Association of Race and Age With Survival Among Patients Undergoing Dialysis

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Context Many studies have reported that black individuals undergoing dialysis survive longer than those who are white. This observation is paradoxical given racial disparities in access to and quality of care, and is inconsistent with observed lower survival among black patients with chronic kidney disease. We hypothesized that age and the competing risk of transplantation modify survival differences by race.

Objective To estimate death among dialysis patients by race, accounting for age as an effect modifier and kidney transplantation as a competing risk.

Design, Setting, and Participants An observational cohort study of 1,330,007 incident end-stage renal disease patients as captured in the United States Renal Data System between January 1, 1995, and September 28, 2009 (median potential follow-up time, 6.7 years; range, 1 day-14.8 years). Multivariate age-stratified Cox proportional hazards and competing risk models were constructed to examine death in patients who receive dialysis.

Main Outcome Measures Death in black vs white patients who receive dialysis.

Results Similar to previous studies, black patients undergoing dialysis had a lower death rate compared with white patients (232,361 deaths [57.1% mortality] vs 585,792 deaths [63.5% mortality], respectively; adjusted hazard ratio [aHR], 0.84; 95% confidence interval [CI], 0.83-0.84; P < .001). However, when stratifying by age and treating kidney transplantation as a competing risk, black patients had significantly higher mortality than their white counterparts at ages 18 to 30 years (27.6% mortality vs 14.2%; aHR, 1.93; 95% CI, 1.84-2.03), 31 to 40 years (37.4% mortality vs 26.8%; aHR, 1.46; 95% CI, 1.41-1.50), and 41 to 50 years (44.8% mortality vs 38.0%; aHR, 1.12; 95% CI, 1.10-1.14; P < .001 for interaction terms between race and each aforementioned age category), as opposed to patients aged 51 to 60 years (51.5% vs 50.9%; aHR, 0.93; 95% CI, 0.92-0.94), 61 to 70 years (64.9% vs 67.2%; aHR, 0.87; 95% CI, 0.86-0.88), 71 to 80 years (76.1% vs 79.7%; aHR, 0.85; 95% CI, 0.84-0.86), and older than 80 years (82.4% vs 83.6%; aHR, 0.87; 95% CI, 0.85-0.88).

Conclusions Overall, among dialysis patients in the United States, there was a lower risk of death for black patients compared with their white counterparts. However, the commonly cited survival advantage for black dialysis patients applies only to older adults, and those younger than 50 years have a higher risk of death.

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placation is the preferred form of re-
nal replacement therapy regardless of 
race, black patients have lower rates of 
transplant referral and longer dialysis 
vintage at referral than their white coun-
terparts.5,44-49

The paradox of enhanced dialysis 
survival in the setting of decreased ac-
tess to care may be in part a byprod-
uct of study design. Population-based 
studies of dialysis survival can mask im-
portant subgroup effects, particularly 
given that the majority of dialysis pa-
tients are older than 65 years.1 As such, 
studies of the dialysis population as a 
whole are dominated by effects among 
older adults,50 in which disparities in 
access to care are attenuated by Medi-
care eligibility. In fact, racial dispari-
ties in CKD mortality occur almost ex-
clusively among younger age groups,51 
as do inequities in access to transplan-
tation.52

Given the hypothesis that dispari-
ties in socioeconomic status and insur-
ance coverage are likely greatest in 
younger ESRD patients, and that these 
disparities are manifest both in rates of 
transplantation and dialysis mortality, 
the goals of this study were (1) to ex-
amine age as an effect modifier of the 
racial disparities in dialysis survival, and 
(2) to determine if differential rates of 
kidney transplantation modify the risk of 
death in dialysis patients.

METHODS

Study Design

The study cohort included 1 330 007 
adults, identified as either African 
American/black (n=407 140) or Cau-
casian/white (n=922 867), as indicated 
on the Centers for Medicare & 
Medicaid Services (CMS) 2728 Medi-
cal Evidence Form, signed and filed for 
each patient by the supervising physi-
cian within 45 days of dialysis initia-
tion or transplant. All patients initi-
ated dialysis or received a predialysis 
transplant for the first time between 
January 1, 1995, and September 28, 
2009.

