costly chronic illnesses in both the developed and developing world. Asthma is a significant factor in the use of health care services, particularly emergency departments and prescription medications. In the United States, asthma is the 13th most costly medical condition and the 7th leading cause of work-loss days (Druss et al. 2002). The cost for patients with asthma in Western countries ranges from $300 to $1,300 per capita per year (Braman 2006). In the future, costs are expected to substantially increase.

The purpose of this chapter is to discuss the cost of asthma to society and to evaluate the role of cost in individual access to care. The impact of cost on societies differs from that on individuals. For societies, the economic burden of an illness can help to prioritize the use of economic resources. Understanding which illnesses, from a societal perspective, use the most resources can suggest illnesses where treatments can be potentially cost saving.

Higher costs can represent a barrier to care. For individuals, the cost of care at the point of service is the important element – and the total cost is unimportant if another payer finances the residual cost. The danger with chronic illnesses such as asthma is that higher cost sharing – which typically leads to reduced use of services – may actually result in greater overall expenditures. For example, individuals may forgo relatively inexpensive services such as medications and preventive care but later require expensive services, such as hospital or emergency department services. Higher cost sharing may also lead to reduced health outcomes if costs serve as a barrier to access to care.

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The Cost of Asthma to Societies

Cost of illness studies are frequently published in the academic literature, as are critiques of these studies that question their value. Cost of illness studies are criticized on a number of grounds (Koopmanschap 1998; Shiell et al. 1987). First, cost of illness studies provide no guidance on the effectiveness of healthcare spending. Cost of illness studies provide the gains that would be associated with the elimination of the illness – a goal that is usually unattainable. This is in contrast to cost effectiveness studies, which quantify the gains associated with a particular intervention. Because cost of illness studies are not associated with interventions, they cannot establish value (Drummond 1992). That an illness is costly does not necessarily imply that there are effective interventions available that could reduce spending. Shiell et al. argue that the use of cost of illness studies is to prioritize illnesses where spending is already potentially inefficient – the less effective the spending, the more costly the illness, the greater justification for more spending if spending is prioritized according to cost of illness studies.

The value of cost of illness studies lies in their ability to prioritize diseases for future economic evaluation (Koopmanschap 1998; Hodgson 1994). Although costly diseases are not necessarily amenable to treatment, it is reasonable to examine the most costly illnesses for potential cost savings. Much as the famous bank robber

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Willie Sutton, when asked why he robbed banks, replied "Because that's where the money is," trying to control spending by focusing on the most costly illnesses is inherently reasonable. Cost of illness studies can show which of the cost components are most important for particular illnesses. Also, by projecting disease costs into the future based on demographics or epidemiological trends, illnesses that will be priorities in the future can be prospectively identified. Bloom et al. (2001) suggest that the three primary purposes of cost of illness studies are to estimate current costs, measure changes over time and generate new research hypotheses.

Methodological Issues

Differences in estimates of the cost of a particular illness, such as asthma, can be caused by differences in perspective, in focus, in time or in methodology. For methodological differences, there are a series of key methodological choices that lead to different estimates. First, there is the decision of what costs to include. Cost of illness studies typically include direct medical care costs, such as hospital care, medications, physician services and other costs directly related to the provision of care. But studies are less consistent in their treatment of indirect costs. Indirect costs are costs associated with the illness that are not directly borne by the health care system. Examples include costs associated with work loss, reduced productivity, and time costs due to missed school and disease mortality. Previous studies have found that estimates of indirect costs for particular illnesses can vary by a factor of seven (Bloom et al. 2001).

The perspective of the study is also important. The standard is to adopt the societal perspective (Gold et al. 1996). The societal perspective is the broadest possible perspective, and it considers all costs and benefits, regardless of source. The reason for this preference is that other perspectives may be misleading. For example, an intervention that refused to pay for asthma medications could be cost reducing for an insurance company or government payer while imposing substantial costs on individuals in the form of higher prices for prescription drugs and on employers in the form of increased worker absenteeism.

The Cost of Asthma

There have been many studies estimating the cost of asthma. However, these studies have varied widely in their estimates of the cost of asthma, even within particular countries. The variability is caused by differences in methodology, data sources (commercial vs. government), timeframe (as costs increase, new medications are developed and the incidence rate changes), sample (elderly vs. working adults vs. children vs. a representative sample) and the costs included (direct, indirect, medications, emergency room visits). Comparing different estimates of the cost of asthma requires consideration of all these factors. Overall, on average, asthma accounts for 1–2% of total health care costs in developed countries (Sennhauser et al. 2005). The key numbers most studies of the cost of asthma try to quantify are the amount and components of direct costs and the amount and components of indirect costs.

Three relatively recent studies have estimated the cost of illness in the United States. Colice et al. (2006) found that employers in the United States spend, on average, $1,680 more per year for individuals with asthma on asthma specific care (Table 19.1) (Colice et al. 2006). The total increased spending for all medical care was found to be $3,567, with the primary cost being prescription drugs ($1,656) and outpatient care ($1,015). Indirect costs were $924 per person, with the bulk of the costs being associated with absenteeism ($779).

