Diabetes-Related Morbidity and Mortality in a National Sample of U.S. Elders

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OBJECTIVE — Although the number of elders with diabetes has increased dramatically, there are few data on rates of mortality and serious complications in older populations with diabetes. To determine such rates, we conducted a population-based, nonconcurrent cohort study using claims data from the 1994–1996 Medicare 5% Standard Analytical File.

RESEARCH DESIGN AND METHODS — Codes from the ICD-9 were used to identify diabetes and the following complications: amputation, lower extremity infection, gangrene, blindness, acute myocardial infarction, ischemic heart disease, stroke, and metabolic disorders. Using these codes, we assembled a cohort of 148,562 Medicare Part A and B beneficiaries who were ≥65 years of age, who were alive on 1 January 1995, who were not in managed care in 1994, and who had a diabetes-related claim in 1994. Age-specific rates of death and complications were then calculated.

RESULTS — During 24 months of follow-up, 22,044 (14.8%) elders with diabetes died. Death rates in men and women increased significantly with age. Compared with their counterparts in the general U.S. population, elders with diabetes suffered excess mortality at every age group, corresponding to an overall standardized mortality ratio of 1.41 (95% CI 1.39,1.43). The incidence of ischemic heart disease and stroke was 181.5 and 126.2 per 1,000 person-years, respectively, which was higher than the incidence of all other diabetes-related complications.

CONCLUSIONS — In every age group, elders with diabetes have significantly higher all-cause mortality rates than the general population. Medicare data may be useful in monitoring trends in diabetes-related morbidity and total mortality in U.S. elders with diabetes.

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Diabetes is an increasingly common disease in U.S. elders. During the 1970s and 1980s, the percentage of adults aged ≥65 years diagnosed with diabetes increased from 8 to 10% (1). The Centers for Disease Control and Prevention estimated that in 1996 there were 3.8 million elders (up from 2.3 million in 1980) with diagnosed diabetes (2), which is consistent with estimates from the 1990s that up to 13% of elders have diagnosed diabetes (3). The true prevalence of diabetes is probably higher, after accounting for those who are undiagnosed (4). Although prevalence of diabetes in the elderly is high, data on mortality and serious complication rates in older populations with diabetes are limited. Morbidity surveillance in the elderly has generally relied on death certificate data and hospital discharge surveys, but these methods are prone to undercoding of diabetes, sampling biases, and difficulties in determining the population at risk. Use of cohort studies remedies these problems, but at the expense of small numbers, particularly of ages older than 75 years (5). Several population-based studies have suggested that the excess mortality associated with diabetes in younger populations is attenuated in the elderly (6–8). However, the precise magnitude of the excess risk in the oldest age groups with diabetes remains uncertain. Also, the extent of diabetes-related morbidity (including lower extremity disease, metabolic disorders, and blindness) in diabetic elders is unclear. Better understanding of the burden of diabetes in the elderly might guide decisions about treatment and prevention at the individual level and about allocation of public health resources at the national level. Therefore, we sought to determine all-cause mortality rates and the incidence of serious diabetes-related complications in a nationally representative cohort of U.S. elders with diabetes.

RESEARCH DESIGN AND METHODS

Study sample

We conducted a national nonconcurrent cohort study of U.S. elders with diabetes by using data from the 5% Standard Analytical File, which contained Medicare claims for 1,941,453 individuals in 1994. Details regarding inclusion/exclusion criteria and data collection have been published (9,10). We selected 1,284,653 beneficiaries aged ≥65 years from the 1994 Medicare Denominator file (containing demographic and eligibility data) who lived in the U.S., who were enrolled in both Medicare Part A (inpatient) and Part B (outpatient), who did not die in 1994, and who were not enrolled in a health maintenance organization (HMO) at any time in 1994 because individual

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Abbreviations: HMO, health maintenance organization; RH, relative hazard; SMR, standardized mortality ratio.

claims for disease episodes would not have been generated in this setting. Individuals were classified as having diabetes if, in 1994, there were at least two Medicare Part B claims with a diabetes-related ICD-9 diagnosis code (250.xx) or at least one hospitalization claim with a diabetes-related diagnosis code; this yielded 178,792 patients with diabetes. Merging the claims-identified diabetes patients with the postexclusion denominator file yielded a final sample of 148,562 elders with diabetes alive as of 1 January 1995.

