Health Care Use of Individuals With Diabetes in an Employer-Based Insurance Population

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Background: Individuals with diabetes use more health care resources than those without the disease. Much less is known about such differences associated with different forms of diabetes.

Methods: People with types 1 and 2 diabetes were identified from claims of a commercial insurer with an enrollment of 828,208. Age- and sex-adjusted rates and observed-to-expected ratios for health care services use, costs, and relative value units were compared for individuals with diabetes and the total plan population.

Results: We identified 13,563 individuals with diabetes (including 4,349 with type 1 and 8,810 with type 2 diabetes). The diabetic population was 1.6% of the total population, but had 9.4% of costs. Individuals with both types of diabetes had higher rates for use of inpatient, outpatient, and professional services. Compared with the total population, inpatient rates for the total diabetic population (for those with type 1 diabetes), were 4.9 (8.3) times higher for established complications of diabetes such as acute myocardial infarction, 9.8 (22.1) times higher for heart failure, 5.6 (8.3) times higher for coronary artery bypass, and 5.1 (8.9) times higher for cardiac catheterization (P < .001 for all). The following relative value unit ratios for physician services were substantially higher for the total diabetic population (for those with type 1 diabetes): 13.2 (27.9) times higher for endocrinologists, 6.3 (12.9) for ophthalmologists, and 9.4 (27.8) for nephrologists.

Conclusions: Use, costs, and intensity of resources used were substantially higher for individuals with diabetes, and markedly higher for the population with type 1 diabetes. Our findings show that people with type 1 diabetes are at substantially higher risk for serious complications than those with type 2 diabetes.

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Diabetes ranks among the most serious chronic diseases, with high risks for multisystem complications. Its incidence and prevalence in the United States have increased notably during the past several decades. Population aging brings projections of substantial further prevalence increases during the next several decades. Thus, clinicians, insurers, and health care policy makers should better understand patterns of use of health care resources and costs for individuals with diabetes.

Chronic complications for people with diabetes have been well documented. They include coronary artery disease, peripheral vascular disease, cerebrovascular disease, nephropathy, neuropathy, and retinopathy. People with diabetes are hospitalized more frequently than those without the disease and use physician services at a higher rate than nondiabetic individuals. Costs associated with diabetes are substantial; in 1997, direct health care costs were estimated at $44.1 billion in the United States, whereas indirect costs such as lost productivity summed to an estimated $54.1 billion. Studies have found substantially greater costs for individuals with diabetes than for those without the disease. There is also evidence of considerably reduced quality of life and shorter life expectancies for people with diabetes.

Much less is known about differences in resource use and cost patterns between people with different forms of the disease. Consistent with recent guidelines of the American Diabetes Association (ADA), we distinguish between people with type 1 and type 2 diabetes. Before the ADA established the type 1 and type 2 classifications, diabetic individuals were distinguished as having insulin- or non–insulin-dependent diabetes mellitus. This classification was largely deter-
SUBJECTS AND METHODS

The sample for this study was the entire enrolled population of a commercial insurer located in Ohio (828,208 individuals). Almost all members resided within the state. This analysis included all claims information from January 1 through December 31, 1996. No single industry dominated the enrollment. Individuals in our analysis represent a racial mix consistent with the racial mix of the working-aged population of Ohio. Once employed by a participating business, no individuals were excluded from enrollment based on health history. The data did not include individuals eligible for benefits under Medicaid or Medicare. All individuals in this analysis were younger than 65 years.

Claims information was provided by the insurer to the Codman Research Group, Andover, Mass, a health care decision support company. The protocol for submitting claims to the insurer was uniform among participating providers. Extensive quality checks were performed on the raw data to verify the information before constructing the data set used for this analysis. All claims were validated (eg, for use of legal codes). Duplicate claims were eliminated. Claims were then assigned into groups of clinically homogeneous service types using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes and procedure codes from Current Procedural Terminology (CPT-4). Inpatient conditions and procedures in our analysis were based on diagnosis-related groups, which were created using a hierarchical clinical grouping algorithm with all ICD-9-CM diagnosis and procedure codes from inpatient discharge records.

