Chapter 30

Economic Impact of Diabetes

Jonathan C. Javitt, MD, MPH, and Yen-Pin Chiang, PhD

SUMMARY

Substantial costs to society and its citizens are incurred for direct costs of medical care for diabetes and for indirect costs, including lost productivity resulting from diabetes-related morbidity and premature mortality. Economic analyses performed in the 1980s suggested that the economic costs associated with diabetes in the United States were between $14 billion and $20 billion in 1980s-era dollars, including an estimated $7.4-$11.6 billion for direct medical care expenditures and an additional $6.3-$10.8 billion for lost productivity. A more recent study estimated $91.8 billion for the cost of diabetes in 1992, including $45.2 billion direct costs and $46.4 billion indirect costs. Another study found that the direct costs of medical care for people with diabetes was $85.7 billion in 1992.

Comparisons among these estimates are made difficult by several methodological issues in estimating the economic costs of illness. The most critical issues in evaluating an economic analysis are 1) the appropriateness and consistency of the method for attributing costs to the underlying condition, 2) the method for valuing human life and health, and 3) methods for estimating volume of medical services. These issues are discussed in this chapter.

Studies have documented that medical costs for persons with diabetes are higher because they visit physician's offices, hospital outpatient departments, and emergency rooms more frequently than their nondiabetic counterparts and are more likely to be admitted to the hospital. Americans with diabetes have two to five times higher per capita total medical expenditures and per capita out-of-pocket expenses than people without diabetes. These expenses and their associated loss of productivity have impact not only on diabetic patients and their families, but on federal and state governments and society as a whole.

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INTRODUCTION

Diabetes is one of the most prevalent chronic diseases in the United States and a leading cause of death. Estimates based on the 1993 National Health Interview Survey (NHIS) indicate that diabetes has been diagnosed in 1% of the U.S. population age <45 years, 6.2% of those age 45-64 years, and 10.4% of those age ≥65 years[1]. In other terms, in 1993 an estimated 7.8 million persons in the United States were reported to have this chronic condition, including 1.5 million persons age <45 years, 3.1 million persons age 45-64 years, and 3.2 million persons age ≥65 years[1]. In addition, based on the annual incidence rates for diabetes (see Chapters 3 and 4), it is estimated that about 625,000 new cases of diabetes are diagnosed each year, including 595,000 cases of non-insulin-dependent diabetes mellitus (NIDDM) and 30,000 cases of insulin-dependent diabetes mellitus (IDDM).

Substantial costs to both society and its citizens are incurred not only for direct costs of medical care for diabetes but also for indirect costs, including lost productivity resulting from diabetes-related morbidity and premature mortality. As documented elsewhere in this book, persons with diabetes are at risk for major complications, including diabetic ketoacidosis, end-stage renal disease, diabetic retinopathy, and amputation. There are also a host of less directly related conditions, such as hypertension, heart disease, peripheral vascular disease, and infections, for which persons with diabetes are at substantially increased risk. A significant portion of the costs associated with these cormorbid conditions can be, and should be, attributed to the underlying diabetes.

A number of economic analyses of the cost of diabetes were performed in the 1980s and 1990s. This chapter examines the methodological differences in these published analyses and provides an update and synthesis of previous cost estimates.

METHODOLOGICAL ISSUES IN ESTIMATING THE COSTS OF ILLNESS

In the 1980s, there were several studies on the costs of diabetes[2-6]. Caution is advised when making comparisons among the estimates generated from multiple studies. Although the studies arrived at relatively consistent cost estimates, different methodologies and baseline years were used in their analyses of the costs of illness.

Several methodological issues in estimation of economic costs of illness deserve attention. The most critical issues in evaluating an economic analysis are: 1) appropriateness and consistency of the method for attributing costs to the underlying condition, 2) method for valuing human life and health, and 3) methods for estimating volume of medical services.

METHODS FOR ATTRIBUTING COSTS TO THE UNDERLYING CONDITION

In evaluating the burden of illness, a consistent method must be established for attributing various clinical conditions, including direct complications of diabetes and some proportion of systemic comorbid conditions for which persons with diabetes are at increased risk, to the underlying condition of diabetes. That allocation strategy, once devised, must be translated into a corresponding coding strategy for ascertaining those conditions from the codes of the International Classification of Diseases commonly used in administrative databases[7]. The attribution of comorbid systemic conditions associated with diabetes may be particularly problematic. Numerous studies have documented that persons with diabetes are at increased risk for many acute and chronic illnesses and complications, such as visual impairment, lower extremity amputation, and cardiovascular disease (see Chapters 14, 18, and 19). The prevalence of hypertension, kidney disease, and peripheral vascular disease are also substantially greater for those with diabetes (see Chapters 7, 16, and 17). To the extent that diabetes causes or increases the risk of these illnesses, one needs to estimate what proportion of these illnesses and associated morbidity and mortality can be attributed to diabetes to determine all of the costs associated with diabetes.