Comparison group

Two national data sets were used for comparison purposes. First, to confirm the national representativeness of the Medicare sample, we compared the demographic characteristics of this study cohort with the 1990 Census (≥65 years of age). Second, to determine the standardized mortality ratio (SMR) related to diabetes, we compared the mortality rates of this cohort with the 1996 vital statistics for individuals aged ≥65 years from the National Center for Health Statistics.

Outcomes classification

We selected diabetes-related complications to investigate based on several considerations, including relatedness to diabetes, typical severity, likelihood of requiring hospitalization or outpatient visit, and/or potential for prevention. Deaths were ascertained using the Medicare Denominator File, which includes data on mortality, including date of death (11). Complications were classified using claims in the 5% Standard Analytical File from 1994 to 1996. A complication was considered to have occurred if at least one claim was made for the outcome. These included amputation (ICD-9 codes 84.10–84.19 and Current Procedural Terminology codes 28810, 28820, 28825), gangrene (ICD-9 codes 785.4, 040.0, and 440.24), lower extremity infection (a composite of lymphangitis [ICD-9 code 457.2] and cellulitis [ICD-9 codes 680.6, 680.7, 682.1, 682.6, and 682.7]), blindness (ICD-9 codes 369.0–369.9), acute myocardial infarction (ICD-9 code 410.x), ischemic heart disease (ICD-9 codes 410–414), stroke (ICD-9 codes 430–438), and the diabetes-related metabolic disorders, i.e., hypoglycemia (ICD-9 codes 251.1 and 251.2), hyperosmolar syndrome (ICD-9 code 250.2), and ketoacidosis (ICD-9 code 250.1).

Analysis

We identified the date of death for deaths occurring in 1995 and 1996. We used survival analysis to calculate event rates, assuming person-time accrued from 1 January 1995 to the date of complication, death, or censoring (12). For determination of complication rates, censoring occurred due to withdrawal to HMO care in 1995 or 1996 (censoring date 31 December 1994 or 1995) or the end of the observation period (31 December 1996). For mortality rates, we did not censor for withdrawal to HMO because Medicare records the date of death for all beneficiaries. We identified claims for diabetes-related complications from 1 January 1994 to 31 December 1996. In all complications analyses, we excluded only individuals with the specific complication of interest in 1994 in order to calculate incidence in 1995–1996. Because discrete episodes of care are difficult to determine for events that can plausibly occur more than once in a year (e.g., ketoacidosis) or even more than once in a hospitalization (e.g., amputation), we only counted the first appearance of the diagnostic code in a given year but allowed for up to one occurrence per year in most analyses. Due to the chronic nature of blindness, ischemic heart disease, and stroke, we identified incident cases of these diagnoses as the first occurring episode after 1 January 1995. All complications were deemed to have occurred at midyear or on the date of death if the patient died before midyear. Based on the age in 1994, we created the following age strata, taking into account aging from 1994 to 1996: 65–69, 70–74, 75–79, 80–84, and ≥85 years. We used these strata to calculate rates by dividing the number of individuals with a complication by the total number of individuals at risk in each strata. Mortality rates were similarly calculated. Where appropriate, we carried out direct age-adjustment using the 1990 Census population aged ≥65 years as the standard. We compared death rates for this cohort to mortality rates drawn from vital statistics for 1996 to calculate a standardized mortality ratio (SMR; ratio of observed number of deaths to expected number of deaths). Confidence intervals for rates and SMRs were calculated assuming that parameters followed a Poisson distribution (12). Cox proportional hazards regression was used to assess the relative hazards associated with age and sex. All significance tests were two-tailed.

RESULTS

Comparability to U.S. elders in the general population

Compared with all U.S. residents aged ≥65 years enumerated in the 1990 census, elders with diabetes in our cohort were similar in terms of sex distribution (39.9 vs. 40% male) and ethnicity (11.9 vs. 9.9% African-American). However, this cohort was substantially older than the general elderly population: 22 vs. 33% aged 65–69 years and 48 vs. 42% aged ≥75 years.

