Studies on the Cost of Diabetes

Thomas J Songer, PhD, MSc
Lorraine Ettaro, BS
and the Economics of Diabetes Project Panel

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Address for correspondence: Thomas J Songer, PhD, MSc
Department of Epidemiology
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA 15261

Introduction

"Each of us faces choices in health care"[1]

Choices and decisions abound in today's health care environment. With increasing health care costs, limits on health care resources, changing reimbursement patterns, and debate over the effectiveness of health care treatments, many of these choices are difficult to embrace. COI estimates are often cited as an important element in the choices made regarding diabetes care and management.

There is, however, considerable debate about the appropriate interpretation of the cost of diabetes. Two studies earlier this decade suggested that the costs of diabetes were markedly higher than previously thought. Later a cost projection study placed the cost figure at an even higher estimate. Over a 6- to 8-year time span, the estimates suggested, in lay terms, that the unadjusted cost of diabetes could have risen from $20 billion per year to $137 billion. This picture is somewhat difficult to believe, since other indicators of the burden of diabetes were not increasing at such a rate.

The goal of this review is to take a step back and look at where we are collectively regarding our knowledge of the cost of diabetes, to identify the strengths and limitations of currently available diabetes COI studies, and to identify future research areas that will help us better understand the economic burden of diabetes.

[1] Fein R. Medical Care, Medical Costs: The Search for a Health Insurance Policy. Cambridge, MA, Harvard University Press, 1989.

Why Conduct a Cost-of-Illness Study?

"... a tool for appraising the adequacy of resources devoted to specific health problems…"[2]

The uses for COI studies have received much attention over time. As noted above, Mushkin[2], Weisbrod[3], and others developed a framework to identify the costs related to disease as one part of a broader effort to identify appropriate health programs for implementation. Since that time, COI estimates have also been proposed for use in identifying the burden of disease, identifying possible areas for future intervention, and identifying possible areas for priority setting in health care and research. Most recently, the National Institutes of Health (NIH) has cited the value of estimates in identifying "orders of magnitude" related to different diseases[4].

At the core, COI estimates represent a descriptive economic method. The estimates provide information that describes the resources used and potential resources lost that are related to a disease. Many researchers have characterized these studies as another measure for assessing the burden of disease. Together with prevalence, incidence, morbidity, and mortality data, cost estimates help to portray the impact that society (or an organization) faces from a disease. An added benefit of the method

[2] Mushkin SJ, Collings F. Economic costs of disease and injury. Public Health Reports 74:795-809, 1959.
[3] Weisbrod BA. Economics of Public Health. Philadelphia: University of Pennsylvania Press, 1961.
[4] National Institutes of Health. Disease-Specific Estimates of Direct and Indirect Costs of Illness and NIH Support. November, 1995.

refined by Rice[5], however, is the ability of COI estimates to integrate a variety of disease end points into one general statement regarding the burden of disease.

There remains, however, considerable debate about the relative value of COI estimates[6,7,8,9]. From an economic perspective, some have argued that COI studies are not appropriate for decision-making and priority-setting[6,10]. In essence, the descriptive nature of their design precludes the criteria that one often seeks when choosing between alternatives. Cost-of-illness estimates are generally focused on average costs. Marginal costs, however, are the more relevant measures necessary for answering priority- setting questions regarding the efficient use of health care resources.

Most striking is the remarkable consistency of the COI studies conducted over the last 30 years. The consistency that we address is the lack of standardization between the estimates. Despite the ground-breaking work of Rice[5], which served to assign a general method for estimating cost of illness, it remains difficult to compare estimates between and within diseases.

Several factors may account for this phenomenon. Primarily, it is difficult to assign one standard method that can account for the nuances of estimating the cost of disease across several disease categories. Data availability and quality, both epidemiologic and economic, differ dramatically by disease. Moreover, the reasons for conducting COI studies have varied markedly between those whose intent lies in advocacy, those simply trying to estimate the burden of disease, and those whose intent lies in decision-making.

With limited comparability, one is left with caveats such as those written by Black[11]; "Because of imperfection of the data, only broad indications of priority can be drawn." A recent report by the NIH[4] also acknowledges this point with respect to the use of COI estimates in drawing priorities for biomedical research: "The applicability of cost-of-illness estimates to policy and budgetary decisions related to life sciences research is limited…"

Actual Uses of Cost-of-Illness Estimates

Cost-of-illness studies are used most often by policymakers, governmental and non-governmental organizations, researchers, and pharmaceutical companies.

Advocacy

Perhaps the greatest use of COI studies is to support advocacy positions of non-governmental organizations (NGOs). Various

[5] Rice DP: Estimating the Cost of Illness, Health Economics Series No. 6, PHS No. 947-6. US Government Printing Office, Washington, DC, 1966.
[6] Rice DP. Cost-of-illness studies: fact or fiction? The Lancet 344:1519-1520, 1994.
[7] Shiell A, Gerard K, Donaldson C. Cost of illness studies: an aid to decision making? Health Policy 8:317-323, 1987.
[8] Behrens C, Henke K-D. Cost of illness studies: no aid to decision making? Reply to Sheill. Health Policy 10:137-141, 1988.
[9] Hodgson TA. Cost of illness studies: no aid to decision making? Comments on the second opinion by Shiell et al. Health Policy 11:57-60, 1989.
[10] Wiseman V, Mooney G. Burden of illness estimates for priority setting: a debate revisited. Health Policy 43:243-251, 1998.
[11] Black DAK, Pole JD. Priorities in biomedical research. Brit J Prev Soc Med 29:222-227, 1975.

groups and organizations use cost figures to gather support for research and programs addressing their diseases. The mission of each of these groups is based on the idea that persons with a given disease will gain improved health and quality of life only if more resources are devoted to its research and treatment. The American Diabetes Association (ADA), for example, has sponsored three of the cost-of-diabetes studies reviewed in this document.

Pharmaceutical companies are increasingly turning to COI estimates to promote the relative burden of the specific diseases in which they have a financial interest. An interesting example of the use of COI estimates by the pharmaceutical industry as a whole can be found at the Internet Web site (www.phrma.org/facts/data/Disease.html) of the Pharmaceutical Research and Manufacturers of America **(Figure 1)**.

This site includes a simple table presenting the annual prevalence and economic costs of certain non-communicable diseases in the United States. This table raises several questions. Foremost, presenting these figures in a table invites comparisons. Are these estimates comparable? To address this question, we sought to locate and verify the original source of the cost estimates.

The first step in this search was to review information provided by NGO Web Sites and then locate the journal and/or study reference. COI estimates were found at the majority of the sites. The estimates, however, were frequently not identical to those listed in the table. Because the years for the estimates in Figure 1 did not appear, it is possible that the information found at the organizations' Web sites was updated.

It was not surprising to find that the COI estimates cited by the NGOs served to highlight the significance of their respective diseases. An excellent example of this phenomenon was found at the Alzheimer's Association Web site (www.alz.org/assoc/media/14.html) where the headline on a news release read "Alzheimer Care Costs U.S. a Trillion Dollars, According to Report" **(Figure 2)**.

Table 1 provides a summary of the original COI studies [12,13,14,15,16]. At a quick glance, one first observes that the estimates are for a variety of years, ranging from 1990-93. Additionally, the estimates for both cancer and arthritis are cost projections from studies dating back to 1985 and 1988, respectively.

In general, the study designs, including the original studies used in the cost projections, all use the prevalence-based human capital approach. Two different methods were used to project the costs of cancer and arthritis. In Brown's estimate of the cost of cancer, adjustments were made for the increased prevalence of cancer as well as for health care cost inflation. Yelin and Callahan adjusted only for general cost inflation in their estimate of the costs associated with arthritis in 1992.

[12] Brown ML. The national economic burden of cancer: an update. J Natl Cancer Inst 82: 1811-1814, 1990.
[13] Yelin E, Callahan LF. The economic cost and social and psychological impact of musculoskeletal conditions. Arthritis and Rheumatism 38:1351-1362, 1995.
[14] Stroke PORT Study 1994. Duke University Medical Center, Durham, NC.
[15] American Diabetes Association. Direct and indirect costs of diabetes in the United States in 1992. Alexandria, VA: American Diabetes Association, 1993.
[16] Greenberg PE, Stiglin LE, Finkelstein SN, Berndt ER. The economic burden of depression in 1990. J Clin Psychiatry 54: 405-418, 1993.

Figure 1. Prevalence and Cost of Uncured Disease in the United States

Cost of Uncured Disease in the U.S. http://www.phrma.org/facts/data/Disease.html

Prevalence and Cost of Uncured Disease in the United States

Uncured Disease	Approximate Annual Prevalence	Approximate Economic Cost ($billions)	Source
Cardiovascular Diseases	56,000,000	$128	American Heart Association
Cancer	10,000,000	$104	American Cancer Society
Alzheimer's Disease	4,000,000	$100	Alzheimer's Association
Diabetes	16,000,000	$ 92	American Diabetes Association
Arthritis	40,000,000	$ 65	Arthritis Foundation; Alliance for Aging Research
Depression	17,400,000	$ 44	National Depressive and Manic Depressive Association
Stroke	3,000,000	$ 30	National Stroke Association
Osteoporosis	28,000,000	$ 10	Alliance for Aging Research

Source: Pharmaceutical Research and Manufacturers of America, 1997

America's Pharmaceutical Companies

Figure 2. Economic Impact of Alzheimer's Disease

Alzheimer Care Costs U.S. a Trillion Dollars, According to Report

A report that Alzheimer's disease will cost this country $1.75 trillion is further evidence that this brain disorder is an urgent public health issue requiring immediate attention, according to the national Alzheimer's Association.

"If the data analysis in this report is accurate, Alzheimer's disease is draining the resources of this country, and its citizens, at a greater rate than even we thought," said Edward Truschke, association president.

The study, "The U.S. Economic and Social Costs of Alzheimer's Disease Revisited," by Richard L. Ernst, Ph.D. and Joel W. Hay, Ph.D. appears in the August 1994 issue of American Journal of Public Health. The study found that Alzheimer's disease costs approximately $174,000 per patient lifetime and is the third most expensive disease in the United States, after heart disease and cancer. Costs include direct medical and social service expenses, unpaid caregiver costs, nursing home costs, and lost earnings and productivity by patients.

The study appeared to use very conservative estimates of the number of people affected by the disease, and its duration. Even so, the cost estimates are overwhelming for our nation, our health care system and American families.

Preventing the disease, or delaying its onset, would greatly reduce its cost, but that requires a stronger commitment by the federal government to biomedical research. "There is considerable momentum now in Alzheimer research, but the payoff requires additional investment," Truschke said. "If we can find a way to delay Alzheimer symptoms for just five years, we could reduce by half the number of people with the disease. This could save the country as much as $50 billion annually."

August 12, 1994

HOME - www.alz.org

Table 1. Estimates of costs of various diseases

Disease	Study	Year	Study Design	Costs Included ($ billion)	Total Cost ($ billion)
Diabetes	ADA	1992	prevalence-based human capital approach	direct, indirect	92
Cancer	Brown	1990	cost projections from 1985 estimate by Rice et al.	direct, indirect (for all neoplasms)	104
Arthritis	Yelin et al.	1992	cost projections from 1988 estimate by Rice	direct (including non-health care sector costs), indirect	65
Depression	Greenberg et al.	1990	prevalence-based human capital approach	direct, indirect (morbidity costs include time lost from work as well as decreased worker productivity attributed to episodes of depression)	44
Stroke	Matchar et al.	1993	---	direct, indirect	30

The studies also vary in the types of costs that were included in the calculations. For example, the arthritis study included non-health care sector costs, such as the cost of transportation, special diets, and extra household help, as direct costs.

With respect to diabetes, one pharmaceutical company has adopted the use of COI methods in its overall health economic strategies. Novo-Nordisk (one of the largest suppliers of insulin worldwide) has developed a model for examining the cost of diabetes by specific country in its service areas. This model will be used to obtain baseline estimates of diabetes-related costs.

Priority Setting

There is evidence that government organizations use COI studies as an aid to decision-making. They use COI estimates as a factor in determining budgetary allocations, prioritizing research funding, and justifying funding for existing and new disease programs.

A search of the Congressional Record for the 105th U.S. Congress for legislation associated with diabetes yielded at least two references to the cost of diabetes. H.R. 1315, the "Diabetes Research Amendment of 1997", contained an estimate for the total health care-related cost of diabetes of more than $130 billion per year, which served to support the establishment of a comprehensive plan for developing future diabetes research initiatives and

directions of the NIH. Remarks by Rep. George R. Nethercutt regarding H.R. 58, the "Medicare Diabetes, Education and Supplies Amendments", included references to diabetes costs of $91.1 billion annually in direct costs and nearly $138 million per year in total costs to support his position on providing reimbursement for diabetes supplies under the Medicare program.

Legislators have also been interested in COI estimates as they relate to research spending. These estimates have supported decisions on targeting research funding. It has been argued that those diseases carrying the larger economic burden should receive greater amounts of funding. Now, however, there is some concern about the validity of the estimates cited in congressional debates.

In 1995 the Senate Appropriations Committee directed the NIH to identify estimates of the societal impact of certain selected diseases on which the NIH conducts research as well as NIH spending for fiscal year 1994 on research into each of the diseases[4]. The estimates were to include standard elements for each of the diseases of concern to allow for some comparability. The purpose of the report was to reveal any discrepancies between disease impact and research funding. The resulting report from the NIH demonstrates several limitations in COI studies and the questionable utility of estimates for supporting policy and budgetary decisions.

As part of its report, the NIH included a bar chart **(Figure 3)** to reflect the direct and indirect costs of a number of diseases. A set of background materials accompanied the chart as an aid to interpreting the figures. The report noted that the estimates could not be compared directly but summarized that the exercise (i.e., comparison) was useful for showing the "order of magnitude" of differences between the diseases.