In a similar population, Birnbaum et al. (2002) found that asthmatic patients have approximately three times higher medical claims than the average beneficiary in an employer population, and total average annual per capita employer expenditures (including indirect costs) were approximately 2.5 times higher ($5,385 vs. $2,121). The bulk of the costs were associated with medical care (59%), followed by prescription drugs (25%) and work loss (16%). Notably, the direct cost of asthma care was $1,119, with the remainder of the increased expenditures for asthma being associated with the treatment of non-asthma diagnoses. However, the overall cost of asthma per capita ($3,264) was not dissimilar to that reported by Colice et al. (2006).

A slightly different estimate was calculated by Cisternas et al. (2003) in a cross-sectional survey data from a community-based panel from northern

Table 19.1 The cost of asthma

Excess cost per capita	Sample	Location	Year(s) of data	Author(s)
$4,214	Employer, including retirees and dependents	USA	2002–2003	Colice et al. (2006)
$497 (direct costs only)	Children in a managed care organization	USA	1992	Lozano et al. (1999)
$3,265	Employer claims	USA	1998	Birnbaum et al. (2002)
$4,912	Physicians claims for pulmonologists, allergist-immunologists, and family practitioners	USA	1998–1999	Cisternas et al. (2003)
$756	Nationally survey	USA	1994	Weiss et al. (1992, 2000)
$791	Children	USA	1996	Wang et al. (2005)
CHF 2,797	Physician practices	Switzerland	1996–1997	Szucs et al. (1999)
741€	Young adults in seven centers	Italy	2000	Accordini et al. (2006)
1,260€	Multicenter study in hospital-based asthma clinics	Italy	1999	Antonicelli et al. (2004)
$2,879	Asthma patients who sought care	Spain	1994–1995	Serra-Batlles et al. (1998)
$1,465	Physician sample	Turkey	2002	Celik et al. (2004)
$238	National survey	Singapore	1992–1993	Chew et al. (1999)

California pulmonologists, allergist-immunologists and family practitioners. Total per-person annual costs of asthma were estimated at $4,912. The majority of costs were direct costs ($3,180 or 65% of the total) with indirect costs equal to $1,732 (35%). Half of the direct costs were attributable to prescription drugs ($1,605) followed by hospital admissions ($463) and non-emergency department ambulatory visits ($342). For indirect costs, the majority of the costs were associated with total cessation of work ($1,062 or 61%), followed by work loss for those who remained employed ($486 or 28%). Costs were dramatically higher for those with severe asthma ($12,813) compared to those with moderate ($4,530) or mild ($2,646) asthma.

Older estimates of the cost of illness related to asthma in the United States include a 1990 estimate of $6.2 billion (Weiss et al. 1992). This study found that 43% of the economic impact was associated with emergency room use, hospitalization and death, with the cost of inpatient hospital services estimated to be $1.6 billion; thirty eight percent of total costs were indirect, led by reduced productivity due to loss of school days with a cost of nearly $1 billion in 1990. Similarly, the total cost of asthma in 1987 (in 1994 dollars) was estimated to be $5.8 billion, with direct costs representing 88% of the total (Smith et al. 1997). Hospitalizations accounted for more than half of all expenditures. Finally, Weiss et al. (2000) estimated that the total cost of asthma in 1994 was $10.7 billion (Table 19.1). Of these, direct medical expenditures accounted for 57% of total costs ($6.1 billion), with prescription drugs accounting for the largest direct medical expenditure ($2.5 billion). For indirect costs, 45% of the $4.6 billion expenditure ($2.07 billion) was attributable to loss of work productivity through disability.

Comparable data are available for other countries. For example, total annual costs associated with asthma in Switzerland were estimated at approximately CHF 1,200 million per year (Szucs et al. 1999). Of these, 61% (CHF 762 million) were for direct medical expenditures and the remainder for indirect costs. The bulk of the indirect costs (75%) was associated with home care for asthmatic patients.

In Italy, the mean annual cost per patient was 741€ (Accordini et al. 2006), with 43% of the total cost associated with direct costs and 57% with indirect costs. Medication costs represented 47% of direct medical expenditures and were followed in importance by hospitalizations (23%). But the mean annual cost per patient ranged from only 379€ for well-controlled asthmatics to 1,341€ for poorly controlled cases. The poorly controlled cases accounted for 46% of the total costs.

More recently, among adult patients in Italy, the total cost of asthma was estimated to be 1,260€ (Antonicelli et al. 2004). Total costs were distributed as follows: drug costs (16%), physician costs (12%), emergency service and hospitalization costs (20%) and indirect costs (52%).

Annual costs varied by disease severity: 720€ for intermittent asthma, 1,046€ for mild persistent asthma, 1,535€ for moderate persistent asthma and 3,328€ for patients with severe persistent asthma.

The per capita annual total cost of asthma in Spain was estimated at $2,879 (Serra-Batlles et al. 1998). The proportion of total costs included $885(31%) for direct costs including prescription medications (45%; $400) and hospitalizations (33%; $289). Indirect costs ($1,993) were led by costs associated with work loss. But the cost varied by disease severity; for patients with mild asthma, the total average annual cost was $1,336. For those with moderate asthma, it rose to $2,407, and it rose further to $6,393 for those with severe asthma. In the Netherlands, the top expenditure for asthma is prescription medications (Rutten van-Molken and Feenstra 2001). Annual per capita direct medical care expenditures in 1993 were estimated to be $499 (Rutten-van Molken et al. 1999).