Event rates

During 24 months of follow-up, 22,044 patients died. The unadjusted all-cause mortality rate was 79.6 per 1,000 person-years (95% CI 78.6–80.7). The rate was 69.9 per 1,000 person-years after adjustment to the 1990 census population. Of note, the mortality rate in the 7,066 persons (4.5% of the 1994 cohort) who enrolled in an HMO in 1995 or 1996 was 30.3 per 1,000 person-years, compared with 82.3 per 1,000 person-years in those who remained enrolled in fee-for-service Medicare. The incidence of the selected diabetes-related complications in 1996 is presented in Table 1. Ischemic heart disease was prevalent in 38% of elders with diabetes in 1994; over the ensuing 2 years, 30% of the remaining cohort recorded a diagnosis of ischemic heart disease. Stroke was the second most common complication; in those without a diagnosis of stroke in 1994 (83% of the 1994 cohort), 22% recorded a diagnosis of stroke in 1996. Infection of the lower extremity and gangrene occurred more frequently than amputation of the lower extremity. The mortality rate was much higher in individuals with incident ischemic heart disease (102 per 1,000 person-years, 95% CI 100.3–103.8) compared with those without ischemic heart disease (59 per 1,000 person-years, 95% CI 57.8–60.4). The highest death rates occurred in individuals with incident acute myocardial infarction (183 per 1,000 person-years), amputation (190 per 1,000 person-years), and gangrene (216 per 1,000 person-years). Of the metabolic

Table 1—*Incidence of diabetes-related complications in 148,562 elders with diabetes*

Complication	n*	Incidence rate per 1,000 person-years (95% CI)
Ischemic heart disease	26,770	181.5 (179.3–183.6)
Acute myocardial infarction	11,361	31.3 (30.7–31.8)
Cerebrovascular accident	26,178	126.2 (124.7–127.8)
Gangrene	6,406	16.7 (16.3–17.2)
Amputation	2,453	9.8 (9.4–10.2)
Lower extremity infection	8,870	37.8 (37.1–38.6)
Hypoglycemia	6,968	28.3 (27.6–28.9)
Ketoacidosis	5,730	24.3 (23.7–24.9)
Hyperosmolar syndrome	1,907	7.6 (7.3–7.9)
Blindness	2,891	10.2 (9.8–10.6)

**n* indicates the number of persons with at least one incident claim for the complication in 1995 or 1996.

complications, hypoglycemia occurred most frequently, whereas hyperosmolar syndrome occurred infrequently.

Excess mortality risk

After age-adjustment using the age distribution of the U.S. population aged ≥65 years in 1990, the mortality rate was 62.3 per 1,000 in women and 81.8 per 1,000 in men. Mortality rates increased with age similarly in men and women with diabetes (Fig. 1). The overall age-adjusted relative risk of mortality for men with diabetes was 1.34 (95% CI 1.31–1.38) compared with women with diabetes.

At every age, mortality in elders with diabetes was significantly greater than mortality in the general population. The SMR for the entire cohort was 1.41 (95% CI 1.39–1.43); the SMR was 1.44 (1.41–1.46) in women and 1.37 (1.34–1.40) in men. Excess mortality declined with age in men and women (Fig. 2). Although the mortality rate was higher in diabetic men than diabetic women, in individuals aged <85 years, the excess mortality was greater in women. Of note, even in individuals aged ≥85 years, excess mortality was still significantly elevated in both men and women with diabetes (overall SMR 1.15, 95% CI 1.12–1.18).

Sex, age, and complication risk

Rates of selected complications are listed, by age group, in Fig. 3. All complication rates increased with age (all *P* values for trend <0.01). After adjusting for age, women had a higher risk of hypoglycemia (relative hazard [RH] 1.27), hyperosmolar syndrome (RH 1.19, $P < 0.001$), ketoacidosis (RH 1.17), and blindness (1.22). Women had a lower risk of amputation (0.70), gangrene (0.78), acute myocardial infarction (0.80), and ischemic heart disease (0.88) (all $P < 0.001$). There was no gender difference in the occurrence of infection of the lower extremity and stroke.