Some previous analyses have included directly attributable complications of diabetes such as retinopathy and neuropathy but have omitted the costs associated with systemic comorbidities such as cardiovascular disease, infection, and stroke. One study provided a good example of how costs that arise as a consequence of excess risk of comorbidities in persons with NIDDM can be included in the cost estimates[6]. The analysis first calculated the etiologic fraction for each comorbid condition attributable to diabetes, then multiplied these fractions by the cost of each diabetes-related comorbid condition.

The inclusion or exclusion of various comorbid clinical conditions in the analysis may result in considerable differences in the estimated economic impact of diabetes. These differences may or may not be significant, depending on the underlying prevalence of the diabetes-related clinical conditions in question. In general, when certain clinical conditions or the excess risk of comorbidities are not attributed to the disease category (as they should have been) in the analysis, the economic impacts of the disease are likely to be understated. On the other hand, an overly broad attribution of comorbidities to diabetes and to the other chronic diseases that are often the target of economic analysis may lead to double counting. In its *reductio ad absurdum*, economic analysis of the cost of chronic diseases may suggest that these diseases in aggregate cost considerably more than the total U.S. health care expenditures.

METHODS FOR VALUING HUMAN LIFE AND HEALTH

The second critical methodological issue in estimating the burden of illness is how the economic costs of an illness are formulated and reported. Economists generally employ two analytical approaches, the human capital method and the willingness-to-pay method, in valuing human life. The human capital approach estimates an individual's value to society in terms of the individual's production potential, i.e., his or her current and future earnings stream[8]. The willingness-to-pay approach bases its estimates on what the individual would be willing to pay to reduce the probability of morbidity or mortality[9]. Although both approaches have their own set of merits and limitations, most of the cost-of-illness studies since Rice[10] have adopted the human capital method in valuing human life and arriving at their estimates. This methodological preference among researchers is mainly a function of the availability of productivity-related sta-

tistics and the difficulties in obtaining willingness-to-pay estimates in practice.

Under the human capital approach, there are two conceptually distinct methods in presenting the costs of illness: an estimate of annual costs for all prevalent cases and an estimate of lifetime costs in an incident cohort of patients. The prevalence-based estimates of the costs of illness measure costs incurred during a specified period, usually 1 year, for all individuals suffering the illness regardless of the time of disease onset. Such prevalence-based estimates provide important information on the expenditures associated with the disease for a given period. The approach is conceptually and empirically straightforward because it is a cross-sectional estimate in nature and does not require additional information on how the natural history of the disease affects medical and other costs at different disease stages. Almost all of the cost-of-illness studies to date have adopted this prevalence-based annual costs approach in arriving at their estimates. Estimates generated by this approach are of limited use, however, in the context of cost-benefit and cost-effectiveness analyses, where it is necessary to know the costs associated with the incidence of disease while evaluating various disease prevention strategies.

The incidence-based cost-of-illness estimates, on the other hand, measure the lifetime costs incurred from disease onset until cure or death for all persons in an incidence cohort, such as all persons who develop the condition in a given year. Since lifetime costs of illness are longitudinal in nature, information regarding the natural history of the disease such as its likely course, duration, and survival rates—as well as the impact of these assumptions on medical care expenses and lost productivity—are essential in arriving at the estimates. As technology and the underlying cost structures of medical care change over time, so will the lifetime costs of illness. Future analyses must reflect these changes to generate more accurate estimates under the incidence-based approach. Despite difficulties in implementation, the incidence-based cost-of-illness approach is still most useful in estimating the benefits associated with reducing disease incidence through existing or hypothetical preventive modalities. The availability of such estimates serve as an important foundation for cost-benefit and cost-effectiveness analyses of various disease prevention and intervention strategies.

In contrast, a prevalence-based cost-of-illness approach is far easier to implement, since it requires only that one be able to measure the direct and indirect economic burden associated with the condition of interest for all persons affected by the condition during a defined interval, most commonly 1 year[11]. While this approach can be readily adapted to estimating national costs of various conditions, it is less applicable to estimating the cost-effectiveness of proposed intervention strategies.

METHODS FOR ESTIMATING VOLUME OF MEDICAL SERVICES

As in all cost-of-illness studies, data on medical service utilization and potential productivity lost due to morbidity and mortality are essential in arriving at cost estimates for diabetes. For medical service utilization, clinical cost-of-illness estimates have generally relied on national surveys, such as the National Hospital Discharge Survey (NHDS), National Ambulatory Medical Care Survey (NAMCS), and National Nursing Home Survey (NNHS), in which data are obtained from hospitals and medical care providers. For potential productivity lost due to morbidity and mortality, the National Health Interview Survey (NHIS) and the U.S. Life Tables have been used as data sources in estimating disability days and premature death. The use of medical care provider survey data, such as that available in the NAMCS, or databases sponsored by various health industries may be problematic in that the sampling frame often excludes certain areas of health care utilization that are not needed for the primary purpose of the survey. For instance, ambulatory visits to hospital outpatient departments and emergency departments were not included in the NAMCS before 1993. Since ~15% of ambulatory care is rendered at hospital outpatient and emergency departments, and this source of care is particularly used by minority and economically disadvantaged persons, any utilization estimate based on the NAMCS is likely to underestimate costs of diabetes care in urban populations. Both the NHDS and the NNHS also face similar concerns of understating the actual utilization of services.