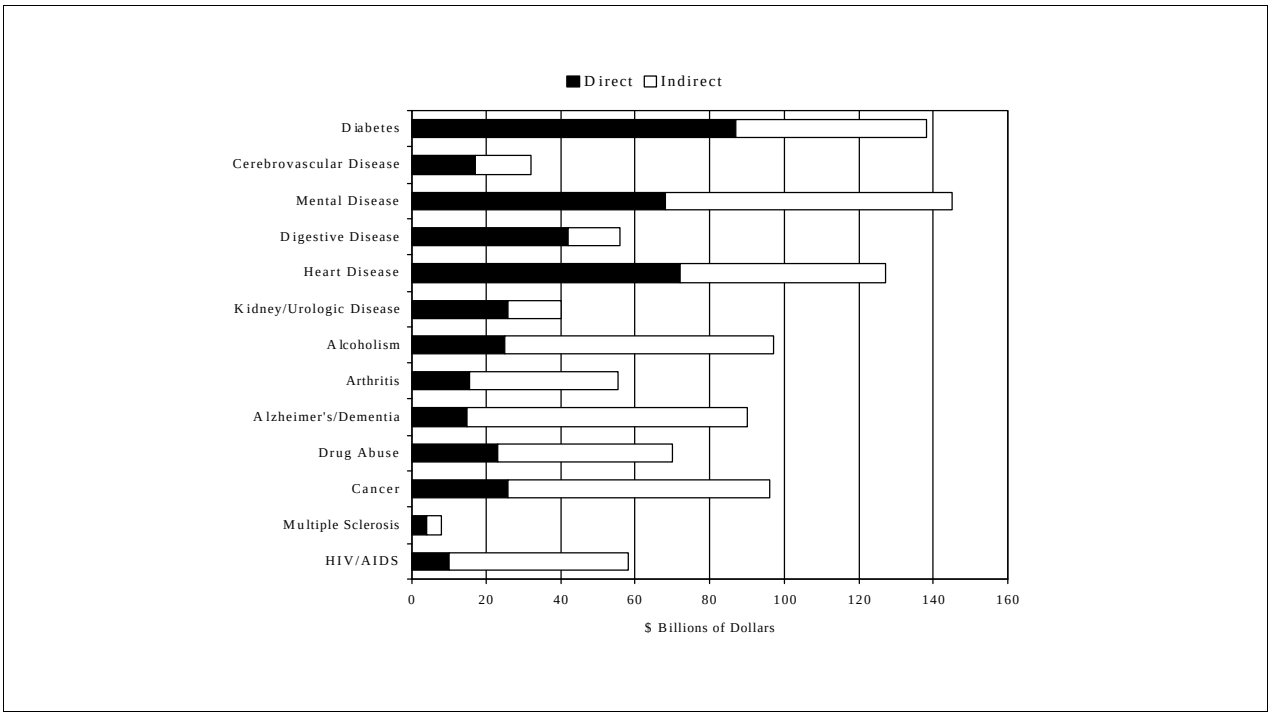
Cost-of-illness studies are not used only on the national level. Washington is one of several states to introduce legislation addressing the cost of diabetes to patients and families. In the debates concerning one piece of legislation, the "Diabetes Cost Reduction Act", advocates have used a cost figure for diabetes of nearly $140 billion to support their arguments. Interestingly, this is the same figure included in the aforementioned NIH report.

The Centers for Disease Control and Prevention (CDC) has also developed a model that can be used by state health departments to estimate the cost of diabetes for their respective jurisdictions[17]. It encouraged states to use the model to help identify ways to decrease diabetes-related costs and to encourage state-specific funding of diabetes prevention activities. A published estimate from Minnesota [(18)] originated from this initiative.

Disease Burden

Researchers, themselves, use COI estimates as a measure of disease burden. Published research reports addressing the epidemiology and/or etiology of a disease as well as the economic and health services aspects of the disease often cite cost figures.

[17] Gorsky RD. Producing estimates of diabetes costs in your state. Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA, 1991.
[18] Roesler J, Bishop D, Walseth J. Economic cost of diabetes Mellitus — Minnesota, 1988. MMWR 40:229-231, 1991.



Source: National Institutes of Health[3]

Figure 3. Health Care Costs of Various Disorders.

To better understand how and to what extent cost-of-diabetes studies have been used by researchers in the United States, we searched the published literature to identify the frequency with which cost-of-diabetes studies were cited between January 1983 and October 1997. For our review, we selected the 14 diabetes cost studies that followed the COI framework to estimate the overall burden of diabetes. We excluded studies that dealt with only a specific aspect of cost, for example, hospitalization costs.

By using both the Life Science Citation Index (Clinical Medicine) and the Social Science Citation Index, we identified journal articles referencing the selected cost studies by year published and category of study or article. The categories were broadly defined as:

a. diabetes and cost-related (e.g., addressed economic, health care utilization, or insurance aspects of diabetes),

b. diabetes and not cost-related (e.g., addressed the epidemiology, etiology, or treatment of disease), and

c. diseases other than diabetes, including those articles that addressed diabetes within a list of other diseases.

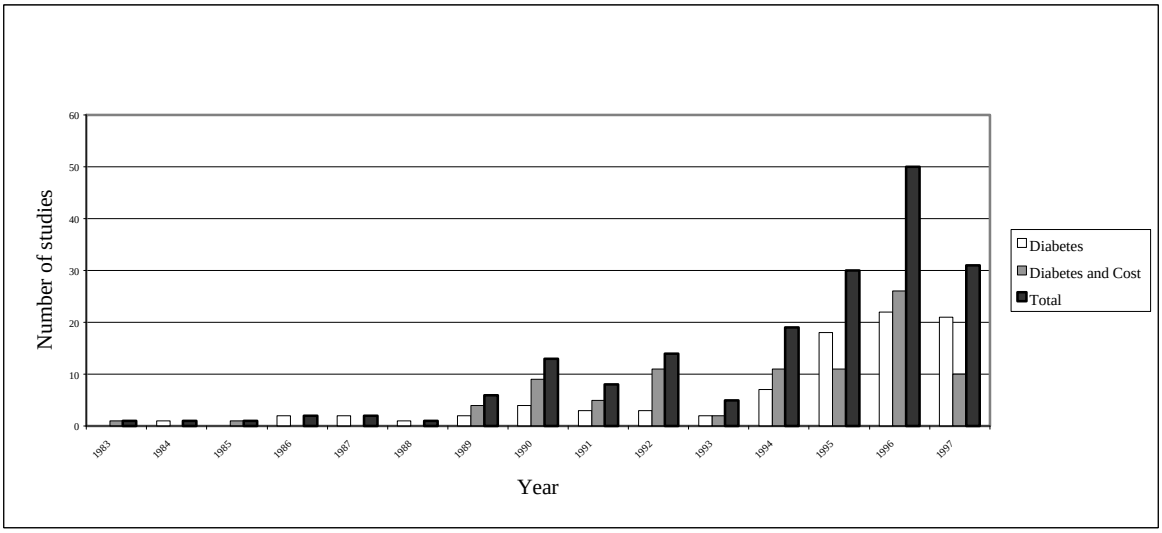


Figure 4. Number of cited cost-of-diabetes studies by year, January 1983 – October 1997.

Titles of articles and journals were used as decision criteria for categorization. If the article category was not clear from the titles, we located and reviewed the article and made a decision on the basis of this review.

From January 1983 through October 1997, cost-of-diabetes studies were cited 184 times in professional journal articles, 86 of these were diabetes and cost-related, 93 were diabetes only-related, and 5 were related to other diseases. Of the 14 selected studies, 10 were cited at least one time. The study by Huse and colleagues[19] and the study by Rubin and colleagues[20] were the two most frequently cited studies. **Figure 4** shows the number of studies cited by year and category.

There is a definite increase, starting after 1988, in the raw number of studies cited. **Figure 5** illustrates the total number of citations per cost-of-diabetes study published. For example, the 10 studies published by 1990 were cited 13 times in 1990 (1.3 citations per study published). From this information, there appears to be an increased use of these studies over time. Not all of the 1997 literature was available for the citation search.

[19] Huse DM, Oster G, Killen AR, Lacey MJ, Colditz GA. The economic costs of non-insulin-dependent diabetes mellitus. JAMA 262:2708-13, 1989.

[20] Rubin RJ, Atlman WM, Mendelson DN. Health care expenditures for people with diabetes mellitus, 1992. J Clin Endocrinol Metab 78:809A-809F, 1994.

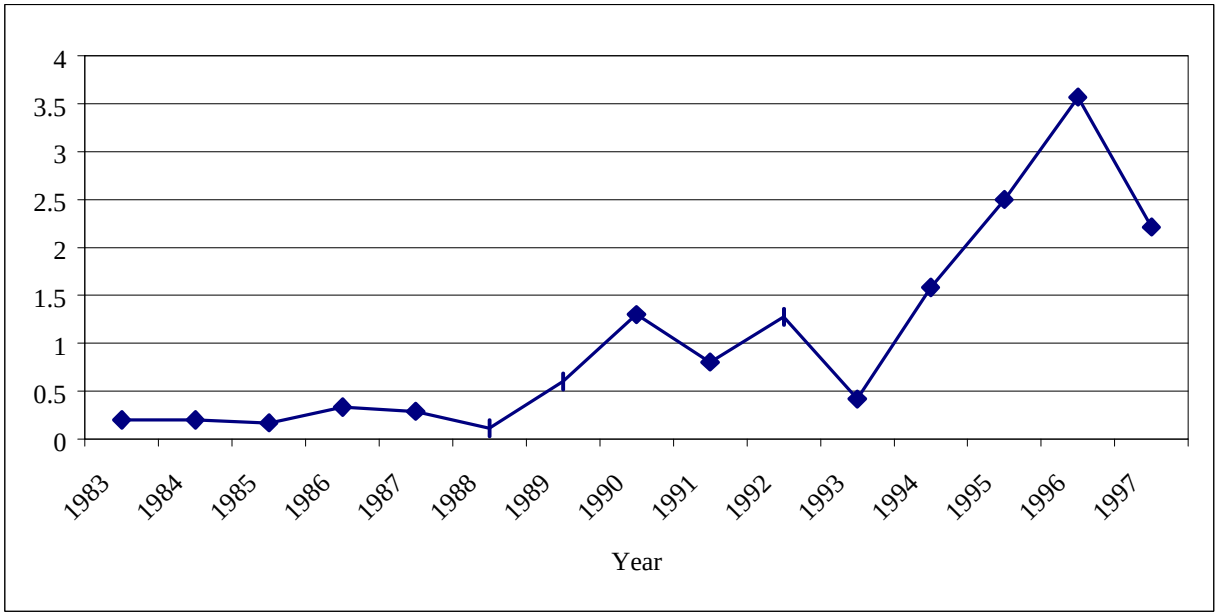


Figure 5. Number of citations per cost-of-diabetes study published

Methods Used in Estimating the Cost of Illness

The origins of today's COI studies lie in the work of Fein[21], Mushkin[2], Weisbrod[22], Rice[23] and others in the late 1950s and early 1960s. At that time, several public health measures were at their peak in public interest. Most notable was the reduction in the prevalence of polio with the advent of the Salk and Sabin vaccines. Then, as now, there was debate on the most appropriate manner to further improve health. Several questions regarding the estimation of the benefits of health projects were under review academically.

In 1966, Dorothy Rice published a monograph [(5)] that proposed a method for estimating costs from the information available in existing data sets. This work became a de facto standard for future COI studies. It addressed the economic cost of illness from the perspective of two categories: direct costs and indirect costs.

A third category, the psychosocial cost of illness, or its impact on quality of life, is often mentioned as another dimension in the cost of illness but usually is not included in COI estimates because of the difficulty in measuring such costs [(5,24,25,26,27)].

[21] Fein R. Economics of Public Health. New York: Basic Books, 1958.
[22] Weisbrod BA. Economics of Public Health. Philadelphia: University of Pennsylvania Press, 1961.
[23] Rice DP, Cooper BS. The economic value of human life. Amer J Public Health 57:1954-1966, 1967.
[24] Cooper BS, Rice DP. The economic cost of illness revisited. Soc Sec Bull 39:21-36, 1976.
[25] Rice DP, Hodgson TA, Kopstein AN. The economic costs of illness: a replication and update. Health Care Fin Rev 7:61-80, 1985.

Direct Costs

Direct economic costs of disease are those generated by the resources used in treating or coping with a disease, including expenditures for medical care and the treatment of the illness (hospital care, physician services, nursing home care, drugs and other medical needs). These direct costs are often easily measured by surveys and studies. Recently researchers have also advocated the inclusion of direct non-medical costs as well, including the transportation costs of patients and costs of care-giving by family members.

Most of the early COI studies used either of two computational methods to determine the direct costs of disease: a "top-down" approach or a "bottom-up" approach[28]. See Boxes 1 and 2 for more details on these designs. The approaches and methods described by Rice [5,24,25] have served as a guide for many subsequent COI studies[29], including those specific to diabetes.

Box 1

"Top-down" approach

This approach is based on costs examined in an aggregate form for specific diseases. It uses data on total health expenditures and the disease-specific rates of use of health care services (identified by primary ICD codes) to arrive at a disease-specific cost estimate.

Costs are calculated by multiplying the total health care expenditures by the proportion of health care services used by the disease group. For example, hospital costs for diabetes would be the multiple of the total expenditures for hospital care by the percentage of all hospital services used by the diabetic population.

$$\text{Total expenditures for hospital care} \times \frac{\text{Use of hospital services by specific diagnosis}}{\text{Total use of Hospital services}}$$

Box 2

"Bottom-up" approach

This approach is based on the costs of individual units of service performed. It uses average cost of service estimates and applies these data to the total number of health care encounters related to the disease to arrive at an estimate of the health care costs of a disease.

For example, the costs of hospital care in diabetes would be calculated by multiplying the average cost of a hospital stay per day by the total number of hospitalized days attributed to the diabetic population.

$$\text{Average cost of hospital care by specific diagnosis} \times \text{Total use for hospital services by specific diagnosis}$$

[26] Hodgson TA, Meiners MR. Cost-of-illness methodology: a guide to current practices and procedures. Millbank Mem Fund Q 60:429-462, 1982.
[27] Scitovsky AA. Estimating the direct cost of illness. Millbank Mem Fund Quarterly 60:463-491, 1982.
[28] Tolpin HG, Bentkover JD. Economic cost of illness: decision-making applications and practical considerations. In Advances in Health Economics and Health Services Research, Vol.4, Scheffler, Rossiter (eds). Greenwich (CT): JAI Press, 1983; pp. 165-197.
[29] Hodgson TA: The state of the art in cost-of-illness estimates. In Advances in Health Economics and Health Services Research, Vol.4, Scheffler, Rossiter (eds). Greenwich, CT, JAI Press, 1983; pp. 129-164.

Indirect Costs

Indirect economic costs address the potential resources that are lost as a result of a disease. They include the societal costs of morbidity, disability, and premature mortality. These non-medical costs of disease are not easily measured or calculated. Indirect costs represent the impact, present and future, of opportunities lost to the individual as a consequence of the disease in question (e.g., diabetes).

Considerable debate focuses on the role of indirect costs in COI studies. This debate involves two primary issues: (1) What do you measure in the assessment of indirect costs? (2) How do you do you measure and value these costs, since the "economic" approach to assigning a monetary value to indirect costs can differ?

For some time, there has been a great deal of discussion over what items deserve consideration in the measurement of indirect costs. Costs may include lost productivity, caregiver costs, loss of leisure, pain and suffering, and quality of life. Lost productivity is more easily quantified than psychosocial effects, which, as previously mentioned, are difficult to measure. Also, including all or several of these costs is problematic because they overlap and therefore may result in a double counting of a portion of indirect costs. A proposed global measure such as quality-adjusted-life year (QALY) could capture these elements and prevent double-counting. There is disagreement, however, about whether productivity and time costs are included in the QALY measure [30,31,32].

There has also been discussion about how to measure indirect costs. The following three approaches have been advocated for this estimation: a human capital base[5,24,25], a willingness-to-pay or contingent valuation base [33,34,35,36], and a friction cost base[37,38,39]. Specific details on these methods are noted in Boxes 3-5.

