Productivity and Medical Costs of Diabetes in a Large Employer Population

SCOTT RAMSEY, MD, PHD[1]
KENT H. SUMMERS, PHD[2]
STEPHANIE A. LEONG, MPP [3]
HOWARD G. BIRNBAUM, PHD[3]
JASON E. KEMNER, MPH[2]
PAUL GREENBERG, MA[3]

OBJECTIVE — The purpose of this study was to assess the economic burden of diabetes from an employer's perspective. We analyzed the costs of diabetes, using claims data for an employed population and the prevalence of selected comorbid conditions.

RESEARCH DESIGN AND METHODS — The data source is a claims database from a national Fortune 100 manufacturer. It includes medical, pharmacy, and disability claims for all beneficiaries (*n* >100,000). Both medical and work productivity costs of diabetes patients are compared by age with those of matched control subjects from the overall beneficiary population. Out-of-pocket and intangible costs are excluded.

RESULTS — In 1998, the employer's mean annual per capita costs were higher for all diabetes beneficiaries than for control subjects ($7,778 ± 16,176 vs. $3,367 ± 8,783; $P < 0.0001$), yielding an incremental cost of $4,410 ± 18,407 associated with diabetes. The medical and productivity costs for employees with diabetes were significantly ($P < 0.0008$) higher than for control subjects. The incremental cost of diabetes among employees ranged from $4,671 (aged 18–35 years) to $4,369 (aged 56–64 years).

CONCLUSIONS — Diabetes imposes a significant economic burden on employers, particularly when including productivity costs. Employers should select health plans that provide enriched benefits to diabetes patients, including ready access to medical and pharmacy services as well as aggressive diabetes management programs.

Diabetes Care 25:23–29, 2002

The burden of diabetes on the working-age population is great. In 1997, there were eight million cases of diabetes nationwide, with another estimated eight million undiagnosed cases (1–3). Diabetes as an underlying cause of death ranked seventh among the top causes of death in the U.S. in 1997 and sixth among those individuals between 45 and 64 years of age (4). Several studies have documented the direct medical cost of diabetes (5–10). The excess per capita average direct medical costs range from $2,257 (staff-model managed care, 1994) (5) to $7,402 (national estimate, 1997) (6). In addition, the economic burden of diabetes includes reduced workforce productivity and participation due to premature mortality, disability, diminished work effectiveness, and absences caused by medical service utilization (11–16).

Relatively little information is available on the economic burden of diabetes borne by employers. In 1997, diabetes was estimated to account for 55 million disability days per year for those under the age of 65 (6). National expenditures were estimated as $54.1 billion, including $37.1 billion for disability. From patient self-reports, diabetes was estimated to cause a one-third reduction in earnings due to reduced workforce participation, with annual costs ranging from $3,700 to 8,700 (16). The employer's perspectives is important because they provide most individuals of working age benefits such as paid sick days, health insurance, and disability coverage. No study has used claims data to evaluate the cost of diabetes from the perspective of the employer.

The goal of this study was to assess the economic burden of diabetes from the employer's perspective. Specifically, we used claims records from a large Fortune 100 company to estimate both medical costs and work loss costs (disability and medically related absenteeism) of diabetes. To determine the incremental employer burden of diabetes, we compared the expenditures for medical care and medically related work loss days of beneficiaries with diabetes with those of a matched sample of beneficiaries without diabetes in the same organization.

RESEARCH DESIGN AND METHODS

Setting and database

The study population was drawn from a Fortune 100 manufacturing firm with facilities throughout the U.S. and >100,000 medical plan beneficiaries, including industrial, service, and professional employees. This company self-insures its health insurance and disability programs. All employees were covered by the health insurance program, and ~90% were covered by disability benefits. Administrative records include payments made by the employer for medical and prescription drug claims for all beneficiaries (employees, spouses, dependents, and retirees under the age of 65 years) and disability claims (for employees only). The medical and pharmacy data are from fee-for-service claims.