Data were drawn from the United 
States Renal Data System, a national reg-
istry of all ESRD patients in the United 
States. Patients were observed from 
ESRD diagnosis until death, which was 
ascertained via linkage to the Social Se-
curity Master Death File. The presence 
or absence of 18 major comor-
dbidities and 2 physical impairments was 
captured via a checklist on the CMS 
2728 Medical Evidence Form. All pa-
tients were observed until death, kid-
ney transplantation, or end of study 
(September 28, 2009). Comorbidity sta-
tus was ascertained at ESRD onset; only 
joining the waitlist, receiving a kidney 
transplant, and occurrence of death 
were measured longitudinally. Rates of 
death and transplantation are high in 
this population; as such, outcomes for 
many patients occurred soon after 
ESRD onset and the median follow-up 
time (time from ESRD onset to first 
noted event) was 21.5 months (range, 
1 day-14.8 years). However, the me-
dian potential follow-up time (time 
from ESRD onset to end of study) was 
6.7 years. This study was reviewed by 
the institutional review board at Johns 
Hopkins School of Medicine and de-
termined to qualify for an exemption 
der the Code of Federal Regula-
tions, Protection of Human Subjects (45 
CFR 46.101[b]) as study participants 
cannot be identified directly or through 
linked identifiers.

Population-Based Survival Analysis

In order to replicate previous studies, 
a multivariate Cox proportional haz-
ards model, including patients of all 
ages, was adjusted for the following fac-
tors: age, race (black vs white), sex, in-
urance type at ESRD onset, body mass 
index (BMI [calculated as weight in ki-
lograms divided by height in meters 
squared]), cause of ESRD, predialysis 
or pretransplant erythropoietin admin-
istration (a surrogate for having ne-
phrology care prior to ESRD onset), ath-
erosclerotic heart disease, cardiac 
failure, peripheral vascular disease, cere-
brovascular disease, hypertension, dia-
tes, smoking, immobility, malig-
nant neoplasm/cancer, chronic obstruc-
tive pulmonary disease, drug depen-
dence, alcohol dependence, and dialysis 
type (peritoneal or hemodialysis).

Patients were censored at transplanta-
tion or end of study.

Age as an Effect Modifier

The cohort was then stratified by age, 
and dialysis survival among black and 
white patients was compared using Cox 
proportional hazards models (ad-
justed for the factors listed previ-
ously). As with the population-based 
survival analysis, patients were cen-
sored at transplantation or end of study. 
To confirm whether differences be-
tween age groups were statistically sig-
nificant, an additional model was built 
including interaction terms for each age 
category and black race.

To account for age-stratified differ-
ences in transplant rates between black 
and white patients, the same analyses 
were repeated using competing risk re-
gression according to the methods of 
Fine and Gray.33 These models, in 
which transplantation was treated as a 
competing risk and end of study as ad-
ministrative censoring, provided an es-
imate of the risk that those who start 
dialysis will die while on dialysis. In 
other words, while the Cox model bet-
ter estimated the risk of death if black 
and white patients underwent trans-
plantation at equal rates (adjusted haz-
ard ratio [aHR]), the competing risk 
model better estimated the risk of death 
on dialysis for patients given the cur-
cent disparities in access to transplan-
tation (adjusted subhazard ratio 
[aSHR]).

Subgroup Analysis

To further explore those patients in 
whom disparities of the highest magni-
tude were identified, dialysis survival 
among additional subgroups within the 
18- to 30-year range were explored by 
sex, insurance, BMI, type of dialysis, 
erthropoietin use, and reported pri-
mary cause of ESRD to determine 
whether racial disparities persisted across 
all or were specific to certain sub-
groups of younger patients.

Statistical Analysis

All analyses were performed by using 
multiprocessor Stata version 11.0/MP
for Linux (StataCorp, College Station, Texas). All hypothesis tests were 2-sided, with statistical significance defined as having a P value of less than .05.