The choice of which method to use in a study can significantly influence the overall results. For example, estimates based on the willingness-to-pay approach are generally considerably larger than those generated by a human capital approach. Similarly, the friction cost approach usually provides the most conservative estimate (i.e., lowest cost) of the three designs.

[30] Brouwer WB, Koopmanschap MA, Rutten FF. Productivity costs measurement through quality of life? A response to the recommendation of the Washington Panel. Health Econ 6:253-259, 1997.

[31] Weinstein MC, Siegel JE, Garber AM, Lipscomb J, Luce BR, Manning WG Jr, Torrance GW. Productivity costs, time costs and health-related quality of life: a response to the Erasmus Group. Health Econ 6:505-510, 1997.

[32] Brouwer WB, Koopmanschap MA, Rutten FF. Productivity cost in cost-effectiveness analysis: numerator or denominator: a further discussion. Health Econ 6:511-514, 1997.

[33] Lubeck DP, Yelin EH. A question of value: measuring the impact of chronic disease. Millbank Mem Fund Q 66:445-464, 1988.

[34] Schelling TC. The life you save may be your own. In Problems in Public Expenditure Analysis. Washington, DC, The Brookings Institute, 1968.

[35] Mishan EJ. Evaluation of life and limb: a theoretical approach. J Polit Econ 79: 687-705, 1971.

[36] Gafni A. Willingness-to-pay as a measure of benefits. Relevant questions in the context of public decision-making about health care programs. Medical Care 29:1246-1252, 1991.

[37] Koopmanschap MA, Ineveld BMV. Towards a new approach for estimating indirect costs of disease. Soc Sci Med 9:1005-1010, 1992.

[38] Gold MR, Siegel JE, Russell LB, Weinstein MC (eds). Cost-Effectiveness in Health and Medicine. New York: Oxford University Press, 1996.

[39] Drummond MF, O'Brien B, Greg GL, Torrance GW. Methods for the Economic Evaluation of Health Care Programmes, second edition. New York: Oxford University Press, 1997.

Box 3

Human Capital Approach

Indirect costs in the human capital approach are seen as the earnings, present and future, lost to that individual as a result of the illness. Individuals are regarded as producing output in their lifetime that can be valued as equal to each individual's market earnings at that time.

The main criticism of the human capital approach is that it values life in terms of the earnings of the individual. Changes in lifestyle due to disease are expressed by changes in the earnings of the individual. Thus, the human capital approach may economically undervalue some segments of society relative to others (e.g. women, the young and the elderly).

Box 4

Willingness-to-Pay Approach

In the "willingness-to-pay" approach, life and lifestyle changes are valued as equal to the amount that the individual is willing to spend to reduce their risk of death or illness. WTP values can be estimated directly via questionnaires asking individuals how much they are willing to pay to reduce their risk of death or illness. Indirect estimates can also be inferred from the observed behaviors of individuals in the marketplace. Although the WTP design can address the limitations of the human capital approach, it has been more difficult and expensive to implement and has been used in comparatively few cost-of-illness studies.

Of the three methods, the human capital approach has been applied most frequently and is the design used in all cost-of-diabetes studies.

In the human capital approach, indirect costs are often valued on the basis of disability (morbidity) and premature mortality[29]. Disability may be temporary or permanent. It usually applies to all individuals who are currently working or keeping house but not to persons who are unable to work or who choose not to work. Permanent disability refers to the permanent loss of work or household output due to illness. Quantification of lost earnings or output due to permanent disability is often based on the assumption that disabled persons, if they were able to work, would have the same employment experience as the general population.

Indirect costs related to premature mortality consider the value of lost productivity in the subsequent years of life that would be expected had death not occurred. These costs are based on the number of disease-specific deaths, the survival experience of the general population, employment rates, earnings, and discount and productivity rates [5,24,25,40]. Discount rates and productivity rates often are selected at the discretion of the researcher. Survival of a patient after disease onset varies widely for some diseases, such as diabetes mellitus[41]; therefore, lost future earnings due to premature mortality will similarly vary by individual.

[40] Hartunian NS, Smart CN, Thompson MS. The incidence and economic costs of cancer, motor vehicle injuries, coronary heart disease, and stroke: a comparative analysis. AJPH 70:1249-1260, 1980.

[41] Dorman JS, LaPorte RE, Kuller LH, et al. The Pittsburgh Insulin-Dependent Diabetes Mellitus (IDDM) Morbidity and Mortality Study: mortality results. Diabetes 33:271-276, 1984.

Box 5

Friction Costs

Friction costs represent the costs associated with the replacement of a sick worker. The concept behind the use of friction costs is that production losses due to illness may not be as great as expected because existing labor pools and workplace structures can absorb some of this lost productivity. Friction costs include costs associated with the amount of time needed to replace a sick worker, training costs for new or temporary employees, and costs associated with any decreases in productivity during temporary work absence of the sick employee or from the substitution of the workforce needed to replace the sick employee.

Data Sources

In the United States, the primary data sources for COI studies have been the surveys and reports of the federal government. These include items such as the health expenditure data of the Health Care Financing Administration (HCFA), the cause of death data of the National Center for Health Statistics (NCHS), and information on the use of health services and their cost from both NCHS and the Agency for Health Care Policy and Research (AHCPR).

The National Medical Expenditure Survey (NMES) and its follow-on, the Medical Expenditure Panel Survey (MEPS), conducted in 1997, provide some of the first information on the average cost of health services by diagnosis. These surveys and reports provide nationally representative data on health care expenditures, utilization, and disability by specific diagnosis. National data on employment and income are also available through government bureaus. Nationally representative data are preferable because they permit cost estimates to be generalized to the entire population without bias.

Perspectives

Nearly all of the COI studies conducted today follow the framework proposed by Dorothy Rice in 1966 [(5)]. This framework examines costs from the societal perspective. It is important to point out that costs can also be examined from other perspectives. We will be seeing, for example, other studies examining the COI from the perspective of an HMO. Also, costs of disease from the perspective of the patient are gaining some attention, particularly as economists debate the growing importance of caregiver costs.

Cost-of-Diabetes Methods

The methodological approaches used to estimate the costs of diabetes have varied. Early studies followed the designs of Rice and examined data by International Classification of Diseases (ICD) category. Recent studies are more complex, examining costs due to co-morbidity and sometimes merging the concepts of the top-down and bottom-up approaches. Examined from a general perspective, cost-of-diabetes studies can be categorized by three study designs. These include designs based on diagnostic category data (ICD codes) from general population surveys, responses from persons with diabetes, and cost projections from previous studies.

Estimates From General Population Data

The bases for the majority of the cost estimates in diabetes have been general population surveys of health, health care, disability, and mortality. These national surveys include diagnosis-specific information based on the ICD codes. In this design, data are attributed to the diabetes mellitus category when diabetes is listed as the primary diagnosis or reason for a health care visit, disability, or cause of death. More recent designs have taken into account the contributions of diabetes as a secondary diagnosis as well.

The earliest reports on the cost of diabetes used the "top-down" approach and were based on work done at the Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC) conducted by Paul Entmacher[42,43]. The SBMLIC estimated the costs of diabetes mellitus over a period of years using diagnostic category data on health care utilization, disability, and mortality. Total health care costs for each of the health care categories came from the relevant surveys of the NCHS, and the portion of these costs attributed to diabetes was the portion of each category for which diabetes was a primary diagnosis. A recent report by Thom has also followed this approach based on primary diagnosis codes.

However, estimates based exclusively on data on persons whose diabetes is the primary diagnosis, cause of death, or reason for disability miss the health care costs incurred by persons whose diabetes is a secondary or tertiary factor. Diabetes mellitus, biologically, is a leading cause of blindness, renal failure, heart disease, and lower limb amputations. Cardiovascular disease is the major cause of death for most persons with diabetes[44]. Often the records of individuals with complications associated with diabetes (e.g., heart disease) do not list diabetes as the primary diagnosis after hospitalization[45] or as the underlying cause of death [44,46]. Furthermore, because chronic diseases such as heart disease occur frequently in the general population, analyses using control groups of individuals without diabetes are needed to separate the excess morbidity costs related to diabetes from those costs that would be expected to occur normally.

Attributable Risk Procedures

In the 1980s, studies of the costs of diabetes began to reflect costs related to diabetes as a secondary or tertiary diagnosis. Using the concept of attributable risk (AR) (see Box 6), analysts tried to overcome concerns about the underestimation of costs that result from using only primary diagnosis data.

[42] Entmacher PS. Report of economic impact of diabetes. NIH publ No. 76-1022, vol 3, part 2. Washington, DC: US Government Printing Office, 1976.

[43] Entamcher PS, Sinnock P, Bostic E, Harris MI. The economic impact of diabetes. In Diabetes in America, Diabetes Data Compiled 1984. National Diabetes Data Group, NIH publ. No. 85-1468. Washington, DC: US Government Printing Office, 1985; XXXII, pp. 1-13.

[44] Harris MI, Entmacher PS. Mortality from diabetes. In Diabetes in America, Diabetes Data Compiled 1984. The National Diabetes Data Group. Washington, DC, US Government Printing Office, NIH Pub. No. 85-1468. August 1985.

[45] Sinnock P. Hospital utilization for diabetes. In Diabetes in America, Diabetes Data Compiled 1984. National Diabetes Data Group. Washington, DC, NIH Pub. No. 85-1468. August 1985.

[46] Palumbo PJ, Elveback LR, et al. Diabetes mellitus: incidence, prevalence, survivorship, and causes of death. Diabetes 25:566-573, 1976

Pracon, Inc.[47], for example, estimated the hospitalization costs for those cases in which diabetes was a secondary or tertiary diagnosis. Total hospital costs included costs associated with hospitalizations directly attributed to diabetes, hospitalizations due to chronic complications of diabetes, hospitalizations attributed to an increased propensity for hospitalizing diabetic patients for conditions not related to diabetes, and additional length of hospital stay for hospitalizations not attributed to diabetes.

Both the 1987 Pracon, Inc. study and its follow-up, the 1992 ADA study[15], derived attributable fractions among the exposed population (i.e., persons with diabetes) and used these fractions in their estimates of health service utilization and costs. In the 1997 ADA study[48], Fox further refined the AR method to consider health care events related to diabetes where diabetes was not recorded as a diagnosis code. To do this, Fox applied a population-attributable risk figure to hospitalization data, rather than a "diabetes" AR. Data from the NMES were used to estimate the excess prevalence of chronic complications of diabetes and general medical conditions.

Hodgson[49] used population attributable risks and diabetes-specific attributable risks in his 1995 estimate of medical expenditures for diabetes. Hodgson based the decision on which AR procedure to use on the availability of data (i.e., data needed to determine diabetes-specific attributable risk were available for only inpatient hospital costs, nursing home care and home health services).

Although AR procedures attempt to more accurately estimate costs attributed to diabetes as a secondary or tertiary factor, they may fail to account for the influence of confounding factors and thus overstate the role of diabetes in that attribution. In order to address this limitation, a more refined method proposed by Partha Deb attempts to adjust for such factors (P. Deb, personal communication). He proposes using a multivariate probit model including medical, demographic and lifestyle variables is estimated to determine the contribution of diabetes to other medical conditions within the AR framework. This method provides probability and cost estimates for each individual with diabetes.

Data Sources

As an appropriate resource, the NMES data are generally preferred because they include diabetes-specific information. A potential limitation of the NMES, however, is that it bases its estimates on a small sample size of persons with diabetes. Approximately 700 to 800 persons with diabetes are included in the NMES sample, and it is likely that fewer than 100 of these had Type 1 diabetes. Using this sample, the 1997 ADA study determined odds ratios for age-race and age-sex specific groups, thus basing its estimates of attributable fraction and, subsequently, health resource use on even smaller sample sizes. The widths of many of the 95 percent confidence intervals for these odds ratios, especially in the younger age range, suggest a great degree of sampling variability.

[47] Pracon, Inc. Direct and indirect costs of diabetes in the United States in 1987. Alexandria, VA: American Diabetes Association, 1988.
[48] American Diabetes Association. Economic consequences of diabetes mellitus in the United States in 1997. Diabetes Care 21:296-309, 1998.
[49] Hodgson TA. Medical care expenditures for diabetes. (draft).

Box 6

Attributable Risk

Attributable risk (AR) represents the relative contribution of a factor (e.g., diabetes) to the overall risk identified. It can be considered from two perspectives; the general population or the disease population.

Disease cohort

With a given outcome, exposure factor, and population (e.g., all persons with diabetes), the attributable fraction among the exposed is the proportion by which the incidence rate of the outcome among those exposed would be reduced if the exposure were eliminated. It may be estimated by the formula [$AF_e=(I_e-I_u)/I$] where I_e is the incidence rate among the exposed and I_u is the incidence rate among the unexposed, or by the formula [$AF_e=(RR-1)/RR$] where RR is the rate ratio, I_e/I_u. It is assumed that causes other than the one under investigation have had equal effects on the exposed and unexposed groups.

Population

With a given outcome, exposure factor, and population (e.g., all persons with and without diabetes), the attributable fraction among the population is the proportion by which the incidence rate of the outcome in the entire population would be reduced if exposure were eliminated. It may be estimated by the formula [$AF_p=(I_p-I_u)/I_p$] where I_p is the incidence rate in the total population and I_u is the incidence rate among the unexposed.

Alternatively, it may be represented by the formula [$AF_p=P_e(RR-1)/1+P_e(RR-1)$] where RR is the rate ratio, I_e/I_u. It is assumed that causes other than the one under investigation have had equal effects on the exposed and unexposed groups.

When applying these concepts to risk of health services utilization:

- The population attributable risk understates the attributable portion of the disease to the extent that the diseased population uses the service relative to the general population. In this situation, health service utilization due to the disease for the diseased population will be understated.
- The attributable risk among the exposed population may understate the attributable proportion of other risk factors, and overestimates the portion attributable to the disease of interest. In this situation, health service utilization due to disease for the diseased population will be overstated.

Source: Last JM (ed.) A Dictionary of Epidemiology. Oxford: Oxford University Press, 1995.

Estimates From Administrative Data Sets

Most published COI studies have used national survey data to estimate health care utilization and costs. Warner and colleagues[50], however, used administrative databases on the state level to estimate the costs of non-insulin-dependent-diabetes mellitus (NIDDM) in Texas in 1992. Individuals with diabetes were identified in billing records from Medicare, Medicaid, state agency programs, pharmaceutical companies, several Veterans Administration and public hospitals, and a migrant/community health center.

The importance of this approach lies in the shifting health care reimbursement system in the United States. Health maintenance organizations (HMOs) are gaining greater shares of the health insurance market. Each HMO usually maintains an extensive database of the medical encounters for which it pays. As the popularity of HMOs increases, the importance of using these data sets for future cost-of-diabetes studies is likely to grow.