The ratio of direct to indirect costs varies widely internationally (Fig. 19.1). The variability likely reflects both the difficulty in estimating indirect costs and real differences in indirect costs. Direct medical expenditures can typically be estimated using payment or claims data. In contrast, indirect costs involve factors such as work loss or school days missed, which are often not available on standardized data sources. But there is little controversy that asthma imposes substantial costs on workers and on their employers. More than 20% of persons with asthma reported one or more complete or partial work days lost per month (Blanc et al. 2001). In a careful assessment of productivity loss in Canada, workers with asthma lost an average of 12 days of work per year due to asthma (Ungar and Coyte 2000). Most productivity loss is due to restricted days rather than absence, on days when the worker is present but productive at a much lower rate ("presenteeism"). However, a study conducted in the United Kingdom found that the cost of presenteeism ($658 annually) is roughly equivalent to that of absenteeism ($597 annually) (Joshi et al. 2006).

The ratio of direct-to-indirect costs ranges from a high of 87% of total costs being associated with direct costs (in a U.S. worker population) to a low of 25% (in Germany) (Stock et al. 2005). The size of the German estimate may be a function of the pension system in Germany. Of the estimated indirect costs, 58% were associated with payment of sick benefits through sickness funds. The highly formalized German system is in contrast to the less formalized U.S. system, which not only complicates data collection but also likely changes the extent of sick leave taken. Indeed, the top three estimates of the proportion of total costs associated with direct costs are all from the United States (with direct costs constituting 87%, 85% and 65% of total costs, respectively). In Canada 61% of the total cost of asthma was associated with direct medical costs (Krahn et al. 1996). However, many of the estimates are near 50%, including those from Italy, Singapore and another United States estimate focusing on children.

The Cost of Asthma in Children

Children have been a particular area of emphasis for cost of illness studies. Typically, children are healthy and relatively low cost. However, caring for children with asthma can be costly. The United Kingdome spends 0.15% of their total health care budget treating children of age 1–5 with "wheezing disorders" (Stevens et al. 2003). Children with asthma use 88% more health care services, including 2.8 times more prescription drugs, 65% more outpatient visits and 2 times more inpatient days than children without asthma (Lozano et al. 1997). Another estimate suggests that children with asthma in the United States use 2.8 times more medical care than children without asthma, including 3.1 times more prescriptions, 1.9 times more ambulatory provider visits, 2.2 times more emergency department visits and 3.5 times more hospitalizations (Lozano et al. 1999).

In the United States, children with asthma used $615 more services per year than children without asthma, including both asthma and non-asthma health care. Yet, failure to diagnose asthma may be even more costly. Stempel et al. (2006) found that children without an asthma diagnosis, but with a prescription for asthma controller or reliever medication, have considerably higher costs than those with both an asthma diagnosis and a prescription for asthma controller or reliever medication. Children with asthma were three times more likely to have co-morbidity than children without asthma (Grupp-Phelan et al. 2001). Children with asthma had a 47% probability of being in the highest total cost quintile, compared to 29% once adjusted for comorbidities.

Among children, the total per capita economic impact of asthma in school-age children was estimated

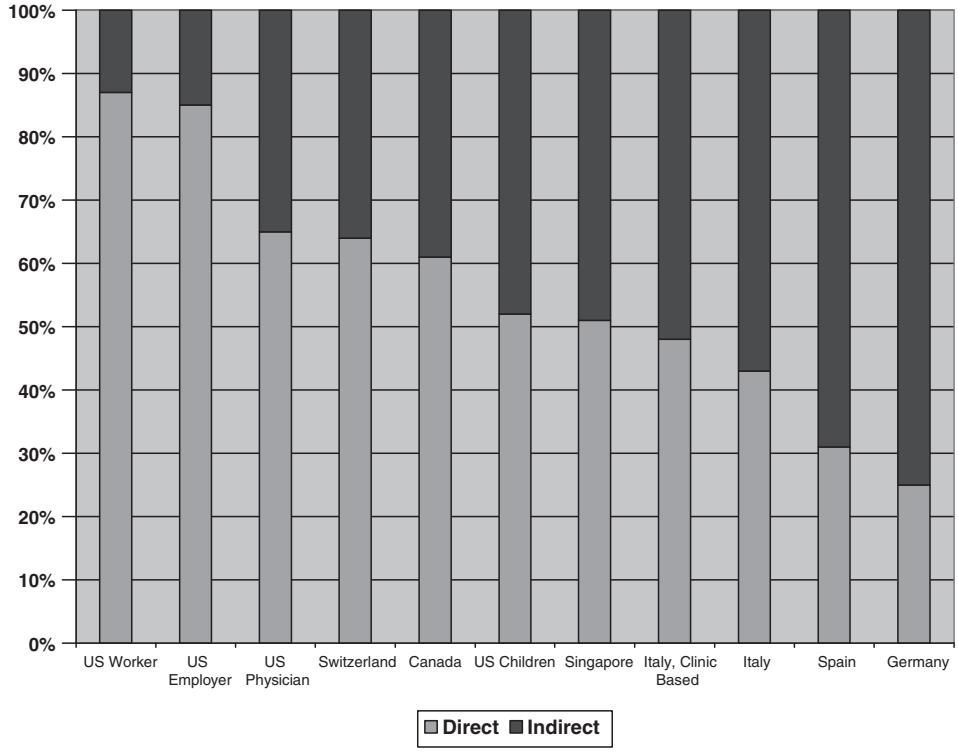

Fig. 19.1 Ratio of direct to indirect costs internationally

to be $791 per child with asthma (Wang et al. 2005). This includes $401 per child in direct medical expenditures (prescribed medicine, hospital inpatient stay, hospital outpatient care, emergency room visits, office-based visits). Children miss, on average, 2.5 days of school per year, and parents' loss of productivity from asthma-related school absence days was valued at $285 per child. Additionally, early death from asthma imposed a societal burden of $105 per child with asthma. However, the long term impact may not be that dire. A recent review of the literature revealed that although asthma limits children's daily activities and adversely affects social activities, there is little evidence of major, adverse long-term social and economic impacts of children's asthma (Milton et al. 2004).