**RESULTS**

**Population-Based Analyses**

Among 1 330 007 incident ESRD patients between 1995 and 2009, black patients were on average younger (58.1 years vs 64.5 years). Although black patients aged 18 to 30 years had rates of comorbid conditions similar to white patients, those older than age 30 years were less likely to have atherosclerotic heart disease (6.7% vs 10.9% for age 31-50 years; 20.6% vs 34.1% for those older than age 50 years) and peripheral vascular disease (4.7% vs 8.4% for age 31-50 years; 12.3% vs 18.6% for those older than age 50 years), and those older than age 50 years were less likely to have cardiac failure (33.5% vs 38.8%) and chronic obstructive pulmonary disease (6.2% vs 11.3%) and more likely to have hypertension (88.6% vs 81.8%, Table 1). Of incident ESRD patients of all ages entering the study, 37.1% of black and 63.5%...
of white patients died as dialysis recipients, and 9.1% of black and 12.4% of white patients received kidney transplants, with 25.7% of transplants in black patients provided from live donors compared with 42.8% in white patients (FIGURE 1). Adjusting for differences in demographics and comorbidities, and censoring for transplantation, black patients had a lower risk of death as dialysis recipients than white patients (aHR, 0.84; 95% CI, 0.83-0.84; P < .001).

**Age-Stratified Analyses**

However, the relationships between race, dialysis survival, and transplantation were substantially modified by patient age, with opposite inferences in the younger age groups. Among 18- to 30-year-olds with incident ESRD entering the study, 27.6% of black and 14.2% of white patients died as dialysis recipients, and 31.9% of black and 54.9% of white patients received transplants (Figure 1). In adjusted models specific to this age group, black patients had a higher risk of death as dialysis recipients censoring for transplantation (aHR, 1.44; 95% CI, 1.37-1.51; FIGURE 2) and treating transplantation as a competing event (aSHR, 1.93; 95% CI, 1.84-2.03; Figure 2).

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**Figure 1.** Percent of Incident ESRD Patients Who Died as Dialysis Recipients or Received a Transplant During the Study Period by Race and Age

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>Died on Dialysis</th>
<th>Received a Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>&lt;80</td>
<td>0.98 (0.98-0.99)</td>
<td>21 388 (82.4)</td>
</tr>
<tr>
<td>71-80</td>
<td>0.95 (0.95-0.96)</td>
<td>52 228 (76.1)</td>
</tr>
<tr>
<td>61-70</td>
<td>0.96 (0.96-0.97)</td>
<td>199 571 (79.7)</td>
</tr>
<tr>
<td>51-60</td>
<td>1.01 (1.00-1.02)</td>
<td>60 227 (64.9)</td>
</tr>
<tr>
<td>41-50</td>
<td>1.18 (1.17-1.19)</td>
<td>14 936 (67.2)</td>
</tr>
<tr>
<td>31-40</td>
<td>1.40 (1.37-1.43)</td>
<td>8 658 (69.5)</td>
</tr>
<tr>
<td>18-30</td>
<td>1.94 (1.87-2.01)</td>
<td>37 772 (61.1)</td>
</tr>
<tr>
<td>Overall</td>
<td>0.90 (0.89-0.90)</td>
<td>232 361 (67.1)</td>
</tr>
</tbody>
</table>

Relative risk (RR) is unadjusted. RR reference category is white patients. CI indicates confidence interval; ESRD, end-stage renal disease.

**Figure 2.** Relative Adjusted Hazard of Death in Black vs White Dialysis Patients, by Age

Each data point and 95% confidence interval (indicated by error bars) represents results from a separate multivariate model (adjusting for demographics and comorbidities). Cox models show hazard ratios (HRs) on a log scale and the Fine and Gray competing risk models show subhazard ratios (SHRs) on log scale. Each HR and SHR represents the hazard of death for black compared with white patients adjusting for demographics and comorbidities. The line at 1.0 represents parity; estimates above the line indicate a higher risk of death for black dialysis patients (compared with similar white dialysis patients); estimates below the line indicate a lower risk of death for black dialysis patients.

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Similarly, among 31- to 40-year-olds with incident ESRD entering the study, 37.4% of black and 26.8% of white patients died as dialysis recipients, and 20.5% of black and 45.1% of white patients received transplants (Figure 1). In adjusted models specific to this age group, black patients had a lower risk of death as dialysis recipients censoring for transplantation (aHR, 0.81; 95% CI, 0.80-0.82) and treating transplantation as a competing event (aSHR, 0.87; 95% CI, 0.86-0.88; Figure 2). In a model including interaction terms for race and each age category, all interaction terms were statistically significant, confirming differences in the race disparity between age subgroups (P<.05 for all).

