Influence of Race on Kidney Transplant Outcomes within and outside the Department of Veterans Affairs

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Inferior outcomes after kidney transplantation among African Americans are poorly understood. It was hypothesized that unequal access to medical care among transplant recipients might contribute to worse posttransplantation outcomes among African Americans and that racial disparities in kidney transplant outcomes would be less pronounced among patients who receive health care within *versus* outside the Department of Veterans Affairs (VA), because eligible veterans who receive care within the VA are entitled to receive universal access to care, including coverage of prescription drugs. A study cohort of 79,361 patients who were undergoing their first kidney transplant in the United States between October 1, 1991, and October 31, 2000, was assembled, with follow-up data on graft survival obtained through October 31, 2001. After multivariable proportional hazards adjustment for a wide range of recipient and donor characteristics, African-American patients were at increased risk for graft failure compared with non–African-American patients (relative risk [RR] 1.31; 95% confidence interval [CI] 1.26 to 1.36). African-American race was associated with a similarly increased risk for graft failure among patients who were VA users (RR 1.31; 95% CI 1.11 to 1.54) and non-VA users (RR 1.31; 95% CI 1.26 to 1.36). In conclusion, racial disparities in kidney transplant outcomes seem to persist even in a universal access-to-care system such as the VA. Reasons for worse outcomes among African Americans require further investigation.

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Most single and multicenter clinical trials and observational studies have indicated significantly poorer allograft survival rates among African Americans after living and deceased donor kidney transplants (1–7). It is unclear whether poorer allograft survival among African Americans compared with other race or ethnicity groups reflects the influence of genetic and immunologic differences or environmental factors such as low socioeconomic status and poor access to care that may affect adherence with posttransplantation immunosuppressive and surveillance regimens (8–12).

To examine the possibility that racial disparities in kidney transplant outcomes reflect differences in access to care during the posttransplantation period, we designed an observational study to compare outcomes after kidney transplantation among patients who received dialysis care within and outside the United States Department of Veterans Affairs (VA). The VA is the largest integrated managed care system in the United States, providing comprehensive medical care to eligible veterans depending on their priority and eligibility level, determined by a multilevel prioritization system that is based in large part on the extent of service-connected condition, period of service, and income. Several previous studies have demonstrated an absence or diminution in racial disparities for a variety of health outcomes among patients who were treated within *versus* outside the VA (13–16). Among kidney transplant recipients, a crucial difference among eligible veterans and those who are eligible for Medicare but not VA services is that prescription drug coverage, particularly immunosuppressant coverage, in the VA health care system is broader than under Medicare (17). Although the recent Medicare proposal has eliminated time limitation on Medicare benefits for immunosuppression drug coverage (18), traditionally, the coverage of immunosuppressive medications for Medicare recipients ended 3 yr after transplantation, in contrast to the VA health care, which covers all medications, including immunosuppressive agents, with a $2 to $7 copayment for higher income veterans who have no service-connected illness (19).

We hypothesized specifically that as a result of differences in access to care, including coverage of immunosuppressive agents during the posttransplantation period, racial disparities in kidney transplant outcomes would be less pronounced among recipients with evidence of VA dialysis coverage before transplantation than among other recipients. We further hypothesized that this effect would be most pronounced during the later posttransplantation period at the time when Medicare coverage of immunosuppressive agents ceases.

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Materials and Methods

Cohort Definition/Data Sources

The study cohort was composed of all adult patients who were undergoing their first kidney transplant in the United States between October 1, 1991, and October 31, 2000. Patients who were undergoing preemptive transplantation were excluded. Follow-up data on graft survival were obtained through October 31, 2001, providing at least 1 yr of posttransplantation follow-up for the entire cohort. For all cohort patients, we ascertained the date of first transplant from the United States Renal Data System (USRDS) PATIENTS File and patient and donor characteristics along with outcomes data from the PATIENTS File along with the USRDS TRANSPLANT, TXUNOS, and RXHIST60 files. The above USRDS files provide comprehensive clinical and demographic data on all transplant recipients during the pre-, peri-, and posttransplantation periods (Figure 1).