Asthma Severity

One area of recent interest is the impact of asthma severity on cost (Table 19.2). Several studies have examined this question in different countries and found similar results. A recent study in France found that costs were substantially higher for patients with poor asthma control (Van Ganse et al. 2002). Direct medical costs for asthma were found to be 1,451€ for poorly controlled patients, but 746€ for moderately controlled patients and only 550€ for well-controlled patients (a ratio of 1.4 and 2.6, respectively). In Hungary, the cost of care, relative to good asthma control, was 1.4 times higher for adults with moderate control and 2.4 times higher for adults with poor control (Herjavecz et al. 2003). In Switzerland, direct asthma costs were 2.5 times higher in the highest severity groups, compared to the lowest severity group, if no asthma exacerbations were present (Schwenkglenks et al. 2003). In the USA, the costs associated with severe asthma were 1.3 times the cost of a patient with moderate asthma and 1.7 times the cost of a patient with mild asthma (Colice et al. 2006) Indeed, more than 80% of resources were used by the most expensive 20% of the patients (Smith et al. 1997) But this may be because high cost asthmatics are more likely to be in fair or poor health (Malone et al. 2000).

Asthma is a problem not just in the developed world, but also in poorer countries. In Turkey, mean

Table 19.2 Ratio of costs among asthmatics with moderate and poor control versus good control

Country	Moderate control	Poor control
France	1.4	2.6
Hungary	1.4	2.4
Switzerland		2.5
United States	1.3	1.7

annual direct medical costs of asthma were $1,465, with prescription medications comprising 81% of total direct costs (Celik et al. 2004). Similarly, in Estonia, 53% of asthma treatment costs were associated with prescription medications (Kiivet et al. 2001). In Singapore, hospitalizations were the leading source of direct costs, while indirect costs were largely attributable to productivity losses (Chew et al. 1999). Finally, in India, median spending on asthma medications for children with mild or moderate persistent asthma was equivalent to one-third of average monthly per capita income, highlighting the profound difficulties faced by poorer countries (Lodha et al. 2003).

The Cost of Asthma to Individuals

The impact of financing mechanisms on cost, access and quality of care has been a topic of considerable interest. Increased cost sharing has the effect of potentially reducing costs for payers (either health insurers or governments) by shifting the responsibility for paying for care to the individual. However, if the individual then forsakes prescription drugs or preventive care, this not only has a potentially deleterious effect on the individual's health, but may also lead to increased spending by the payer in the form of emergency department visits or hospitalizations. Alternatively, by rewarding high quality care with higher payments, payers can potentially improve the quality of care provided.

The annual cost to the healthcare system of nonadherence to prescribed medications (including asthma) has been estimated at $300 billion (Bender and Rand 2004). Since 1991, the National Institutes of Health has recommended that children with even moderate asthma may benefit from daily treatment with anti-inflammatory drugs. In the Florida Medicaid program, the proportion of children receiving at least one prescription for a preventive drug rose from 27% of children in 1990–1992 to 53% in 1997–1998, an approximate doubling in the proportion who received a prescription for a daily anti-inflammatory drug; but low adherence rates were evident even among those with the severest asthma (David 2004).

Asthmatics who visit the emergency department are likely to be adults with daily or weekly asthma symptoms who are in fair or poor health status, and who delay care for asthma because of cost or insurance issues (Meng et al. 2006). Similarly, children without health insurance are not less likely to be diagnosed with asthma, but are less likely to be prescribed asthma medications (Freeman et al. 2003). This suggests that the key to reducing the use of emergency departments is to control asthma symptoms and to reduce delays in receiving asthma care. Data from the nationally representative Behavioral Risk Factor Surveillance System (BRFSS) showed that individuals with asthma having interruptions in health insurance coverage were at greater risk of using urgent or emergency care (Markovitz and Andresen 2006). However, the association disappeared when controlling for race/ethnicity, employment status, gender, age and other independent variables, suggesting that there may be other factors that explain both lack of insurance and increased risk of using urgent or emergency care.

This increased risk of high utilization of emergency departments is also true among Medicaid children with asthma despite the absence of cost sharing. Children on Medicaid use the emergency department more than privately insured children, even after controlling for asthma-related primary care visits, use of asthma specialists, age, gender, use of medication and symptomatology (Ortega et al. 2001). Individuals with Medicaid insurance are also more likely to use the emergency department as their usual source of care for problems with asthma (Ferris et al. 2002).

