Survival on Dialysis Among American Indians and Alaska Natives With Diabetes in the United States, 1995–2010

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Objectives. We assessed survival in American Indians and Alaska Natives (AI/ANs) with end-stage renal disease attributed to diabetes who initiated hemodialysis between 1995 and 2009.

Methods. Follow-up extended from the first date of dialysis in the United States Renal Data System until December 31, 2010, kidney transplantation, or death. We used the Kaplan-Meier method to compute survival on dialysis by age and race/ethnicity and Cox regression analysis to compute adjusted hazard ratios (HRs).

Results. Our study included 510 666 persons—48% Whites, 2% AI/AN persons, and 50% others. Median follow-up was 2.2 years (interquartile range = 1.1–4.1 years). At any age, AI/AN persons survived longer on hemodialysis than Whites; this finding persisted after adjusting for baseline differences. Among AI/AN individuals, those with full Indian blood ancestry had the lowest adjusted risk of death compared with Whites (HR = 0.58; 95% confidence interval = 0.55, 0.61). The risk increased with declining proportion of AI/AN ancestry.

Conclusions. Survival on dialysis was better among AI/AN than White persons with diabetes. Among AI/AN persons, the inverse relationship between risk of death and level of AI/AN ancestry suggested that cultural or hereditary factors played a role in survival. (*Am J Public Health.* 2014;104:S490–S495. doi:10.2105/AJPH.2014.301942)

End-stage renal disease (ESRD), which is kidney failure requiring dialysis or transplantation, is a costly and disabling condition that disproportionately affects racial/ethnic minority populations.[1] In 2010, approximately 408 000 people in the United States were living on dialysis,[2] including approximately 6000 patients who were American Indian/Alaska Native (AI/AN) persons, and nearly half of the new dialysis patients belonged to racial/ethnic minorities.[2,3] Diabetes is the leading cause of ESRD, accounting for approximately 45% of new cases in the United States. Because both diabetes and dialysis disproportionately affect racial/ethnic minority populations,[1,3–5] a greater proportion of incident ESRD is attributed to diabetes among AI/AN persons (71%), Hispanics (60%), and Asians (50%) than among Whites.[2]

Although survival on dialysis has improved across treatment modalities, it remains much reduced; half of the patients with ESRD attributed to diabetes die within 3 years of beginning dialysis in the United States.[1] Regardless of the type of ESRD treatment, survival is generally poorer in diabetic ESRD patients than in those without diabetes, primarily because of the higher coexistent morbidity associated with diabetes, particularly cardiovascular diseases.[6–9] Survival on dialysis, however, is generally longer among non-White than White patients, although a few smaller studies have focused on the ESRD population with diabetes.[6,10,11]

In this study, we assessed survival in persons in the US Renal Data System (USRDS) who initiated hemodialysis between 1995 and 2009 with diabetes as the primary cause of kidney failure. Adjusted risk of death during hemodialysis was compared across the AI/AN population and 4 other mutually exclusive racial/ethnic groups, including Whites, in an attempt to explain the survival differences among these groups.

METHODS

We extracted patient-level data from the USRDS standard analysis files. The USRDS, which is administered by the National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, collects, analyzes, and distributes information on people receiving ESRD treatment from medical claims reports to the Centers for Medicare and Medicaid Services (CMS).[1] The data collected in the USRDS include demographic characteristics and ESRD-related information, such as first date of treatment, primary cause of renal failure, date of transplant (if applicable), and date of death.[1] Primary diagnosis (i.e., the primary cause of kidney failure) is taken from the CMS Medical Evidence Report, which is completed by the renal care provider for each new ESRD patient and is based on the physician's assessment of the patient. We used USRDS data from 1995 to 2009 to determine the overall number of persons in the United States who began hemodialysis treatment of ESRD with diabetes listed as the primary diagnosis. The USRDS registry includes self-identified race and ethnicity for virtually all patients. In the present study, we defined 5 mutually exclusive racial/ethnic groups based on the primary self-reported race and ethnicity as follows: non-Hispanic Whites (Whites), non-Hispanic Blacks (Blacks), non-Hispanic Asians (Asians), non-Hispanic AI/AN persons, and Hispanics. Hispanic persons may be of any race. Hereafter, we used the terms for race to designate non-Hispanic groups, and we used the term non-White to designate racial/ethnic groups other than Whites. In addition to obtaining AI/AN race from the USRDS database, AI/AN race and blood quantum, that is, an indicator to the degree of Native American ancestry or Indian blood (e.g., full, one half, one quarter, and less than one quarter), was assessed from Indian Health Service (IHS) records, which included nearly 60% of AI/AN persons from the US general population.[7] Blood quantum data were missing in fewer than 10% of the AI/AN cases that were linked in the USRDS

and IHS databases. Of all AI/ANs, 7435 AI/AN individuals (77%) had available self-reported AI/AN ancestry information.