Diabetes sample: identification of beneficiaries with diabetes

To identify beneficiaries with diabetes in the database, we used a combination of diagnosis codes and drug-specific pharmacy claims. Beneficiaries with diabetes were identified as those who, between 1996 and 1998, had two or more medical and/or disability claims with a diabetes diagnosis code (ICD-9 codes 250.xx) or

From the [1]Fred Hutchinson Cancer Research Center, University of Washington, Seattle, Washington; [2]Eli Lilly, Indianapolis, Indiana; and [3]Analysis Group/Economics, Cambridge, Massachusetts.
Address correspondence and reprint requests to Kent H. Summers, Lilly Corporate Center, Indianapolis, IN 46285. E-mail: summers_kent_h@lilly.com.
Received for publication 18 June 2001 and accepted in revised form 10 October 2001.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

one or more prescription drug claims for a hypoglycemic agent. A sample of 8,748 beneficiaries with diabetes was identified using this algorithm. Because of the difficulties in differentiating type 1 diabetes patients from those with type 2 diabetes in administrative databases, we elected not to make this distinction in analyses reported here.

Matched control sample: beneficiaries without diabetes

We matched each beneficiary with diabetes to one control beneficiary without diabetes over the study period (1996–1998). Subjects with diabetes were matched to control subjects with respect to age (identical numerical age), sex, job classification (salaried/nonsalaried; bargaining/nonbargaining), health plan, and state of residence. Matched control subjects were not selected on the basis of health care or disability claims, and thus the control group included individuals with no claims. When more than one matched control was available, we selected one randomly from among the pool of possible matches using a computerized randomization process in SAS version 8 for Windows (17).

Identifying conditions comorbid with diabetes

To better understand the reasons for excess illness-related work loss among those with diabetes, we identified comorbidities often associated with diabetes in both the diabetes sample and control subjects. We focused on comorbidities that are recognized in the literature to drive medical costs, morbidity, and mortality in diabetes (2,8,10,18–20). These conditions included cardiovascular disease, hypertension, infections related to diabetes (e.g., septicemia, bacteremia), other metabolic diseases (e.g., hyperosmolarity), nephropathy, neuropathy, and retinopathy. Records were searched over the analysis period of the year 1998 for ICD-9 codes related to each comorbidity.

Costs of diabetes

The term “costs” refers to payments by the employer to health care providers or employees for medically related missed workdays. The incremental cost of diabetes for this analysis is the excess cost incurred by diabetes patients over the control subjects. Our goal for matching was to minimize the chance that factors other than diabetes would influence the incremental cost analyses.

Direct medical care costs

Direct costs were reimbursements from the employer to health care providers for inpatient, outpatient, physician, and prescription drug services, as well as for other services (e.g., physical therapy, nursing home services). Costs were reported based on claims for services provided in 1998. Patients’ out-of-pocket and nonmedical costs (e.g., deductibles, transportation) as well as intangible costs are excluded because of the employers’ perspective of the analysis.

Productivity costs

Productivity costs in this study are based on “medically related absences,” including both sporadic work loss associated with use of medical services and extended work loss caused by disability. Because actual dates of medical care and disability were known, we counted only workdays (omitting weekends and holidays). Estimates of the cost of time lost from work for medical care were based on the type and frequency of visits to health care providers. If a medical service claim for an employee was recorded during a workweek day, then the following algorithm was applied to determine the number of medically related work absence days: *1*) for hospital care, a full day absent for each day in the hospital, and *2*) for outpatient or office care, a half day was counted. Because the disability benefit covers lost work beginning with the sixth consecutive day of a work absence, patients who claimed disability were also assigned five medically related work absence days before their period of disability (21). Productivity costs attributable to disability were based on the employer’s payments for disability claims. Productivity costs for medically related sporadic absences were based on the employer’s average wage for the affected employee’s job classification.

Other productivity measures include costs from reductions in work performance while on the job, work loss caused by sporadic absences for illness when medical care was not sought, and friction costs of worker replacement (12,22,23). Our database did not contain information that could be used to estimate these productivity impacts. Hence, our estimates of productivity costs are conservative.