For each claim submitted, the insurer recorded an allowed dollar amount, in addition to charges, that incorporated subscriber cost-sharing information (eg, deductibles and co-payments). All costs in this analysis were based on allowed dollars paid per claim. To provide a comprehensive picture of resource consumption, all unique claims submitted by providers for payment were included in the data set. If the insurer paid the claim, or a portion of the claim, the claim diagnosis and procedure categories were included for the individual, along with the allowed dollar amount. Diagnoses and procedures for denied claims were also included in the data. The allowed dollar amount for denied claims was recorded as 0. Proprietary software (Pandora Managed Care Information System) was used to compile, organize, and analyze the data. All claims for each enrollee were aggregated under a unique member identifier. Next, the data were organized in the following 3 ways: (1) by total diabetic, type 1 diabetic, type 2 diabetic, and total populations for all services and costs; (2) by medical event (all claims for a defined type of service or procedure); and (3) by demographic category (age and sex cohorts).

In addition to ICD-9-CM and CPT-4 codes, our analysis included information about total relative value units (RVUs) for physician services. The RVUs were based on the Resource-Based Relative Value Scale, which was implemented in 1992 as a payment system for physician services provided to Medicare beneficiaries. Commercial insurers are increasingly using the scale to develop fee schedules. Relative value units, like rates of use of services and dollars, can be used to compare medical care resource consumption among populations. They provide a useful supplement to use and cost comparisons. They take into account factors such as amount of work and effort, technical training, and practice expense required to perform a given service, regardless of physician specialty. A service provided by a specialist may be billed at a higher rate than the equivalent service provided by a primary care physician; regardless of these charge differences, however, the RVU for the given service is the same. Thus, RVUs allow comparisons of resource use that are independent of market rate mechanisms, reimbursement controls, and differential access to specialists across various forms of managed care.

We used ICD-9-CM diagnosis codes (250.00-250.93) to classify individuals as having diabetes. The following mined by insulin use. The new ADA guidelines classify individuals as having type 1 diabetes when their pancreatic islet β-cells do not produce insulin. Individuals are classified as having type 2 diabetes when they have a relative, instead of absolute, insulin deficiency. Those with type 2 diabetes may or may not require insulin therapy. Although the causes of type 1 and type 2 diabetes differ, both carry risks for serious long-term health problems. A few studies distinguishing between type 1 and type 2 diabetes have found that individuals with type 1 diabetes are at higher risk for long-term complications, use more physician services, and have higher costs than those with type 2 diabetes.

Most previous epidemiological studies of diabetes have examined use of health care resources by using a major health event, such as acute myocardial infarction, and focusing on end-point complications. This approach may overstate the incidence of serious complications associated with the disease. Furthermore, this approach gives inadequate attention to the long interval between the onset of diabetes and the development of serious chronic complications. It may therefore underestimate the impact of the disease on more routine use of health care resources and costs. Since many of the more serious long-term complications of diabetes emerge at later ages, epidemiological analyses contingent on major health events are likely to especially underestimate use and costs for younger populations, such as those covered by employer-based health insurance. Thus, a greater understanding of differential effects of type 1 and type 2 diabetes among people of working age would be useful, particularly if the analysis captures the experience of a representative sample of individuals by avoiding major health event eligibility criteria.