We identified all patients who had received pretransplant dialysis care within the VA between 1991 and 2001 using VA acute inpatient, outpatient, and extended care workload as well as data on care provided under a VA contract or paid by the VA on a fee basis (20–22). These data are maintained at the VA's Austin Automation Center. For purposes of this analysis, we refer to patients who received pretransplant dialysis care in the VA or whose pretransplant dialysis care was paid for by the VA as "VA users" and those who did not as "non-VA users."

Because most ESRD patients are eligible for Medicare irrespective of age (23), many VA users have the option of choosing either Medicare or VA health insurance as their primary health insurance. Therefore, ESRD patients who are VA users often have a greater variety of potential sources of health coverage than those who are non-VA users. We assumed that patients who had received pretransplant dialysis care within the VA represented a group that could rely on having access to VA care and specifically to immunosuppressive agents throughout the posttransplantation period, if needed. We were also able to determine which members of this group underwent kidney transplant surgery

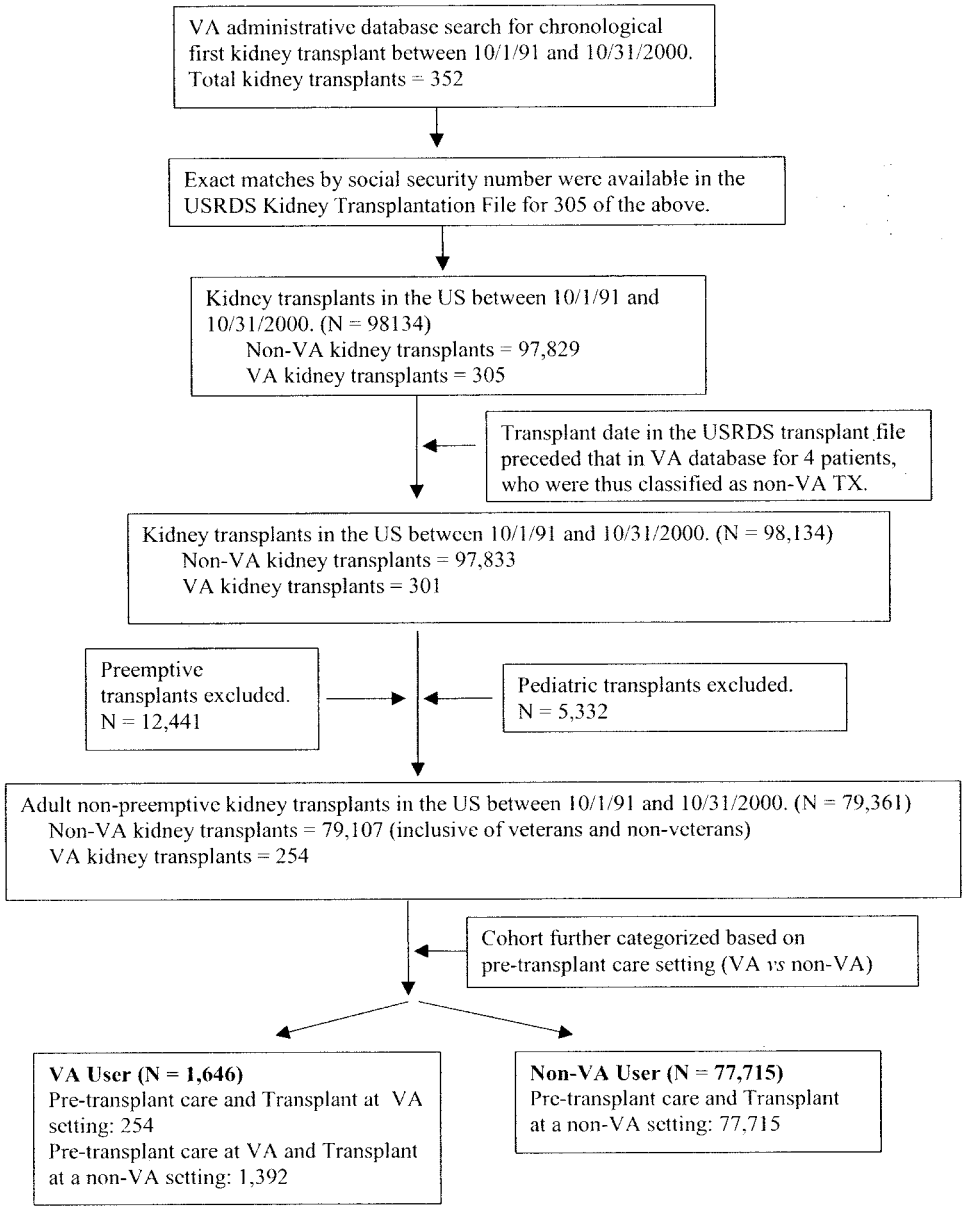

Figure 1. Study cohort.