To ascertain date and causes of death, we used data from the CMS ESRD Death Notification form, which is required by the CMS to be completed by renal providers in reporting ESRD death events.

Study Sample

The study included incident hemodialysis patients who were at least 20 years old at the initiation of hemodialysis between January 1, 1995, and December 31, 2009. Patients were included if they had diabetes listed as the primary cause of kidney failure (*International Classification of Diseases, Ninth Revision*[12] code 250.40 or 250.41) in the USRDS, and available information on the primary cause of death.

The study began in 1995 because before that year dialysis units and transplant centers were required to file the Medical Evidence Report only for Medicare-eligible patients (i.e., those people who had enough credits by paying Social Security taxes).[1] Since 1995, renal care providers have been required to complete the CMS Medical Evidence Report for each new patient with ESRD regardless of Medicare eligibility status. Thus, the USRDS database included the entire ESRD population regardless of insurance type. All patients included in our analysis did not have missing information on age, gender, and race/ethnicity.

Statistical Analysis

We presented clinical and demographic characteristic features at the beginning of hemodialysis for patients in the 5 racial/ethnic categories. Patient follow-up extended from the date of first dialysis treatment to the date of death, kidney transplantation, or December 31, 2010, whichever came first. We estimated unadjusted survival as a function of follow-up time, stratified by the 5 racial/ethnic categories and by age groups, and 95% confidence intervals (CIs) using the Kaplan-Meier product-limit survival curve. We assessed differences in survival by the log-rank test. We used Cox regression analysis to estimate the hazard ratios (HRs) and 95% CIs for death from any cause associated with race/ethnicity, unadjusted and adjusted for baseline age, gender, body mass index (BMI), estimated glomerular filtration rate (eGFR), current smoking, before dialysis, and comorbidities, such as hypertension, chronic obstructive pulmonary disease (COPD), cardiovascular disease (CVD), malignancy, and erythropoietin treatment ascertained in the Medical Evidence Report. Erythropoietin treatment is recommended for the treatment of anemia,[8] a risk factor for CVD,[9,13] among patients with kidney disease. CVD included coronary heart disease, heart failure, myocardial infarction, transient ischemic cerebral attack, arrhythmia, and peripheral artery disease. Because a subgroup of patients had complete information on eGFR, current smoking, BMI, treatment with erythropoietin, hypertension, CVD, COPD, and malignancy, we presented all HRs for this subgroup (n = 379 486 patients, representing 74% of the whole cohort). Each model included quadratic terms for age because of the nonlinear relationship with mortality. We assessed the adequacy of the fit of each model to individual observations by inspection of deviance residuals. Product terms (i.e., interaction) of predictor variables did not significantly improve the regression models and were not included. HRs for death compared with Whites were also computed for 6493 AI/AN persons (67% of the AI/AN population) with complete information on all of the previously described covariates. Of these AI/AN individuals, 4826 had information on AI/AN ancestry, and 1667 were not linked to the IHS database.

RESULTS

Our study included 510 666 persons (mean age = 62.6 years; 51% male), of whom 48% were White, 28% Black, 18% Hispanic, 4% Asian, and 2% AI/AN. Baseline characteristics of the study cohort are shown in Table 1 according to the 5 racial/ethnic groups. Baseline characteristics presented in Table 1 were missing in no more than 25.5% of White, 22.7% of Black, 22.5% of Asian, 23.0% of AI/AN, and 25.4% of Hispanic individuals. Compared with the other race/ethnicities, Whites were on average older, more likely to be male and current smokers, and had a higher prevalence of CVD, COPD, and malignancy at the start of dialysis. AI/AN persons were on average younger than other groups and had lower eGFR levels; Blacks had the lowest proportion of males, highest mean BMIs, highest prevalence of hypertension, and lowest hemoglobin levels. Erythropoietin treatment before dialysis was most frequent among Asians and least frequent in Hispanic patients, whereas current smoking, COPD, and malignancy were least frequent in Asians and Hispanics.