We used administrative data to estimate use of health care resources and costs, distinguishing between people with type 1 and type 2 diabetes. We also compared the health care use and costs of the diabetic population with those of a large comparison population. Administrative data provide ready access to timely information about trends in use and costs. The size of the administrative data set used in this study allowed us to examine the health care experience of a large number of individuals. This permitted analyses of more clinical categories than data from more in-depth surveys, where costs of collecting information constrain sample size. The approach used
criteria for classification were used: at least 1 inpatient admission for which the principal diagnosis was recorded as diabetes, or at least 2 inpatient admissions or 2 outpatient facility or physician office visit claims for which any diagnosis was recorded as diabetes. Claims for laboratory, pathology, or radiology services were not used to identify individuals with diabetes, since their use could incorrectly identify individuals as having diabetes based on the reason for testing (eg, screening) rather than test results. However, to ensure a complete representation of resource consumption, these claims were included in the analyses of use of resources and cost, with individuals grouped by population using the other criteria. The selection criteria were designed to minimize the percentage of nondiabetic individuals included in the diabetic population, ie, to minimize the amount of false-positive data. When individuals were identified as having diabetes, ICD-9-CM diagnosis codes were again used to classify them into the type 1 or type 2 category. The type 1 category includes all individuals with any ICD-9-CM diagnosis code from 250.0x through 250.9x, where x is the fifth digit, with a value of 1 or 3. The type 2 category includes all people with ICD-9-CM diagnosis codes from 250.0x through 250.9x, where x is the fifth digit with a value of 0 or 2. Individuals identified as having diabetes, but with all recorded diabetes ICD-9-CM diagnosis codes absent the fifth digit, were assigned to the category “diabetes, type not specified.” Of the 828208 plan enrollees, 13563 individuals were identified as having diabetes. Of the total diabetic population, 4349 were classified as having type 1 diabetes, 8810 were classified as having type 2 diabetes, and 404 were assigned to the nonspecified category.

For all individuals in the data set, we identified all ICD-9-CM diagnoses and all CPT-4 procedures. When a procedure was repeated 2 or more times, procedures and associated costs were summed. Thus, we treated each procedure as a separate event of health care resource use. Once a given diagnosis was identified, the individual with the diagnosis was assigned to a group of individuals with the same diagnosis. Each individual could be assigned only once to a given diagnosis, but multiple treatments related to that diagnosis could be recorded and analyzed.

We grouped ICD-9-CM diagnoses and CPT-4 procedures into standard categories and compared use and costs for selected ICD-9-CM and CPT-4 codes among the diabetic (total, type 1, and type 2) populations and the total study population. We used the indirect method to calculate age- and sex-adjusted observed-to-expected ratios for use, costs, and RVUs based on ICD-9-CM diagnoses and CPT-4 procedures for the diabetic (total, type 1, and type 2) populations, comparing each age- and sex-adjusted ratio with that of the total enrolled population (the benchmark rate). To calculate expected values, rates for the standard population were determined separately for men and women in each of 12 age categories. These rates were applied to corresponding age/sex categories of the target population (eg, total diabetic population) to identify the expected number of occurrences in the target population. These expected values for the age/sex categories of the target population were then summed to yield the total number of expected occurrences. The target population’s observed value was then compared with its expected value, producing the observed-to-expected ratio. Following an established practice of epidemiological research, the total plan population was used as the comparison (standard) group for the diabetic populations in all comparisons of use of health care resources in this study. Since our results were derived using the total rather than the nondiabetic population as the comparison population, it is likely that they underestimate cost and use differences between these groups. The diabetic population constitutes only 1.6% of the total population, however, so the degree of understatement is likely to be slight. The χ2 test was used to determine whether rates of use were statistically significantly higher (or lower) than the benchmark rate. Tests of statistical significance were not applied to costs or RVUs.

in this analysis complements traditional epidemiological methods. The most notable advantage of the approach used in this study is that it overcomes the limitation of many epidemiological methods used to examine morbidity associated with diabetes, ie, our approach is not contingent on a major health event.

**RESULTS**

Table 1 shows the age and sex distributions of the nondiabetic and the total diabetic populations. Notably larger percentages of individuals in the diabetic population were concentrated in the older age groups, compared with people in the nondiabetic population. This is an expected finding, since adult-onset diabetes is more common in people 40 years and older. In results not shown, the type 2 diabetic population was older than the type 1 diabetic population (mean ages, 50.8 and 45.7 years, respectively).

Although the total diabetic population constituted only 1.6% of the total population, it accounted for 9.4% of overall costs. The analogous figures were 0.1% and 4.8% for the type 1 population, and 1.1% and 4.5% for the type 2 population. Total annual per capita costs for the nondiabetic population were $909, compared with $5659 for the diabetic population. Thus costs were more than 6 times higher for individuals with diabetes than for those without the disease. A larger percentage of people in the diabetic population were older, and older individuals typically consume more health care resources than younger ones. However, the older age of the diabetic population did not account for the higher costs (Figure 1). For each age group, the proportion of total costs attributable to individuals with diabetes was substantially higher than the proportion of individuals in that age group with diabetes.