Table 1. Baseline recipient and donor characteristics[a]

Variable (% Missing Data)	VA Users (n = 1646)		Non-VA Users (n = 77,715)	
	African-American (n = 688)	Non–African-American (n = 958)	African-American (n = 19,323)	Non–African-American (n = 58,392)
Recipient characteristics				
age (yr; mean ± SD; 0)	48.5 ± 11.8	52.7 ± 10.7	44.7 ± 12.6	45.9 ± 13.1
female gender (%; 0)	5	4	42	40
BSA (m^2; mean ± SD; 14)	1.97 ± 0.18	1.97 ± 0.18	1.89 ± 0.21	1.84 ± 0.22
employed (%; 18)	38	44	32	29
college educated (%; 49)	49	45	39	47
independent in activities of daily living (%; 15)	64	61	66	69
peak PRA (≥50%; 4)	5	4	9	6
most recent PRA (%; 4)				
0	80	78	74	75
<50	18	19	22	22
≥50	1	2	4	3
vintage (months; median, 25th to 75th quartile; 0)	32.5, 17.7–49.8	21.4, 12.6-35.7	30.0, 16.3-48.7	18.4, 9.4-33.5
PD at initiation of ESRD treatment (%; 0)	12	17	16	24
PD at the time of transplant (%; 0)	10	17	15	24
transplant era (% patients; 0)				
1991–1993	17	19	17	18
1993–1995	22	22	21	21
1995–1997	24	23	23	23
1997–2000	37	36	39	38
comorbidities (% with condition)				
treated COPD (38)	1	2	<1	<1
treated hypertension (38)	84	78	81	75
cerebrovascular disease (38)	2	2	2	2
cardiovascular disease (38)	15	20	8	12
peripheral vascular disease (38)	3	7	3	5
diabetes (34)	28	38	30	35
Donor characteristics				
age (yr; mean ± SD; 6)	36.1 ± 15.9	37.1 ± 15.7	35.2 ± 16.2	36.1 ± 15.9
female gender (%; 1)	39	42	43	45
race (%; 3)				
African American	29	5	34	6
Asian	<1	1	<1	2
Caucasian	70	92	64	91
Other	<1	1	<1	1
cause of death (% patients; 0)				
trauma	37	30	33	28
vascular (cerebrovascular and cardiovascular)	37	32	35	29
other	26	38	32	42
cold ischemia time (h; mean ± SD; 12)	18.9 ± 10.6	17.2 ± 10.9	17.9 ± 11.2	15.7 ± 11.6
HLA mismatch (%; 4)				
0	5	14	6	13
1	3	6	3	6
2	9	14	11	15
3	24	26	24	24
4	26	20	26	20
5	20	14	20	15
6	12	6	10	7
Donor type (% living; 0)	12	24	19	29

[a]VA, Veterans Affairs; BSA, body surface area; PRA, panel reactive antibody; PD, peritoneal dialysis; COPD, chronic obstructive pulmonary disease.

Table 2. Recipient and donor factors associated with allograft failure (univariate analysis)[a]