**Subgroup Analyses in 18- to 30-Year-Olds**

The age subgroup with the highest disparity in risk of death between black and white dialysis patients was that of 18- to 30-year-olds. As such, further exploration of this subgroup was performed to better understand potential mechanisms for the marked difference in racial disparities among younger patients. In the 18- to 30-year-old subgroup, black patients were less likely to have private insurance (22.1% vs 33.8%), more likely to have Medicare or no insurance (71.1% vs 51.4%), more likely to have hypertension as the primary cause of renal failure (27.6% vs 11.2%), and less likely to receive erythropoietin (21.4% vs 30.1%). Rates of other comorbidities were similar by race (Table 1). Further stratification of 18- to 30-year-olds by clinically important subgroups showed that the disparity for black patients persisted across all with the exception of those with a BMI of 35 or higher (aHR, 1.09; 95% CI, 0.94-1.26) and those with diabetes as the primary cause of ESRD (aHR, 1.02; 95% CI, 0.93-1.11). In a competing risk analysis, a substantial survival disparity persisted across all subgroups (Table 2).

**Table 2. Relative Adjusted Hazard of Death (Black vs White) Among 18- to 30-Year-Old Dialysis Patients**

<table>
<thead>
<tr>
<th>Stratum</th>
<th>White Patients</th>
<th>Black Patients</th>
<th>Censored SHR (95% CI)a</th>
<th>Competing Risks SHR (95% CI)b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex: Men</td>
<td>1899</td>
<td>2539</td>
<td>1.54 (1.44-1.66)</td>
<td>2.10 (1.96-2.25)</td>
</tr>
<tr>
<td></td>
<td>1783</td>
<td>2672</td>
<td>1.43 (1.25-1.43)</td>
<td>1.77 (1.65-1.90)</td>
</tr>
<tr>
<td>Insurance: Medicare</td>
<td>524</td>
<td>480</td>
<td>1.35 (1.17-1.55)</td>
<td>1.96 (1.69-2.24)</td>
</tr>
<tr>
<td></td>
<td>631</td>
<td>631</td>
<td>1.47 (1.39-1.56)</td>
<td>1.85 (1.74-1.95)</td>
</tr>
<tr>
<td>BMI &lt;18</td>
<td>318</td>
<td>385</td>
<td>1.56 (1.32-1.83)</td>
<td>1.93 (1.63-2.28)</td>
</tr>
<tr>
<td>18-24.9</td>
<td>1787</td>
<td>2166</td>
<td>1.59 (1.49-1.71)</td>
<td>2.13 (1.99-2.29)</td>
</tr>
<tr>
<td>25-29.9</td>
<td>619</td>
<td>971</td>
<td>1.43 (1.28-1.59)</td>
<td>2.03 (1.82-2.27)</td>
</tr>
<tr>
<td>30-34.9</td>
<td>316</td>
<td>465</td>
<td>1.12 (0.96-1.31)</td>
<td>1.48 (1.26-1.74)</td>
</tr>
<tr>
<td>BMI ≥35</td>
<td>321</td>
<td>657</td>
<td>1.09 (0.94-1.26)</td>
<td>1.38 (1.19-1.61)</td>
</tr>
<tr>
<td>Use of erythropoietin: No</td>
<td>2492</td>
<td>3933</td>
<td>1.51 (1.43-1.59)</td>
<td>1.97 (1.86-2.09)</td>
</tr>
<tr>
<td></td>
<td>933</td>
<td>877</td>
<td>1.22 (1.11-1.36)</td>
<td>1.79 (1.61-1.99)</td>
</tr>
<tr>
<td>Cause of ESRD: Hypertension</td>
<td>2438</td>
<td>1057</td>
<td>1.33 (1.16-1.54)</td>
<td>1.65 (1.43-1.90)</td>
</tr>
<tr>
<td></td>
<td>1561</td>
<td>1231</td>
<td>1.02 (0.93-1.11)</td>
<td>1.35 (1.24-1.48)</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>619</td>
<td>670</td>
<td>1.21 (1.07-1.37)</td>
<td>1.71 (1.51-1.95)</td>
</tr>
<tr>
<td>Urologic</td>
<td>196</td>
<td>77</td>
<td>1.63 (1.21-2.18)</td>
<td>2.32 (1.74-3.10)</td>
</tr>
<tr>
<td>Other</td>
<td>862</td>
<td>1975</td>
<td>2.18 (1.99-2.38)</td>
<td>2.88 (2.63-3.15)</td>
</tr>
<tr>
<td>Unknown</td>
<td>168</td>
<td>1924</td>
<td>1.64 (1.28-2.12)</td>
<td>2.06 (1.58-2.60)</td>
</tr>
</tbody>
</table>