Cost projections From Previous Estimates

Several diabetes cost estimates have been projected from the results of previous cost studies. In this design, cost estimates from a previous study and changes in the health care utilization and mortality rates associated with diabetes, as well as the change in prevalence and inflation rates, have been used to forecast the economic costs of diabetes. There is some concern about this approach since it combines the limitations of the previous studies and those of its own. The primary restraint is that the cost estimates are based on the assumption that the changes in the costs of diabetes will be similar to the changes in inflation, utilization, prevalence, and mortality rates. This may or may not be true.

For example, Platt and Sudover[51] used cost projections from the 1975 SBMLIC data to estimate the total expenses for diabetes in 1979. Miller[52] and Smeeding[53] used diagnostic category statistics and data from previous SBMLIC studies to derive their cost estimates for 1979 and 1980, respectively. More recently, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) of the NIH used indirect cost estimates from the ADA[15] and direct cost estimates from a study by Rubin and colleagues[20] to project the cost of diabetes in 1995.

Individual-Based Estimates

The costs of diabetes have also been estimated from data on individuals with diabetes. Cost estimates derived in this fashion have been determined from survey data of the reported experience of persons with diabetes. This approach differs from the first design, where costs were based on diagnostic category data. The advantage of surveying individuals is that more precise estimates of the costs of diabetes can be attained because individual costs and

[50] Warner DC, McCandless RR, De Nino LA, Cornell JE, Pugh JA, Marsh GM. Cost of diabetes in Texas, 1992. Diabetes Care 19:1416-1419, 1996.

[51] Platt WG, Sudover SG. The social and economic costs of diabetes: an estimate for 1979. Elkhart, IN: Home Health Care Group, Ames Division, Miles Laboratories, Inc., 1983.

[52] Miller LV. Socioeconomic impact of diabetes mellitus. In Brodoff, Bleicher (eds). Diabetes Mellitus and Obesity. Baltimore: Williams & Wilkins, 1982.

[53] Smeeding TM, Booton LA. Measuring and valuing the economic benefits of diabetes control. 19th National Meeting, Public Health Conference on Records and Statistics, August 23-24, 1983; pp 80-85.

utilization patterns are observed directly, rather than estimated from ICD categories.

Also, if a representative sample of the population is used, data based on the reports of individuals with diabetes are much more likely to reflect the experience of the diabetes population than are data based on diagnostic categories. The disadvantage of surveying costs among a representative sample of individuals with diabetes is that it is an expensive process. Furthermore, many of the national estimates related to diabetes are based on the responses of a limited number of persons. Sampling variability may influence the results in this event, particularly for subgroup analyses.

Three primary data sources have been used to estimate the costs of diabetes from the viewpoint of the individual with diabetes. These include information from the National Medical Care Expenditure Survey (NMCES), the National Medical Care Utilization and Expenditure Survey (NMCUES), and the NMES. In the future, data from the MEPS will also be available.

Data on the health care costs of diabetes obtained from the NMCES, NMCUES, and NMES have been reported. In all three surveys, the use and cost of health services are examined over a 1-year period. Individuals with diabetes were identified in the survey by their responses to questions on medical history (e.g., "Has a doctor ever told you that you have diabetes or sugar?"). Expenditures for the entire diabetes population have been estimated by multiplying the average costs for the individuals with diabetes by the prevalence estimate for diabetes. The indirect costs of diabetes have not been studied with this approach.

Using the 1977 NMCES, Taylor[54] estimated the direct costs of diabetes. Rubin and colleagues[20], using data from the 1987 NMES, estimated the annual health care costs for individuals with diabetes in 1992. Like the NMCES in 1977, the NMES is a survey of non-institutionalized persons. Therefore, nursing home costs were not included in either of these estimates.

Incidence-Based Estimates

Most cost-of-diabetes studies base their estimates on a prevalence cohort of diabetic individuals. Such estimates look at the costs of diabetes in all prevalent cases at one specified point in time, usually 1 year. Incidence-based methods, on the other hand, examine the costs of diabetes in a cohort of incident cases of diabetes developing during a specified time period. Costs incurred from diagnosis through the natural progression of the disease, and until death are of interest here rather than the costs over 1 year. Incidence-based estimates can provide information about the lifetime costs of diabetes.

Policy Analysis, Inc.[55], has calculated the only incidence-based estimate of the cost of diabetes in the United States. It used primary diagnosis data from government surveys and other studies to estimate the lifetime costs of diabetes for all persons diagnosed with the disease in 1977 and incidence rates for diabetes from national government surveys to derive age-

[54] Taylor AK. Medical expenditures and insurance coverage for people with diabetes: estimates from the National Medical Care Expenditure Survey. Diabetes Care 10:87-94, 1987.

[55] Policy Analysis Inc. Evaluation of cost of illness ascertainment methodology, Part II. Applications of methodology to ascertain lifetime economic costs of illness in an incidence cohort. Final Report to the National Center for Health Statistics. DHHS Contract No. 233-79-2048, December, 1981.

and sex-specific incidence rates. Information about cumulative relative survival rates for persons with diabetes was then applied to the diabetic cohort to determine the expected survival experience of this population. To estimate health care utilization and costs, the investigators calculated expected utilization rates and costs by age. As the diabetic cohort passed through each age group, the rates in that age group were applied to the cohort.

More recent incidence-based estimates of the cost of insulin-dependent diabetes mellitus (IDDM) have been generated in England and Wales[56] and in Spain[57].

Cost-of-Diabetes Estimates — Results

Some may say that the diabetes field has been blessed with a plethora of cost estimates over the last 30 years. A review of the literature finds several studies in this area, in contrast with other diseases, for which the number of estimates of cost of illness is fairly small.

Total Costs

Estimates of the economic costs of diabetes mellitus in the United States are listed in **Table 2** and suggest that the costs of diabetes are quite substantial and growing. Total cost estimates range from $2.6 billion in 1969 to $98.2 billion in 1997, with the highest estimate being $137.7 billion in 1995. Although several of the reports consider only direct costs, most include both direct and indirect costs.

These figures taken at face value do not provide a complete and accurate picture of cost trends. Are the costs of diabetes really increasing? The costs of diabetes may differ because of price inflation, an increasing prevalence of diabetes, a greater use of services, or better use of higher quality services. We examined the trends for total direct costs after controlling for price inflation and changes in the prevalence of diabetes. It was not possible to assess the impact of changes in the quality of services over time; however, some of the changes in quantity of services will be captured in the prevalence calculation.

Three indices were used to adjust for price inflation: the consumer price index (CPI) for medical care, the overall CPI, and the GDP (gross domestic product) deflator (Appendix A). There has been some discussion about which of these is the most appropriate index to use. Adjustments using each of the indices are presented in Appendices B through E. Overall, the adjusted estimates based on the CPI (all items) and those based on the GDP deflator were not markedly different (Appendix E). The estimates adjusted by the CPI (medical care component), however, were notably higher than

[56] Gray A, Fenn P, McGuire. The cost of insulin-dependent diabetes mellitus in England and Wales. Diabetic Medicine 12:1068-1076, 1995.
[57] Hart WM, Espinosa C, Rovira J. A simulation model of the cost of incidence of IDDM in Spain. Diabetologia 40:311-318, 1997.

Table 2. Estimates of the economic costs of diabetes mellitus in the United States

Study	Year	Method	Design	Total Costs ($ billion)	Direct $	Direct %	Indirect $	Indirect %
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1969	Top-down	Primary diagnosis data from federal surveys	2.6	1.0	38	1.6	62
SBMLIC	1973	Top-down	Primary diagnosis data from federal surveys	4.0	1.65	41	2.37	59
SBMLIC	1975	Top-down	Primary diagnosis data from federal surveys	5.3	2.5	47	2.8	53
Werner [58] (United States)	1975	--	--	5.1	2.2	43	2.9	57
Werner (Pennsylvania)	1975	--	--	.311	.137	44	.175	56
SBMLIC	1977	Top-down	Primary diagnosis data from federal surveys	6.8	3.4	50	3.4	50
Taylor	1977	Bottom-up	Estimated from diabetic Individuals in the general population	--	6.9	--	--	--
Policy Analysis, Inc.	1977	Bottom-up	Lifetime costs estimated from diagnostic category data	10.8	3.7	34	7.1	66
Platt, Sudover	1979	Bottom-up	Cost projections	15.7	5.6	36	10.0	64
IDDM	1979	Bottom-up	Cost projections	4.8	1.8	38	3.0	62
Miller	1979	Bottom-up	Diagnostic category data from federal surveys and other cost studies	12.4	7.4	60	5.0	40

[58] Werner JL, Tokuhata GK. Diabetes mellitus: its annual cost in Pennsylvania and the United States, 1975. Nov 1975.

Table 2. (page 2 of 3) Estimates of the economic costs of diabetes mellitus in the United States

Study	Year	Method	Design	Total Costs ($ billion)	Direct $	Direct %	Indirect $	Indirect %
SBMLIC	1980	Top-down	Primary diagnosis data from federal surveys	9.7	4.8	49	4.9	51
Smeeding, Booton	1980	--	Diagnostic category data from federal surveys	18.9	5.7	30	10	53
Carter Center	1980	Bottom-up	Diagnostic category data and other cost studies	--	7.9	--	--	--
SBMLIC	1984	Top-down	Cost projections from 1980 SBMLIC data	13.8	7.4	54	6.3	46
Huse	1986	Top-down	Diagnostic category data from federal surveys	19.8	11.6	59	8.2	41
Pracon, Inc,	1987	Bottom-up	Diagnostic category data	20.4	9.6	47	10.8	53
Weinberger[59] (diabetics ≥ 65 yrs old)	1987	Bottom-up	Cost projections	--	5.2	--	--	--
Roesler (Minnesota)	1988	Bottom-up	Estimates of health care utilization from national study applied to Minnesota state population	0.30	0.19	63	0.11	37
Kegler[60] (North Carolina)	1990	Bottom-up	Diagnostic category data	1.24	.574	46	.664	54
Warner (Texas)	1992	Bottom-up	Principle diagnosis data from billing records; federal and state survey data	4.0	1.6	40	2.4	60

[59] Weinberger M, Cowper PA, Kirkman MS, Vinicor F. Economic impact of diabetes mellitus in the elderly. Clinics in Geriatric Medicine 6:959-970, 1990.
[60] Kegler MC, Lengerich EJ, Norman M, Sullivan L, Stoodt G. The burden of diabetes in North Carolina. NCMJ 56:141-144, 1995.

Table 2. (page 3 of 3) Estimates of the economic costs of diabetes mellitus in the United States

Study	Year	Method	Design	Total Costs ($ billion)	Direct $	Direct %	Indirect $	Indirect %
Rubin ("identified" diabetics)	1992	Bottom-up	Survey of noninstitutionalized diabetic individuals in the general population	--	105.2	--	--	--
("confirmed" diabetics)		"	"	--	85	--	--	--
ADA	1992	Bottom-up	Diagnostic category data	91.8	45.2	49	46.6	51
Thom	1993	Top-down	Primary diagnosis data from Federal surveys	20	15.1	75	5	25
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)	1995	Bottom-up	Cost projections	137.7	91.1	66	46.6	34
Hodgson	1995	Top-down	Range of expenditures estimated from diagnostic category data from federal surveys	--	47.9 (34.3, 63.7)	--	--	--
ADA	1997	Bottom-up	Diagnostic category data	98.2	44.1	45	54.1	55

those adjusted by other indices. Recent reports [61,62,63] have suggested that there are deficiencies in the CPI and that adjustment based on the GDP deflator is preferred. We have calculated adjusted estimates with all of these indices, but the adjusted estimates presented in this report are based on the GDP deflator. To adjust for differences in prevalence, we examined the ratios of the prevalence of diabetes in 1997 to that for each of the study years (Appendix A) to adjust to the same base year (1997) prevalence.

On looking at the data in the tables in more detail (Appendices B, C, and D), one will note that the adjustment to the reported figures is influenced more by the changing prevalence of diabetes than by the change in price inflation. This indicates that a large part of the increase noted in the figures reported over time is related to the increase in the prevalence of diabetes.

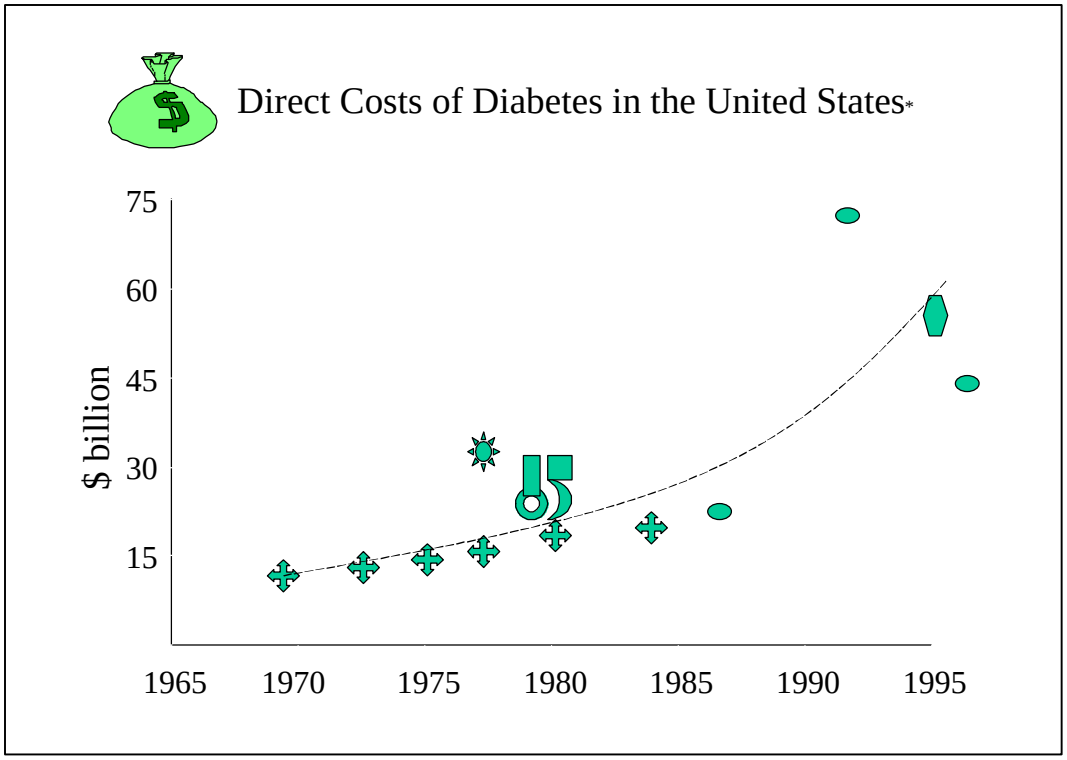
The adjusted direct cost estimates show that inflation and changes in diabetes prevalence account for much of the apparent increase in diabetes costs **(Figure 6)**. In the 1970s and 1980s the curve is relatively flat except for a jump for the Taylor study. The SBMLIC studies, having used the most consistent methodology over time, show a very small increase in adjusted direct costs and are represented in the flat part of the curve. Of note is the increase in costs estimated in the 1990s. This and the earlier jump illustrate the influence of changes in methodologies on the cost estimates and raise some concern about the cost-of-diabetes studies in general. Mainly, are the estimates continually trying to outdo each other? The issue raised by Hodgson of scaling estimates to a cap figure then becomes more relevant in this atmosphere. Generally, the marked increase in the 1990s is due to the inclusion of diabetes as a secondary diagnosis. We will explore the reasons for this in more detail in the next section.