Variable	RR and 95% CI
Recipient race	
African-American race *versus* non–African-American race	1.47 (1.43–1.51)
Site of pretransplant care and transplant setting	
VA user (inclusive of VA dialysis and VA transplant and VA dialysis and non-VA transplant) *versus* non-VA user (non-VA transplant and non-VA dialysis)	1.40 (1.30–1.50)
Recipient age (per 10-yr increase)	1.11 (1.09–1.12)
Recipient age^2 (per 10-yr increase)	1.01 (1.00–1.01)
Recipient female gender	0.98 (0.96–1.00)
Comorbidities (present *versus* absent)	
treated COPD	1.13 (1.11–1.15)
treated hypertension	1.18 (1.16–1.20)
cerebrovascular disease	1.14 (1.13–1.16)
cardiovascular disease	1.14 (1.13–1.16)
peripheral vascular disease	1.14 (1.13–1.15)
diabetes	1.17 (1.15–1.19)
Recipient BSA	
<1.6	0.94 (0.91–0.98)
1.6–1.8	0.94 (0.91–0.98)
1.8–2.0	1.00 (referent)
2.0–2.2	1.06 (1.02–1.20)
>2.2	1.15 (1.09–1.21)
Duration on dialysis pretransplant (per 1-yr increase)	1.04 (1.04–1.05)
Dialysis modality at ESRD initiation	
peritoneal dialysis *versus* hemodialysis	0.91 (0.88–0.93)
Dialysis modality pretransplantation	
peritoneal dialysis *versus* hemodialysis	0.92 (0.85–1.00)
Recipient socioeconomic factors	
functional status (independent in activities of daily living *versus* not)	0.77 (0.74–0.80)
employed *versus* unemployed	0.96 (0.95–0.98)
college educated *versus* not	0.85 (0.82–0.88)
HLA mismatch	
0	0.74 (0.70–0.77)
1	0.93 (0.87–0.98)
2	0.95 (0.91–0.99)
3	1.00 (referent)
4	1.12 (1.08–1.16)
5	1.16 (1.12–1.20)
6	1.20 (1.15–1.27)
PRA	
peak PRA >50%	1.23 (1.18–1.29)
most recent PRA >50%	1.26 (1.18–1.34)
Cold ischemia time	
<1 h	1.00 (referent)
1–12 h	1.23 (1.16–1.30)
13–24 h	1.52 (1.46–1.60)
>25 h	1.73 (1.64–1.83)
Transplant era	
1991–1993	1.00 (referent)
1993–1995	0.94 (0.91–0.97)
1995–1997	0.77 (0.74–0.80)
1997–2000	0.75 (0.73–0.79)
Living donor *versus* cadaver donor	0.66 (0.64–0.68)
Donor race	
Caucasian	1.00 (referent)
African American	1.28 (1.24–1.32)
Other	0.87 (0.81–0.93)
Donor age (per 10-yr increase)	1.10 (1.09–1.11)
Donor female gender	1.06 (1.04–1.09)
Mechanism of donor death (vascular [cardio- and cerebrovascular] *versus* nonvascular)	1.44 (1.41–1.47)

[a]RR, relative risk; CI, confidence interval.

within *versus* outside the VA. Details of the diagnostic codes used in this search are provided in the Appendix. Patients who were identified in this search then were linked via social security number, name, and date of birth to USRDS data using an existing USRDS matching algorithm. The study was approved by the University of California San Francisco Institutional Review Board, the San Francisco VA Medical Center Research and Development Committee, and the Edward J. Hines, Jr., VA Hospital Institutional Review Board and Research and Development Committee.

Primary Predictor Variables

The predictor variable for the primary analysis was African-American (*versus* non–African-American) race as recorded in the USRDS PATIENTS file. Non–African-American race was selected as the referent category because <5% of VA users belonged to racial/ethnic groups other than African American or Caucasian. Our primary analyses measured the association of African-American race with graft and patient survival in the overall cohort and among VA user and non-VA user subgroups. In addition, we examined overall graft and patient survival among VA users who underwent kidney transplantation within *versus* outside the VA.

Secondary Predictor Variables

Multivariable analyses were adjusted for the following recipient factors: age and vintage at the time of transplantation; gender; body surface area (BSA) <1.6, 1.6 to 1.8, 1.8 to 2.0 (referent), 2.0 to 2.2, and >2.2 m^2; dialysis modality at initiation of ESRD (peritoneal *versus* hemodialysis); dialysis modality immediately before transplant (peritoneal *versus* hemodialysis); transplant era (1991 to 1993 [referent], 1993 to 1995, 1995 to 1997, and 1997 onward); and comorbid conditions, including diabetes (classified as insulin dependent and non–insulin dependent), treated chronic obstructive pulmonary disease, treated hypertension, cerebrovascular disease, peripheral vascular disease, and cardiovascular disease/angina. We also included data on functional status (independent in activities of daily living *versus* not); employment status at the time of transplant (employed *versus* unemployed); educational level (college educated *versus* not); and most recent and peak panel reactive antibody status categorized as 0%, <50%, and ≥50% as reported by USRDS. The following donor characteristics were also included: Age, gender, race (categorized as Caucasian [referent], African American, and other), donor type (living *versus* deceased), number of HLA mismatches (0 to 6), cold ischemia time (categorized as <1 h [referent], 1 to 12 h, 13 to 24 h, and ≥25 h) as reported by USRDS, and cause of donor death (vascular [cerebrovascular and cardiovascular] *versus* nonvascular).