If the differences are not due to structural, enabling or need factors, then why do Medicaid children use more high cost services? One study found that the high usage of these services was concentrated among a small percentage of provider practices and patients (Fredrickson et al. 2004). The parents of these children expressed a preference for primary care treatment, but had trouble contacting their primary care physicians and obtaining urgent appointments and believed their physicians preferred that they use emergency services in place of primary care. Although the children had multiple risk factors, the parents had no memory of

their health care provider explaining asthma risk factors during primary care visits. The parents also reported a lack of continuity of care and difficulties in obtaining medications. This suggests that the children were receiving sub par asthma care, despite the removal of financial barriers. A similar result was found among a Medicaid population in Kentucky with asthma: nonadherence to expert asthma guidelines was common; less than 10% of patients who received rescue medications used inhaled steroids regularly (Piecoro et al. 2001). However, one study found that higher hospitalization rates among inner-city children in Rochester, New York were due to higher incidence of severe acute asthma exacerbations (McConnochie et al. 1999).

In Canada, where universal health insurance is provided without cost sharing, there is mixed evidence regarding the impact of income on asthma medication adherence (Blais et al. 2006). Although low and high income adolescents (ages 13–17) had similar rates of medication adherence, low income children (ages 5–12) had lower rates of medication adherence when a stricter definition of adherence was used and had similar rates of adherence when an alternative definition with lower thresholds was used. Along the same lines, very poor, poor and nonpoor groups had similar number of office visits for asthma, but very poor children were more likely to use emergency services (Sin et al. 2003).

Together, these observations suggest that although insurance may play a role in determining how asthmatics use health care, there are other factors at work that are at least as important as the financing mechanism. For example, in Spain, patients with asthma were more likely to use the emergency department than those in France or Italy (Van Ganse et al. 2006). This result was found despite few differences between the individuals with asthma in the three countries in terms of either asthma burden or use of prescription medications. The rate of asthma hospitalizations was also similar across the three countries, but the cost of emergency care in all asthma severity categories was up to ten times higher in Spain than in France or Italy. The authors conclude that the results are likely driven by unseen attributes of the Spanish health care system.

Access to insurance matters; in the USA, quality of care is lower for the uninsured. Among patients in emergency departments for acute asthma, uninsured patients received poorer quality of care on seven (out of seven) quality measures than insured patients (Ferris et al. 2002). In a multivariate analysis, uninsured patients had lower quality of care on five of seven measures and had lower initial peak expiratory flow. Despite differences in indicators of quality of care between types of insurance, short term patient outcomes were similar across all insurance types.

Generally, private insurance plans cover recommended asthma services. An analysis of 98 health plans from every state and the District of Columbia found that most plans provided coverage for all recommended health services for asthma, although the coverage tended to be better in managed care products versus preferred provider organizations (Fox et al. 2003). Despite this, there are large, systematic differences between health plans in terms of the rate of compliance of plan members with asthma to recommended guidelines for asthma care (Eisenberg 2004). In the previously mentioned analysis of patients in the emergency departments for acute asthma, managed care patients were more likely to have used inhaled steroids in the month prior to arrival in the emergency department than indemnity-insured patients, and they received the best overall care (Ferris et al. 2002). However, patients hospitalized for asthma from managed care plans had both shorter average length of stays and higher readmission rates (Ather et al. 2004).

In the United States, employer claims files show that the controller-to-reliever ratio rose steadily over from 1995 to 2000, suggesting that the quality of care was improving (Crown et al. 2004). On the other hand, out-of-pocket payments for asthma medications also increased, with larger increases for controllers than relievers. After controlling for other independent variables, the authors found that mean plan-level out-of-pocket copayments did not have a statistically significant effect on patient-level asthma treatment patterns. However, the prescribing patterns of physicians and physician practices strongly influenced treatment patterns. Similarly, in Sweden, large variations in costs across different primary health clinics were found even after controlling for asthma severity (Arnlind et al. 2006). And in Switzerland, costs were higher for patients treated by nonspecialists, for those without supplementary insurance, and for those treated in rural areas and in French-speaking cantons (Szucs et al. 2000).

Can insurance or payment mechanisms be used to either improve the quality of care or reduce the cost of care? One challenge is that these may be contradictory goals; increased compliance leads to fewer asthma attacks and better asthma control, but is likely to

increase primary-care costs (Dasgupta and Guest 2003). However, in some high cost populations, inhaled corticosteroids are cost effective and lead not only to significant clinical improvement but also to savings in both direct and indirect costs (Navarro and Parasuraman 2005). These populations are the focus of disease management programs.

There are a number of suggestive studies of disease management that show the promise of reducing the cost of care while simultaneously improving quality. For example, a small randomized trial of young women hospitalized with an asthma exacerbation found that intervention by asthma nurse specialist decreased hospitalizations by 60% and readmissions for asthma by 54%, and led to reductions in health care costs (direct and indirect) of $6,462 per patient (Castro et al. 2003). Similarly, in a Medicaid based disease management program, the intervention group exhibited 18% lower costs as compared to a matched control group (Tinkelman and Wilson 2004). Another program in a Medicaid managed care plan improved quality of life and reduced utilization (Jowers et al. 2000). Case management has also been found to have a positive impact on a number of case studies (Anonymous 2002). Finally, an asthma disease management program that helped physicians manage asthma in a fee-for-service primary care case management program reduced the rate of emergency visit claims by 23% and increased the rate of prescribing reliever drugs by 25% (Rossiter et al. 2000). The project suggested a return-on-investment of $3–$4 for every incremental dollar spent. But these studies are fraught with difficulties in replication and specificity of the particular population studied. Methodologically, controlling for issues such as regression to the mean is challenging. However, it seems likely that such programs can be effective for certain high cost populations.