CONCLUSIONS — The results of this study support the following conclusions. First, diabetes is associated with excess mortality in U.S. elders, even in those aged ≥85 years. Second, the leading causes of diabetes-related morbidity in elderly individuals are ischemic heart disease and stroke. Third, all complications assessed increase with age. Finally, this work suggests that it is feasible to use claims data for national surveillance of diabetes-related morbidity and mortality. Strengths of our study include a large, nationally representative sample of patients with diabetes, the use of survival time analysis, and a study design that both allowed for the temporal separation of exposure from outcomes and minimized the possibility of detecting preexisting complications.

The major limitation of this study is the exclusive reliance on claims data, which raises concerns about possible misclassification bias. Individuals not identified as having diabetes in 1994 may lack Medicare Part B coverage, may be enrolled in an HMO, may have undiagnosed diabetes, or may be nonusers of care. Individuals without Medicare Part B coverage may not be able to afford it, thus rendering our identified cohort healthier due to a higher socioeconomic status, whereas those individuals who were enrolled in an HMO in 1994 are likely to be healthier than this cohort. In fact, individuals who were censored due to HMO enrollment in 1995 and 1996, after adjustment for age and sex, were less likely to have had prevalent ischemic heart disease, stroke, amputation, or gangrene in 1994. Individuals with undiagnosed diabetes have an elevated all-cause and cardiovascular mortality risk, but not as high as those diagnosed with diabetes (13). It is also possible that individuals simply did not list diabetes as one of the diagnoses supporting a claim. However,

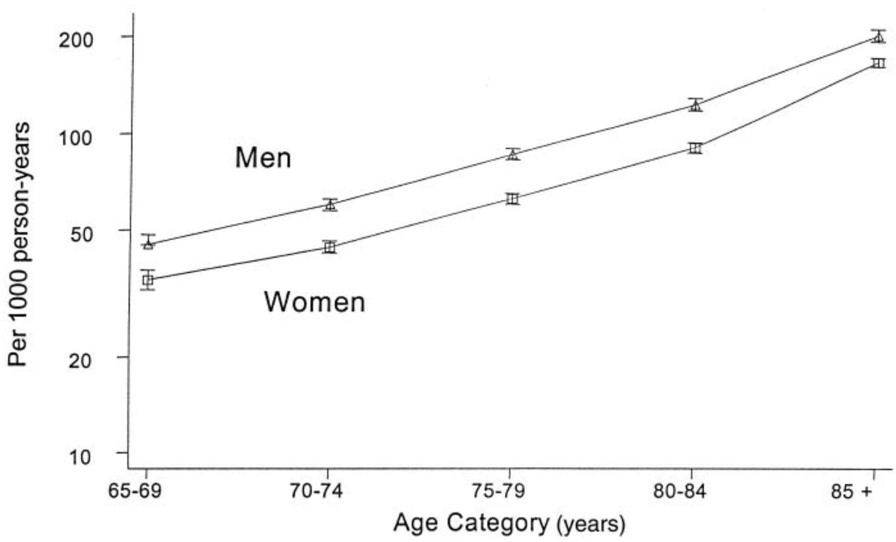

Figure 1—*Mortality rate in 148,562 U.S. elders with diabetes, by age and gender. Symbols indicate point estimate and vertical bars indicate 95% CIs.*