Outcome Measures

For the primary analysis, we adopted the United Network for Organ Sharing definition of graft survival as "organ removal, death, or replacement on chronic allograft support system" (http://www.unos.org/PoliciesandBylaws/policies.asp). We conducted companion analyses using the alternative outcome of overall patient survival.

Statistical Analyses

We compared baseline recipient and donor characteristics across VA user and non-VA user groups stratified by African-American and non–African-American race. We also compared recipient and donor characteristics among VA users who received a transplant within *versus* outside the VA using the *t* test, the Wilcoxon rank-sum test, or the χ^2 test.

We measured the association of African-American race with time to graft failure and time to death using survival analysis. We compared unadjusted graft survival among African-American and non–African-American VA users and non-VA users with Kaplan-Meier curves and the log-rank test. We used Cox proportional hazards analysis to measure the univariate and multivariable associations of baseline patient and donor characteristics with graft survival. In the primary analysis focusing on graft survival, patients were censored at the time of graft failure or death or at the end of follow-up. Companion analyses in which death was considered a graft loss were conducted.

Multivariable analyses were conducted in the overall study sample and after stratification by subgroup (VA users, non-VA users, VA users who received a transplant within the VA, and VA users who received a transplant outside the VA). To evaluate further the estimated effects of differences in access to care within the VA *versus* outside the VA after the 3-yr "coverage" period, we measured composite allograft survival after stratification for time after transplantation (<3 *versus* ≥3 yr) among VA users and non-VA users who received a transplant after 1994. Multivariable models were adjusted for all donor and recipient characteristics that were significantly associated with the outcome in univariate analysis ($P < 0.05$). We tested the proportional hazards assumption using standard residual-based techniques (24). To determine whether VA status modified the association of race with graft survival, we tested a VA-user × race interaction term in multivariable models.

In addition to adjusting for covariates in multivariable regression, we attempted to address selection effects using propensity scores (17) because veteran status was not randomly allocated. To develop the propensity score, we included in a separate multivariable logistic regression analysis all factors that differed among the VA user and non-VA user groups, using a more liberal "significance" criterion of $P < 0.25$. Using VA user status as the dependent variable, we fit a model predicting the likelihood or "propensity" of VA user status. We then incorporated the propensity score as a covariate in the proportional hazards regression model using time to graft failure as the dependent variable. Inclusion of the propensity score as a covariate in a multivariable regression theoretically normalizes the likelihood of a nonrandomly allocated treatment or exposure (in this case, VA user status) and may adjust for unobserved confounding and selection bias, thereby refining regression estimates.

All multivariable models were adjusted for a random effect for center. The possibility that transplant recipients from the same center may be more similar than transplant recipients from different centers was accommodated for by using the robust variance method of Lin and Wei (25) in multivariable Cox models. Explicitly including center effects in the models was not practical because of the large number of different centers. For all analyses, missing data were handled by creating a missing indicator variable for the categorical variables that were missing >5% of values and for continuous variables that were missing >10% of values. Otherwise, a mean value was imputed for missing continuous variables. All statistical analyses were conducted using STATA statistical software, version 8.0 (College Station, TX).

Results

The study sample was composed of 79,361 patients (77,715 non-VA users and 1646 VA users). A total of 254 VA users received a transplant within the VA, and 1392 received a transplant outside the VA. Among all transplant recipients, 58,520 received deceased donor grafts (57,184 non-VA users and 1336 VA users) and 20,841 received living donor grafts (20,531 non-VA users and 310 VA users).