Conclusion

Asthma is a costly illness, regardless of country, payment system, population characteristics or timeframe. Asthma is expensive for children, the elderly and working age populations. Asthma imposes high costs for the healthcare system, in the form of direct medical costs, and on employers and asthmatics in the form of work loss, days with reduced health and school days lost.

The causes of direct medical care expenditures for asthma are variable. Traditionally, hospital costs have been the most expensive element of care. This observation provided inspiration for policy makers to improve care because asthma hospitalizations are viewed as potentially avoidable, and in many of the studies reviewed, hospitalizations were the most expensive element of care. However, in several studies prescription drugs were found to be more expensive than hospital care. This is partially due to sample selection issues; in populations with less severe asthma, prescription drug expenditures will likely outweigh hospital expenditures. However, reduced hospital expenditures may reflect improving care and a concomitant reduction in hospitalizations due to asthma.

From the individual standpoint, it is clear that payment rules matter. Asthmatics without health insurance experience barriers accessing care, tend to delay seeking services, are less likely to use asthma medications and are more likely to end up in costly settings such as emergency departments. However, there is also tremendous variability in the quality of care provided within more uniform national health care systems, such as France, Sweden, Canada and Switzerland, and within the relatively uniform Medicaid system. Creating more even financial access to care may mitigate differences in access, but significant differences will remain. Even when use of primary care services is uniform across different income groups, adherence to prescribed medications and use of emergency and urgent care services is not. Further research into understanding critical socio-demographic and cultural differences in care seeking behavior among asthmatics is warranted.

It appears that there is some potential in using payment systems to provide improved care. For example, managed care plans are able to demonstrate differences in quality of care, and efforts to reward better care may yield intended results. Related evidence indicates that disease management programs may be able to improve outcomes and reduce costs in certain high cost populations.

Standard asthma care is well covered by most insurance plans, in the United States, Canada and Europe. However, there are many potentially valuable additional services that could be covered by health insurance such as home environmental modification. For insurers, a concern emerges that paying for services that are beneficial for those with severe symptoms may lead to substantial costs if the services are utilized more generally.

Chernew et al. (2007) proposes to replace the standard insurance design with a “Value Based Insurance Design” whereby cost-sharing and benefit design is

driven not just by costs, but also by evidence of clinical benefits. This can be done most easily by targeting particular clinical services that are "high value," such as controller medications. Under this scheme, exceptions to the standard benefit package would be made for these high value services to encourage their use. The drawback to this approach is that it may lead to increases in use by both those for whom there is high clinical value and by some for whom there is less value.

A more challenging alternative is to alter the design of the insurance based on diagnosis. For example, if a person were diagnosed with severe asthma, a set of additional benefits would become available. This could include not just medications, but also such benefits as home environmental modification. Such an approach has already been successfully piloted at the University of Michigan for diabetics (Chernew et al. 2007), suggesting that a similar approach for asthma may be possible.

References

Accordini S, Bugiani M, Arossa W, Gerzeli S, Marinoni A, Olivieri M, Pirina P, Carrozzi L, Dallari R, De Togni A, de Marco R (2006) Poor control increases the economic cost of asthma. A multicentre population-based study. Int Arch Allergy Immunol 141(2):189–198

Anonymous (2002) Diverse approaches to asthma DM succeed in Medicaid populations. Dis Manag Advis 8(5):71–77

Antonicelli L, Bucca C, Neri M, De Benedetto F, Sabbatani P, Bonifazi F, Eichler HG, Zhang Q, Yin DD (2004) Asthma severity and medical resource utilisation. Eur Respir J 23(5):723–729

Arnlind MH, Nokela M, Rehnberg C, Jonsson EW (2006) The relationship between pharmaceutical costs, disease severity, and health-related quality of life in asthmatics in Swedish primary care. J Asthma 43(8):585–591

Ather S, Chung KD, Gregory P, Demissie K (2004) The association between hospital readmission and insurance provider among adults with asthma. J Asthma 41(7):709–713

Bender BG, Rand C (2004) Medication non-adherence and asthma treatment cost. Curr Opin Allergy Clin Immunol 4(3):191–195

Birnbaum H, Berger W, Greenberg P, Holland M, Auerbach R, Atkins K, Wanke L (2002) Direct and indirect costs of asthma to an employer. J Allergy Clin Immunol 109(2):264–270

Blais L, Beauchesne MF, Levesque S (2006) Socioeconomic status and medication prescription patterns in pediatric asthma in Canada. J Adolesc Health 38(5):607.e9–607.e16

Blanc PD, Trupin L, Eisner M, Earnest G, Katz PP, Israel L, Yelin EH (2001) The work impact of asthma and rhinitis: findings from a population-based survey. J Clin Epidemiol 54(6):610–618

Bloom B, Bruno D, Maman D, Jayadevappa R (2001) Usefulness of US cost-of-illness studies in healthcare decision making. Pharmacoeconomics 19(2):207–213