Specific Cost Estimates

SBMLIC: 1969-1984 [40,41]

The earliest cost-of-diabetes estimates from the SBMLIC show the economic cost of diabetes increasing from $2.6 billion in 1969 to a projected $13.8 billion in 1984. The direct costs (or health care costs) of diabetes rose from $1.0 billion in 1969 to a projected $7.4 billion in 1984, and the indirect costs (or the loss of earnings due to diabetes) rose from $1.6 billion to $6.3 billion in the same timeframe. The proportional distribution of direct and indirect costs in these estimates changed slightly over time, with direct costs making up approximately 38 percent of the total costs in 1969 and then changing to a relatively equal split in the later reports.

[61] Huskamp HA, Newhouse JP. Is health spending slowing down? Health Affairs. Winter 1994; 32-38.
[62] Newhouse JP. Measuring medical prices and understanding their effects. (The Baxter Foundation Prize Address). The Journal of Health Administration Education 7:19-26, 1989.
[63] Newhouse JP. Medical care costs: How much welfare loss? Journal of Economic Perspectives 6:3-21, 1992.



SBMLIC[61,62]
Taylor[51]
Platt and Sudover[47]
Miller[48]
Smeeding and Booton[49]
Carter Center[65]
Pracon, Inc., and the ADA[15,43,44]
Hodgson[45]

Figure 6.

*Adjusted by GDP deflator (1992 base year) to 1997 dollars.
Adjusted by prevalence of diabetes.

Platt and Sudover: 1979 [51]; Miller: 1979 [52]; Smeeding and Booton: 1980 [53]

The SBMLIC estimates also shaped other early reports on the costs of diabetes. Using cost projections from the 1975 SBMLIC data, Platt and Sudover calculated the cost of diabetes in 1979 to be $15.7 billion. Miller used diagnostic category statistics and data from previous SBMLIC studies to derive a cost estimate of $12.4 billion for 1979. Smeeding and Booton used government surveys and statistics and data from the SBMLIC to derive its estimated cost of diabetes of $18.9 billion for 1980.

Taylor: 1977 [54]

Using an individual-based approach, versus the aggregate approach used in the SBMLIC reports, Taylor and colleagues estimated the direct costs of diabetes in 1977 were $6.9 billion. Only direct costs were addressed in this report. Additionally, nursing home costs, which were not included in the NMCES study, were not a part of this estimate.

Policy Analysis, Inc.: 1977 [55]

The only incidence-based estimate in the United States provided a figure of $10.8 billion in total lifetime costs of diabetes for all persons diagnosed with diabetes in 1977. On a per capita basis, the 1977 value of the future cost of diabetes was $18,257. In other words, roughly $18,000 in future costs would be saved for each new case of diabetes prevented. The greatest part of the costs (66%) was attributable to the indirect costs of diabetes.

Huse: 1986 [19]

Estimates of the cost of diabetes continued to increase through the 1980s as studies began to include costs related to chronic complications and comorbidities due to diabetes. According to a study by Huse and colleagues, the cost of NIDDM in 1986 was $19.8 billion. This estimate was one of the first to include health care costs related to complications of diabetes. The health care costs related to diabetes complications, such as cardiovascular, renal, and eye diseases, among others, accounted for approximately $4.8 billion of the total costs.

Gray: 1992 [56]

Using an incidence-based approach, Gray and colleagues estimated that the cost of IDDM in England and Wales in 1992 was £96 million. Renal replacement therapy was the most expensive direct cost category.

Thom: 1993 [64]

According to an estimate by Thom, the cost of diabetes in 1993 was $20 billion, including $15.1 billion in direct costs and $5 billion in indirect costs. This study used primary diagnosis data and a top-down approach to derive these figures.

Hart: 1994 [57]

Using a discrete event simulation model of incidence and lifetime costs, Hart and colleagues estimated the lifetime direct health care costs of IDDM in Spain. This cost was calculated at 8.06 billion pesetas for an incident cohort of diabetic cases diagnosed in 1994. The average lifetime cost per capita was 5.1 million pesetas.

[64] Thom TJ. Economic costs of neoplasms, arteriosclerosis, and diabetes in the United States. In Vivo 10:255-260, 1996.

Pracon, Inc. : 1987 [47]; American Diabetes Association: 1992 [15] and 1997 [48]

The 1987 cost-of-diabetes study by Pracon, Inc. provided an estimate for the cost of diabetes of $20.4 billion. Of the $6.9 billion in total inpatient hospital care costs, just $1.3 billion was directly attributed to diabetes, while the largest portion of this total was $3.3 billion for hospital care due to chronic complications of diabetes.

In the 1992 ADA cost study, Fox and colleagues estimated the cost of diabetes was $91.8 billion in 1992 — an apparent increase of more than four times the costs reported in 1987. Both direct and indirect costs exhibited similar fourfold increases. Inpatient hospital costs in 1992 were reported at $37.2 billion — a substantial increase from the 1987 estimate for this cost component. As in the 1987 ADA study by Pracon, Inc., hospital care costs directly attributed to diabetes (approximately $4 billion) made up the smallest portion of inpatient hospital costs. Hospital care due to unrelated conditions, estimated at $14.4 billion, accounted for the largest portion of hospital costs, and hospital care due to chronic complications contributed $9.7 billion to this cost category.

The most recent ADA cost-of-diabetes study[48] estimated that the total economic costs of diabetes were $98.2 billion in 1997. Interestingly, direct costs actually decreased from $45.2 billion in the 1992 ADA study to $44.1 billion in 1997. This decrease can be largely attributed to a decrease in inpatient hospital costs from $37.2 billion to $27.5 billion.

Rubin: 1992 [20]

Rubin and colleagues provided another estimate of the cost of diabetes in 1992. This study estimated health care expenditures for individuals with diabetes at $105.2 billion. Unlike the 1992 ADA study, this study estimated all health care costs incurred by persons with diabetes, not just costs specifically attributable to diabetes.

National Institutes of Health – 1995 [4]

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) estimate is a cost projection study. It combines direct cost information from the Rubin study[20] and indirect costs from the 1992 ADA study[15] and adds an estimate of the annual cost of nursing home care. The resulting figure of $137.7 billion for the cost of diabetes in 1995 is the largest of the estimates to date. The NIDDK is no longer using this estimate in its work, preferring to cite the 1997 ADA estimates now.

Hodgson: 1995 [49]

Hodgson provides another estimate of health expenditures that includes costs due to chronic complications and other medical conditions attributed to diabetes. Hodgson, however, added other dimensions by 1) calculating the sensitivity of his estimates within one standard deviation, and 2) scaling his estimates to a standard from the health expenditure data series of the Health Care Financing Administration (HCFA). The rationale for scaling is the view that there is a limit to how high the costs of diabetes can be.

Total medical care expenditures attributed to diabetes in the study ranged from $34.3 billion to $63.7 billion, with a middle estimate of approximately $47.9 billion. Of this total, $18.8

billion was attributed to health care expenditures where diabetes was listed as a primary diagnosis, $18.7 billion was attributed to expenditures for chronic complications due to diabetes, and $6 billion was attributed to costs associated with increased health care use for other unrelated conditions among persons with diabetes. This report did not look at indirect costs.

Direct Costs

In addition to listing total cost estimates, **Table 2** provides total cost estimates broken down into direct and indirect costs. There is no apparent trend in the percentage distribution of direct and indirect costs. In general, indirect costs make up a slightly larger proportion of total costs.

Direct costs rose from $1 billion in 1969 to $44.1 billion in 1997. When adjusted to 1997 dollars for inflation and changes in diabetes prevalence, however, the increase in direct care costs is muted somewhat, from $12.04 billion (1969 adjusted figure) to $44.1 billion (Appendix B).

The Rubin estimate of $105.2 billion in direct health care costs **(Table 2)** (indirect were not included here) is the highest of the direct cost figures; however, as will be discussed later, this amount includes all health care costs of diabetic individuals, not only costs attributed to diabetes. The largest portion of direct costs arises from the cost of hospital care, and, in general, this portion has increased over time **(Table 3)**.

Tables 3 and 4 present breakdowns of health resource utilization and costs for the three major cost categories included in the calculation of total direct costs: hospitalization, nursing home stays, and outpatient visits. Figures for the direct cost components are not adjusted for inflation or changes in diabetes prevalence. Unless otherwise noted, absence of health resource information in these tables is due to lack of details reported in the relevant studies. Costs for hospital care clearly make up the majority of the direct costs related to diabetes. Comparisons of these estimates are limited because of the different methodologies used in each study.

Because of the consistency of the SBMLIC data, it is of value when evaluating trends. The data of the SBMLIC suggests that direct costs increased substantially from 1973 to 1984. In the SBMLIC studies, hospital costs as a percentage of total direct cost remained relatively steady, while nursing home costs as a proportion of direct costs increased from 1973 to 1984.

As can be seen in **Table 5,** health care components considered in the direct cost calculation vary between the studies. In general, all studies have included costs associated with hospital care, physician services, and prescription drugs. There are marked discrepancies, however, with respect to the cost of nursing home stays, emergency department services, home health care, and others.

Indirect Costs

Table 6 lists the major cost components included as indirect costs. These figures are not adjusted for inflation or changes in diabetes prevalence. It appears that permanent disability costs have increased as a proportion of total indirect costs during this time period. Various discount rates, usually 4 percent or 6 percent have been used and can have a substantial impact on the estimated present value of future earnings. The SBMLIC data shows that indirect costs

increased while mortality costs as a percentage of the total indirect costs decreased steadily from 1969 to 1984.

Both the SBMLIC and the ADA provide estimates of indirect costs associated with disability and premature mortality. The SBMLIC estimates consider only disability costs based on diabetes as the primary reason for disability and mortality costs based upon deaths for which diabetes was listed as the underlying cause of death. In the ADA studies, indirect costs include disability for which diabetes was the primary cause; however, these studies also attempted to account for deaths with diabetes as a contributory cause.

Platt and Sudovar[51] (1979: $7.4 billion) have reported that the expenses related to disability (morbidity) were quite substantial. The SBMLIC (1984: $4.4 billion), Huse (1986: $2.6 billion for NIDDM), and the earliest ADA report by Fox and Jacobs (1987: $3.3 billion), however, did not report such a high figure for disability costs.

The Pracon, Inc., and the ADA studies also included estimates of indirect costs due to absenteeism **(Table 6)**. These costs represented the number of days lost from work and housekeeping by people with diabetes compared with those without diabetes. Indirect costs due to absenteeism grew from $55 million in 1987 to $1,433 million – a substantial increase despite use of similar methods and data sources.

Table 3. Estimates of direct costs for health care services in diabetes, by study

Study	Year	Hospital Care ($ million)	Hospital Care (%)	Physician Visits ($ million)	Physician Visits (%)	Nursing Home Care ($ million)	Nursing Home Care (%)
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1973	800	48	400	24	185	11
SBMLIC	1975	1050	42	590	23	520	21
Werner (United States)	1975	1090	50	298	14	237	11
Taylor	1977	4826	70	980	14	--	--
Platt, Sudover	1979	1119	20	1584	28	830	15
IDDM		336	--	475	--	110	--
Miller	1979	4400	59	1395	19	1530	21
Smeeding, Booton	1980	--	--	--	--	--	--
SBMLIC	1980	2200	46	840	18	1240	26
Carter Center	1980	6200	78	652	8	663	8
SBMLIC	1984	3540	48	1180	16	1950	26
Huse (NIDDM)	1986	4870	42	2190	19	3440	30
Pracon, Inc.	1987	6930	72	372	4	942	10
Weinberger (diabetics >65 yrs old)	1987	4108	79	255	5	306	6
ADA	1992	37,200	82	1047	2	1833	4
Rubin	1992	65,200	--	11,000	--	--	--
Thom	1993	6200	41	4000	27	1700	11
Hodgson	1995	20,123 † (14,914, 25,664)	42	8906‡ (6314, 12,241)	19	5952 † (4721, 7250)	12
ADA	1997	27,454	62	3209	7	5510	12

† May include expenditures for hospice services
‡ Amount also contains expenditures for other professional services. In general, for all diagnoses, other professional services account for only 10% of the combined total (Hodgson, personal communication).

Table 4. Estimates of health care utilization with data sources, by study

Study	Year	Prevalence (millions)	Hospital care	Physicians' services	Nursing home care
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1973	4.2	5,200,000 days	34,000,000 visits	--
		1973 National Health Interview Survey (NHIS)	Hospital Discharge Survey	1969 National Disease and Therapeutic Index	Prevalence of chronic conditions and impairments among residents and personal care homes, May-June 1964, 1967 NCHS
SBMLIC	1975	4.8	2.2% of inpatient care	40,000,000 visits	6.0% of total nursing home expenditures
		1975 NHIS	1973 Hospital Discharge Survey	National Disease and Therapeutic Survey	1973-1974 National Nursing Home Survey (NNHS)
Taylor	1977	4.6	20,253,420 days	39,959,338 visits	--
		1977 National Medical Care Expenditure Survey (NMCES)	1977 NMCES	1977 NMCES	--
Policy Analysis, Inc.	1977	595,400 incident cases	5,686,560 days	11,023,000 visits	710,819 months
		Unpublished data from the National Diabetes Data Group, National Institute for Arthritis, Metabolism, and Digestive Diseases	1977 National Hospital Discharge Survey (NHDS)	1977 National Ambulatory Medical Care Survey (NAMCS)	1977 NNHS; 1973-1974 NNHS used for age- and sex-specific estimates
Platt, Sudover	1979	6.5	7,401,720 days	45,253,000 visits	254,924 residents
IDDM		1.9	2,220,518 days	13,575,900 visits	33,905 residents
	--		"Utilization of Short Stay Hospitals" and "Estimating the Cost of Illness", U.S. Department of Health, Education and Welfare	survey	1973-1974 NNHS

Table 4. (page 2 of 4) Estimates of health care utilization with data sources, by study

Study	Year	Prevalence (millions)	Hospital care	Physicians' services	Nursing home care
Miller	1979	6.5	27,000,000 days	19,500,000 visits	255,000 residents
	--		1974 NHDS; CDC Community Diabetes Control Demonstration Projects, 1978 Phase I Report Summary		
Carter Center	1980	5.1	24,628,000 days	16,300,000 visits	189,600 residents
		1978 NHIS	1980 NHDS	1980 NAMCS; 1978 NHIS	1977 NNHS
Huse (NIDDM)	1986	5.8	--	--	--
		1984 through 1986 cycles of the NHIS	1980 NHDS	1980 NAMCS	1977 NNHS
Pracon, Inc.	1987	6.5	11,486,000 days includes: 2,240,200 directly attributable 5,709,800 chronic complications 45,700 increased intensity of care 2,700,000 increased length of stay	13,400,000 visits	446,856 months
		1985 NHIS	1986 NHDS; 1986 Pracon telephone survey of 20 physicians	1985 NAMCS	1985 NNHS