Baseline Patient Characteristics

African-American recipients composed a much larger percentage of VA users than non-VA users (Table 1). Substantial differences in patient and donor characteristics were present among African-American and non–African-American recipients and among members of these groups who were VA users and non-VA users, respectively. Specifically, within both VA and non-VA user groups, compared with all other recipients, African Americans were older, had longer dialysis vintage before transplant, were less likely to be on peritoneal dialysis, had a higher prevalence of most comorbidities, received kidneys with longer cold ischemia time, and had a lower prevalence of living donor transplants compared with non–African-American recipients. Among African-American and non–African-American recipients, VA users were older, had larger mean BSA, were less likely to be on peritoneal dialysis, and had a higher prevalence of most comorbidities and lower functional status than non-VA users. In addition, living donor transplantation was less common and mean cold ischemia time was longer among VA users.

Among VA users, a higher percentage of those who received a transplant outside the VA were African American (44 *versus* 30%; $P < 0.001$). Those who received a transplant outside the VA also had a higher prevalence of hypertension (83 *versus* 64%; $P < 0.001$), were less likely to have undergone living donor transplant (18 *versus* 25%; $P = 0.008$), and were less likely to have zero mismatch (10 *versus* 15%; $P < 0.001$).

Survival Analysis

In univariate analysis, African-American race was strongly associated with decreased graft survival (Table 2). This was true among VA users and non-VA users (Figure 2). In addition, VA user *versus* non-VA user status, older age, most comorbid conditions, higher BSA, higher panel reactive antibody, HLA mismatch, hemodialysis as pretransplant dialysis modality, lower education level, unemployed status, and lack of independence in activities of daily living were significantly associated with graft failure. Among donor characteristics examined, older age, female gender, African-American race, deceased (rather than living) donor, donor death with a vascular mechanism, and longer cold ischemia time were significantly associated with graft failure.

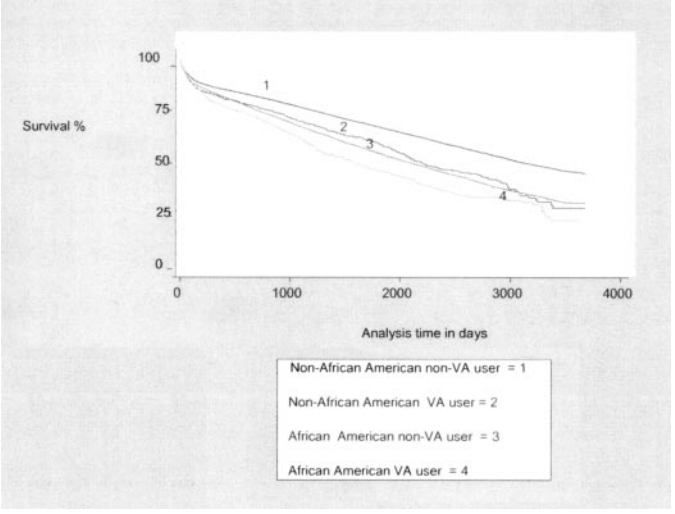

Figure 2. Unadjusted association of the transplant recipient based on veteran status and African-American race with allograft survival. $P < 0.001$ by using the log rank sum test for differences.

African-American race was associated with poorer allograft survival even after adjustment for a wide range of recipient and donor characteristics (Table 3). Furthermore, the relative risk (RR) of graft failure by race was remarkably similar among VA users and non-VA users and VA users who received a transplant within and outside the VA. Of note, the association of African-American race with graft survival was consistently stronger than that for overall patient survival across these subgroups. Among all transplant recipients, VA users had a roughly 20% higher risk for graft failure (RR 1.21; 95% confidence interval [CI] 1.12 to 1.30) and 14% higher risk of mortality (RR for VA users 1.14; 95% CI 1.07 to 1.22) compared with non-VA users. We found no significant interaction of race with VA user status in either graft failure ($P = 0.32$) or patient survival ($P = 0.63$) models. On subgroup analysis, there was no statistically significant difference in graft (RR for VA users who received a transplant within the VA 0.86; 95% CI 0.68 to 1.10; $P = 0.23$) or patient (RR 0.97; 95% CI 0.74 to 1.26; $P = 0.82$) survival among VA users who received a transplant within *versus* outside the VA. In these analyses also, the interaction of race with VA user status was NS for either graft ($P = 0.79$) or patient ($P = 0.97$) survival.