Braman SS (2006) The global burden of asthma. Chest 130(1):4S–12S

Castro M, Zimmermann NA, Crocker S, Bradley J, Leven C, Schechtman KB (2003) Asthma intervention program prevents readmissions in high healthcare users. Am J Respir Crit Care Med 168(9):1095–1099

Celik GE, Bavbek S, Paaolu G, Mungan D, Abadolu O, Harmanci E, Misirligil Z (2004) Direct medical cost of asthma in Ankara, Turkey. Respiration 71(6):587–593

Chernew M, Rosen A, Fendrick AM (2007) Value-based insurance design. Health Aff 26(2):w195–w203

Chew FT, Goh DY, Lee BW (1999) The economic cost of asthma in Singapore. Aust N Z J Med 29(2):228–233

Cisternas MG, Blanc PD, Yen IH, Katz PP, Earnest G, Eisner MD, Shiboski S, Yelin EH (2003) A comprehensive study of the direct and indirect costs of adult asthma. J Allergy Clin Immunol 111(6):1212–1218

Colice G, Wu E, Birnbaum H, Daher M, Marynchenko M, Varghese S (2006) Healthcare and workloss costs associated with patients with persistent asthma in a privately insured population. J Occup Environ Med 48(8):794–802

Crown WH, Berndt ER, Baser O, Finkelstein SN, Witt WP, Maguire J, Haver KE (2004) Benefit plan design and prescription drug utilization among asthmatics: do patient copayments matter? Front Health Policy Res 7:95–127

Dasgupta R, Guest JF (2003) Factors affecting UK primary-care costs of managing patients with asthma over 5 years. Pharmacoeconomics 21(5):357–369

David C (2004) Preventive therapy for asthmatic children under Florida Medicaid: changes during the 1990s. J Asthma 41(6):655–661

Drummond M (1992) Cost of illness studies: a major headache? Pharmacoeconomics 2(1):1–4

Druss B, Marcus SC, Olfson M, Pincus A (2002) The most expensive medical conditions in America. Health Aff 21(4):105–111

Eisenberg SS (2004) Building the case for asthma as a disease management program. Dis Manag 7(3):202–215

Ferris TG, Blumenthal D, Woodruff PG, Clark S, Camargo CA, MARC Investigators (2002) Insurance and quality of care for adults with acute asthma. J Gen Intern Med 17(12):905–913

Fox HB, McManus MA, Reichman MB (2003) Private health insurance for adolescents: is it adequate? J Adolesc Health 32(6 Suppl):12–24

Fredrickson DD, Molgaard CA, Dismuke SE, Schukman JS, Walling A (2004) Understanding frequent emergency room use by Medicaid-insured children with asthma: a combined quantitative and qualitative study. J Am Board Fam Pract 17(2):96–100

Freeman NC, Schneider D, McGarvey P (2003) The relationship of health insurance to the diagnosis and management of asthma and respiratory problems in children in a predominantly Hispanic urban community. Am J Public Health 93(8):1316–1320

Gold M, Siegel J, Russell L, Weinstein M (1996) Cost-effectiveness in health and medicine. Oxford University Press, Oxford

Grupp-Phelan J, Lozano P, Fishman P (2001) Health care utilization and cost in children with asthma and selected comorbidities. J Asthma 38(4):363–373

Herjavecz I, Nagy GB, Gyurkovits K, Magyar P, Dobos K, Nagy L, Alemao E, Ben-Joseph R (2003) Cost, morbidity, and control of asthma in Hungary: The Hunair Study. J Asthma 40(6):673–681

Hodgson T (1994) Cost of illness in cost-effectiveness analysis: a review of the methodology. Pharmacoeconomics 6(6):536–552

Joshi AV, Madhavan SS, Ambegaonkar A, Smith M, Scott VG, Dedhia H (2006) Association of medication adherence with workplace productivity and health-related quality of life in patients with asthma. J Asthma 43(7):521–526

Jowers JR, Schwartz AL, Tinkelman DG, Reed KE, Corsello PR, Mazzei AA, Bender DR, Lochhead RA (2000) Disease management program improves asthma outcomes. Am J Manag Care 6(5):585–592

Kiivet RA, Kaur I, Lang A, Aaviksoo A, Nirk L (2001) Costs of asthma treatment in Estonia. Eur J Public Health 11(1):89–92

Koopmanschap M (1998) Cost of illness studies. Useful for health policy? Pharmacoeconomics 14(2):143–148

Krahn MD, Berka C, Langlois P, Detsky AS (1996) Direct and indirect costs of asthma in Canada, 1990. CMAJ 154(6):821–831

Lodha R, Puranik M, Kattal N, Kabra SK (2003) Social and economic impact of childhood asthma. Indian Pediatr 40(9):874–879

Lozano P, Fishman P, VonKorff M, Ad Hecht J (1997) Health care utilization and cost among children with asthma who were enrolled in a health maintenance organization. Pediatrics 99(6):757–764

Lozano P, Sullivan SD, Smith DH, Weiss KB (1999) The economic burden of asthma in US children: estimates from the National Medical Expenditure Survey. J Allergy Clin Immunol 104(5):957–963

Malone DC, Lawson KA, Smith DH (2000) Asthma: an analysis of high-cost patients. Pharm Pract Manag Q 20(1):12–20

Markovitz BP, Andresen EM (2006) Lack of insurance coverage and urgent care use for asthma: a retrospective cohort study. BMC Public Health 6:14

