Incidence of Treatment for End-Stage Renal Disease Among Individuals With Diabetes in the U.S. Continues to Decline

NILKA RIOS BURROWS, MPH
YANFENG LI, MPH
LINDA S. GEESS, MA

OBJECTIVE — We examined trends in incidence of treatment for diabetes-related end-stage renal disease (ESRD) in the U.S.

RESEARCH DESIGN AND METHODS — Using the U.S. Renal Data System, we obtained the number of individuals having diabetes listed as primary diagnosis who initiated ESRD treatment between 1990 and 2006. Incidence was calculated using the estimated U.S. population with diabetes from the National Health Interview Survey and then was age adjusted based on the 2000 U.S. standard population. Trends were analyzed using joinpoint regression.

RESULTS — The number of individuals who began diabetes-related ESRD treatment increased from 17,727 in 1990 to 48,215 in 2006. From 1990 to 1996, the age-adjusted diabetes-related ESRD incidence increased somewhat from 299.0 to 343.2 per 100,000 diabetic population (P = 0.45). However, from 1996 to 2006, the age-adjusted diabetes-related ESRD incidence decreased by 3.9% per year (P < 0.01) from 343.2 to 197.7 per 100,000 diabetic population. Among individuals with diabetes aged <45 years, diabetes-related ESRD incidence decreased by 4.3% per year (P < 0.01) from 1990 to 2006. Among older individuals, incidence increased during the 1990s but decreased in later years, by 3.9% per year (P < 0.01) among individuals aged 45–64, by 3.4% per year (P < 0.01) among individuals aged 65–74 years, and by 2.1% per year (P = 0.02) among individuals aged ≥75 years.

CONCLUSIONS — Diabetes-related ESRD incidence in the diabetic population has declined in all age-groups, probably because of a reduction in the prevalence of ESRD risk factors, improved treatment and care, and other factors.

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From the Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

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 Declining incidence of diabetes-related ESRD

The total number of individuals who began treatment for ESRD increased from 49,868 in 1990 to 108,928 in 2006. Of these cases of ESRD, 17,727 (36%) were diabetes related in 1990 and 34,355 (31%) in 2006. Throughout this period, the number of individuals with diagnosed diabetes aged <45 years, diabetes-related ESRD incidence decreased from 1990 to 2006, a 4.3% decrease per year (Table 1, Fig. 1). From 1990 to 1996, among individuals aged 45–64 years, incidence increased significantly, from 285.4 to 421.9 per 100,000 diabetic population, a decline of 3.9% per year. Among individuals with diabetes aged <45 years, diabetes-related ESRD incidence decreased from 1990 to 2006, a 4.3% decrease per year (Table 1, Fig. 1). From 1990 to 1996, among individuals aged 45–64 years, incidence increased from 285.4 to 273.8 in 1998.

**Table 1—Incidence rates of diabetes-related ESRD and APC, by age, sex, and race or ethnicity, United States, 1990–2006**

|                  | Incidence rate* | Trend                  |
|------------------|-----------------|------------------------|
|                  | 1990 | 2006             | Period   | APC (95% CI) | P    |
| Total            | 285.4 | 273.8            | 1990–1996 | 5.8 (3.5 to 8.0) | <0.01 |
|                  |       |                  | 1996–2006 | −2.9 (−3.6 to −2.2) | <0.01 |
|                  |       |                  | 1990–1996 | 1.1 (−1.9 to 4.1) | 0.45  |
|                  |       |                  | 1996–2006 | −3.9 (−4.7 to −3.1) | <0.01 |
| Age (years)      |      |                  |           |                |      |
| <45              | 300.1 | 142.3            | 1990–2006 | −4.3 (−5.1 to −3.4) | <0.01 |
| 45–64            | 340.6 | 273.8            | 1990–1996 | 3.2 (0.6 to 5.9) | 0.02  |
| 65–74            | 263.8 | 368.6            | 1990–1998 | 6.2 (3.2 to 9.2) | <0.01 |
| ≥75              | 172.5 | 328.5            | 1990–1999 | 10.9 (8.9 to 12.9) | <0.01 |
|                  |       |                  | 1999–2006 | −2.1 (−3.7 to −0.3) | 0.02  |
| Sex†             |      |                  |           |                |      |
| Male             | 363.7 | 230.5            | 1990–2006 | −2.8 (−3.6 to −1.9) | <0.01 |
| Female           | 250.6 | 168.6            | 1990–1996 | 2.4 (−1.5 to 6.4) | 0.20  |
|                  |       |                  | 1996–2006 | −4.3 (−5.3 to −3.3) | <0.01 |
| Race†§           |      |                  |           |                |      |
| White            | 266.2 | 164.7            | 1990–1996 | 1.3 (−3.0 to 5.7) | 0.53  |
|                  |       |                  | 1996–2006 | −5.0 (−6.0 to −4.0) | <0.01 |
| Black            | 408.9 | 327.7            | 1990–1996 | −1.7 (−2.9 to −0.6) | <0.01 |
| Hispanic†§       | 306.7 | 254.3            | 1997–2006 | −1.5 (−3.3 to 0.3) | 0.09  |