Analysis

Our aim for the analysis was to assess the average (mean differences) between the diabetes and control populations. Averages are useful to employers or insurers trying to estimate the total expected productivity costs of individuals with diabetes relative to those without diabetes. We calculated prevalence rates of selected comorbidities (e.g., cardiovascular disease, hypertension, and retinopathy) as well as average costs per patient. Medical, productivity, and total (medical plus productivity) costs are reported in 1998 dollars. All cost data are reported as the means ± SD, unless otherwise noted. Descriptive statistics were generated with the SAS version 8 software program (17). We used t tests and χ^2 tests to evaluate the statistical significance of differences in outcomes of the diabetes sample and matched control subjects.

RESULTS

Population demographics

A sample of 8,170 beneficiaries with diabetes were matched to control subjects without diabetes. The prevalence rate of diabetes was 3.5% in the employer population. This is consistent with estimates for the U.S. that include unemployed and retired individuals (24). Table 1 lists demographic information for the diabetic and matched control populations compared with a 10% random sample of the employer population. The diabetes sample was older (mean age 53 vs. 39 years; $P < 0.0001$) and more likely to be male (51 vs. 56%; $P < 0.0001$) than the average beneficiaries. In addition, 19% of the beneficiary population was under 18 years of age in 1998, versus 1% of those with diabetes ($P < 0.0001$). Similarly, 20% of the beneficiary population was between the ages of 56 and 64 years, versus 47% of those with diabetes. Individuals with diabetes were more likely to be employed than those in the overall beneficiary population (47 vs. 34%; $P < 0.001$) and less likely to be spouses or dependents (39 vs. 59%; $P < 0.001$).

Prevalence of comorbidities

The prevalence of diabetes-related comorbidities for diabetic and control subjects is depicted in Fig. 1. Prevalences of all comorbidities were significantly higher in the diabetes sample than in the control group across all age strata ($P <$

Table 1—*1998 demographic characteristics*

	Overall beneficiary population	Diabetes sample	Matched control subjects
(*n*)	10% random sample	8,170	8,170
Sex (% female)	49	44	43
Work status (%)			
Employees	34	47	48
Retired	6	14	14
Spouses/dependents	59	39	39
Mean age in 1998 (years)	39	53	53
Age categories (%)			
<18	19	1	1
18–35	16	3	3
36–45	16	9	10
46–55	28	40	40
56–64	20	47	46

0.0001). In both the diabetes and control groups, cardiovascular disease and hypertension were the most common comorbidities.

Utilization and costs

Medical service utilization. On average, beneficiaries with diabetes used more of all types of medical services than control subjects. In 1998, diabetes patients had an average of 3.4 inpatient, 5.5 outpatient, and 9.1 office claims, compared with 1.3, 2.9, and 4.9, respectively, among control subjects. Two factors explain this higher level of service utilization. First, diabetes patients are more likely to use all types of services than control beneficiaries. Of the diabetes patients, 20% used inpatient services, 67% used outpatient services, and 82% used office services, compared with 10, 48, and 62%, respectively, for control subjects. Second, diabetes patients who used medical services had more utilization than control subjects. On average, diabetes inpatient users had 16.6 inpatient claims, outpatient users had 8.0 outpatient claims, and office users had 11.1 office claims, compared with 12.9, 6.2, and 7.8 claims, respectively, for control users of these services.

Medical and productivity costs for all beneficiaries. Table 2 presents the medical and work loss costs for the diabetes sample and matched control subjects. In 1998, the employer's cost for beneficiaries with diabetes (including employees, their spouses, and dependents) were higher than for beneficiaries without diabetes ($7,778 ± 16,176 vs. $3,367 ± 8,783; $P < 0.0001$). By subtracting the average costs of the two groups, we find that the incremental medical and productivity cost of beneficiaries with diabetes compared with control subjects was $4,410 ± 18,407. When stratified by age, total medical and productivity costs for beneficiaries in the diabetes sample ranged from $2,589 ± 4,491 for those