Table 4. (page 3 of 4) Estimates of health care utilization with data sources, by study

Study	Year	Prevalence (millions)	Hospital care	Physicians' services	Nursing home care
Weinberger (diabetics ≥ 65 yrs old)	1987	3.2	5,453,700 days includes: 3,914,000 attributed to diabetes 1,539,700 not attributed to diabetes	7,239,335 visits	145,441 months
	--		1987 Pracon Inc. report	1985 NAMCS	1987 Pracon Inc. report
ADA	1992	7.3	20,214,600 days includes: 2,317,500 directly attributable 5,962,000 chronic complications 6,550,700 other comorbid conditions 5,384,400 increased length of stay	15,700,700 visits	17,794,100 days
		1990 Centers for Disease Control (CDC)	1990 NHDS; 1991 Quality of Care/Medicare Provider Analysis and Review (QC/MEDPAR) file	1990 NAMCS	1985 NNHS
Rubin	1992	11.1 ("identified") 7.7 ("confirmed")	--	--	--
		1987 National Medical Expenditure Survey (NMES)	1987 NMES	1987 NMES	1987 NMES
Thom	1993	---	3,483,000 days	12,997,000 visits	11,824,000 days
			1993 NHDS	1993 NAMCS	1985 NNHS

Table 4. (page 4 of 4) Estimates of health care utilization with data sources, by study

Study	Year	Prevalence (millions)	Hospital care	Physicians' services	Nursing home care
Hodgson	1995	--	--	--	--
	--		1993 NHDS; 1992 MEDPAR file; I1994 Veterans' Administrations; IMS America 1994	1992 NAMC; 1993 NHIS 1987 NMES	1985 NNHS 1990 Census Bureau; IMS America 1994
ADA	1997	7.7	13,872,146 days includes: 1,457,539 diabetes and acute complications 4,919,984 chronic complications 7,494,623 general medical conditions	30,270,663 visits	69,734,083 days
		1987 NMES	1994 NHDS	1994 NAMCS	1995 NNHS

Table 5. Cost components included in estimates of direct health care costs for diabetes

Study	Year	Hospital	Physician	services	Prescription	Nursing home	Outpatient/	Laboratory	Vision	Dental	Daily self-	Home health
		care	In	Out	drugs	care	ER	tests	care	care	management	care
SBMLIC	1969-1984	*		*	*	*	*					
Werner	1975	*		*	*	*	*				*	
Taylor	1977	*	*	*	*		*		*	*	*	*
Policy Analysis, Inc.	1977	*		*	*	*		*			*	
Platt, Sudover	1979	*		*	*	*		*			*	
Miller	1979	*		*	*	*	*	*	*		*	
Smeeding, Booton	1980											
Carter Center	1980	*		*	*	*						
Huse	1986	*		*	*	*	*					
Pracon Inc.	1987	*	*	*	*	*	*	*			*	
Weinberger	1987	*	*			*		*			*	
Roesler	1988	*	*	*	*	*	*	*			*	
Kegler	1990	*										
ADA	1992	*	*	*	*	*	*	*			*	*
Warner	1992	*	*	*	*	*	*					*
Rubin	1992	*		*	*		*			*	*	*
Thom	1993	*		*	*	*						*
Hodgson	1995	*	*	*	*	*	*	*	*		*	*
ADA	1997	*	*	*	*	*	*				*	*

Table 6. Estimates of indirect costs due to absenteeism, disability and mortality from diabetes, by study

Study	Year	Absenteeism ($ million)	Permanent Disability ($ million)	Mortality ($ million)	Discount Rate (%)
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1969	--	464	1129	--
SBMLIC	1973	--	980	1385	6%
SBMLIC	1975	--	1680	1070	4%
Werner (United States)	1975	--	1064	1280	4%
SBMLIC	1977	--	2340	1040	--
Platt, Sudover	1979	--	--	1528	weighted
IDDM		--	--	458	discount rate
SBMLIC	1980	--	3440	1460	--
SBMLIC	1984	--	4440	1880	--
Huse	1986	--	2600	5600	4%
Pracon, Inc.	1987	55	3143	7489	4%
ADA	1992	851	11,179	26,983	6%
Thom	1993	--	--	4700	6%
ADA	1997	1433	32,450	16,962	4%

Cost-of-Diabetes Estimates — Comparisons

A look at the cost-of-diabetes estimates in more detail suggests several observations regarding both the estimates and their methods. We present here five specific observations that illustrate key points in this regard.

1. The Early Studies

It is possible to observe that many of the earliest estimates are very similar in magnitude despite different methods (see **Figure 6**). Although superficially one might assume that this provides a level of consistency and "reliability" to the estimates, upon further analysis of the methods one finds that nearly all of these early studies are using the data of the SBMLIC in one form or another. This likely leads to their similarity.

Studies by Platt and Sudover[51], Miller[52], and Smeeding and Booton[53] in 1979 and 1980 report cost estimates 1.3 to 2.0 times higher than the costs estimated by the SBMLIC for 1980. These four studies used similar estimates of the magnitude of diabetes. However, Platt and Sudover used the health resource utilization and cost data from the 1973 SBMLIC report for their 1979 estimate of $15.7 billion **(Table 2)**.

Miller's estimate of the total costs of diabetes **(Table 2)** – $12.4 billion – was calculated with the "bottom-up" procedure (versus the "top-down" procedure used in the SBMLIC estimates). Direct cost data from the 1975 SBMLIC report were adjusted for inflation to 1979 dollars and for increased prevalence of diabetes.

Smeeding and Booton used government surveys and statistics and direct and indirect cost data from the SBMLIC to calculate the cost of diabetes in 1980 to be $18.9 billion **(Table 2)** – surprisingly, almost twice the 1980 SBMLIC estimate of $9.7 billion **(Table 2)**.

2. Person-Based Versus Utilization-Based

Another interesting "comparison" can be made between the 1977 estimates of $6.9 billion by Taylor[54], and of $3.4 billion by the SBMLIC **(Table 2)**. This difference is even more notable given that the SBMLIC direct cost estimate included nursing home costs (SBMLIC, 1977), whereas this cost component was not a part of the NMCES estimate (Taylor, 1987). The primary reason for this difference lies in the design utilized in both studies. Using data from the NMCES, Taylor estimated costs from the reported experiences of individuals with diabetes.

The SBMLIC exclusively used primary diagnosis data in its calculations. The degree of difference between the cost estimates suggests that relying upon data where diabetes is the primary diagnosis may considerably underestimate the health care costs of diabetes. This can again be seen in a comparison of the 1980 SBMLIC estimate and the estimate by the Carter Center of Emory University for that same year. As with its prior estimates, the SBMLIC used only primary diagnosis data to generate its direct cost estimate of $4.8 billion. Using many of the same data sources, but including diagnoses beyond the primary diagnosis, the Carter Center estimated the direct cost of diabetes for 1980 to be $7.9 billion[65] **(Table 2)**.

3. Pracon, Inc., and ADA Studies — 1987, 1992, and 1997

As previously discussed, cost-of-diabetes studies in the 1980s tried to overcome the concern with underestimation of costs by including costs where diabetes is a secondary or tertiary diagnosis. The 1986 estimate from Huse and colleagues[19] and the 1987 ADA estimate from Fox and Jacobs were the first results of studies that employed attributable risk procedures in their estimates of diabetes costs. This, in part, accounted for the observed increase in the costs of diabetes.

It is interesting to compare the 1987 ADA study and the 1992 ADA study. A huge jump in the cost estimate for diabetes appeared at this time – $20.4 billion to $92 billion. Further, even after adjusting direct costs for inflation and changes in prevalence to 1997 dollars, the direct cost estimates differ more than threefold – $20.2

[65] Carter Center. Closing the Gap; the problem of diabetes mellitus in the United States. Diabetes Care 8:391-406, 1985.

billion in 1987 versus $70.8 billion in 1992 – despite roughly similar methods.

For example, the 1992 ADA cost study used the same attributable risk procedure used in the 1987 Pracon, Inc., study. However, the later study incorporated more categories of health care resources, including costs associated with emergency room visits, home health care, hospital outpatient department, and dietitian services, and used different data sources to ascertain inpatient hospital utilization. Both studies used the National Hospital Discharge Survey (NHDS), but the 1992 study also used the Quality of Care/Medicare Provider Analysis and Review (QC/MEDPAR) File.

Table 7. Comparison of unit costs used by ADA studies for hospital care and nursing home care

Study	Year	Hospitalization Day ($ per day)	Nursing Home Day ($ per day)
Pracon, Inc.	1987	572	2107 (per month)
ADA	1992	1706 (due to diabetes) 1633 (due to chronic complications) 2192 (due to unrelated conditions) 1706 (due to added length of stay)	103
ADA	1997	1979	79

The most significant differences between the studies are the large increases found for hospital services and disability related to diabetes. There appear to be several reasons for this difference. First, the 1992 ADA study incorporated more hospital admissions related to the complications of diabetes. The total number of hospital days almost doubled from 11.5 million days in 1987 to 20.2 million in 1992 **(Table 4)**. Second, the l992 study used substantially higher "per item" cost figures, particularly for the average cost of a hospital stay **(Table 7)**.

Using data from the American Hospital Association, the 1987 Pracon, Inc., study estimated the cost of a hospital day at $572, whereas the 1992 study used the National Medical Expenditure Survey (NMES) to estimate a cost of $1706 per hospital day **(Table 7)**. The increase in inpatient hospitalization costs reflects, in part, the combined effects of increased hospital days and increased costs per hospital day. Last, disability related to diabetes grew 3.5 times in 5 years. In 1987, 9,319 workers were estimated to be newly permanently disabled due to diabetes. This number increased to 47,800 in 1992.

A minimal increase in total costs is observed between 1992 and 1997. While indirect costs increased, both direct and inpatient hospital costs declined. Direct costs in 1992 are slightly higher than those in 1997. When adjusted for inflation and diabetes prevalence, direct costs in 1992 are more than 1.5 times the direct costs 5 years later in 1997. The authors attribute the decrease in direct costs largely to a decrease in

hospital costs. Unit costs per hospital day do not appear to have contributed to the change in total hospital costs.

It was the decrease in inpatient hospital days, from 20.2 million in 1992 to 13.9 million in 1997, which accounted for most of the decrease in total hospital costs **(Table 4)**. The reasons for this decrease in hospital days are not entirely clear. It is reasonable to attribute some of the decrease to a shift in site of service, but a difference in study designs in these 2 years may have affected the estimates of hospital days and thus their comparability.

This difference in study designs is diagrammed in **Figure 7**. Both studies used the reporting of ICD-9-CM diagnosis codes of 250 or 251 to identify hospitalizations for the treatment of people with diabetes. Both studies also used AR procedures for calculating costs attributed to diabetic complications and other co-morbid conditions/general medical conditions. The AR methods used, however, were different.

The 1992 study used the AR among persons with diabetes for each of eight subcategories of chronic complications of diabetes and for other co-morbid conditions. These disease-specific attributable fractions (AFs) were then applied to the total number of hospital days for persons with diabetes in each subcategory to give an estimate of the number of hospital days attributable to diabetes. An added length of stay was calculated for the remaining portion of hospital days (due to chronic complications of diabetes as well as other co-morbidities) not attributed to diabetes.

The 1997 study changed this procedure in two ways. First, it used the AR for the population (rather than the attributable risk among persons with diabetes) for each of the subcategories of complications and general medical conditions. Data from the NMES were used to estimate the excess prevalence of chronic complications of diabetes and general medical conditions in age-sex and age-race specific groups. Odds ratios for the demographic groups were used to approximate the relative prevalence of each medical condition. The AFs were then multiplied by the total number of hospitalizations, from the NHDS, in the entire population for each subgroup. The use of the population ARs in the 1997 ADA study necessarily understates the proportion of health service utilization attributed to diabetes, because persons with diabetes are more likely than persons in the general population to be hospitalized.

Second, instead of relying on secondary diagnosis codes to identify health care utilization due to complications of diabetes and general medical conditions (as in the 1992 study), the 1997 study used only primary diagnosis code information on chronic complications and assumed that a certain proportion (population AR) was due to diabetes. This change in methodology was an attempt to achieve more accurate estimates of expenditures attributed to diabetes when diabetes is not reported[48]. It is noted in the 1997 ADA study that published reports have described underreporting of diabetes as a limitation of hospital discharge data. The combination of these two effects may explain part of the apparent decrease in hospitalization costs between the 1992 and 1997 ADA studies.

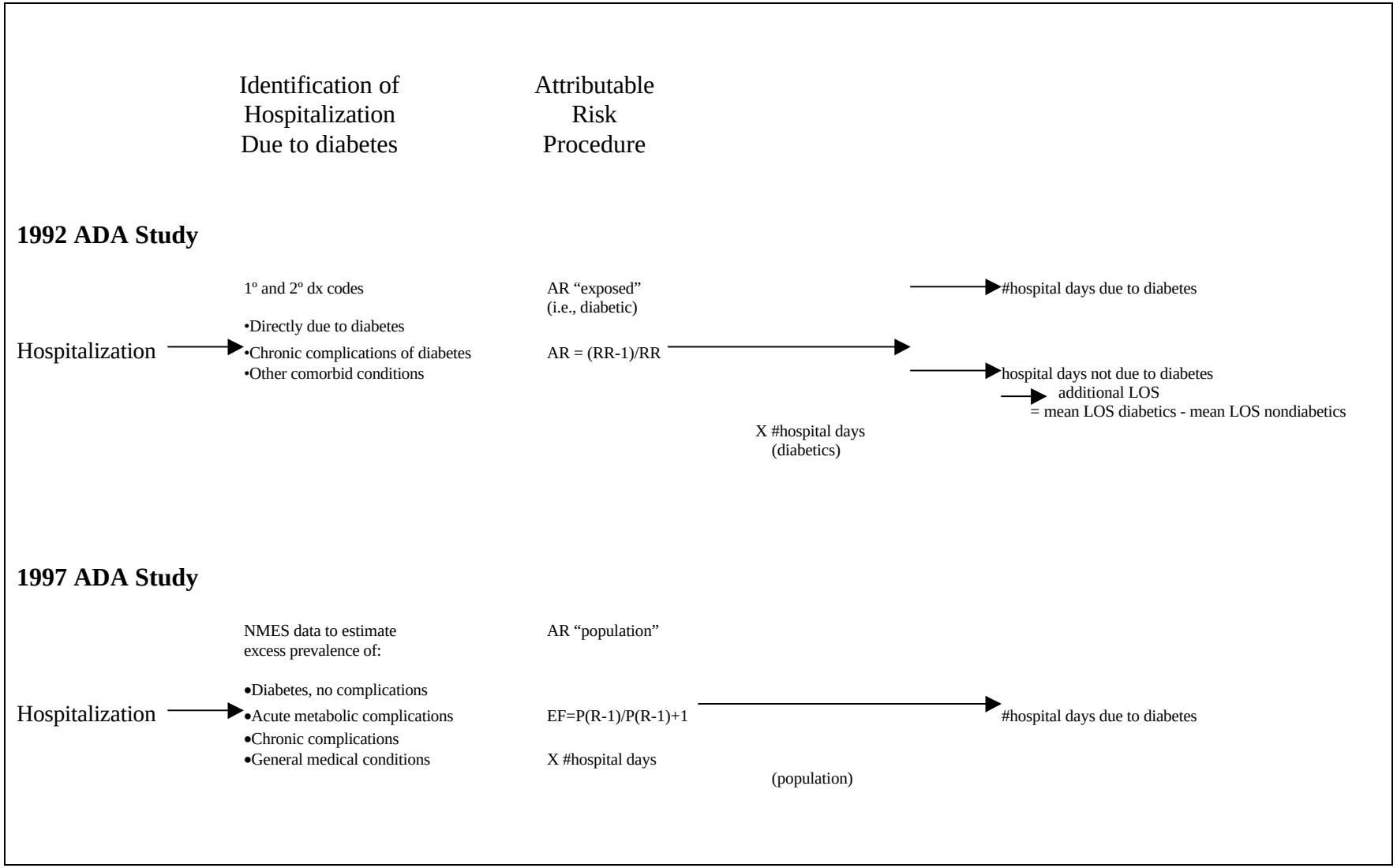


Figure 7. Attributable risk procedures – ADA studies.