During the median follow-up time of 2.24 years (interquartile range [IQR] = 1.05–4.09 years), 338 526 (66%) patients died, representing 73% of Whites, 62% of Blacks, 57% of Asians, 60% of AI/ANs, and 59% of Hispanics (Table 2). Overall, the median survival on hemodialysis was 3.11 years (95% CI = 3.09, 3.12). Survival was longer at younger ages and declined with increasing age. However, at any age, AI/AN populations and other non-White racial/ethnic groups with diabetes had longer survival on hemodialysis than Whites, with AI/AN and Asian persons having longer absolute survival overall and Asians experiencing the longest age-specific median survival time. During follow-up, 35 890 (7.0%) patients were censored at the date of their first kidney transplant, half of whom were Whites. Of all Whites starting dialysis between 1995 and 2009, 7.7% received a first transplant compared with 6.0% of all Blacks, 7.0% of all Asians, 7.6% of all AI/AN persons, and 6.9% of all Hispanics. The median time to the first transplant was shortest for Whites (1.5 years; IQR = 0.8–2.7 years), longest for AI/AN (2.8 years; IQR = 1.5–4.4 years) and Black patients (2.8 years; IQR = 1.6–4.4 years), and intermediate for Asians (2.5 years; IQR = 1.4–4.1 years) and Hispanics (2.6 years; IQR = 1.4–4.3 years).

The leading causes of death in the cohort were CVD, representing 55.8% of all deaths, and infections, with 15.9% of the deaths. Malignancy accounted for 2.8%, withdrawal from dialysis for 5.2%, and unknown or unidentified causes for 9.6% of the deaths. Other causes, including external causes of death, represented each less than 1.0% of the deaths. The leading causes of death were the same for each racial/ethnic group.

The survival advantage of AI/AN and other non-White racial/ethnic groups persisted after adjusting for multiple confounders in

TABLE 1—Characteristics of the Incident Population Ascertained in the Medical Evidence Report at the Beginning of Hemodialysis for Diabetes-Related End-Stage Renal Disease, by Race/Ethnicity: United States, 1995–2009

Characteristic	All (n = 510 666), Mean or % (95% CI)	White (n = 244 574), Mean or % (95% CI)	Black (n = 143 884), Mean or % (95% CI)	Asian (n = 21 031), Mean or % (95% CI)	AI/AN (n = 9669), Mean or % (95% CI)	Hispanic (n = 91 508), Mean or % (95% CI)
Age, y	62.58 (62.54, 62.61)	64.42 (64.37, 64.47)	60.58 (60.51, 60.65)	63.86 (63.69, 64.02)	58.42 (58.19, 58.67)	60.93 (60.85, 61.00)
Male	51.23 (51.09, 51.36)	54.70 (54.50, 54.89)	44.34 (44.08, 44.60)	53.43 (52.75, 54.10)	45.57 (44.57, 46.57)	52.87 (52.55, 53.20)
eGFR, ml/min/1.73 m^2	10.23 (10.22, 10.24)	10.70 (10.68, 10.72)	10.09 (10.07, 10.12)	8.98 (8.92, 9.04)	9.00 (8.92, 9.08)	9.63 (9.60, 9.66)
Serum creatinine, mg/dl	6.48 (6.48, 6.49)	5.90 (5.89, 5.91)	7.28 (7.26, 7.30)	7.04 (6.99, 7.08)	6.91 (6.85, 6.97)	6.63 (6.61, 6.65)
Hemoglobin, g/dl	9.83 (9.82, 9.83)	10.00 (9.99, 10.01)	9.56 (9.55, 9.57)	9.91 (9.88, 9.93)	9.70 (9.66, 9.73)	9.78 (9.77, 9.79)
Erythropoietin treatment	33.55 (33.41, 33.68)	36.62 (36.42, 36.82)	30.40 (30.15, 30.65)	37.93 (37.23, 38.63)	31.75 (30.74, 32.78)	29.32 (29.01, 29.64)
BMI, kg/m^2	29.17 (29.15, 29.19)	29.59 (29.56, 29.63)	29.70 (29.66, 29.74)	25.84 (25.76, 25.93)	29.07 (28.93, 29.22)	27.99 (27.95, 28.04)
Hypertension diagnosis	81.44 (81.33, 81.54)	78.83 (78.67, 78.99)	85.07 (84.88, 85.25)	82.10 (81.58, 82.62)	82.87 (82.11, 83.62)	82.38 (82.13, 82.63)
CVD diagnosis	70.71 (70.58, 70.85)	76.21 (76.03, 76.38)	65.17 (64.90, 65.44)	65.32 (64.59, 66.03)	65.22 (64.18, 66.25)	65.56 (65.22, 65.90)
COPD diagnosis	7.48 (7.40, 7.55)	10.77 (10.65, 10.90)	5.35 (5.23, 5.46)	3.23 (2.99, 3.48)	4.36 (3.97, 4.79)	3.32 (3.20, 3.44)
Current smoking	4.52 (4.47, 4.58)	5.44 (5.35, 5.53)	4.81 (4.70, 4.92)	2.28 (2.08, 2.49)	4.87 (4.45, 5.32)	2.10 (2.01, 2.19)
Malignancy diagnosis	3.80 (3.75, 3.85)	4.96 (4.88, 5.05)	3.28 (3.19, 3.37)	2.33 (2.13, 2.55)	2.48 (2.18, 2.81)	1.98 (1.89, 2.07)