**COMMENT**

In this national study of dialysis survival among 1 330 007 incident ESRD patients, we have shown that the commonly cited survival advantage for black patients undergoing dialysis applies only to those older than 50 years of age. In marked contrast, younger black patients have as much as twice the hazard of death as dialysis recipients compared with their white counterparts, even after adjusting for many demographic factors and comorbidities. Additionally, the disparity in younger patients widens when the differential rates of kidney transplantation for black and white patients are considered in a competing risk analysis.

Our population-based results are consistent with many earlier studies, supporting face validity of our study cohort and analytical approach. However, the demonstration of significant age-based effect modification of the racial differences in dialysis survival is novel, challenging conventional wisdom and identifying a
significant disparity among younger black patients that needs to be addressed. The finding of increased mortality among younger black ESRD patients is consistent with previous findings among the general population and in those with CKD but not yet ESRD.

The majority of dialysis patients are older than 65 years of age, so inferences from population-based models are driven by this subgroup and may not be generalizable to patients of all ages. Younger patients may be fundamentally different from older patients in the prevalence of comorbidities, socioeconomic status, and the underlying biology of disease. Furthermore, comorbidities and socioeconomic status disparities likely influence outcomes of younger and older adults differentially. Previous studies have shown that age modifies race and sex disparities in transplant patients. Likewise, this study has shown that inferences about survival of dialysis patients drawn from the entire population, in this case that black patients have a lower death rate as dialysis recipients than their white counterparts, do not apply to younger patients. Assuming that population-based inferences are generalizable to subgroups within the population has the potential to mislead clinical decision making. Furthermore, while older black patients have better survival as dialysis recipients compared with older white patients, it is important to note that patients of all ages and races derive a survival benefit from transplantation vs remaining on dialysis.5,25

Additionally, accounting for transplant as a competing risk brings to light an even greater disparity in death on dialysis in younger age groups in which transplant is most common and racial disparities in access are greatest. Use of this method allows us to infer that the 2-fold increased hazard of death on dialysis in younger black patients is composed of 2 distinct components: one of differential rates of transplantation and one of biology (or some interaction between biology and socioeconomic factors). Blacks are much less likely to receive a transplant from a live donor; as such interventions to reduce transplant disparities should prioritize the improvement of live donation rates for blacks.

One potential contributor to the significant racial disparity among younger adults, but not older adults, is insurance coverage: young black patients are more likely to be uninsured (or Medicaid insured) than young white patients, while all older adults are Medicare eligible. As hypothesized, disparity in insurance is greater among the younger ESRD population; however, even among those with private insurance, young black patients had a higher risk of death as dialysis recipients than their white counterparts. And even among young patients with previous erythropoietin stimulating agent use, a proxy for medical care during CKD progression, young black dialysis patients experienced a higher risk of death. It is likely, then, that any socioeconomic contributors to this disparity remain uncharacterized or unmeasured.

Several limitations merit consideration. First, only patients who survived long enough to develop ESRD were captured, and therefore the impact of differential mortality for black dialysis patients in earlier stages of CKD survival could not be quantified. Black patients with CKD die at a higher rate than their white counterparts, possibly causing a survivor bias in which the black patients who survive to ESRD are healthier than white patients who survive to ESRD. Without linkage of CKD data to the United States Renal Data System registry, we were unable to quantify the effects of this survival bias.

Second, comorbidity data captured in the CMS 2728 Medical Evidence Form is coded as presence or absence of disease, and nuances of severity of comorbidities could not be considered. However, the CMS 2728 Medical Evidence Form does provide a rich source of comorbidity information, and this comorbidity ascertainment was adequate to demonstrate consistency between our initial population-based analyses and previous literature.

In summary, this study challenges the widespread notion that black patients undergoing dialysis survive longer than their white counterparts. Despite a survival advantage in older age groups, black patients younger than 50 years are at substantially increased risk of death as dialysis recipients. Inequities in dialysis survival are compounded by inequities in access to transplantation. Determining why younger black patients are at increased risk of death as dialysis recipients is critical in order to improve clinical decision making and inform policies aimed at achieving equity in ESRD care.

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