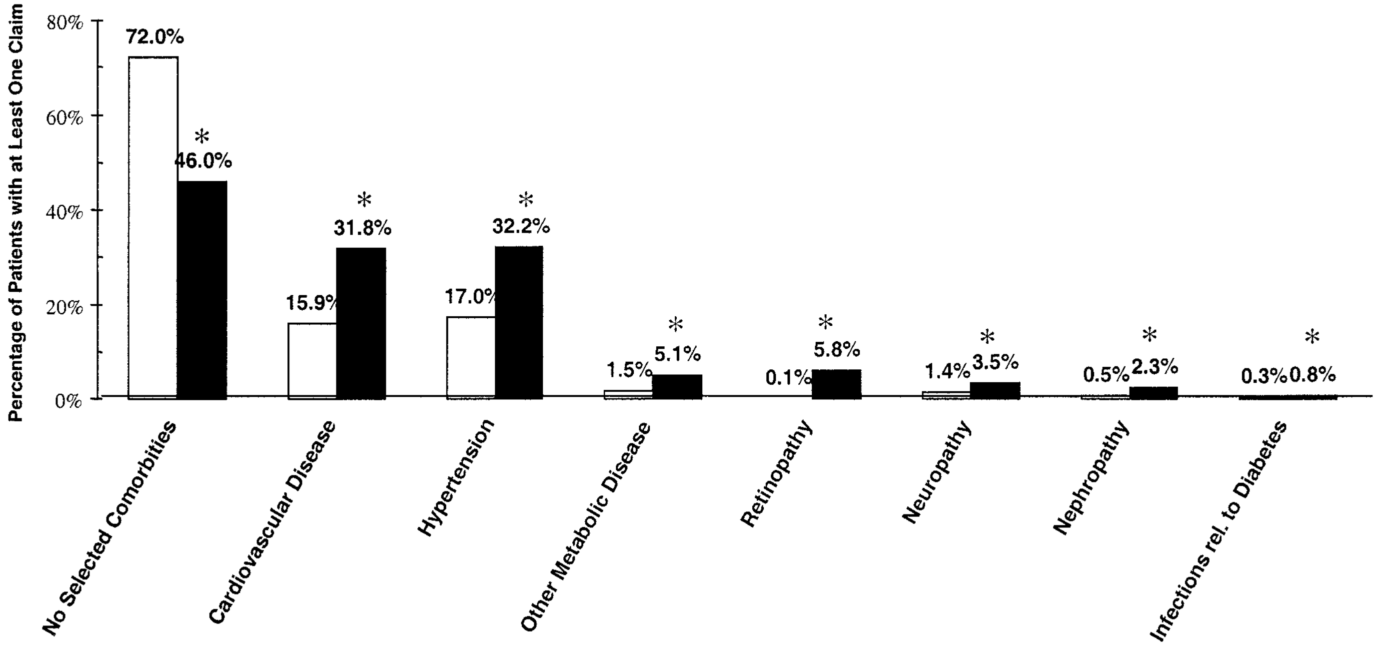

Figure 1—*Treated prevalence of selected comorbidities for diabetes patients and matched control subjects. The ICD-9 codes of the selected related comorbidities associated with diabetes are as follows: cardiovascular disease (410.xx to 414.xx, 415.xx to 417.xx, 420.xx to 429.xx, 430.xx to 438.xx, 440.xx to 448.xx, and 785.4x); hypertension (401.xx to 404.xx); infections related to diabetes (e.g., septicemia, bacteremia) (038.xx and 790.7x); other metabolic diseases, hyperosmolarity (251.0x, 251.1x, 251.2x, 270.3x, 251.3x, and 276.xx); nephropathy (583.81, 580.9x, 581.81, 581.9x, 582.9x, 583.xx, 588.8x, and 593.9x); neuropathy (358.01, 354.xx to 355.xx, 713.5x, 337.1x, and 357.2x); retinopathy (362.0x, 362.1x, 362.2, 362.41, 363.31, 369.xx, 366.41, and 365.44).* ■, *Diabetes sample;* □, *matched control subjects.* *$P < 0.0001$ *vs. matched control subjects.*

Table 2—*1998 Total medical and productivity costs for diabetes and matched control beneficiaries*