To investigate more specific sources of the diabetic population’s higher health care resource consumption, age- and sex-adjusted observed-to-expected ratios were used to compare resource use and costs of the diabetic and total populations. These comparisons were made for inpatient facility and outpatient care and for all professional service categories (Figure 2). Compared with the total population, rates of use of inpatient services were more than 4 times higher for the total diabetic population, more than 7 times higher for those with type 1 dia-
Professional outpatient services by professional providers such as psychologists, nurse practitioners, and physician assistants. Compared with the total population, rates for use of professional services were 2.6 times more for the total diabetic population, about 3.5 times more for those with type 1 diabetes, and more than 2 times more for those with type 2 (P < .001 for all comparisons). Significantly higher use rates in these categories for diabetic populations were reflected in substantially higher age- and sex-adjusted observed-to-expected costs. For inpatient services, compared with the total population, costs were more than 4.8 times greater for the total diabetic population, about 8.7 times greater for those with type 1 diabetes, and more than 3 times greater for those with type 2. For outpatient services, costs were 2.8 times more for the total diabetic population, 5 times more for those with type 1 diabetes, and 2 times more for those with type 2. Again, compared with the total population, costs for professional services were nearly 3 times greater for the total diabetic population, more than 4 times greater for those with type 1 diabetes, and more than 2 times greater for those with type 2. Rates of use and their differences among the various populations for each of these service categories are roughly comparable to the corresponding cost rates and their differences. This suggests that the primary determinant of higher costs for diabetic individuals is their greater use of services, rather than higher cost per service.

We also examined use of outpatient facilities, physician services, and ancillary services, such as laboratory and radiology tests. Here we compared use among the total diabetic, type 1 diabetic, type 2 diabetic, and total populations for selected high-volume ambulatory categories (Figure 3). All rates were adjusted for age and sex. The category of outpatient facility encounters includes services such as a single visit to a hospital outpatient department or to a free-standing ambulatory surgery facility, where multiple procedures were performed in the same visit (as in the case where a single visit might include a physician examination, sedation, and diagnostic colonoscopy). Such instances were counted as single encounters. For outpatient facility encounters, the rate was 2.5 times higher for the total diabetic population, 3.8 times higher for those with type 1 diabetes, and nearly 2 times higher for those with type 2 than for the total population (P < .001 in all cases). For emergency department visits, the rate was more than 2 times higher for the total diabetic population, more than 3 times higher for those

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Table 1. Age and Sex Distributions of Nondiabetic and Diabetic Insured Populations*

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>Nondiabetic Population (n = 814,645)</th>
<th>Diabetic Population (n = 13,563)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>All</td>
<td>399,893 (49.1)</td>
<td>414,752 (50.9)</td>
</tr>
<tr>
<td>&lt;17</td>
<td>114,603 (14.1)</td>
<td>108,485 (13.3)</td>
</tr>
<tr>
<td>17-34</td>
<td>105,689 (13.0)</td>
<td>113,449 (13.9)</td>
</tr>
<tr>
<td>35-44</td>
<td>74,318 (9.1)</td>
<td>83,280 (10.2)</td>
</tr>
<tr>
<td>45-54</td>
<td>67,654 (8.3)</td>
<td>72,380 (8.9)</td>
</tr>
<tr>
<td>55-64</td>
<td>37,629 (4.6)</td>
<td>37,158 (4.6)</td>
</tr>
</tbody>
</table>

* Data are given as number (percentage) of subjects.

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Figure 1. Diabetic individuals as a percentage of total health care plan population and expenditures. No tests of statistical significance were applied.