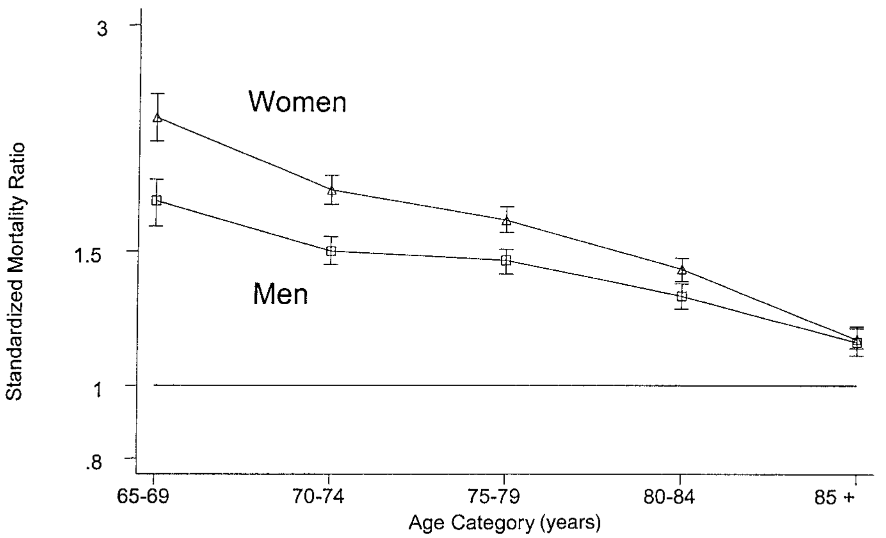

Figure 2—*Standardized mortality ratio in 131,535 U.S. elders with diabetes versus the general U.S. population aged ≥65 years, by age and sex. Symbols indicate point estimates and vertical bars indicate 95% CIs.*

our scheme for defining diabetes has been reported to have a sensitivity of 63% and a specificity of 98% (14). Furthermore, of our initial sample (after general exclusions), 14% had diabetes, which is consistent with national estimates of the prevalence of diabetes in the elderly U.S. population. Moreover, when clinical and claims data were compared, high specificity was demonstrated for diagnoses such as congestive heart failure, hyperlipidemia, angina, and stroke (15). Similar data for many other complications are not available, although the specificity for death is likely to be high because it results in the termination of benefits.

Methodological issues have impeded the determination of accurate morbidity and mortality rates in elders with diabetes, whether based on vital statistics/death certificate data or cohort studies (8,16). Previously published mortality rates in elderly diabetic individuals range from 51.4 to 89.7 per 1,000 person-years at ≥65 years of age (7,17,18) and up to 136 per 1,000 person-years at ≥75 years of age (16). In comparison, our mortality rates are somewhat lower. Several possible explanations may account for this difference. The previously published estimates are chiefly from the 1980s, and death rates may have declined in the following 10 years. Alternatively, eliminating from our population in 1994 individuals without Medicare Part B coverage may have resulted in a population with diabetes comprising individuals with a better socioeconomic status and/or better access to care who are less likely to die. Possibly counteracting this influence, however, is the observation that the HMO enrollees in 1995/1996 had lower death rates than those who remained, suggesting that those excluded in 1994 would have also had lower death rates. Finally, there may be underascertainment of death by Medicare, compared with cohort studies, but without personal identifiers, vital status cannot be validated against the national death index.

Because we compared mortality rates with those of the general population, which includes individuals with diabetes, the excess risk of death due to diabetes is probably underestimated in this study. However, the inverse association of excess mortality (as indicated by the SMR) with age is consistent with previous studies of mortality related to diabetes, whether reporting SMR or relative risk (7,8,19–21). Similarly, the greater excess of death in elderly diabetic women than diabetic men, compared with their nondiabetic counterparts, has also been reported elsewhere (16).

The complication rates we report may be conservative because for complication-specific analyses, we chose to exclude elders with that specific complication in 1994. However, we may have overestimated rates of complications by excluding Medicare HMO enrollees from our cohort, which may have resulted in a less healthy population. Nonetheless, our complication rates are similar to previous reports using cohort-derived data or national surveillance data with regard to amputation (6.2–11.9 per 1,000 person-years) (22–24) and hypoglycemia (18.1 per 1,000 person-years) (25). Published U.S. surveillance data for 1994 showed a rate of 10.2 fewer extremity amputations per 1,000 diabetic