	Mean and median annual payments per person			
Age group	Diabetes sample	Control subjects	Difference	*P*
<18 Years (*n* = 91)				
Inpatient	$445	$309	$136	
Outpatient	$617	$247	$370	
Office	$319	$133	$186	
Other	$338	$60	$278	
Prescription drug	$870	$583	$287	
Medically related work loss	$0	$0	$0	
Total				
Mean ± SD	$2,589 ± 4,491	$1,332 ± 4,750	$1,257	0.07
Median	$1,540	$171	$1,369	
18–35 Years (*n* = 232)				
Inpatient	$1,182	$337	$845	
Outpatient	$1,217	$515	$702	
Office	$430	$203	$227	
Other	$200	$30	$170	
Prescription drug	$1,116	$239	$877	
Medically related work loss	$1,121	$520	$601	
Total				
Mean ± SD	$5,265 ± 9,466	$1,844 ± 3,680	$3,421	<0.0001
Median	$1,856	$370	$1,486	
36–45 Years (*n* = 793)				
Inpatient	$2,101	$485	$1,616	
Outpatient	$1,260	$490	$770	
Office	$470	$248	$222	
Other	$163	$69	$94	
Prescription drug	$1,413	$431	$606	
Medically related work loss	$1,448	$805	$643	
Total				
Mean ± SD	$6,855 ± 16,257	$2,528 ± 5,914	$4,399	<0.0001
Median	$2,458	$527	$1,931	
46–55 Years (*n* = 3,292)				
Inpatient	$2,152	$639	$1,513	
Outpatient	$1,412	$689	$723	
Office	$526	$287	$239	
Other	$140	$44	$96	
Prescription Drug	$1,720	$606	$1114	
Medically related work loss	$1,467	$753	$714	
Total				
Mean ± SD	$7,417 ± 12,954	$3,018 ± 7,313	$4,427	<0.0001
Median	$2,949	$722	$2,227	
56–64 Years (*n* = 3,762)				
Inpatient	$3,254	$1,310	$1,944	
Outpatient	$1,650	$860	$790	
Office	$565	$312	$253	
Other	$126	$38	$88	
Prescription drug	$1,878	$815	$1,063	
Medically related work loss	$1,095	$657	$438	
Total				
Mean ± SD	$8,568 ± 18,918	$3,993 ± 10,542	$4,575	<0.0001
Median	$3,314	$1,139	$2,175	
Total				
Mean ± SD (*n* = 8,180)	$7,778 ± 16,176	$3,367 ± 8,783	$4,410	<0.0001
Median	$3,006	$883	$2,123	

Data are means, except where indicated as medians.

aged <18 years to \$8,568 ± 18,918 for those aged 56–64 years. Costs for beneficiaries in the matched control sample ranged from \$1,332 ± 4,750 for those aged <18 years to \$3,993 ± 10,542 for those aged 56–64 years. The average total cost for a beneficiary with diabetes ranged from 1.9 to 2.9 times that for a beneficiary in the control population without diabetes, across each age category.

To investigate the sensitivity of the findings to outlier values, we also tabulated median cost values. Table 2 illustrates that the findings are not greatly affected by outliers, because the pattern of the medians is similar to that of the mean values.

Composition of costs for beneficiaries with diabetes. As expected, the costs for inpatient care increased with age. This is particularly true among diabetic patients (Table 2). Costs of ambulatory care also follow this pattern and are similar to inpatient costs in magnitude. Each of these components exceeded the prescription drug component in every age category among beneficiaries in the diabetes sample. As expected, productivity costs do not exist in the <18 years of age cohort. Across age cohorts, work loss costs represented a larger proportion of combined costs (range 16.5–31.8%) in the diabetes sample than in control subjects (range 12.8–21.3%). This difference of proportion is associated with higher medical costs among beneficiaries in the diabetes sample. Furthermore, this consideration of work loss costs provides a conservative estimation because they are experienced by employees only, but diluted across all other beneficiaries. Also, work loss costs account for both a larger percentage of total cost and more absolute dollar amounts among the youngest compared with the oldest age group.