4. Fox and Rubin

Two studies provided estimates for the baseline year 1992. Rubin and colleagues[20] estimated that the health expenditures for persons with diabetes were $105 billion, or roughly 1 in 7 of all health care expenditures. Fox and the ADA estimated the direct costs for diabetes as $45 billion. These are markedly different figures and reflect different measures. Rubin, for example, considers all expenditures for persons with diabetes, some of which will be unrelated to diabetes. Fox, on the other hand, estimates the costs that are directly attributable to diabetes. There is some concern about the interpretation of Rubin's estimate. Basically, if the medical care expenditures for all diseases were estimated in a similar way and then added together, the sum of the individual cost estimates would be greater than the total health care expenditures for the country.

The 1997 ADA cost-of-diabetes study also provided an estimate of total health care costs for persons with diabetes. Both the Rubin study and the 1997 ADA study used the 1987 NMES to estimate the prevalence of diabetes and the health care costs. However, Rubin's estimate, even his more conservative estimate for persons "confirmed" to have diabetes, was higher than the 1997 ADA cost estimate. The reasons for these marked differences are not entirely clear.

5. ADA and Hodgson

The ADA studies and the Hodgson study[49] accounted for health care costs due to chronic complications and other health conditions attributed to diabetes. However, as mentioned before, the studies employed slightly different methodologies. The ADA estimate of direct health care costs of $45.2 billion for 1992 is slightly less than the Hodgson estimate of $47.9 billion in medical care expenditures for 1995. Adjusting the 1992 ADA estimate for price inflation results in an estimate for 1995 ($54.1 billion) that is 20 percent higher than the estimate by Hodgson.

The difference in these estimates is due primarily to the difference in estimated inpatient hospital expenditures. The ADA's estimate for inpatient hospital costs was higher than Hodgson's estimate: $44.9 billion (adjusted to 1995 dollars by Hodgson) versus $20.1 billion. While hospital costs due directly to diabetes as well as those due to chronic complications of diabetes were similar in the two studies, estimates of costs due to unrelated conditions (ADA: $17.3 billion versus Hodgson: $7.2 billion) and costs due to added length of stay (ADA: $11.1 billion versus Hodgson: $1.2 billion) were substantially different. Unit cost per hospital day for unrelated conditions, higher in the ADA estimate, appears to have contributed to the difference there. Differences in costs related to increased length of stay were due, in part, to different assumptions about added length of hospital stay.

Summary

"The boy … would be crying a wolf, a wolf, when there was none, and then could not be believed when there was.."

L'Estrange, Aesop's Fables, The Shepard Boy and the Wolf, 1692

The diabetes economics literature is extensive and diverse. Although many discrepancies exist between the studies conducted, one can draw several conclusions from a review of the literature. The main conclusions are highlighted below.

Much attention and effort have been directed toward establishing the burden of health conditions in economic terms. Over the last four decades, a large number of economic studies of diabetes have been performed. Consistent with the morbidity and mortality burden found in clinical and epidemiological studies, COI studies have repeatedly found a large economic burden associated with diabetes. The estimates of the ADA[48] and Hodgson[49] suggest that the direct costs may be on the order of $50 billion per year.

As with other chronic diseases, tremendous interest in the economics of diabetes continues. One trend is clear: Many different players in this arena, political leaders, policymakers, health care providers, health care purchasers, and patients pose different questions requiring different economic approaches to reach an answer. Although COI studies can provide a monetary figure to describe the burden of diabetes, this reality suggests that COI estimates may be limited in their usefulness as a basis for health policy or health care allocation decisions.

It is reasonable to conclude that diabetes is a comprehensive, chronic disorder, with both short-term and long-term complications. Established methods in estimating the costs of diabetes (that rely on primary diagnosis data) are likely to severely underestimate the impact of diabetes. In the political environment that shapes decisions on health care and biomedical research funding, it is understandable that attempts to estimate the costs of long-term complications attributable to diabetes have arisen. From an epidemiologic basis, the approach to estimating these secondary costs by means of an attributable fraction is appropriate. Determining an appropriate attributable risk figure will require a great deal of effort.

As noted earlier, the two attributable risk procedures (population or disease-specific) are not synonymous, and whichever is used will affect estimates of the proportion of health care utilization attributable to diabetes. The disease-specific AR is preferable, but the available data will largely determine the choice of procedure.

Although the majority of studies attempt to address the costs of treating diabetes and its complications, studies such as Rubin's, which look at the total health care expenditures related to persons with diabetes, provide a different and unique perspective.

Indirect costs represent additional burdens created by a disease. They highlight potential resources lost as a result of disability and premature mortality. Thus, indirect costs are important to all economic studies. They accounted for more than one-half of the costs in these cost-of-illness studies. However, there are major challenges in determining what should be measured, how to measure it, and how to assign

a monetary value when one examines indirect costs. The epidemiology of premature mortality and short- and long-term disability is reasonably well described, but assigning costs is problematic. Therefore some investigators prefer to estimate only the direct costs of diabetes.

It appears that the data sources and methods used to estimate the cost of diabetes apparently have settled between two designs: one based on the national data available from annual surveys of the NCHS and the HCFA, such as the NHDS, and the second based on the periodic surveys of individuals with diabetes, such as the NMES. Each design has its own strengths and weaknesses. The estimates of the NMES are appealing because they are based on specific responses, utilization, and cost characteristics of persons with diabetes. However, the number of persons with diabetes in the survey sample is relatively small, and extrapolation to subgroups is difficult in this setting.

The scaling approach presented by Hodgson appears appropriate. In essence, it argues that there should be a cap on the costs of diabetes. This is enlightening since some diabetes studies give the impression of trying to outdo each other. In this environment, there are many opportunities for misstating or misinterpreting the cost-of-illness data in diabetes. Further, when one "compares" diabetes with other diseases in setting priorities, it is difficult not to wonder whether the process has degenerated into a game of "my disease is more costly than your disease." Like those who heard the boy who cried wolf, those working in the diabetes field should be concerned that the estimates have credibility and are believable.

Despite several advances in the approach to estimating the costs of diabetes, there is no standard for estimating these costs. The current estimates are not directly comparable because of the different methods used. Even the ADA studies are not comparable, despite being conducted by the same author. It is not possible, then, to assess the true extent to which the costs of diabetes may have increased.

The purpose of the cost-of-diabetes studies is unclear. Few of the studies explicitly identified their purpose. The reader is often left to surmise the intent of the contractors or authors. That being said, there is limited evidence for concluding that contracted studies are being used for anything other than advocacy.

Limitations in Current Cost-of-Diabetes Studies

In general, the number of cost-of-diabetes studies undertaken is relatively large, and several advances have occurred in our understanding and estimation of the economic impact of diabetes. Several areas related to the cost of diabetes, however, have received little attention.

1. Most of the current estimates are broad in perspective. Little information is available on costs specific to Type 1 diabetes, Type 2 diabetes, or gestational diabetes. Further, the nature of the cost data on specific subgroups, such as gender, race, or age categories, is preliminary. These estimates would be important for identifying in more detail areas for future interventions.

2. Only one incidence-based estimate for the cost of diabetes exists in the United States, whereas three estimates are now available in

Europe. Future studies in this area would be helpful for identifying the potential costs that can be reduced if complications, or even diabetes itself were prevented.

3. There has been little evaluation of the impact of sampling error or variation on cost estimates. The report by Hodgson has been the only study to consider the possible impact of variance on the estimates.

4. Better epidemiologic data are needed, for example data on the contribution of diabetes to other diagnoses and the contribution of co-morbidities and other factors to diabetic complications. Such data would lead to better information on the attributable risks related solely to diabetes.

5. Methods for measuring and valuing indirect costs need to be refined.

6. Two areas in the diabetes field have received little attention from a COI perspective: (1) Several initiatives that focus on treating and reducing the impact of diabetes complications are under way; however, the cost of each specific complication of diabetes has not been estimated. Incidence-based studies in this area could highlight the potential savings resulting from prevention. (2) A common concern of the lay public is the cost of living with diabetes. Further studies that define the burden of diabetes from this perspective could address this concern.

A Proposed Framework for Future Research

At this point, researchers have conducted many cost-of-diabetes studies in the United States. Indeed, many will argue that the current data are adequate for their intended purposes and thus there is not a need for another project in the near future.

Eventually, however, there will be a need to conduct another cost-of-diabetes study. Also, as we have noted, limited information exists in several areas. We therefore propose the following areas for consideration in the conduct of future investigations.

1. Current studies have been confined to a relatively small number of data sets, such as the NMES, NHDS, and National Health Interview Survey (NHIS), and analysts have not examined the value of using information from large epidemiologic cohorts in, for example, the AR debate.

   From existing epidemiologic cohorts, identify information, such as:
   - *a. other unrelated diagnoses attributed to diabetes and*
   - *b. other comorbidities that increase health care use.*

   The latest studies have not addressed our current epidemiologic understanding of these items to any large extent. If an understanding can be reached, consider including these data or criteria in future standards.

2. Currently, cost-of-diabetes studies provide an estimate of impact that neglects to highlight its possible range. The work of Hodgson illustrates that the cost burden may vary, in some cases significantly.

   Future studies should attempt to estimate the standard errors to the extent possible and include confidence intervals when possible.

3. Past research has consistently shown that the greatest advances in an area come with

standardization. This is especially true in epidemiology. This concept, likewise, should be considered for the area of the cost of diabetes. In fact, the recent work of the panel on *Cost-Effectiveness in Health and Medicine*[38] has gone a long way in this direction in cost-effectiveness studies.

Certainly, standards in the estimation of the costs of diabetes would have benefits. Comparisons between studies are not currently possible because of dramatic methodological differences between the reports. Data sources on costs and outcomes, however, are lacking, particularly in areas outside the United States.

Consider the development of standards for estimating the costs of diabetes, with a focus on:

- *a. strategies for identifying diabetes from data sets,*
- *b. strategies for assigning cost data to utilization information, and*
- *c. a framework on which costs to include.*

Although the overall analytic approach can and should be individualized to a specific study, elements such as those listed above would greatly benefit from standardization. Hodgson's estimate of direct health care costs for diabetes appears to be the most comprehensive in its inclusion of cost components. These cost components combined with the error variances and scaling of estimates seem like reasonable minimum standards, although necessary data may no be available.

4. Future studies should identify the data contained in the reports explicitly. Much of the methodology underlying the estimation of diabetes costs cannot be found in the published literature.
   Detailed supplemental reports to diabetes COI studies should be available.

5. The purpose of undertaking the diabetes cost study should be identified so that the reader can draw an appropriate analysis of the estimate. There are clear perspectives on the cost of diabetes area. Advocacy groups whose goal is finding the biggest dollar figure to attach to their disease sponsor some studies. The goal of other studies is to define the public health burden of diabetes and supplement other epidemiologic data on diabetes with a figure (monetary) that the lay public can better understand.

   Future studies should make explicit the intended use of their estimates.

6. Of the AR procedures, use of the disease-specific attributable risk provides the most accurate estimate of health resources utilization and costs. However, currently available data sources do not allow for determination of disease-specific attributable risks for all health care components.

   - *a. When possible, researchers should identify disease-specific ARs and*
   - *b. Investigate whether standard sources of data for attributable risk are feasible and recommended.*

7. One of the limitations noted earlier is a lack of information on many aspects of costs. Given this, we should consider adding cost information to large-scale studies.

   An effort should be made to obtain cost information from new sources.

a. *a cost module could be added to the National Health Interview Survey Diabetes Supplement.*
b. *Medicare Beneficiary Survey*
c. *NHANES I Epidemiologic Follow-up Survey*.
d. Databases of managed care organizations.

In summary, economic information is of great importance as a basis for defining the burden of and developing public health policies for diabetes. The current focus of future research efforts should be in refining economic methods, specifically for attributable fractions and indirect costs; improving interpretation and communication of study findings; and conducting cost-effectiveness assessments of interventions as they are tested.

Appendices

Appendix A

Price inflation and diabetes prevalence adjusters

Year	Diabetes prevalence * (millions)	GDP deflator †	CPI – all items ‡	CPI – medical care ‡
1969	3.378 §	0.2843	36.7	31.9
1973	4.191	0.3442	44.4	38.8
1975	4.780	0.4071	53.8	47.5
1977	5.084 §	0.4697	60.6	57.0
1979	5.466	0.5444	72.6	67.5
1980	5.466	0.5928	82.4	74.9
1984	6.053	0.7576	103.9	106.8
1987	6.641	0.8293	113.6	130.1
1992	7.417	1.0000	140.3	190.1
1993	7.813	1.0264	144.5	201.4
1995	9.057 §	1.0782	152.4	220.5
1997	10.300 #	1.1274	160.5	234.6

* *Source:* National Health Interview Survey, *Diabetes in America*, chapter 4, references 15-27.
† *Source:* U.S. Bureau of Economic Analysis, *Survey of Current Business* (fiscal year 1992 = 1.000).
‡ *Source:* U.S. Bureau of Labor Statistics, *Consumer Expenditure Survey* (base period 1982-1984 = 100).
§ Prevalence estimates extrapolated from Source 1.
 # Source: Centers for Disease Control and Prevention, 1997, in The American Diabetes Association. Economic consequences of diabetes mellitus in the United States in 1997. Diabetes Care 1998;2:296-309.