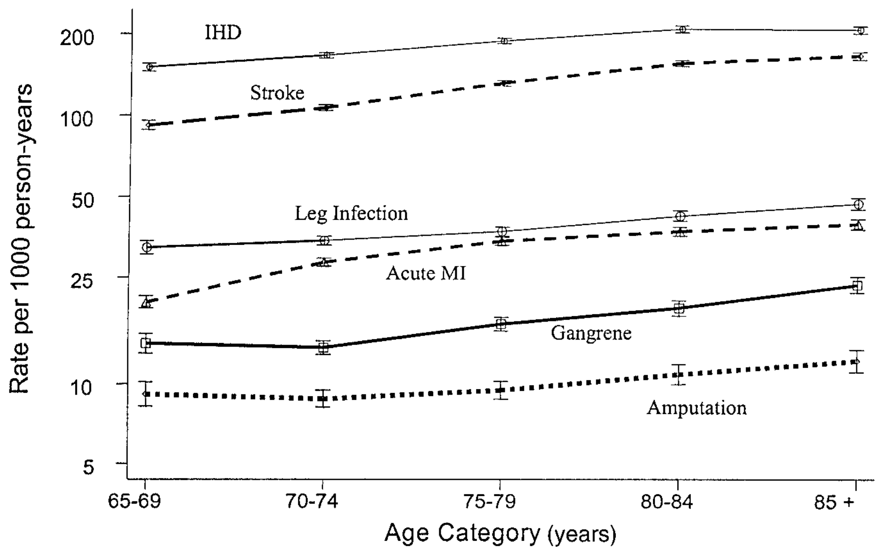

Figure 3—*Rates of serious diabetes-related complications in 1996 in 131,595 elders with diabetes. Symbols indicate point estimates and vertical bars indicate 95% CIs. IHD, ischemic heart disease.*

elders aged 65–74 years and 11.9 per 1,000 in those aged ≥75 years (26). The rate of ketoacidosis is higher in this cohort than that reported by the Centers for Disease Control and Prevention in 1994: 4.6 discharges per 1,000 diabetic patients aged ≥65 years (27). Data from the Wisconsin Epidemiologic Study of Diabetic Retinopathy demonstrated an incidence of blindness of 4 per 1,000 person-years in insulin users aged 65–74 years (28). Our estimate of 10.2 per 1,000 person-years may be higher because we were unable to determine whether the cause of blindness was related to diabetes or other aging-related causes, such as macular degeneration.

There are several implications of our study. First, Medicare data may be useful as a surveillance tool for monitoring trends in diabetes-related morbidity and mortality in elderly individuals over time. Second, greater efforts to prevent cardiovascular disease and lower extremity complications are needed in elderly individuals with diabetes. Finally, the observation that diabetes is associated with excess mortality across age groups suggests that the treatment of diabetes and the conditions that commonly accompany it may be desirable even in the oldest patients.