Medical and productivity costs for employee (only) beneficiaries with diabetes. Total costs for employees in the diabetes sample were significantly ($P <$ 0.0008) higher than control subjects, ranging from \$7,774 (aged 18–35 years) to \$10,132 (aged 56–64 years). The incremental medical and productivity cost for employees with diabetes compared with control employees was highest in the younger age cohorts, at \$4,671 for those aged 18–35 years, \$4,825 for those aged 36–45 years, and \$4,369 for those aged 56–64 years. Across all age groups, mean annual work loss costs alone for diabetic employees ranged from 1.7 to 2.2 times that of matched control employees. The proportion of medical and work loss costs attributable to employees in the diabetes sample ranged from 31 to 42%, compared with a range of 33 to 53% for matched control employees. This proportion was larger among control employees because of their lower direct medical costs. Thus, costs for diabetic employees, as a group, are enhanced by the economic burden of medically related work loss.

Across all age groups, the relative likelihood that an employee in the diabetes sample would have at least one disability claim in 1998 for any reason was 33%, versus 20% for an employee in the control group. Among diabetic employees and control subjects who claimed disability during 1998, the mean duration of a disability claim was 41 ± 98 days for diabetic employees, versus 22 ± 73 days for the control group ($P < 0.0001$). Across age groups, total disability days claimed were significantly higher for diabetic employees. The mean annual number of work loss days for ambulatory visits or hospitalizations was 8 ± 13 days for diabetic employees versus 5 ± 11 days for control subjects.

CONCLUSIONS — This study assessed the economic burden of diabetes from an employer's perspective, considering direct health care costs and productivity costs associated with work loss and disability. Using claims data, we found a mean annual incremental cost of \$4,410 for all beneficiaries with diabetes and \$4,413 for employees with diabetes compared with control beneficiary and employees, respectively. We found that >30% of the costs associated with diabetic employees are attributable to medically related work absences and disability. Relative to beneficiaries without diabetes, those with diabetes had a larger proportion of costs attributable to work loss, more disability claims, and longer durations of disability. Thus, diabetes represents a significant burden for employers, both in terms of medical and productivity costs. The lower work losses in the oldest group versus the youngest age group may be explained by the "healthy worker" effect (i.e., after a certain age, the sickest individuals drop out of the workforce).

Our diabetes beneficiary sample, although derived from a large employer, appears to be relatively representative of the U.S. population in terms of diabetes prevalence. Also, our findings of expenditures for medical care are consistent with prior studies (5,8–10). Several studies have considered the productivity cost burden of diabetes, but they did not use actual employer payments from administrative data (13–16).

Study limitations

A number of caveats must be considered when interpreting these results. The analysis was limited to administrative claims data and are subject to the usual limitations of such data, such as the absence of clinical detail and validation of its accuracy (12). Because our sample was an employed population, it did not include those who are unemployed, uninsured, or at the upper end of the age range. Therefore, our results do not provide insight regarding unemployed or uninsured patients, or those enrolled in public assistance plans such as Medicaid or Medicare. It may be that, for example, with higher rates of absenteeism or disability, diabetic patients are less likely to be employed. Also, the sample excluded patients enrolled in capitated health plans. Such plans may be expected to enroll healthier beneficiaries. Although the focus of our study was on the work loss costs of morbidity, we did not have the data to consider reduced levels of productivity while at work, incremental sporadic work loss, or the costs of hiring replacement workers. Also, we did not have data to consider the indirect costs of mortality. The analysis also excluded out-of-pocket costs to employees and their families. Although certain classes of expense are unavailable (e.g., child care), an additional issue is that those individuals who do not meet deductibles may still incur substantial costs in the aggregate that will not be captured in the analysis. Moreover, these omitted costs may be higher among the control subjects because their costs will generally be lower. Thus, these results represent a conservative estimate of the economic burden of diabetes to employers.

Our findings that cardiovascular disease and hypertension were much more common among diabetic patients are consistent with other literature. We note that because those with diabetes seek health care services more often than control subjects, additional opportunities exist for diagnosing these comorbid conditions.

Furthermore, it may be that the relatively high prevalence of hypertension may also be due in part to lower thresholds for diagnosing hypertension among those with diabetes (25,26).