Figure 2. Observed-to-expected ratios for use and expenditures for inpatient, outpatient, and professional services for total, type 1, and type 2 diabetic populations. Categories indicated are inpatient services and procedures, outpatient facility services and procedures, and professional services. Use ratios were all statistically significant at P < .001. No tests of statistical significance were applied for expenditures.
with type 1 diabetes, and 1.7 times higher for those with type 2 than for the total population (P<.001 in all instances). For physician office visits, the rate was about 2.4 times higher for the total diabetic population, 2.7 times higher for those with type 1 diabetes, and about 2.2 times higher for those with type 2 than for the total population (P<.001 in all cases). In the physician consultation category, rates were more than 3 times higher for the total diabetic population, more than 5 times higher for those with type 1 diabetes, and about 2.3 times higher for those with type 2 compared with the total population (P<.001 in all instances). Diabetic individuals were also more likely to use ancillary services, such as laboratory and radiology tests; the rate was 2.8 times higher for the total diabetic population, 3.3 times higher for those with type 1 diabetes, and 2.5 times higher for those with type 2 (P<.001 in all cases). Collectively, these findings indicate that individuals with diabetes used significantly more physician and ancillary services, and that the highest rate was in the type 1 diabetic population.

To identify differences in the volume and intensity of resources used by physicians to provide care to diabetic populations, we calculated the age- and sex-adjusted observed-to-expected ratio of total RVUs for primary care physicians and selected physician specialists (Figure 4). The observed-to-expected RVU ratios generated for physician services provide a combined measure of the volume of services used and the intensity of those services. In all instances, observed-to-expected RVUs for physician services to diabetic populations were notably higher than those for the total population. This was especially the case for physicians who commonly treat long-term complications of the disease, such as ophthalmologists, endocrinologists, and nephrologists. For primary care physicians, the RVU observed-to-expected ratio was 2.8 times higher for the total diabetic population than for the total population, 3.5 times higher for those with type 1 diabetes, and 2.5 times higher for those with type 2. Endocrinologists specialize in the care of individuals with diabetes. In this category, again compared with the total population, the RVU measure was 13.2 times higher for the total diabetic population, 27.9 times higher for those with type 1 diabetes, and 7 times higher for those with type 2. In the ophthalmology specialist category, compared with the total population, the RVU measure was 6.3 times higher for the total diabetic population, almost 13 times higher for those with type 1 diabetes, and 3.7 times higher for those with type 2. In the nephrology specialist category, compared with the total population, the RVU measure was 9.4 times higher for the total diabetic population, almost 28 times higher for those with type 1 diabetes, and 2.1 times higher for those with type 2. These results reinforce our finding of greater use of physicians among diabetic populations. They indicate that the intensity level of care provided to diabetic individuals by physicians, particularly for the type 1 diabetic population, is markedly higher than the corresponding level for individuals without the disease. This is true for primary care physicians and for a broad spectrum of physician specialists.

To further explore the markedly higher use of inpatient services by the diabetic population, selected inpatient conditions and procedures were examined (using ICD-9-CM and CPT-4 codes), comparing inpatient use among the diabetic populations and the total population (Table 2). All rates were adjusted for age and sex. The diabetic populations had significantly higher rates for conditions and procedures commonly associated with long-term complications of diabetes. Rates of cardiovascular-related conditions and procedures were significantly higher in the diabetic populations; the total diabetic population had a stroke rate nearly 6 times higher and an acute myocardial infarction rate about 5 times higher (P<.001 in both instances). Rates of cardiac catheterization, coronary artery bypass, and coronary angioplasty were all

![Figure 3. Observed-to-expected ratios for facility and physician encounters for total, type 1, and type 2 diabetic populations. Observed-to-expected ratios in all categories were statistically significant at P<.001.](image1)

![Figure 4. Observed-to-expected ratios of relative value units (RVUs) for primary care and referral specialists for total, type 1, and type 2 diabetic populations. No tests of statistical significance were applied.](image2)
Using a large sample of individuals covered by employer-based health insurance, we examined the use of health care resources and economic costs of a defined population of people younger than 65 years with diabetes. We distinguished between individuals with type 1 and type 2 diabetes, and compared their use of health care resources and health care costs, with benchmark rates established by the total enrolled population. The approach used in our study relies on analysis of administrative data provided by a large commercial insurer. Our findings for the use of health care resources by the diabetic population are consistent with morbidity patterns generally associated with diabetes, patterns identified in studies that use more conventional epidemiological approaches. Individuals in the diabetic populations were significantly more likely to be treated for conditions and procedures related to complications of the disease such as cardiovascular, ophthalmologic, renal, and peripheral vascular disease, than were individuals in the total plan population. We found that in the diabetic population, use of resources, costs, and intensity of resource use (RVUs) were markedly higher for individuals with type 1 diabetes than for those with type 2 diabetes. Direct tests of statistical significance were not applied to comparisons of the type 1 and type 2 diabetic populations. Nonetheless, differences in resource use between these 2 groups were substantively large in most instances. Our findings reinforce the importance of distinguishing between type 1 and type 2 diabetes.