Entmacher[4] suggested an alternative approach to deriving cost estimates from population-based surveys such as the annual NHIS, the 1977 National Medical Care Expenditure Survey (NMCES), and the 1987 National Medical Expenditure Survey (NMES). Assuming that individual respondents to these surveys can provide valid utilization information on various medical categories, a national probability sample with proper statistical weight can, theoretically, present a reasonable estimate of national medical care utilization. Another advantage of population-based survey data is that it can provide some insight into the burdens and impacts of the diseases from the individual's

perspective. Information, such as out-of-pocket medical care expenses, can be obtained from the NHIS, NMCES, and NMES. The national population-based health surveys are limited, however, in that unless specific questions about certain diseases or health conditions are included in the survey, detailed diagnosis and procedure data are generally not available. Thus, it is usually more difficult to obtain disease-specific estimates from such sources. In the case of diabetes, fortunately, the NHIS included a diabetes supplement focusing on the health care management and service utilization of persons with diabetes in 1976 and again in 1989.

The 1987 NMES household survey, conducted by the Agency for Health Care Policy and Research (AHCPR), consisted of a national multistage area probability sample of 35,000 individuals in 14,000 households[12,13]. The 1987 NMES included the question, "Did a doctor or other medical person ever say that (the sample person) had diabetes (high blood sugar)?" The validity of relying on the response to this question to identify diabetic subjects, however, is questionable. The inclusion of the phrase "high blood sugar" in characterizing diabetes status may lead individuals with hyperglycemia alone to respond positively to the question. Since not all individuals with high blood sugar have diabetes, prevalence estimates based solely on the response to this question in the 1987 NMES will be overstated. Moreover, costs associated with this cohort of individuals, comprising a mixture of those with diagnosed diabetes and those with hyperglycemia, will understate the costs associated with diabetes per person with diabetes. An estimate based on this survey question in the 1987 NMES, extrapolated to the U.S. population of 1992, rendered 11.2 million prevalent diabetes cases in 1992[14]. This estimate is 50% higher than the estimate of 7.4 million derived from the 1992 NHIS, which asks the question, "During the past 12 months, did anyone in the family have diabetes?" However, NMES is the only survey that collected cost data for a national sample of the U.S. population on utilization of medical services in the hospital, physicians' offices, and emergency rooms, as well as cost data on medication. The data have been used for estimating medical cost in several studies[14,15].

DIRECT AND INDIRECT COSTS OF DIABETES

Of the several studies on the economic costs of diabetes conducted in the 1980s, almost all used the human capital approach in valuing human life and relied on prevalence-based annual cost estimates in their analyses. This section synthesizes and updates the cost estimates in four of these analyses, i.e., those by the Carter Center of Emory University[3], Entmacher and colleagues[4], Pracon Inc.[5], and Huse and colleagues[6]. To facilitate the comparisons, this section presents the original estimate figures from these studies. In addition, we have updated cost estimates to 1990 dollars by adjusting the original figures using the Consumer Price Index-U inflater. Tables 30.1 and 30.2 show how these estimates compare with each other in different cost categories.

Table 30.1
Estimates of the Economic Costs of Diabetes in the U.S.

Cost component	Carter Center (1980)	Entmacher (1984)	Huse (1986)	Pracon (1987)
	(dollars in billions)			
Direct costs	7.9 (12.4)	7.4 (9.3)	11.6 (13.8)	9.6 (11.0)
Indirect costs	10.0 (15.8)	6.3 (7.9)	8.2 (9.7)	10.8 (12.4)
Total costs	17.9 (28.2)	13.7 (17.2)	19.8 (23.5)	20.4 (23.4)

Figures in parentheses are estimates adjusted by the chapter authors to 1990 dollars using the Consumer Price Index-U inflater.

Source: References 3-6

In classic cost-of-illness studies, costs are usually divided into direct costs for medical care and indirect costs from lost productivity due to morbidity and mortality. The direct cost component usually includes expenditures associated with medical treatments, such as hospital and nursing home care, physician services, prescription drugs, laboratory tests, medical supplies, and other medical professional services. The relevant expenditures apply not only to diabetic con-

Table 30.2
Estimates of the Direct Costs of Diabetes in the U.S.