*Per 100,000 diabetic population. †Age-adjusted based on the 2000 U.S. standard population. ‡The racial groups include people of both Hispanic and non-Hispanic origin. ¶Data for 1997. APC, annual percent change.

**Figure 1—Modeled age-specific incidence of diabetes-related ESRD in the population with diabetes, U.S., 1990–2006. Predicted values: ▲—▲, <45 years; ■—■, 45–64 years; ●—●, 65–74 years; ——, ≥75 years. Predicted values were modeled using joinpoint regression analysis.**
and then declined 3.4% per year to 368.6 in 2006. Among individuals aged ≥75 years, incidence increased from 172.5 per 100,000 diabetic population in 1990 to 380.0 in 1999 and declined from 1999 to 2006 by 2.1% per year to 328.5 per 100,000 diabetic population.

From 1990 to 2006, the age-adjusted diabetes-related ESRD incidence was higher among men than among women (Fig. 2). Throughout this period, the age-adjusted diabetes-related ESRD incidence among men decreased at an average of 2.8% per year, from 363.7 per 100,000 diabetic population in 1990 to 230.5 in 2006 (Table 1). The decline in incidence among women did not begin until 1996, with the age-adjusted incidence decreasing at an average of 4.3% per year, from 299.3 per 100,000 diabetic population in 1996 to 168.6 in 2006 (Table 1). Before 1996, the age-adjusted diabetes-related ESRD incidence among women displayed a nonsignificant increase from 250.6 per 100,000 diabetic population in 1990 to 299.3 in 1996 (Table 1).

From 1990 to 2006, the age-adjusted diabetes-related ESRD incidence by race or ethnicity was highest among blacks and lowest among whites (Fig. 2). During this period, the age-adjusted diabetes-related ESRD incidence among blacks decreased significantly by 1.7% per year from 408.9 per 100,000 diabetic population to 327.7 (Table 1). However, among whites, diabetes-related ESRD incidence did not begin to decline until 1996, from 296.7 per 100,000 diabetic population to 164.7 in 2006, a decline of 5.0% per year (Table 1). Among Hispanics, the age-adjusted diabetes-related ESRD incidence decreased between 1997 and 2006 but not significantly (Table 1).

CONCLUSIONS — We found that diabetes-related ESRD incidence in the population with diabetes has continued to decline, which is consistent with a previous report (4) and suggests that current efforts in prevention of ESRD may be successful. The decreasing trends in diabetes-related ESRD incidence are now being seen in all age-groups, men, women, whites, and blacks, unlike previously reported data showing declining incidence only among individuals aged <65 years, women, and whites (4). However, from 1997 to 2006, diabetes-related ESRD incidence among Hispanics did not decrease as it did among the other populations, so additional strategies are needed to improve this trend.

Diabetes-related ESRD incidence declined throughout the study period among individuals with diabetes aged <45 years. Most individuals with diabetes in this age-group are likely to have type 1 diabetes, and intensive insulin therapy has been shown to reduce the risk of kidney disease in individuals with type 1 diabetes (12). Between 1999 and 2002 and 2003 and 2006, the proportion of individuals with diabetes aged 20–39 years achieving glycemic control target levels increased significantly (13), suggesting that improved glycemic control may have contributed to the declining trends. In the older age-groups, diabetes-related ESRD incidence began to decline in 1996 for those aged 45–64 years, in 1998 for those aged 65–74 years, and in 1999 for those aged ≥75 years. Reasons to explain the decreasing trends cannot be gleaned from surveillance data but may include early detection and management of kidney disease, improved treatment and care, better control of ESRD risk factors (i.e., diabetes and hypertension), or other factors (14–16). Furthermore, new pharmacological agents, such as ACE inhibitors and angiotensin-receptor blockers, also have been determined to be renoprotective, independent of their ability to reduce blood pressure (17). Between 70 and 75% of patients aged ≥65 years with diabetes and chronic kidney disease (CKD) use ACE inhibitors or angiotensin receptor blockers, and the percentage is nearly 80% among those aged 20–64 years (1).