McConnochie KM, Russo MJ, McBride JT, Szilagyi PG, Brooks AM, Roghmann KJ (1999) Socioeconomic variation in asthma hospitalization: excess utilization or greater need? Pediatrics 103(6):e75

Meng YY, Babey SH, Brown ER, Malcolm E, Chawla N, Lim YW (2006) Emergency department visits for asthma: the role of frequent symptoms and delay in care. Ann Allergy Asthma Immunol 96(2):291–297

Milton B, Whitehead M, Holland P, Hamilton V (2004) The social and economic consequences of childhood asthma across the lifecourse: a systematic review. Child Care Health Dev 30(6):711–728

Navarro RP, Parasuraman B (2005) Cost effectiveness of asthma controller therapies: influence of disease severity and other variables. Manag Care Interface 18(6):31–40

Ortega AN, Belanger KD, Paltiel AD, Horwitz SM, Bracken MB, Leaderer BP (2001) Use of health services by insurance status among children with asthma. Med Care 39(10):1065–1074

Piecoro LT, Potoski M, Talbert JC, Doherty DE (2001) Asthma prevalence, cost, and adherence with expert guidelines on the utilization of health care services and costs in a state Medicaid population. Health Serv Res 36(2):357–371

Rossiter LF, Whitehurst-Cook MY, Small RE, Shasky C, Bovbjerg VE, Penberthy L, Okasha A, Green J, Ibrahim IA, Yang S, Lee K (2000) The impact of disease management on outcomes and cost of care: a study of low-income asthma patients. Inquiry 37(2):188–202

Rutten van-Molken MP, Feenstra TL (2001) The burden of asthma and chronic obstructive pulmonary disease: data from The Netherlands. Pharmacoeconomics 19(Suppl 2):1–6

Rutten-van Molken MP, Postma MJ, Joore MA, Van Genugten ML, Leidl R, Jager JC (1999) Current and future medical costs of asthma and chronic obstructive pulmonary disease in The Netherlands. Respir Med 93(11):779–787

Schwenkglenks M, Lowy A, Anderhub H, Szucs TD (2003) Costs of asthma in a cohort of Swiss adults: associations with exacerbation status and severity. Value Health 6(1):75–83

Sennhauser FH, Braun-Fahrlander C, Wildhaber JH (2005) The burden of asthma in children: a European perspective. Paediatr Respir Rev 6(1):2–7

Serra-Batlles J, Plaza V, Morejon E, Comella A, Brugues J (1998) Costs of asthma according to the degree of severity. Eur Respir J 12(6):1322–1326

Shiell A, Gerard K, Donaldson C (1987) Cost of illness studies: an aid to decision-making? Health Policy 8:317–323

Sin DD, Svenson LW, Cowie RL, Man SF (2003) Can universal access to health care eliminate health inequities between children of poor and nonpoor families?: a case study of childhood asthma in Alberta. Chest 124(1):51–56

Smith DH, Malone DC, Lawson KA, Okamoto LJ, Battista C, Saunders WB (1997) A national estimate of the economic costs of asthma. Am J Respir Crit Care Med 156(3):787–793

Stempel DA, Spahn JD, Stanford RH, Rosenzweig JR, McLaughlin TP (2006) The economic impact of children dispensed asthma medications without an asthma diagnosis. J Pediatr 148(6):819–823

Stevens CA, Turner D, Kuehni CE, Couriel JM, Silverman M (2003) The economic impact of preschool asthma and wheeze. Eur Respir J 21(6):1000–1006

Stock S, Redaelli M, Luengen M, Wendland G, Civello D, Lauterbach KW (2005) Asthma: prevalence and cost of illness. Eur Respir J 25(1):47–53

Szucs T, Anderhub H, Rutishauser M (1999) The economic burden of asthma: direct and indirect costs in Switzerland. Eur Respir J 13:281–286

Szucs TD, Anderhub HP, Rutishauser M (2000) Determinants of health care costs and patterns of care of asthmatic patients in Switzerland. Schweiz Med Wochenschr 130(9):305–313

Tinkelman D, Wilson S (2004) Asthma disease management: regression to the mean or better? Am J Manag Care 10(12): 948–954

Ungar WJ, Coyte PC (2000) Measuring productivity loss days in asthma patients. The Pharmacy Medication Monitoring Program and Advisory Board. Health Econ 9(1):37–46

Van Ganse E, Laforest L, Pietri G, Boissel JP, Gormand F, Ben-Joseph R, Ernst P (2002) Persistent asthma: disease control, resource utilisation and direct costs. Eur Respir J 20(2): 260–267

Van Ganse E, Antonicelli L, Zhang Q, Laforest L, Yin DD, Nocea G, Sazonov Kocevar V (2006) Asthma-related resource use and cost by GINA classification of severity in three European countries. Respir Med 100(1):140–147

Wang LY, Zhong Y, Wheeler L (2005) Direct and indirect costs of asthma in school-age children. Prev Chronic Dis 2(1):A11

Weiss KB, Gergen PJ, Hodgson TA (1992) An economic-evaluation of asthma in the United-States. N Engl J Med 326(13):862–866

Weiss KB, Sullivan SD, Lyttle CS (2000) Trends in the cost of illness for asthma in the United States, 1985–1994. J Allergy Clin Immunol 106(3):493–499