Note. AI/AN = American Indian/Alaska Native; BMI = body mass index; CI = confidence interval; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease; eGFR = estimated glomerular filtration rate. Race groups are non-Hispanic; Hispanic persons may be of any race. Information is missing on BMI (4%), eGFR (2%), hemoglobin (11%), serum creatinine (1%), erythropoietin treatment (10%), and CVD (14%).

a Cox regression analysis (Table 3). All HRs are presented for the subgroup with complete data (n = 379 486 patients, representing 74% of the whole cohort). Compared with Whites, the unadjusted risk of death was 44% lower in AI/ANs, and 40% lower in Asians, Blacks, and Hispanics, respectively. Age and gender adjustment increased these HRs, particularly for the AI/AN patients. After further adjustments for baseline BMI, eGFR, current smoking, treatment with erythropoietin, and history of hypertension, CVD, COPD, or malignancy, the risk of death was 31% lower for AI/AN, Black, and Hispanic patients, respectively, and 38% lower in Asians. Among AI/AN persons, those with full Indian blood ancestry had a lower adjusted risk of death than Whites (HR = 0.58; 95% CI = 0.55, 0.61; Figure 1). The HR increased to 0.75 (95% CI = 0.70, 0.81) with declining proportion of AI/AN ancestry in those with at least one half (but less than full) blood quantum; 0.85 (95% CI = 0.75, 0.97) in those with at least one quarter (but less than half) blood quantum; and 0.95 (95% CI = 0.82, 1.11) in those with less than one quarter blood quantum. Among AI/ANs who did not appear in the IHS database, the HR of death was similar to the groups with at least one quarter but less than full blood quantum (HR = 0.80; 95% CI = 0.76; 0.85). Age- and gender-adjusted analysis for those with missing covariates yielded HRs that were similar to those in the cohort with complete data.

DISCUSSION

In contrast with racial/ethnic disparities for diabetes-related complications,[5] survival on

TABLE 2—Median Survival Time According to Race/Ethnicity and Age at Initiation of Dialysis for Diabetes-Related End-Stage Renal Disease: United States, 1995–2010

Age Group	Median Survival, Years (95% CI)					Total	
	White (n = 244 574)	Black (n = 143 884)	Asian (n = 21 031)	AI/AN (n = 9669)	Hispanic (n = 91 508)	No. Deaths	Median Survival, Years (95% CI)
20–39 y	4.13 (3.98, 4.24)	6.64 (6.35, 7.01)	8.55 (7.93, 9.19)	6.83 (5.97, 7.75)	7.36 (6.88, 7.73)	9910	5.58 (5.46, 5.72)
40–59 y	3.43 (3.39, 3.46)	5.36 (5.28, 5.42)	5.89 (5.73, 6.13)	5.64 (5.40, 5.86)	5.60 (5.50, 5.71)	90 930	4.59 (4.55, 4.62)
60–79 y	2.14 (2.12, 2.16)	3.39 (3.36, 3.43)	3.75 (3.65, 3.84)	3.36 (3.23, 3.47)	3.30 (3.26, 3.36)	203 517	2.69 (2.67, 2.70)
≥ 80 y	1.19 (1.16, 1.22)	1.60 (1.53, 1.67)	1.83 (1.69, 1.97)	1.72 (1.40, 1.91)	1.43 (1.34, 1.50)	34 169	1.31 (1.28, 1.33)
Total median survival, all age groups	2.35 (2.34, 2.37)	4.00 (3.97, 4.03)	4.17 (4.08, 4.25)	4.28 (4.15, 4.39)	4.02 (3.98, 4.06)		3.11 (3.09, 3.12)

Note. AI/AN = American Indian/Alaska Native; CI = confidence interval. Total number of deaths: 338 526 (177 724 in Whites; 89 164 in Blacks; 12 016 in Asians; 5791 in AI/ANs; 53 831 in Hispanics). Race groups are non-Hispanic; Hispanic persons may be of any race.