An alternative explanation for the decline in diabetes-related ESRD incidence is that the large and sustained increase of new cases of diabetes that has occurred since the 1990s (2) may have led to a large number of individuals who have not had diabetes long enough to develop ESRD. Furthermore, in 1997, the American Diabetes Association revised the diagnostic criteria for diabetes, lowering the threshold of the fasting glucose value from 140 to 126 mg/dl (18). This change may have resulted in a greater number of individuals with milder disease, detected earlier in the disease process. Once these patients with new-onset, milder disease have had diabetes long enough, it is possible that the encouraging trends in diabetes-related ESRD incidence may reverse. In addition, it is possible that improved survival among individuals with diabetes could lead to longer diabetes durations and, thus, greater opportunity to develop ESRD.

Even though diabetes-related ESRD incidence in the population with diabetes has decreased since 1996, diabetes-related ESRD incidence in the general population and the number of new cases of diabetes-related ESRD continue to increase, albeit at a slower rate (1,2). Reducing the number of new cases of diabetes-related ESRD will be difficult to achieve as our population ages and...
the prevalence of ESRD risk factors, such as diabetes, continues to increase (2). Nearly 24 million adults in the U.S. had diabetes in 2007 (3), and 75% of adults with diabetes have hypertension (i.e., blood pressure ≥130/80 mm of mercury or use prescription medications for hypertension) (16). Furthermore, >26 million U.S. adults were estimated to have CKD (19), placing them at risk of progressing to ESRD. For reasons that are not yet clear, individuals belonging to minority populations in the U.S. may progress rapidly from CKD to ESRD (20). Increased awareness of the risk of developing kidney disease among individuals with diabetes or hypertension (21) and interventions, such as blood glucose and blood pressure control (22,23), to prevent or delay the onset of kidney disease or reduce its progression are needed to sustain and improve trends in diabetes-related ESRD incidence.

The findings in this report are subject to several limitations. First, data were collected for individuals whose ESRD treatment was reported to CMS; those who died from ESRD before receiving treatment, those who refused treatment, and those whose treatment was not reported to CMS were not included (5). Second, because the incidence of diabetes-related ESRD was defined in terms of initiation of ESRD treatment, changes in incidence may have been due to changes in factors other than disease incidence. These factors may include better access to ESRD treatment or acceptance of treatment, changes in treatment and care practices, greater recognition of the etiologic role of diabetes in ESRD, or a combination of these. The primary diagnosis was taken from the CMS Medical Evidence Report and was based on the physician’s assessment of the patient (5), which may have affected trends, especially if patients had other ESRD risk factors such as hypertension. From 1999 to 2004, three of four individuals with diabetes also had hypertension (16). Third, the estimated population with diabetes from the NHIS was based on self-report and underestimates the total population with diabetes in the U.S. Approximately 25% of individuals with diabetes have not had their diabetes diagnosed (3). Fourth, the low estimate of the population with diabetes in 1996 and the survey redesign in 1997 resulted in a large increase in the number of individuals with diagnosed diabetes between 1996 and 1997 (9). Despite the dip in the number of cases between 1996 and 1997, joinpoint regression analysis indicated that the prevalence and incidence of diabetes increased steadily (i.e., without significant changes in direction or magnitude) between 1990 and 2006 (2,24). Furthermore, exclusion of the 1996 data did not substantively affect diabetes-related ESRD incidence trends (4). More investigation is needed to determine what other factors might explain the declining diabetes-related ESRD incidence in the population with diabetes since 1996. Finally, the correlation between the length of time diabetic patients had the disease and their risk for developing diabetes-related ESRD was not assessed because of a lack of data on duration of diabetes.

Diabetes-related ESRD is a costly and disabling condition with a high mortality rate that continues to disproportionately affect U.S. minority populations (1). In 2006, the age-adjusted diabetes-related ESRD incidence among Hispanics and blacks with diabetes was 1.5 and 2.0 times greater than that for whites. Intervention programs to prevent ESRD and eliminate racial/ethnic disparities should aim to raise awareness about kidney disease and promote early diagnosis, prevent and control ESRD risk factors, and improve patient outcomes, especially among populations with a greater burden of ESRD. Continued surveillance of diabetes-related ESRD using USRDS data will help public health officials monitor and assess progress in lowering incidence and reducing racial/ethnic disparities. New initiatives at the Centers for Disease Control and Prevention are currently underway to establish a national surveillance system for CKD and its risk factors that can estimate the magnitude of disease in the U.S., monitor trends, and identify groups at risk (25).

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