Cost component	Carter Center (1980)	Entmacher (1984)	Huse (1986)	Pracon (1987)
		(dollars in billions)		
Hospitalization	6.2 (9.8)	5.8-7.0 (7.3-8.8)	4.9 (5.8)	6.9 (7.9)
Nursing home	7.0 (1.1)		3.4 (4.0)	1.0 (1.1)
Physician visit	0.7 (1.1)	0.5-1.0 (0.6-1.3)	2.2 (2.6)	1.7 (1.9)
Medication			0.8 (1.0)	
Other			0.2 (0.3)	

Figures in parentheses are estimates adjusted by the chapter authors to 1990 dollars using the Consumer Price Index-U inflater.

Source: References 3-6

ditions but also to the additional comorbidity conditions that can be attributed to diabetes. In recent years, some studies[16] have suggested that certain support costs, such as expenditures for research and training, should be included in the direct costs. In practice, the estimates of direct costs are usually derived by multiplying the total units of certain types of medical care services or supplies utilized by the average unit costs of the services or supplies.

Indirect costs usually refer to the resources lost, instead of used, as a result of illness. Its components include the values of reduced and lost productivity due to morbidity, disability, and premature mortality. In practice, the measurement of the value of productivity is based on the assumptions that earnings (including both wages and wage supplements such as various insurance benefits and pensions) represent productivity and that certain value for household work should be imputed to add to the earning figures. Actual ascertainment of the indirect cost then involves applying average daily earnings to work-loss days for the short-term morbidity cases and discounting future stream-of-lifetime earnings into its present value for cases involving permanent disability and premature death.

DIRECT COSTS

The noneconomist reading any of the studies cited in this chapter may find the term "cost" used in a confusing, although economically correct, manner. From an economist's perspective, the cost of a service is quite different from its price. While price is a function of what is paid in the marketplace, cost is a function of the inputs (labor, consumable goods, depreciation, etc.) required to produce that service. Often, the estimated costs of medical care may seem quite low in relation to their common price.

Physician service costs

Huse and colleagues[6] employed the etiologic fraction method to derive estimates from published 1980 health expenditure data for diseases of the nervous system and sense organs, circulatory system, genitourinary system, and skin and subcutaneous tissue. After adjusting for growth in the U.S. population and per capita health expenses, they estimated that $2.2 billion ($2.6 billion in 1990 dollars) were spent on physician services for NIDDM in 1986. The Pracon study[5] adopted a slightly different approach and estimated that ~13.4 million diabetes-related outpatient physician visits occurred in 1987. With each visit costing an average $27.82, the total cost of physician services amounted to $0.4 billion in 1990 dollars. In the study conducted by the Carter Center[3], the authors assumed the cost of an average visit in 1980 to be $40. They estimated the total cost of physician visits was $0.7 billion per year ($1.1 billion in 1990 dollars). Entmacher and colleagues[4] estimated that $0.5-$1.0 billion were spent on patient visits to physicians in 1984 ($0.6-$1.3 billion in 1990 dollars).

Hospital service costs

The Pracon study[5] included costs directly attributed to diabetes, chronic complications of diabetes, and increased propensity to hospitalize diabetic patients in its estimate of the cost of hospital services. The study estimated >2.2 million hospital days were associated with providing care to patients with a primary diagnosis of diabetes in 1987. In addition, an estimated 5.71 million hospital days were attributed to the treatment of persons with diabetes-related renal, ophthalmologic, neurologic, and cardiovascular complications. They further assumed that persons with diabetes suffering certain comorbidities might have been hospitalized, whereas a nondiabetic person with the same complication would have been treated on an ambulatory basis, thus attributing the hospitalization cost to diabetes rather than to the comorbid condition. There were 845,700 hospital days attributed to diabetes. The total cost of hospitalizations for persons with diabetes was estimated to be $6.9 billion in 1987.

The study by Huse and colleagues[6], using etiologic fraction methodology, estimated the cost of NIDDM in 1986 to be $4.9 billion ($5.8 billion in 1990 dollars). The Carter Center study[3] based its estimate of the cost of hospitalizations on the number of hospital days incurred in hospitalizations for which diabetes was listed as a discharge diagnosis (one of seven possible diagnoses listed on the hospital discharge record). The authors assumed that the cost of a hospital day was $205. The total cost of hospitalization for diabetes, according to the Carter Center study, was $6.2 billion ($9.8 billion in 1990 dollars) per year in 1980.

Entmacher and colleagues[4] estimated that almost 50% of the total amount of direct costs of diabetes can be attributed to the cost of hospitalizations. The estimate of hospitalization costs using the human capital approach was $3.5 billion in 1984 and did not include costs incurred for conditions other than diabetes. Entmacher also reported cost estimates for hospitalizations with diabetes as a primary or secondary diagnosis. Data from the 1980 NHDS and the 1980 National Medical Care Utilization and Expenditure Survey (NMCUES) were used to estimate the number of hospitalizations. The total cost of hospitalizations for

diabetes was estimated to be $5.8-$7.0 billion ($7.3-$8.8 billion in 1990 dollars).