TABLE 3—Unadjusted and Adjusted Hazard Ratios for Death From Any Cause in Hemodialysis Patients Treated for Diabetes-Related End-Stage Renal Disease, by Race/Ethnicity: United States, 1995–2010

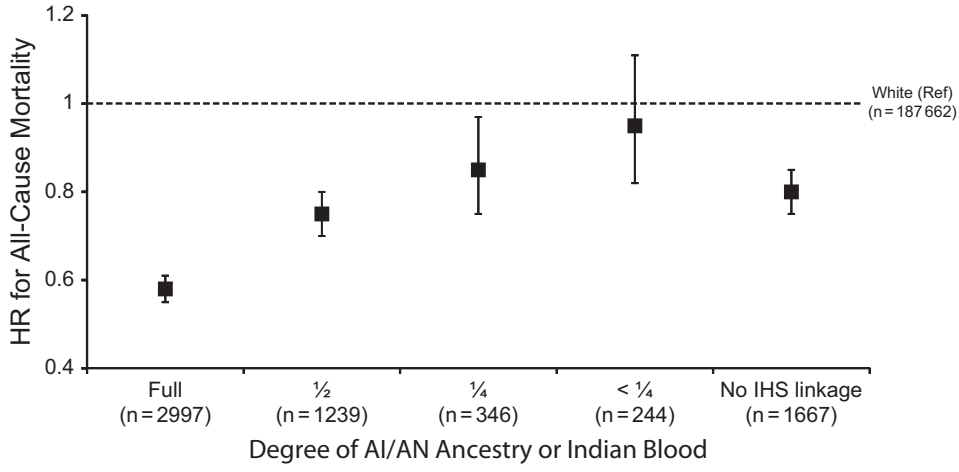
Race/Ethnicity	Model		
	Unadjusted HR (95% CI)	Age and Gender Adjusted HR (95% CI)	Fully Adjusted[a] HR (95% CI)
White (n = 187 662; Ref)	1.00	1.00	1.00
Black (n = 106 393)	0.60 (0.59, 0.61)	0.67 (0.66, 0.68)	0.69 (0.68, 0.70)
Asian (n = 14 618)	0.60 (0.58, 0.61)	0.60 (0.59, 0.62)	0.62 (0.60, 0.63)
AI/AN (n = 6493)	0.56 (0.54, 0.57)	0.66 (0.64, 0.68)	0.69 (0.67, 0.71)
Hispanic (n = 64 320)	0.60 (0.59, 0.61)	0.68 (0.67, 0.68)	0.69 (0.68, 0.69)

Note. AI/AN = American Indian/Alaska Native; CI = confidence interval; HR = hazard ratio. Race groups are non-Hispanic; Hispanic persons may be of any race. HRs for Whites relative to all other racial/ethnic groups combined were 1.67 (95% CI = 1.66, 1.68; unadjusted), 1.50 (95% CI = 1.49, 1.51; age and gender adjusted), and 1.46 (95% CI = 1.45, 1.48; fully adjusted). All models include only patients with no missing information on the covariates in the fully adjusted model, representing 74% of the entire cohort, and a quadratic term for age. The reference group is non-Hispanic Whites on hemodialysis with a primary diagnosis of diabetes.