To test whether the absence of significant differences in the association of race among VA and non-VA users was explained by the existence of Medicare coverage for immunosuppressive agents during the first 3 yr posttransplantation, we conducted a subgroup analysis that was restricted to patients who had a kidney transplant after 1994 (the year after which Medicare extended coverage for immunosuppressive agents to 3 yr posttransplantation) and had a functioning graft for 3 yr or more. This subcohort consisted of 596 VA users and 31,819 non-VA users. In this analysis, African-American race was still associated with allograft failure overall (RR 1.40; 95% CI 1.30 to 1.50) and after further stratification by VA user status (RR 1.79 [95% CI 1.18 to 2.71] for VA users; RR 1.39 [95% CI 1.29 to 1.49] for non-VA users). In addition, across all races, VA users in this subcohort experienced poorer allograft survival compared with non-VA users (RR of graft failure 1.37; 95% CI 1.14 to 1.64).

Finally, we conducted companion analyses with propensity score adjustment to determine whether the findings described with standard regression techniques might be modified by residual confounding or selection bias associated with VA user status. The RR estimates for African-American race were virtually indistinguishable from those obtained with the usual Cox models (data not shown).

Discussion

In a large national cohort of kidney transplant recipients, we found that African-American race was associated with a roughly 30% higher risk for graft failure and 10% higher risk for

Table 3. Multivariable analyses of allograft failure and mortality by African-American race[a]

	Adjusted Graft Failure (RR, CI)	Adjusted Mortality (RR, CI)
All patients (n = 79,332)	1.31 (1.26–1.36)	1.10 (1.06–1.14)
VA user (n = 1646)	1.31 (1.10–1.57)	1.10 (0.90–1.34)
Non-VA user (n = 77,715)	1.31 (1.26–1.36)	1.11 (1.07–1.15)
VA user received transplant in VA (n = 254)	1.34 (0.76–2.35)	0.96 (0.53–1.74)
VA user received transplant outside VA (n = 1392)	1.31 (1.10–1.56)	1.10 (0.88–1.36)

[a]Multivariable analysis is adjusted for various recipient factors, including age; gender; veteran status (VA user *versus* non-VA user); presence of comorbid conditions (diabetes, treated hypertension, treated cerebrovascular disease, coronary artery disease, and peripheral artery disease); BSA (<1.6, 1.6 to 1.8, 1.8 to 2.0, 2.0 to 2.2, >2.2 m^2); education level (college educated *versus* not); functional status (independent in activities of daily living *versus* not); employment (employed *versus* unemployed); duration on dialysis pretransplantation; dialysis modality at ESRD initiation (peritoneal dialysis [PD] *versus* hemodialysis [HD]; dialysis modality pretransplantation (PD *versus* HD); HLA mismatch (0 to 6), peak PRA ≥50% (yes or no); most recent PRA ≥50% (yes or no); transplant era (1991 to 1993, 1993 to 1995, 1995 to 1997, 1997 to 2000); and donor factors, including age; gender; race (African-American, Caucasian, and other); cold ischemia time classified as <1 h, 1 to 12 h, 13 to 24 h, and >25 h; donor type (living *versus* deceased donor); and mechanism of donor death (vascular [cardio- and cerebrovascular] *versus* nonvascular).

death. Although we originally had hypothesized that racial disparities in outcomes after kidney transplantation would be less pronounced in a universal access health care system such as the VA, to our surprise the association of African-American race with graft failure was remarkably consistent across VA users and non-VA users and among VA users who received a transplant within and outside the VA. These associations were still evident among recipients who survived beyond 3 yr after transplantation, at which time Medicare coverage of immunosuppressive agents ended.

Several previously published studies in non-ESRD populations have demonstrated fewer racial disparities in disease outcomes among patients who are cared for within *versus* outside the VA. For example, there seems to be no racial disparity in outcomes among patients with *Pneumocystis carinii* pneumonia and colorectal and lung cancer treated within the VA, whereas such disparity does occur outside the VA (13–15). In fact, for a variety of common medical conditions, mortality rates actually seem to be lower among African-American than among Caucasian veterans (16).