Long-term care costs

According to the Huse study[6], nursing home care cost a total of $3.44 billion ($4.0 billion in 1990 dollars) in 1986. In the Pracon study[5], the number of nursing home stays was determined for stays directly attributed to diabetes, its chronic complications, and the increased propensity to institutionalize diabetic patients in nursing homes. In 1987, there were 446,856 months of institutionalized care provided to persons with diabetes. The cost of providing this care was estimated to be $1.0 billion ($1.1 billion in 1990 dollars). According to the Carter Center study[3], the median length of stay for diabetic patients was 85 days, with an average cost per median stay of $3,500. Therefore, the total cost of nursing home care for diabetic patients was calculated to be $0.7 billion ($1.1 billion in 1990 dollars). Entmacher[4] estimated that $2.0 billion was spent on nursing home care in 1984 ($2.6 billion in 1990 dollars).

Medication, laboratory, and other costs for therapy and management

Pracon estimated the cost of medications to be $1.3 billion ($1.5 billion in 1990 dollars), which included the cost of insulin, syringes, cotton swabs, self-administered glucose and urine tests, oral hypoglycemic medication, and laboratory tests ordered or administered by a physician[5]. Huse estimated the cost of medications to be $0.8 billion ($0.9 billion in 1990 dollars)[6]. Entmacher estimated that $0.6 billion was spent on medications ($0.7 billion in 1990 dollars)[4].

INDIRECT COSTS

Productivity lost due to short-term morbidity

The indirect cost component in the Pracon study included the costs of time for physician visits and work-loss days[5]. The total amount of labor days lost by persons with diabetes due to outpatient physician visits was estimated to be 1,379,103 person-days per year, resulting in a cost of about $0.87 billion. A total of 873,432 work days were lost due to diabetes illness or symptoms, with an associated cost of $0.55 billion. Short-term morbidity was, therefore, associated with a loss of $1.42 billion in productivity in 1987.

Productivity lost due to permanent disability and premature mortality

Huse estimated $2.6 billion ($3.1 billion in 1990 dollars) in foregone productivity related to disability associated with diabetes[6]. The Pracon study estimated that diabetes disabled 9,319 workers[5]. The indirect cost attributed to long-term disability was $3.1 billion. Entmacher estimated the indirect cost due to disability that resulted in lost wages and earnings to be $4.4 billion in 1984 ($5.6 billion in 1990 dollars)[4].

Huse estimated $5.6 billion in foregone productivity related to premature mortality ($6.6 billion in 1990 dollars)[6]. Pracon estimated there were 80,339 deaths in 1987 due to diabetes, either as a direct or contributory cause. The cost associated with the premature mortality was $7.5 billion ($8.9 billion in 1990 dollars)[5]. Entmacher estimated the indirect cost in lost wages and earnings due to premature mortality to be $1.9 billion in 1984 ($2.3 billion in 1990 dollars)[4].

The Carter Center study estimated that 37,500 person-years of productivity were lost each year by working people with diabetes, 53,000 person-years were lost each year by homemakers, and 116,300 person-years were lost by unemployed diabetic people[3]. Among people age <65 years, there were 411,000 years of life lost before age 65 years, based on diabetes listed as one of the causes of death on death certificates. There is considerable underreporting of diabetes as the underlying cause of death because it is rarely the proximal cause of death (as opposed to myocardial infarction, stroke, etc.; see Chapter 11). In many cases, diabetes is listed only as a contributing cause of death and is not captured in summary databases. To estimate the true mortality associated with diabetes, the authors of the Carter Center report multiplied (somewhat arbitrarily) the underlying cause of death data by a factor of 10, which resulted in a total of 1,450,000 years of life lost each year. The total indirect cost was estimated to be $10.0 billion per year ($15.8 billion in 1990 dollars).

Given the broad variations in underlying assumptions, it is reassuring to note that most of the diabetes cost analyses, except for the Entmacher study, arrived at similar estimates for the total cost burden of diabetes. In fact, because the Entmacher study focused only on costs directly associated with diabetes, one would expect a lower estimate. Because of this assumption, which excludes the excess risk of comorbid conditions attributable to diabetes, the Entmacher study does not serve, nor was it intended to serve, as a complete estimate of the cost of diabetes. The best estimate of the annual economic burden of diabetes in

the United States during the 1980s, based on the Huse and Pracon studies, is about $20 billion, including $10-$12 billion for direct medical costs.

THE COSTS OF SYSTEMIC MORBIDITY AND MORTALITY ATTRIBUTABLE TO DIABETES

Results from a study on costs of diabetes in 1992 were published by the American Diabetes Association (ADA)[15]. The study employed the prevalence-based approach[11] to estimate the costs of diabetes in 1992. The information on prevalence, incidence, morbidity, mortality, and health resources used were derived from data collected primarily in 1985-91. The estimates for 1992 were accomplished by inflating each measure by the proportion of the combined increases in the U.S. civilian population from the year the data represent to 1992.