Implications
Working-age individuals with serious illness will cost their employer more in terms of productivity and medical costs than those without serious morbidities. Our study quantifies the economic burden employers face for their employees with diabetes. Given our findings, discriminatory hiring practices and insurance underwriting could pose a threat to working-age individuals with diabetes. In a study using simulated job decisions, diabetic and obese applicants were less likely to be hired because of presumptions of poorer work habits and medically related work absences (27). To address this concern, the federal Health Insurance Portability and Accountability Act of 1996 (HIPAA) provides protection from discrimination in insurance (28). This law prohibits group health insurance plans from using a "preexisting condition" to deny or limit coverage or raise premiums. One implication of our work is that the diabetic community needs to raise its awareness of the potential for employment discrimination and to perhaps consider funding research to identify whether employment discrimination is a serious problem among those with the disease.

Although improved diabetes control has been shown to improve clinical outcomes and reduce medical costs (29,30), it may also lead to a more productive workforce (31). Our results indicate that the burden due to medically related work loss may be substantial for working-age individuals with diabetes. Furthermore, medically related work losses are important in younger as well as older patients. Our study suggests that evaluations of the economic benefits of aggressive diabetes management should not focus solely on direct medical costs, including prescription medications. Indeed, it may be that labor productivity can be enhanced through optimized use of medications (32). We suggest that trials determining the efficacy of intensive therapies to reduce diabetes-related complications should include an evaluation of their impact on productivity for working-age subjects. Controlled studies evaluating the impact of modifications of the work environment that will foster adherence to behaviors known to benefit those with diabetes (ready access to medicines, healthy food choices, and opportunities for exercise) are also warranted.

Future research
Several areas of importance related to diabetes and worker productivity are still unknown. More information is needed on how diabetes impacts on-the-job work performance. The relation between poor glycemic control, with its attendant symptoms and productivity, is not well known. Correspondingly, we also need to know more about the impact of improving glycemic control on productivity. Finally, future studies should evaluate the impact of home and workplace-based diabetes management programs on productivity.

Acknowledgments— This work was performed by Analysis Group/Economics, which was sponsored by an unconditional research grant from Eli Lilly.

The authors would like to thank Pamela Erickson for editorial assistance and Erin Lentz for her data analysis support.

References

1. Roman SH, Harris MI: Management of diabetes mellitus from a public health perspective. *Endocrinol Metab Clin North Am* 26:443–474, 1997
2. O'Brien JA, Shomphe LA, Kavanagh PL, Raggio GSCD, Caro JJ: Direct medical costs of complications resulting from type 2 diabetes in the U.S. *Diabetes Care* 21: 1122–1128, 1998
3. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, Wiedmeyer HM, Byrdholt DD: Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults: the Third National Health and Nutrition Examination Survey, 1988–1994. *Diabetes Care* 21:518–241, 1998
4. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Diabetes Public Health Resource, Statistics: Diabetes surveillance report, chapter 3: mortality, Table 3.2 [article online], 1999. Available from http://www.cdc.gov/diabetes/statistics/survl99/chap3/table2.htm. Accessed 20 September, 2001.
5. Brown JB, Nichols GA, Glauber HS, Bakst AW: Type 2 diabetes: incremental medical care costs during the first 8 years after diagnosis. *Diabetes Care* 22:1116–1124, 1999
6. American Diabetes Association: Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care* 21:296–309, 1998
7. Brown JB, Pedula KL, Bakst AW: The progressive cost of complications in type 2 diabetes mellitus. *Arch Intern Med* 159: 1873–1880, 1999
8. Hodgson TA, Cohen AJ: Medical care expenditures for diabetes, its chronic complications and its comorbidities. *Prev Med* 29:173–186, 1999
9. Selby JV, Ray GT, Zhang D, Colby CJ: Excess costs of medical care for patients with diabetes in a managed care population. *Diabetes Care* 20:1396–1402, 1997
10. Ramsey SD, Newton K, Blough D, McCullough DK, Sandhu N, Wagner EH: Patient-level estimates of the cost of complications in diabetes in a managed-care population. *Pharmacoeconomics* 16: 285–295, 1999
11. Songer TJ: Disability in diabetes. In *Diabetes in America*. 2nd ed. Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1995, pp. 259–282 (NIH publ. no. 95-1468)
12. Burton WN, Conti DJ, Chen CY, Schultz AB, Edington DW: The role of health risk factors and disease on worker productivity. *J Occup Environ Med* 41:863–877, 1999
13. Persson U: The indirect costs of morbidity in type II diabetic patients. *Pharmacoeconomics* 8 (Suppl. 1):28–32, 1995
14. Valdmanis V, Smith DW, Page MR: Productivity and economic burden associated with diabetes. *Am J of Public Health* 91:129–130, 2001
15. Mayfield JA, Deb P, Whitecotton L: Work disability and diabetes. *Diabetes Care* 22: 1105–1109, 1999
16. Ng YC, Jacobs P, Johnson JA: Productivity losses associated with diabetes in the US. *Diabetes Care* 24:257–261, 2001
17. SAS User's Guide: *SAS/STAT User's Guide. Version 8*. Cary, NC, SAS Inst., 1999
18. Farquhar I, Sorkin A, Summers KH, Weir E: Concomitant illnesses in patients with diabetes: mortality, benefits of newer treatments and individual and societal costs. *Research in Human Capital and Development, Investing in Health: The Social and Economic Benefits of Health Care Innovation.* Vol. 14. Farquhar I, Sorkin A, Summers K, Eds. Kidlington, U.K., Elsevier Science, 2001, p. 1–22
19. Smith TL, Melfi CA, Kesterson JA, Sandmann BJ, Kotsanos JG: Direct medical charges associated with myocardial infarction in patients with and without diabetes. *Med Care* 37 (4 Suppl.):AS4–AS11, 1999
20. CDC Diabetes in Managed Care Work Group: Diabetes mellitus in managed care: complications and resource utilization. *Am J Managed Care* 7:501–508, 2001