That racial disparities in kidney transplant outcomes were present to an approximately equal extent among VA and non-VA users may reflect the absence of marked differences in access to care among these two groups in the setting of comprehensive Medicare coverage for the majority of transplant recipients (23). Similar results were obtained when considering time frames within and outside the 3-yr coverage window. These findings suggest that access to care (including immunosuppressive agent coverage) does not seem to explain the observed large racial disparities in kidney transplant outcomes. Rather, a variety of other processes such as renal sensitivity to hypertension (7), poor donor recipient HLA matching (26,27), racial HLA antigen variants and greater MHC polymorphism (28,29), increased immune responsiveness (30), and differences in the metabolism of various immunosuppressive agents (31–33) could contribute to poorer allograft survival among African Americans. In addition, racial disparities in health outcomes may be related to subtle differences in patients' perception of care, preferences for new medical interventions, and physician biases in providing care (34–36). In support of this contention, several VA studies have shown substantial perceived racial differences in access to care within the VA (37) in addition to racial disparity in processes of care or disease outcomes (38–40).

It is unclear from the present analysis why VA users experienced worse graft and patient survival than non-VA users. Our results suggest that overall poor allograft survival among VA users is not explained by poor performance among a particular veteran subgroup such as those who received a transplant within *versus* outside the VA. Given the small magnitude of the point estimate and the inability to adjust for severity of comorbid conditions or for socioeconomic status, it is most likely that our results may be explained by residual confounding by these and other factors. However, it is also possible that differences in pre- or posttransplantation care among VA users compared with non-VA users may underlie differences in outcomes after kidney transplantation between these two groups. Further studies will be required to understand better the differences in posttransplantation outcomes among VA and non-VA users who undergo kidney transplantation.

There are several limitations to the analyses presented herein. First, despite the completeness and the relatively large sample size of USRDS data and adjusting for a wide variety of donor and recipient characteristics, residual confounding by disease severity, socioeconomic status, income levels, differences in geographic access, or other factors not included in the model may have influenced the results. Second, we had limited ability to compare transplant outcomes among VA users who received a transplant within *versus* outside the VA as a result of the relatively small number of patients in the former group. Third, the VA user cohort was predominantly male and thus limits the generalizability of our study findings to women. Fourth, we were unable to characterize in detail differences between VA users and non-VA users in posttransplantation care. Finally, although graft and patient survival are typical metrics for quality of transplant care, these are not comprehen-

sive measures of care after kidney transplantation as they do not incorporate measures of patient quality of life.

In summary, in a large national cohort of kidney transplant recipients, African-American race was strongly associated with poorer graft and patient survival even after extensive adjustment for donor and recipient characteristics, regardless of whether the patients were VA or non-VA users and whether they survived beyond the period of Medicare immunosuppression coverage. These results demonstrate that in contrast to many other disease states, racial disparities in kidney transplant outcomes persist in a universal access-to-care system such as the VA. Further studies are needed to understand the elevated risk for graft failure among African Americans and whether this relates to more subtle differences in quality and accessibility of posttransplantation care among African Americans or to race-specific differences in biologic factors that are known to be associated with graft failure.

Appendix

Procedure codes used to identify the VA dialysis population	
ICD-9-CM[a] Procedure Code	
39.95	Hemodialysis
54.98	Peritoneal dialysis
CPT-4 Procedure Code	
90935	Hemodialysis, single evaluation
90937	Hemodialysis, repeat evaluation
90945	Peritoneal dialysis, single evaluation
90947	Peritoneal dialysis, repeat evaluation
Clinic stop codes	
601	Acute hemodialysis treatment
602	Chronic assisted hemodialysis
603	Limited self-hemodialysis
604	Home hemodialysis training
605	Acute peritoneal dialysis treatment
606	Chronic assisted peritoneal dialysis
607	Limited self-peritoneal dialysis
608	Home peritoneal dialysis training
609	Home hemodialysis treatment
610	Contract dialysis
611	Telephone dialysis

Procedure codes used to identify the VA dialysis population	
ICD-9-CM Procedure Code	
55.61	Kidney autotransplant
55.69	Kidney transplant NEC
CPT-4 Procedure Code	
50360	Transplantation of kidney
50365	Transplantation of kidney

[a]ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; CPT-4, Current Procedural Terminology, version 4.

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