Direct medical costs of diabetes, its complications, and other comorbid conditions were estimated to be $45.2 billion. Indirect costs were $46.6 billion for economic loss due to disability and premature death from diabetes. The total costs of diabetes in 1992, therefore, were $91.8 billion (Table 30.3). This total is four times that of previous estimates, even after adjusting for inflation using the Consumer Price Index U-inflater. In part, this striking difference is attributable to increases over time of medical care costs in excess of the Consumer Price Index and to more intensive and expensive technology of care over time. However, there are significant differences in methodology between the ADA analysis and previous work that must be considered.

Table 30.3
Total Economic Costs of Diabetes, U.S., 1992

Cost component	Total cost (dollars in billions)	Percent of total cost
Direct cost		
Institutional		
Hospital	37.23	40.5
Nursing home	1.83	2.0
Outpatient	6.16	6.7
Total	45.22	49.2
Indirect cost		
Short-term morbidity	8.46	9.2
Long-term morbidity	11.18	12.2
Mortality	26.98	29.4
Total	46.43	50.8
Grand total	91.85	100.0

Source: Reference 15

The ADA analysis included direct medical and indirect components not considered by previous studies. For example, the cost of home health care visits, dietitian/nutritionist visits, and durable medical equipment such as glucose monitors were included in direct medical costs. Also, health care services attributed to excess risk attributable to diabetes of systemic comorbid conditions were ascertained more comprehensively. As a result, the total hospital days due to systemic cormorbid conditions attributed to diabetes in 1992 was 10 times that estimated in 1987, as was the estimate of nursing home days and physician visits. Finally, a total of 344,914 deaths in 1992, compared with 80,339 in 1987, were attributed to diabetes. This is partly a function of mortality databases used in the ADA study that better capture contributory causes of death.

ECONOMIC IMPACT OF DIABETES ON AFFECTED INDIVIDUALS

Diabetes, like most chronic health conditions, not only places substantial economic burdens on society as a whole but also imposes considerable economic burdens on individual patients and their families. The classic cost-of-illness analyses based on aggregate-level national utilization and expenditure data, however, are of little help in providing the economic impact of diseases from the individual's perspective. Although a large portion of medical expenses are usually borne by private and public health insurance programs for individuals with such coverage, persons with diabetes may still incur a substantial amount of out-of-pocket expenses for physician services, medications, laboratory tests, and other services that require shared payments. As previously described, the structure of currently available health expenditure surveys is not particularly useful for estimating national costs of diabetes and its complications. However, these surveys offer insights into how individual patients and their families are affected economically by diabetes.

Because individuals with diabetes tend to use more medical services than nondiabetic individuals, they are likely to incur not only higher total medical expenditures but also higher out-of-pocket expenses. Entmacher, based on the 1976 NHIS, showed that the per capita out-of-pocket medical expenses for diabetic patients are much higher than for the nondiabetic population across all age groups[4]. The differences were especially significant in the costs for prescribed medicine, for which diabetic individuals incurred 1.6-3.5 times more out-of-pocket expenses than the gen-

eral population, depending on age. For physician services, diabetic persons also had 1.4-1.8 times higher out-of-pocket expenses. Although there was no difference in out-of-pocket hospital expenses in the elderly group, younger diabetic subjects still experienced 10%-30% more out-of-pocket hospital expenses than those without diabetes[4].

Table 30.4 presents our analysis of total and out-of-pocket medical expenses for selected medical services based on the 1987 NMES[17,18]. The data on per capita total medical expenditures and per capita out-of-pocket expenses are shown for persons with and without diabetes who used medical services in the survey. In addition, cost ratios are shown for persons who used each medical service and for all persons in the diabetic and general population groups. On an aggregate level, our findings are consistent with those based on the 1976 and 1989 NHIS data. The data in Table 30.4 suggest that persons with diabetes not only visit the physician's office and the hospital outpatient department more frequently than their nondiabetic counterparts, but they are also more likely to be admitted to the hospital emergency department. Among those who used ambulatory medical services, people with diabetes tended to have both higher per capita total medical expenditures and higher per capita out-of-pocket expenses than people without diabetes. Among individuals who had a physician office visit during 1987, those with diabetes had substantially higher total expenditures ($541 versus $311) and out-of-pocket expenses ($245 versus $167) for physician services than their nondiabetic counterparts. Those with diabetes similarly incurred 10%-20% higher out-of-pocket expenses for hospital outpatient and emergency department services. The expenditure figures shown in Table 30.4 for emergency room services are significantly understated because many emergency room visits led to inpatient hospitalizations and were categorized as such in the NMES data. Since prescribed medicines in many cases may not be covered by health insurance, or there may be a higher threshold for the insurance deductible and copayment for prescribed medicines, diabetic individuals appear to experience substantially higher economic burdens for prescribed medicine than nondiabetic individuals. Per capita expenditures for prescribed medicines for diabetic persons were much higher than for their nondiabetic counterparts ($470 versus $147), and the difference in per capita out-of-pocket expenses for prescribed medicines was also substantially greater for the diabetic population ($286 versus $97). This finding is consistent with the results reported by Entmacher[4].