[a]In addition to gender, baseline age, and squared age, the model included baseline body mass index, estimated glomerular filtration rate, current smoking status, treatment with erythropoietin before dialysis, and history of hypertension, cardiovascular disease, chronic obstructive pulmonary disease, or malignancy.

hemodialysis was longer among AI/AN and other non-White patients with diabetes than among Whites with diabetes. After adjustment for multiple demographic characteristics and clinical variables at initiation of hemodialysis, the risk of death was 31% lower in AI/AN, Black, or Hispanic patients compared with Whites, and 38% lower in Asians. Among the 5 racial/ethnic groups studied, Asian patients with diabetes had the lowest risk of death while on hemodialysis. This was the first study, to our knowledge, to compare survival on dialysis for diabetes-related ESRD in 5 US racial/ethnic groups, including AI/AN persons, and to analyze survival on dialysis among AI/AN individuals by blood quantum. Our findings were consistent with those of previous studies, indicating a survival advantage among American Indians,[6] Blacks,[10] and Hispanics[11,14] with diabetes compared with Whites on dialysis. A study conducted in White, Black, and Hispanic incident dialysis patients over a similar period of time showed that mortality risk was lowest in Hispanics, intermediate in Blacks, and highest in Whites.[15] Although patients with diabetes were not analyzed separately in the study by Yan et al.,[15] the survival advantage persisted in the older age groups, who were more likely to receive therapy for diabetic ESRD. The survival advantage among non-White groups on dialysis has been described for at least 20 years,[10,16] and the reasons for this advantage have yet to be elucidated. Combined with the higher incidence of diabetes-related ESRD, longer survival on dialysis largely explained the greater prevalence of diabetes-related ESRD among racial/ethnic minority populations.[1,5] Nevertheless, death rates have declined and 5-year survival has improved for people initiating dialysis overall, suggesting that treatment and care practices in the dialysis population have improved.[1]

AI/AN and other racial/ethnic minority populations in the United States are disproportionately affected by diabetes,[5] and among those who develop diabetes, the adjusted incidence rates of ESRD are 1.6 to 3.3 times higher than those among Whites with



Note. AI/AN = American Indian and Alaska Native; HR = hazard ratio; IHS = Indian Health Service. Information on blood quantum—an indicator to the degree of Native American ancestry or Indian blood—was obtained from the IHS patient database. The reference group is non-Hispanic Whites on hemodialysis with a primary diagnosis of diabetes (dashed horizontal line). Whiskers represent 95% confidence intervals around the hazard ratio estimates.

FIGURE 1—Hazard ratio and 95% confidence intervals for death from any cause among American Indians and Alaska Natives with diabetes at initiation of hemodialysis, by degree of blood quantum: United States, 1995–2010.

diabetes,[1] suggesting that the latter are more likely to die, mainly of CVD,[17] before receiving treatment for ESRD. However, this potential bias did not appear to result in a White chronic kidney disease population being healthier at the start of renal replacement therapy than other racial/ethnic groups. In our study, Whites with diabetes were older, more likely to be current smokers, and had a higher frequency of serious comorbidities, such as CVD, COPD, and malignancy than any of the other 4 racial/ethnic groups at the start of dialysis. Taken together, comparing the HRs between the fully adjusted and unadjusted models, these factors explained only 23% of the excess risk for death in Whites relative to AI/AN persons, 15% relative to Blacks or Hispanics, and 3% of the excess risk relative to Asians. Thus, other differences in demographic, clinical, or socioeconomic characteristics,[18–23] at or after initiation of dialysis, might be responsible for the differential survival in hemodialysis patients with diabetes.

By contrast, dialysis-related complications, including accelerated atherosclerosis, left ventricular hypertrophy, inflammation, and malnutrition might progress at slower rates in non-White than White patients on dialysis treatment, and adjusting for baseline differences only might not capture these changes. Follow-up measurements after start of dialysis were not available for a time-dependent adjustment. In addition, we adjusted for baseline confounders that were measured consistently throughout the 15-year study in at least two thirds of the incident cohort; therefore, other potentially explanatory variables might have been missed. Median time to first transplant might be another confounding factor, but it was unlikely that this explained the degree of the survival differential between Whites and non-Whites. The bias in survival, with Whites having the shortest median time to first transplant compared with non-Whites, would be in the direction of favoring Whites; this was not the case. Thus, our findings provided conservative estimates of the race/ethnicity effect.