In a related result, the RVU findings indicate that physician services provided to individuals with diabetes are notably more resource intensive than those provided to people in the total plan population. In addition, again measured by RVUs, individuals with type 1 diabetes used substantially more resources than those with type 2. Those with type 1 diabetes also visited primary care physicians at a higher rate those with type 2. This suggests that these individuals have access to preventive and routine follow-up care, but that their medical management by primary care physicians may not prevent referral to and treatment by specialists. The chronic

### Table 2. Observed-to-Expected Ratios for Inpatient Admission Categories

<table>
<thead>
<tr>
<th>Diabetes Category</th>
<th>Type 1</th>
<th>Type 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions</td>
<td>7.2</td>
<td>3.0</td>
<td>4.2</td>
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<tr>
<td>Cardiovascular/vascular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>10.8</td>
<td>4.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Heart failure</td>
<td>22.1</td>
<td>5.3</td>
<td>9.8</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>8.3</td>
<td>3.8</td>
<td>4.9</td>
</tr>
<tr>
<td>Cardiac catheterization, excluding acute myocardial infarction</td>
<td>8.9</td>
<td>3.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Coronary angioplasty</td>
<td>7.7</td>
<td>4.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Coronary artery bypass</td>
<td>8.3</td>
<td>4.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Cardiac valve</td>
<td>3.7</td>
<td>3.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Cardioid endarterectomy</td>
<td>12.2</td>
<td>5.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>8.2</td>
<td>2.4</td>
<td>4.0</td>
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<tr>
<td>Skin/tissue</td>
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<td></td>
<td></td>
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<tr>
<td>Cellulitis</td>
<td>15.4</td>
<td>5.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Skin grafts</td>
<td>25.3</td>
<td>4.0</td>
<td>10.6</td>
</tr>
<tr>
<td>Infectious disease</td>
<td>14.5</td>
<td>4.3</td>
<td>7.3</td>
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<td>Renal/Urinary</td>
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<td>Kidney/urinary tract infections</td>
<td>13.3</td>
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<td>6.4</td>
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<td>Renal dialysis</td>
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<tr>
<td>Orthopedic</td>
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<tr>
<td>Fractures, hip/femur</td>
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<td>1.3</td>
<td>4.4</td>
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<tr>
<td>Major joint procedures</td>
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<tr>
<td>Back and neck procedures</td>
<td>2.7</td>
<td>1.9</td>
<td>2.1</td>
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</table>

*P < .001.
†Indicates not applicable; χ² statistic was not calculated when the expected value was less than 6.
‡P < .01.
nature of many complications of diabetes may simply require more resource-intensive interventions. Although the data and methods used for our analysis complement more traditional epidemiological approaches, several limitations of this study should be acknowledged. Our data are not representative of the entire US population. Given our reliance on commercial insurer claims information, these data are unlikely to representative of uninsured populations or Medicaid populations. Because our analysis excludes people 65 years and older, it is also not representative of older populations. Furthermore, our data are restricted to the enrolled population of a single populous state.

Ohio's 1996 diabetes prevalence for all ages ranked it in a middle range of prevalence, along with most states. The prevalence of diabetes among working-aged individuals in our sample is 2.2%, considerably less than the 3.3% prevalence for Ohio's working-aged population in 1996. Much of this difference is likely due to the prevalence of diabetes among working-aged individuals not included in our study, ie, the uninsured, disabled individuals covered by Medicare, those who receive coverage through the military, and those served by Medicaid. A portion of the difference may also result from our inability to identify separately the use of health care resources by individuals who may have received a diagnosis of diabetes before the study, but whose resource use during the study period did not fulfill our selection criteria. Using the Medical Expenditure Panel Survey, we estimated a 1996 national diabetes prevalence for the working-aged population of 3.1%; for those of working age covered by private group health insurance, the prevalence was 2.7%. Including enrollees' children, the prevalence was 2.4%.