A study by Rubin and colleagues estimated total health care expenditures and per capita annual health care expenditures for diabetic and nondiabetic persons using data on diabetes prevalence, health care use, and health care costs from the 1987 NMES survey[14]. Only total per capita health care expenditures were identified in this survey (indirect costs were not studied). Diabetes was ascertained in two ways. In one, persons with diabetes were identified as having "confirmed diabetes" based on a record of taking insulin or another diabetic drug, an encounter with the health care system specifically related to diabetes as indicated by the presence of a diabetes-specific ICD9-CM code, or a record of purchasing diabetic items such as syringes or test paper. This method yielded a diabetes prevalence, extrapolated to the 1992 U.S. population, of 7.7 million, which is similar to the 1992 NHIS estimate of 7.4 million (see Chapter 4). The other method was based on a positive response to the survey question, "Did a doctor or other medical person ever say that (the sample person) had diabetes

Table 30.4

Total and Out-Of-Pocket Medical Expenses: Diabetic Patients Versus the General Population

	Percent with medical expense		Average total medical expenditure ($) per person with expense		Average out-of-pocket expenditure ($) per person with expense		Cost ratio, diabetic vs. general population			
							Persons with expense		All persons	
Type of expense	DM	Gen. pop.	DM	Gen. pop.	DM	Gen. pop.	Total	Out-of-pocket	Total	Out-of-pocket
Physician office visit	94	71	541	311	245	167	1.7	1.5	2.3	1.9
Hospital outpatient visit	37	17	1,609	909	282	249	1.8	1.1	3.9	2.5
Emergency room visit	27	5	414	266	121	101	1.6	1.2	7.8	6.0
Prescribed medication	97	57	470	147	286	97	3.2	3.0	5.5	5.1

DM, diabetes mellitus patients; gen. pop., general population. Costs shown are costs per person for those who used any medical care; the ratio of costs for those with versus those without diabetes is shown for persons with an expense and for all persons (costs averaged over all persons, with or without an expense in the year).

Source: Authors' analyses of the 1987 National Medical Expenditure Survey adjusted to 1992 dollars, References 17 and 18

Table 30.5
Direct Medical Care Expenditures for Persons with Confirmed Diabetes and for Persons with Diabetes or High Blood Sugar

Expenditure category	Confirmed diabetes	Diabetes or high blood sugar
No. of people (millions)	7.7	11.1
Expenditures per person ($)	11,157	9,493
Inpatient	7,153	5,885
Office visit	1,045	989
Outpatient	1,225	1,127
Drugs and DME	1,056	891
Dental	110	130
Home health care	438	357
Emergency room	131	115
Total expenditures ($ billions)	85.7	105.2

DME, durable medical equipment; data are based on the 1987 National Medical Expenditure Survey, extrapolated to 1992 estimates; costs are averaged over all persons in the survey identified as having either "confirmed diabetes" or "diabetes or high blood sugar"; the latter category probably includes a substantial number of persons who do not have diagnosed diabetes.

Source: Reference 14

(high blood sugar)?" As discussed above, this method overestimates by 50% the prevalence of diagnosed diabetes.

The Rubin study estimated that total direct medical care costs for people with confirmed diabetes was $11,157 per person in 1992 (Table 30.5). For the estimated 7.7 million people with diabetes, the total costs of care were $85.7 billion, or 11.7% of U.S. health care expenditures. Costs for inpatient hospital care for persons with confirmed diabetes was 5.9 times the cost for those without diabetes ($7,153 average annual cost in 1992 per person with diabetes versus $1,222 per person without diabetes). This comparison was not adjusted for the older age of the diabetic population. Comparisons by age for total costs for the group of people with "diabetes or high blood sugar" compared with those without diabetes showed cost ratios of 1.5 for age 18-24 years and for age ≥75 years and higher ratios, as great as 3.3, for the middle age groups.

Inpatient hospital care costs accounted for 64% of all health care expenditures for people with confirmed diabetes (Table 30.5). This finding is similar to the Entmacher study[4], which estimated that hospitalizations accounted for the highest proportion of health expenditures associated with diabetes. The Rubin study estimated that the average cost for physician visits per person with confirmed diabetes was 1.9 times the cost for nondiabetic persons ($1,045 versus $554) and emergency care was 1.56 times higher ($131 versus $84). Costs for prescription drugs and durable medical equipment for diabetic persons were estimated to be 5.3 times the costs for nondiabetic persons ($1,056 versus $201). The total per capita annual health care expenditures for persons with confirmed diabetes were 4.3 times the expenditures for nondiabetic persons ($11,157 versus $2,604, all ages combined).