Major strengths of the study were the analysis of a large national cohort of dialysis patients with diabetes over a long period of time, analysis of survival on dialysis among AI/AN persons by blood quantum, and validation of the AI/AN classification using the IHS patient database to minimize the potential misclassification bias of AI/AN persons in the USRDS database.[24,25] We also had some limitations in the present findings. First, we collected data only for individuals whose ESRD treatment was reported to CMS, which excluded those who died before receiving dialysis and those who refused treatment. Although this might have occurred differentially between Whites and non-Whites, the proportion of these patients was likely small. Second, potentially relevant clinical variables, such as hemoglobin A1c and serum albumin concentration, were collected only with the new and improved Medical Evidence Report introduced in 2005, and therefore, these levels were inconsistently ascertained over the 15-year study. Third, diabetes as primary diagnosis was taken from the CMS Medical Evidence Report and was based on the physician's assessment of the patient, possibly introducing misclassification bias for the primary cause of ESRD. Finally, for the fully adjusted regression analysis, approximately 25% of patients with missing data were discarded, potentially introducing severe bias. Nevertheless, age and gender adjustment in those with missing information on other covariables yielded similar HRs as age and gender adjustment in the complete case analysis. Furthermore, eliminating adjustments for those variables that were least frequently ascertained (COPD, current smoking, and erythropoietin treatment) increased the sample, but did not change the overall results, indicating that the bias introduced by complete case analysis was likely minor.

In summary, in this incident dialysis cohort with diabetes related ESRD, survival was longer among AI/AN than White patients, which contributed to the higher prevalence of ESRD in this population.[1] Among AI/AN persons, those with full Indian blood ancestry had the lowest adjusted risk of death compared with Whites, and this risk increased with declining proportion of AI/AN ancestry, suggesting that hereditary factors played a role in how patients responded to dialysis treatment. The linkage between the USRDS and IHS databases provided an important tool to improve the racial identification of AI/AN persons and strengthen the survival analyses. Although the adjusted analysis accounted for a number of baseline differences among racial/ethnic groups with diabetes, additional clinical, socioeconomic, or cultural characteristics at or after initiation of dialysis might be responsible for the differential survival in hemodialysis patients with diabetes. Reducing the number of patients beginning treatment for diabetes-related ESRD would be difficult to achieve because of the aging population and the continued growth in the prevalence of diabetes in the United States.[5,26] Nevertheless, efficacious treatments and practices exist, and enhancing the effectiveness of existing therapies is paramount in reducing the risk of ESRD among people with diabetes.[27–31] Ultimately, preventing diabetes among those at highest risk, including AI/AN persons, is the best way to reduce the number of ESRD cases. ■

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Note. *The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC) or the Indian Health Service (IHS).*

Contributors

N. Ríos Burrows and K. McKeever Bullard had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. N. Ríos Burrows, P. Cho, K. McKeever Bullard, A. S. Narva, and P. W. Eggers conceptualized and designed the study. N. Ríos Burrows and P. W. Eggers acquired the data. N. Ríos Burrows, K. McKeever Bullard, and P. W. Eggers analyzed and interpreted the data. N. Ríos Burrows and K. McKeever Bullard drafted the article. N. Ríos Burrows, K. McKeever Bullard, P. Cho, A. S. Narva, and P. W. Eggers wrote the critical revision of the article for important intellectual content. K. McKeever Bullard and P. Cho performed the statistical analysis. N. Ríos Burrows supervised the study.

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Human Participant Protection

CDC and IHS determined this project to constitute public health practice and not research; therefore, no formal institutional review board approvals were required.

References

1. US Renal Data System. *USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2013.

2. US Renal Data System. Renal Data Extraction and Referencing (RenDER) System [online query system]. Available at: http://www.usrds.org. Accessed May 3, 2013.

3. Burrows NR, Li Y, Williams DE. Racial and ethnic differences in trends of end-stage renal disease: United States, 1995 to 2005. *Adv Chronic Kidney Dis*. 2008; 15(2):147–152.

4. Centers for Disease Control and Prevention. *National Diabetes Fact Sheet: National Estimates and General Information on Diabetes and Prediabetes in the United States, 2011*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2011.

5. Centers for Disease Control and Prevention. Diabetes Data and Trends. Available at: http://www.cdc.gov/diabetes/statistics/index.htm. Accessed May 3, 2013.

6. Nelson RG, Hanson RL, Pettitt DJ, Knowler WC, Bennett PH. Survival during renal replacement therapy for diabetic end-stage renal disease in Pima Indians. *Diabetes Care*. 1996;19(12):1333–1337.

7. Indian Health Service. Trends in Indian Health. Available at: http://www.ihs.gov/DPS/index.cfm?module=hqPubTrends03. Accessed May 3, 2013.

8. Kidney Disease: Improving Global Outcomes (KDIGO) Anemia Work Group. KDIGO clinical practice guideline for anemia in chronic kidney disease. *Kidney Int*. 2012;2(4 suppl 2):279–335.