Another potential limitation is that individuals covered by this commercial insurer could select from as many as 5 benefit plan options, ranging from a traditional indemnity plan to a capitated managed care plan. Our data did not allow us to control at the level of the individual for self-selection into particular plans. Across the 5 benefit plans, the proportion of each plan constituted by individuals with diabetes was reasonably consistent. Moreover, this insurer provided generous benefits and comprehensive hospital coverage in all of its plans. The primary differences between the benefit plans were the degree of cost sharing, differing deductible and co-payment levels, and the form of medical management. Most research has shown that the degree of medical management does not play an important role in health care provided to diabetic individuals; physicians usually use similar treatment protocols, regardless of insurance type. In addition, research has demonstrated that the demand for short-term health care resources such as those examined in this study is highly inelastic. These findings imply that differences in medical management and cost sharing are not likely to account for differences in resource consumption between the diabetic and total populations in our analysis. The facts that billing standards were uniform across all plans and that all claims were to be submitted by providers even when the patient was part of a managed health care plan further reduce the potential influence of this limitation. Further, the insurer had designed the plans to encourage age optimal service levels, with incentives for providers to avoid excessively large and small claim volumes. It therefore seems unlikely that enrollee self-selection accounts in large measure for our findings.

The most important limitation is that, given the high prevalence of type 1 diabetes relative to type 2 diabetes in our data, it is likely that a number of people with type 2 diabetes who required insulin were misclassified as having type 1 diabetes. In the population at large, individuals with type 2 diabetes constitute about 90% of all diabetics. Since the prevalence of type 2 diabetes increases dramatically with age, and our analysis was restricted to people younger than 65 years, it is reasonable to expect that our sample's prevalence ratio of type 1 to type 2 diabetes would be higher than that of the general population. However, one factor is likely to contribute to misclassification of those with type 1 and type 2 diabetes in our data. The new ADA guidelines, switching from the insulin- and non–insulin-dependent diabetes mellitus to the types 1 and 2 classifications, became effective in October 1993. It takes time before changes of this sort become widely adopted in the medical community, and before practitioners incorporate them in daily practice. Many practitioners may have continued to rely on the familiar older classification standard despite the new guidelines.

In our data, it seems most likely that people classified by physicians as having type 1 diabetes had type 1 diabetes or type 2 diabetes requiring insulin. Regardless of any classification problems in the period after the ADA's 1993 policy change, it remains clear from our findings that people in the type 1 diabetic group used resources more intensively than those not requiring insulin. Thus, regardless of the classification limitation, our results highlight the importance of glycemic control. The diagnosis limitation in this study applies to any research based on administrative data. This limitation also affects clinical practice studies in medical centers, hospitals, and group practice settings. Our findings, therefore, highlight the need for communicating to the medical community the new diagnosis standards and the need for accurate diagnoses in claims.

Our results provide a better understanding of morbidity differences between individuals with type 1 and type 2 diabetes. Both forms of the disease carry substantial risks for serious long-term complications, although type 2 diabetes is much more prevalent and is often complicated by hypertension, dyslipidemia, and obesity. However, our findings confirm that type 1 diabetes is associated with substantially greater per capita use of health care resources and costs. Insurers can use these results to inform risk adjustments for people in these populations, or calculations of the consumption of health care resources and financial effects of including type 1 and type 2 diabetic individuals in employer-based health insurance plans. From the perspective of the clinician, our findings provide insight into medical problems that are more common among diabetic individuals and highlight the fact that individuals with type 1 diabetes are at substantially higher risk for serious complications than those with type 2. Our findings suggest an opportunity to focus improved medical management on diabetic individuals with the greatest risk for complications.
role in managing the disease. Many studies indicate an opportunity for enhanced management of diabetes, such as intensive preventive care and screening and intensive pharmacological therapy. Our results suggest the advisability of creating a special focus on patients with type 1 diabetes.

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