The estimated costs per person with "diabetes or high blood sugar" were substantially lower than costs per person with confirmed diabetes (Table 30.5). This is probably because of the inclusion of a substantial number of people who did not have diagnosed diabetes in the category "diabetes or high blood sugar."

INTERNATIONAL COMPARISONS OF DIABETES COSTS

A brief review of the experiences of other countries can provide some perspective on how health care resources have been allocated in the United States and whether U.S. diabetic patients endure a larger economic impact for the illness, compared with patients in other countries.

Studies on the costs of diabetes have been conducted in France[19], Sweden[20], and Canada[21]. Most international studies, however, are not as comprehensive as the U.S. studies presented in this chapter. The French study focused only on direct costs. It was based on a sample of 109 patients divided into insulin-dependent and non-insulin-dependent groups. The Canadian study, which also focused on direct costs, was based on a survey of 205 patients. The Swedish study was the only one based on statistical databases.

For insulin-dependent patients in the French study, physician visits comprised 5% of direct costs, whereas 8% of the direct costs for non-insulin-dependent patients was spent on physician visits. In Sweden, 14% of direct costs were spent on physician visits, and in Canada an even larger percentage (20.9%) of direct costs was spent on physician services. In the U.S. cost studies described in this chapter, the percentage of direct costs spent on physician visits ranged from 4% to 10%.

The cost of hospitalizations accounted for 40% of the direct costs in Sweden, compared with U.S. estimates ranging from 43% to 92%. In Sweden, 23% of the direct cost of diabetes was spent on nursing home care, while the percentage spent on nursing home care in U.S. studies ranged from 9% to 30%.

The percentage of direct costs for insulin-dependent patients in the French study was 45%, while 34% of direct costs were spent on medications for non-insulin-dependent diabetes. In Sweden, medications made up 19% of the direct costs. In the United States, 9%-14% of the direct costs were spent on medications.

CONCLUSION

The findings reported in this chapter demonstrate the profound economic effect of diabetes on patients, their families, and society. The highest estimate of costs attributable to diabetes ($92 billion) is about 13% of U.S. healthcare expenditures[15]. Based on the NMES data for confirmed diabetes, Rubin estimated that expenditures for health care for people with diabetes totaled $85.7 in 1992, or 11.9% of total U.S. health care expenditures were incurred by 3.1% of the U.S. population[14]. It is important to note that our analysis of per capita medical expenditures and per capita out-of-pocket expenses associated with diabetes shown in Table 30.4 includes only those persons with and without diabetes who used medical services during the period of the NMES. These data indicate that diabetic individuals use a much higher proportion of medical services and incur much higher expenses than nondiabetic individuals who use medical services for other reasons. The cost ratios for total expenditures ranged from 1.6 to 3.2 comparing the diabetic with the general population. Cost ratios for out-of-pocket expenses ranged from 1.1 to 3.0. However, it is important to remember that a majority of Americans without diabetes use few or no medical services in a given year, whereas nearly all of those with diabetes must avail themselves of medical care. When the NMES survey data were adjusted for the large number of healthy individuals who used no medical care in a given year, the cost ratios were much greater, ranging from 2.3 to 7.8 for per capita total expenditures and 1.9 to 6.0 for out-of-pocket expenses (Table 30.4).

The discussion on the economic costs of diabetes in this chapter has focused mainly on society's and the individual's perspectives. Alternatively, one can take the perspective of the federal, state, or local government and estimate only budgetary expenditures or loss in tax revenues instead of lost wages or productivity. Costs typically included in cost-of-illness studies, such as reduced productivity and output loss, do not contribute directly to federal budgetary costs. On the other hand, transfer payments and tax losses are government expenditures that are usually excluded from cost-of-illness studies.

From the federal government's perspective, transfer payments and tax losses are arguably the most essential cost elements associated with the morbidity and mortality caused by diabetes. An economic justification for federally funded programs to prevent diabetes and its complications should include these essential elements in its perspective. Thus far, however, this analytic framework has been applied only to prevention of secondary complications of diabetes, not to costs of treating the condition itself[22]. As the cost of health care in the United States crosses the trillion dollar threshold, this perspective becomes increasingly important in our understanding of diabetes.

Dr. Jonathan C. Javitt is Associate Professor of Ophthalmology and Public Policy and Director of the Worthen Center for Eye Care Research, Georgetown University Medical Center, Washington, DC; Dr. Yen-Pin Chiang served as Research Assistant Professor, Georgetown University Medical Center, and is currently on the staff of the Health Care Financing Administration, U.S. Department of Health and Human Services, Washington, DC.

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