9. Sarnak MJ, Tighiouart H, Manjunath G, et al. Anemia as a risk factor for cardiovascular disease in the Atherosclerosis Risk in Communities (ARIC) study. *J Am Coll Cardiol*. 2002;40(1):27–33.

10. Cowie CC, Port FK, Rust KF, Harris MI. Differences in survival between black and white patients with diabetic end-stage renal disease. *Diabetes Care*. 1994; 17(7):681–687.

11. Murthy BV, Molony DA, Stack AG. Survival advantage of Hispanic patients initiating dialysis in the United States is modified by race. *J Am Soc Nephrol*. 2005; 16(3):782–790.

12. *International Classification of Diseases, Ninth Revision*. Geneva, Switzerland: World Health Organization; 1980.

13. Vlagopoulos PT, Tighiouart H, Weiner DE, et al. Anemia as a risk factor for cardiovascular disease and all-cause mortality in diabetes: the impact of chronic kidney disease. *J Am Soc Nephrol*. 2005;16(11):3403–3410.

14. Frankenfield DL, Rocco M, Roman S, McClellan W. Survival advantage for adult Hispanic hemodialysis patients? Findings from the End-Stage Renal Disease Clinical Performance Measures Project. *J Am Soc Nephrol*. 2003;14:180–186.

15. Yan G, Norris KC, Yu AJ, et al. The relationship of age, race, and ethnicity with survival in dialysis patients. *Clin J Am Soc Nephrol*. 2013;8(6):953–961.

16. Pugh JA, Tuley MR, Basu S. Survival among Mexican-Americans, non-Hispanic whites, and African-Americans with end-stage renal disease: the emergence of a minority pattern of increased incidence and prolonged survival. *Am J Kidney Dis*. 1994;23(6):803–807.

17. Collins AJ, Li S, Gilbertson DT, Liu J, Chen S-C, Herzog CA. Chronic kidney disease and cardiovascular disease in the Medicare population. *Kidney Int Suppl*. 2003;64:S24–S31.

18. Yan G, Cheung AK, Ma JZ, et al. The associations between race and geographic area and quality-of-care indicators in patients approaching ESRD. *Clin J Am Soc Nephrol*. 2013;8(4):610–618.

19. Buckalew VM Jr, Freedman BI. Reappraisal of the impact of race on survival in patients on dialysis. *Am J Kidney Dis*. 2010;55(6):1102–1110.

20. Feroze U, Noori N, Kovesdy CP, et al. Quality-of-life and mortality in hemodialysis patients: roles of race and nutritional status. *Clin J Am Soc Nephrol*. 2011; 6(5):1100–1111.

21. Noori N, Kovesdy CP, Dukkipati R, et al. Racial and ethnic differences in mortality of hemodialysis patients: role of dietary and nutritional status and inflammation. *Am J Nephrol*. 2011;33(2):157–167.

22. Kimmel PL, Fwu CW, Eggers PW. Segregation, income disparities, and survival in hemodialysis patients. *J Am Soc Nephrol*. 2013;24(2):293–301.

23. Sandhu GS, Khattak M, Rout P, et al. Social adaptability index: application and outcomes in a dialysis population. *Nephrol Dial Transplant*. 2011;26(8):2667–2674.

24. Newman JM, Marfin AA, Eggers PW, Helgerson SD. End state renal disease among Native Americans, 1983–86. *Am J Public Health*. 1990;80(3):318–319.

25. Sugarman JR, Lawson L. The effect of racial misclassification on estimates of end-stage renal disease among American Indians and Alaska Natives in the Pacific Northwest, 1988 through 1990. *Am J Kidney Dis*. 1993; 21(4):383–386.

26. Burrows NR, Li Y, Geiss LS. Incidence of treatment for end-stage renal disease among individuals with diabetes in the US continues to decline. *Diabetes Care*. 2010;33(1):73–77.

27. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977–986.

28. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ*. 2000;321 (7258):405–412.

29. Adler AI, Stratton IM, Neil HA, et al. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): prospective observational study. *BMJ*. 2000;321 (7258):412–419.

30. UK Prospective Diabetes Study Group. Efficacy of atenolol and captopril in reducing risk of macrovascular and microvascular complications in type 2 diabetes (UKPDS 39). *BMJ*. 1998;317 (7160):713–720.

31. Nelson RG. Is treatment of nephropathy in type 1 diabetes efficacious but ineffective? *J Am Soc Nephrol*. 2011;22(3):402–404.