Appendix B

Direct costs, adjusted for price inflation, using GDP deflator, and diabetes prevalence

Study	Year	As Reported ($ billion)	Adjusted for Inflation ($ billion – 1997)	Adjusted for Inflation and Diabetes Prevalence ($ billion – 1997)
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1969	1.00	3.95	12.04
SBMLIC	1973	1.65	5.4	13.28
SBMLIC	1975	2.52	6.98	15.04
Werner	1975	2.25	6.23	13.42
SBMLIC	1977	3.40	8.16	16.53
Taylor	1977	6.94	16.66	33.74
Policy Analysis, Inc.	1977	10.80	25.92	52.52
Platt, Sudover	1979	5.64	11.68	22.01
Miller	1979	7.46	15.44	29.09
SBMLIC	1980	4.80	9.13	18.73
Smeeding, Booton	1980	5.66	10.76	20.28
Carter Center	1980	7.85	14.93	28.14
SBMLIC	1984	7.43	11.06	18.81
Pracon, Inc.	1987	9.60	13.05	20.24
Rubin	1992	85.71	96.63	134.19
ADA	1992	45.22	50.98	70.80
Thom	1993	15.10	16.59	23.04
Hodgson	1995	47.87	50.06	56.93
ADA	1997	44.14	44.14	44.14

Appendix C

Direct costs, adjusted for price inflation, using CPI – all items, and diabetes prevalence

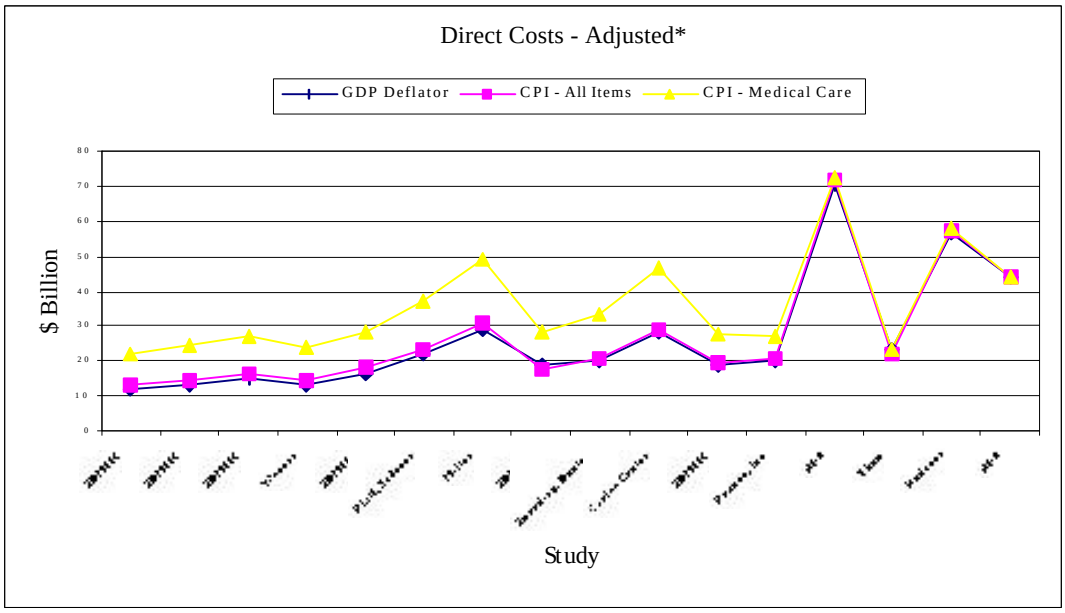
Study	Year	As Reported ($ billion)	Adjusted for Inflation ($ billion – 1997)	Adjusted for Inflation and Diabetes Prevalence ($ billion – 1997)
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1969	1.00	4.36	13.28
SBMLIC	1973	1.65	5.96	14.66
SBMLIC	1975	2.52	7.52	16.20
Werner	1975	2.25	6.71	14.46
SBMLIC	1977	3.40	9.00	18.24
Taylor	1977	6.94	18.38	37.23
Policy Analysis, Inc.	1977	10.80	28.60	57.95
Platt, Sudover	1979	5.64	12.47	23.50
Miller	1979	7.46	16.48	31.06
SBMLIC	1980	4.80	9.35	17.62
Smeeding, Booton	1980	5.66	11.02	20.77
Carter Center	1980	7.85	15.29	28.82
SBMLIC	1984	7.43	11.48	19.53
Pracon, Inc.	1987	9.60	13.56	21.03
Rubin	1992	85.71	98.05	136.16
ADA	1992	45.22	51.73	71.84
Thom	1993	15.10	16.77	22.11
Hodgson	1995	47.87	50.42	57.33
ADA	1997	44.14	44.14	44.14

Appendix D

Direct costs, adjusted for price inflation, using CPI – medical care, and diabetes prevalence

Study	Year	As Reported ($ billion)	Adjusted for Inflation ($ billion – 1997)	Adjusted for Inflation and Diabetes Prevalence ($ billion – 1997)
Statistical Bureau of the Metropolitan Life Insurance Company (SBMLIC)	1969	1.00	7.32	22.33
SBMLIC	1973	1.65	9.98	24.50
SBMLIC	1975	2.52	12.45	26.82
Werner	1975	2.25	11.11	23.94
SBMLIC	1977	3.40	13.99	28.35
Taylor	1977	6.94	28.56	57.86
Policy Analysis, Inc.	1977	10.80	44.45	90.06
Platt, Sudover	1979	5.64	19.61	36.94
Miller	1979	7.46	25.91	48.82
SBMLIC	1980	4.80	15.03	28.33
Smeeding, Booton	1980	5.66	17.73	33.41
Carter Center	1980	7.85	24.59	46.34
SBMLIC	1984	7.43	16.32	27.85
Pracon, Inc.	1987	9.60	17.31	26.85
Rubin	1992	85.71	105.77	146.88
ADA	1992	45.22	52.11	72.36
Thom	1993	15.10	17.59	23.19
Hodgson	1995	47.87	50.93	57.92
ADA	1997	44.14	44.14	44.14

Appendix E



*Taylor, Policy Analysis, Inc., and Rubin studies removed from figure due to marked methodological differences

Appendix F

The goal of the economics of diabetes project was to conduct a critical review of the literature regarding the cost of diabetes in the United States and to develop a research agenda for future diabetes economics studies. This report was contracted as part of this project. In addition, a panel of experts (economists, health services researchers, and epidemiologists) was convened on April 6-7, 1998 in Atlanta, GA to assess the current knowledge about the costs of diabetes, assess the strengths and limitations of the currently available diabetes cost studies, and identify future research strategies. The following is a summary of the discussions from this meeting as well as a list of panel members.

Economics of Diabetes Project
Summary and Key Findings of Panel Meeting
April 6-7, 1998, Atlanta, GA

The meeting was attended by 10 expert panel members and several CDC staff (see attached agenda, panel members and CDC participant list)

Robert Rubin, M.D., presented his study (Rubin RJ et al. Health care expenditures for people with diabetes mellitus, 1992. J Clin Endocrin Met 1994; 78: 809A-809F) noting that the cost of care on persons with diabetes was $105 billion in the U.S. in 1992. He clearly explained that the purpose of his study was to examine cost in persons with diabetes, not the portion attributable to diabetes. The study took a health services perspective and determined the extent to which health care resources were disproportionately consumed in the diabetic population. He found that a major portion of costs was incurred in the hospital. These findings resulted in further investigations attempting to improve the use of hospital resources.

Thomas Hodgson, Ph.D., presented his recently completed (and unpublished) diabetes cost-of-illness (COI) study. He found that the total direct costs of diabetes in the U.S. were $48 billion in 1995. He used several data sources, determined the degree of variability in the estimates, scaled the total cost to the total expenditures, and used both the attributable fraction and population attributable fraction to determine the diabetes contribution to various other chronic and acute conditions.

Nancy Fox, Ph.D., presented her 1997 American Diabetes Association-sponsored COI study (The American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. Diabetes Care 1997; 21: 296-309) which estimated $44 billion in direct costs and $54 billion in indirect costs for diabetes in 1997. She used several datasets and the population attributable fraction to determine the diabetes fraction when it was listed as secondary and tertiary diagnoses. Compared to her 1992 ADA-sponsored COI study, the direct costs were slightly less in the 1997 study due to shorter hospital stays and a shift from inpatient care to outpatient care.

Partha Deb, Ph.D., presented some preliminary analyses examining the attributable fraction methodology and found that including simple demographic variables in models to determine the attributable fractions dramatically changed the values.

Thomas Songer, Ph.D., gave an overview of several COI studies. There is an apparent trend showing the cost of diabetes increasing dramatically from $3 billion in 1969 to over $100 billion in 1997. However, during this period the data and methods have changed dramatically making direct comparisons between studies over this time period difficult. The major increase in cost noted in the 1980s and 1990s was due to inclusion of attributable fractions and indirect costs.

Cameron Donaldson, Ph.D., discussed the value of COI studies. He noted that COI studies are used to set health priorities and research priorities. He questioned whether this was an appropriate use of the COI results because of the paradox where the most expensive disease will get more resources. This strategy disregards further understanding of why the disease is expensive. He discussed the challenges in measuring the indirect costs (premature mortality, short term and long term disability, pain/suffering, and quality of life), and that good methods do not currently exist.

Key points in subsequent discussions and group sessions were:

1. Further diabetes COI studies are not needed currently. It was suggested that none are needed for at least 5 years. Determination of when to repeat COI studies may be dictated by dramatic changes in the future of either the natural history of the disease or its treatment.
2. COI studies have usually been conducted following requests from Congress, political officials, and advocacy groups.
3. COI studies may be used inappropriately for policy decisions. They may provide crude understanding of which conditions are costly. For specific diseases, they help in understanding where most costs are incurred (which can be target areas for further research and interventions).
4. There is a need to better understand the quality of economic information needed to make policy decisions. A "perfect" study is not always necessary.
5. Indirect costs (premature mortality, productivity loss, long/short term disability, and quality of life) are very important to all economic studies. However, there are major challenges as to what should be measured, how to measure it, and how to assign a monetary value.
6. The attributable fraction of expenditures (i.e., the portion of expenditures that are solely attributable to diabetes) account for a major portion of the direct costs. However, limitations in the datasets, incomplete coding, and undiagnosed diabetes make a precise, accurate, and valid attributable fraction difficult to determine. Multi-discipline approaches (economists, health services researchers, and epidemiologists) need to refine the methods.
7. There is a need for uniform economic data. For diabetes, a data panel routinely administered in national surveys would be of great benefit.
8. Methods for economic studies should be standardized for identifying diabetes from various datasets. However, the analytic strategies should not be restricted. Studies need to describe the methods better. Detailed supplemental reports are necessary for subsequent investigators to duplicate and extend previous findings.
9. Cost-effectiveness studies are important to make policy decisions on health care delivery.
10. All health care intervention studies should have cost-effectiveness studies planned and conducted concomitantly.

In summary, economic information is of great importance for defining the burden and developing public health policies for diabetes. The current focus of further research for the Division of Diabetes Translation and the greater diabetes community should be in refining economics methods, specifically for attributable fractions and indirect costs, and in conducting cost-effectiveness assessments of interventions as they are tested.

Meeting Agenda

April 6, 1998

9:00 a.m.	Introduction/Orientation	CDC	10 min.
	Overview, goals and objectives		
9:10 a.m.	Cost of care for person with diabetes	Rubin	20 min.
	Q and A, Discussion		10 min.
9:40 a.m.	Cost of diabetes	Hodgson	20 min.
	Q and A, Discussion		10 min.
10:10 a.m.	Cost of diabetes and cost of care for diabetes	Fox	20 min.
	Q and A, Discussion		10 min.
10:40 a.m.	Break		
10:55 a.m.	Cost of diabetes – new methods	Deb	20 min.
	Q and A, Discussion		10 min.
11:25 a.m.	Other diabetes cost studies – overview	Songer	20 min.
	Q and A, Discussion		10 min.
11:55 a.m.	Lunch		65 min.
1:00 p.m.	Value of various economic studies	Donaldson	10 min.
1:10 p.m.	Breakout groups – Groups A and B		
	Topics*: Values of studies		
	Information gaps, strengths, weaknesses of studies		
	Framework for future research activities		
3:30 p.m.	Group A report		
4:15 p.m.	Group B report		
5:00 p.m.	Discussion		
5:15 p.m.	Adjourn		

* Specific questions to address will be presented

April 7, 1998

9:00 a.m.	Comments on draft of literature review	Songer	90 min.
10:30 a.m.	Additional recommendations	CDC	90 min.
12:00 p.m.	Manuscript development process	CDC	30 min.
12:30 p.m.	Adjourn		

Economics of Diabetes Project Panel

Partha Deb, Ph.D.
Department of Economics
Indiana University-Purdue University
Cavanaugh Hall 516
425 University Boulevard
Indianapolis, IN 46202
pdeb@iupui.edu

Cameron Donaldson, Ph.D.
Health Economics Research Unit
University of Aberdeen
University Medical Building Foresterhill
Aberdeen AB25 2ZD
United Kingdom

Nancy Ray Fox, Ph.D.
Medtap International
7101 Wisconsin Avenue, Suite 600
Bethesda, MD 20814
ray@medtap.com

Joel W. Greer, Ph.D.
Health Care Financing Administration
7500 Security Blvd., C3-24-07
Baltimore, MD 21244-1850
JGREER3@HCFA.GOV

Thomas Hodgson, Ph.D.
National Center for Health Statistics
6525 Belcrest Road
Room #7090
Hyattsville, MD 20782
tah2@cdc.gov

Willard G. Manning, Jr., Ph.D.
Department of Health Studies
The University of Chicago
5841 S. Maryland Avenue, MC2007
Chicago, IL 60637
wmanning@health.bsd.uchicago.edu

Dorothy P. Rice, Ph.D.
Professor Emeritus
University of California
Institute for Health and Aging
3333 California St., Room #340
San Francisco, CA 94118

Thomas Songer, Ph.D.
5145 Rangos Research Center
3460 Fifth Avenue, 5th floor
Pittsburgh, PA 15213
tjs@pitt.edu

Steven M.Teustch, M.D., MPH
Merck & Co. Inc.
P.O. Box 4, WP39-169
West Point, PA 19486-0004
steven_teutsch@merck.com

Robert J. Rubin, M.D.
President, Lewin Group
9302 Lee Highway
Suite 500
Fairfax, VA 22031

CDC Staff

Michael M. Engelgau, M.D.
Ann Fagot, M.D.
Linda Geiss, M.A.
Ed Gregg, Ph.D.
Stephen Sorensen, Ph.D.
Theodore Thompson, M.S.
Kabayam Venkat-Narayan, M.D.
Frank Vinicor, M.D.
David F. Williamson, Ph.D.
Abdiaziz Yassin, Ph.D.