21. Birnbaum HG, Cremieux PY, Greenberg PE, LeLorier J, Ostrander J, Venditti L: Using healthcare claims data for outcomes research and pharmacoeconomic analyses. *Pharmacoeconomics* 16:1–8, 1999
22. Luce BR, Manning WG, Siegel JE, Lipscomb J: Estimating costs in cost-effectiveness analysis. In *Cost-Effectiveness in Health and Medicine*. New York, Oxford University Press, 1996, p. 176–213
23. Drummond MF, O'Brien B, Stoddart GL, Torrance GW: *Methods for the Economic Evaluation of Health Care Programmes*. Oxford, U.K., Oxford University Press, 1994, p. 21,48,78,79
24. National Institute of Diabetes and Digestive and Kidney Disease: Diabetes statistics [article online], 1999. Available from: http://www.niddk.nih.gov/health/diabetes/pubs/dmstats/dmstats.htm. Accessed May 2001
25. Clark MJ Jr, Sterrett JJ, Carson DS: Diabetes guidelines: a summary and comparison of the recommendations of the American Diabetes Association, Veterans Health Administration, and American Association of Clinical Endocrinologists. *Clin Ther*. 22:899–910 [discussion 898], 2000
26. Miller CD, Phillips LS, Tate MK, Porwoll JM, Rossman SD, Cronmiller N, Gebhart SSP: Meeting American Diabetes Association guidelines in endocrinologist practice. *Diabetes Care* 23:444–448, 2000
27. Klesges RC, Klem ML, Hanson CL, Eck LH, Ernst J, O'Laughlin D, Garrott A, Rife R: The effects of applicant's health status and qualifications on simulated hiring decisions. *Int J Obesity* 14:527–535, 1990
28. Field RI: The frontiers of genetics and the transformation of medicine and business. *Research in Human Capital and Development* 14:155–196, 2001
29. Diabetes Control and Complications Trial Research Group: Lifetime benefits and costs of intensive therapy as practiced in the diabetes control and complications trial. *JAMA* 276:1409–1415, 1996
30. UK Prospective Diabetes Study (UKPDS) Group: Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes. *Lancet* 352:837–853, 1998
31. Testa MA, Simonson DC: Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus. *JAMA* 280:1490–1496, 1998
32. Rizzo JA, Abbott TA 3rd, Pashko S: Labour productivity effects of prescribed medicines for chronically ill workers. *Health Econ* 5:249–265, 1996