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References

1. Kenny SJ, Aubert RE, Geiss LS: Prevalence and incidence of non-insulin-dependent diabetes. In *Diabetes in America*. Harris MI, Cowie CC, Stern MP, Boyko EJ, Reiber GE, Bennett PH, Eds. Washington, DC, U.S. Govt. Printing Office, 1995, p. 47–67
2. Centers for Disease Control and Prevention Diabetes Surveillance, 1999. Available from http://www.cdc.gov/diabetes/statistics/survl99/chap2/table01.htm. Accessed 20 May 2001
3. Mokdad AH, Ford ES, Bowman BA, Nelson DE, Engelgau MM, Vinicor F, Marks JS: Diabetes trends in the U.S.: 1990–1998. *Diabetes Care* 23:1278–1283, 2000
4. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, Wiedmeyer HM, Byrd-Holt 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* 21:518–524, 1998
5. Geiss LS, Herman WH, Smith PJ: Mortality in non-insulin-dependent diabetes. In *Diabetes in America*. Harris MI, Cowie CC, Stern MP, Boyko EJ, Reiber GE, Bennett PH, Eds. Washington, DC, U.S. Govt. Printing Office, 1995, p. 233–257
6. Ford ES, DeStefano F: Risk factors for mortality from all causes and from coronary heart disease among persons with diabetes: findings from the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Am J Epidemiol* 133:1220–1230, 1991
7. Gu K, Cowie CC, Harris MI: Mortality in adults with and without diabetes in a national cohort of the U.S. population, 1971–1993. *Diabetes Care* 21:1138–1145, 1998
8. Panzram G: Mortality and survival in type 2 diabetes mellitus. *Diabetologia* 30:123–131, 1987
9. Krop JS, Powe NR, Weller WE, Shaffer TJ, Saudek CD, Anderson GF: Patterns of expenditures and use of services among older adults with diabetes: implications for the transition to capitated managed care. *Diabetes Care* 21:747–752, 1998
10. Krop JS, Saudek CD, Weller WE, Shaffer TJ, Powe NR, Anderson GF: Patterns of expenditures and use of services among older adults with diabetes. *Diabetes Care* 22:1660–1666, 1999
11. Mitchell JB, Bubolz T, Paul JE, Pashos CL, Escarce JJ, Muhlbaier LH, Wiesman JM, Young WW, Epstein RS, Javitt JC: Using Medicare claims for outcomes research. *Med Care* 32:JS38–JS51, 1994
12. Kahn HA, Sempos CT: Follow-up studies: person-years. In *Statistical Methods in Epidemiology*. New York, Oxford University Press, 1989
13. Saydah S, Loria CM, Eberhardt MS, Brancati FL: Subclinical states of glucose intolerance and risk of death in the U.S. *Diabetes Care* 24:447–453, 2001
14. Hebert PL, Geiss LS, Tierney EF, Engelgau MM, Yawn BP, McBean AM: Identifying persons with diabetes using medicare claims data. *Am J Med Qual* 14:270–277, 1999
15. Jollis JG, Ancukiewicz M, DeLong ER, Pryor DB, Muhlbaier LH, Mark DB: Discordance of databases designed for claims payment versus clinical information systems: implications for outcomes research. *Ann Intern Med* 119:844–850, 1993
16. Geiss LS, Herman WH, Smith PJ: Mortality in non-insulin-dependent diabetics. In *Diabetes in America*. Harris MI, Bennet PH, Boyko EJ, Cowie CC, Eds. Washington, DC, U.S. Govt. Printing Office, 1995, p. 233–255
17. Panzram G, Zabel-Langhennig R: Prognosis of diabetes mellitus in a geographically defined population. *Diabetologia* 20:587–591, 1981
18. Stengard JH, Tuomileho J, Pekkanen J, Kivinen P, Kaarsalo E, Nissinen A, Karvonen MJ: Diabetes mellitus, impaired glucose tolerance and mortality among elderly men: the Finnish cohort of the Seven Countries Study. *Diabetologia* 35:760–765, 1992
19. Sasaki A, Uehara M, Horiuchi N, Hasegawa K: A long-term follow-up study of Japanese diabetic patients: mortality and causes of death. *Diabetologia* 25:309–312, 1983
20. Wong JS, Pearson DW, Murchison LE, Williams MJ, Narayan V: Mortality in diabetes mellitus: experience of a geographically defined population. *Diabet Med* 8:135–139, 1991
21. Waugh NR, Dallas JH, Jung RT, Newton RW: Mortality in a cohort of diabetic patients. *Diabetologia* 32:103–104, 1989
22. Morris AD, McAlpine R, Steinke D, Boyle DI, Ebrahim AR, Vasudev N, Stewart CP, Jung RT, Leese GP, MacDonald TM, Newton RW: Diabetes and lower-limb amputations in the community: a retrospective cohort study. *Diabetes Care* 21:738–743, 1998
23. Trautner C, Haastert B, Giani G, Berger M: Incidence of lower limb amputations and diabetes. *Diabetes Care* 19:1006–1009, 1996
24. Most RS, Sinnock P: The epidemiology of lower extremity amputations in diabetic individuals. *Diabetes Care* 6:87–91, 1983
25. Shorr RI, Ray WA, Daugherty JR: Incidence and risk factors for serious hypoglycemia in older persons using insulin or sulfonylureas. *Arch Intern Med* 157:1681–1686, 1997
26. Centers for Disease Control and Prevention: Nontraumatic lower extremity amputation. In *Diabetes Surveillance, 1997*. Atlanta, GA, U.S. Dept. of Health and Human Services, 1997, p. 151–159
27. Centers for Disease Control and Prevention: Diabetic ketoacidosis. In *Diabetes Surveillance, 1997*. Atlanta, GA, U.S. Dept. of Health and Human Services, 1997, p. 161–182
28. Klein R, Klein BE: Vision disorders in diabetes. In *Diabetes in America*. Harris MI, Cowie CC, Stern MP, Boyko EJ, Reiber GE, Bennett PH, Eds. Washington, DC, U.S. Govt. Printing Office, 1995, p. 293–336