# Geographic Variation in Black-White Differences in End-of-Life Care for Patients with ESRD

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**Geographic Variation in Black-White Differences in End-of-Life Care for Patients with End-stage Renal Disease**

*Running Head:* Racial and Geographic Differences in ESRD Patients

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**Abstract**

Background and Objectives: Patterns of end-of-life care among patients with end-stage renal disease (ESRD) differ by race. Whether the magnitude of racial differences in end-of-life care varies across regions is not known.

Design, Setting, Participants, and Measurements: Observational cohort study using data from the United States Renal Data System (USRDS) and regional healthcare spending patterns from the Dartmouth Atlas of Healthcare. Cohort included 101,331 black and white patients 18 years and older who initiated chronic dialysis or received kidney transplantation between June 1, 2005 and September 31, 2008 and died before October 1, 2009. We examined black-white differences in the odds of in-hospital death, dialysis discontinuation and hospice referral by quintile of end-of-life expenditure index (EOL-EI).

Results: In adjusted analyses, the odds ratios for dialysis discontinuation for black vs. white patients ranged from 0.47 (95% confidence interval (CI) 0.43-0.51) in the highest spending quintile to 0.63 (95% CI 0.54-0.74) in the lowest quintile (P for interaction <0.001). Hospice referral ranged from 0.55 (95% CI 0.50-0.60) in the highest spending quintile to 0.82 (95% CI 0.69-0.96) in the lowest quintile (P for interaction <0.001). The association of race with in-hospital death also differed in magnitude across spending quintiles, ranging from 1.21 (95% CI 1.08-1.35) in the 5$^{th}$ quintile to 1.47 (95% CI 1.27-1.71) in the second quintile (P for interaction <0.001).

Conclusion: There are pronounced black-white differences in end-of-life outcomes among patients with ESRD that vary substantially across regions of the US.

**Introduction**

Black patients experience disproportionately high rates of end-stage renal disease (ESRD).[1-6] Racial differences in a range of practices and outcomes such as pre-dialysis care, choice of dialysis modality, access to kidney transplant, and survival have been well-described among patients with ESRD.[6-17 1, 15, 18-20] Compared with these other outcomes and care practices, racial differences in patterns of end-of-life care among patients with ESRD have received much less attention.[21-24]

Prior studies have found that compared with white patients, black patients receiving chronic dialysis are less likely to complete advance directives,[23] less likely to discontinue dialysis,[21, 22, 25, 26] less likely to be referred to hospice,[21, 25] and more likely to receive intensive interventions such as intubation, feeding tube placement and cardiopulmonary resuscitation (CPR) during the final month of life.[27] While these findings do not necessarily imply differences in the quality of end-of-life care for black and white patients -- particularly if they reflect racial variation in goals and preferences at the end of life[28] -- they do highlight the importance of efforts to better understand the scope of, and rationale for racial differences in patterns of end-of-life care in this population.

There is likely substantial complexity to the relationship between race and treatment practices at the end-of-life. Prior studies among older Medicare beneficiaries have described considerable variation in the magnitude of racial differences in care across regions with differing patterns of healthcare spending.[29] Prior studies have demonstrated that systematic differences in where black and white patients with ESRD live seem to contribute to racial differences in outcomes and care practices such as time to transplant and nephrology referral.[8, 30-32] To our knowledge, the extent to which racial differences in end-of-life care among patients with ESRD vary across regions has not been described. Understanding how racial differences in end-of-life treatment practices vary

geographically may be particularly important because a disproportionate percentage of black patients with ESRD are concentrated in a relatively small number of predominantly black zip codes.[30, 31] These zip codes are disproportionately urban, resource poor and tend to be located in hospital referral regions with the highest levels of Medicare spending among patients approaching the end of life.[25] We evaluated the hypothesis that the magnitude of racial differences in patterns of end-of-life care among patients with ESRD would vary across hospital referral regions with differing levels of Medicare spending.

## Materials and Methods

### Patients and Data Sources

We used data from the United States Renal Data System (USRDS), a national registry for ESRD, to identify all 366,022 patients between the ages of 18 and 100 years who initiated chronic dialysis or received a kidney transplant for the first time between June 1, 2005 and September 31, 2008. Among these, 142,856 patients died before October 1, 2009. Of these, we excluded 10,207 who were missing information on zip code, estimated glomerular filtration rate (eGFR), body mass index (BMI), co-morbid conditions, or functional status at onset of ESRD. We excluded a further 31,318 patients who were missing information on study outcomes (place of death, whether dialysis was discontinued before death and whether they were referred to hospice), yielding an analytic cohort of 101,311 patients. Compared with those decedents excluded from the analytic cohort because they were missing information on covariates or study outcomes, members of the analytic cohort were less likely to be black but had a similar age and gender distribution (Supplemental Table 1).

The USRDS Patients file provided information on demographic characteristics, date of first dialysis, and date of death. The USRDS Medical Evidence file provided information on eGFR, BMI, co-morbid conditions (coronary artery disease (CAD), peripheral arterial disease (PAD),

diabetes mellitus, stroke, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), cancer, and functional status (whether the patient could transfer or ambulate) at onset of ESRD, whether a patient was under the care of a nephrologist prior to dialysis initiation, hemodialysis access type (fistula vs. other) and initial treatment modality (hemodialysis, peritoneal dialysis, or transplantation). The USRDS Death file provided information on cause of death, site of death (in vs. outside the hospital), whether dialysis was discontinued and whether the patient was referred to hospice before death as reported by the nephrology provider on the Centers for Medicare and Medicaid Services (CMS) ESRD death notification form.

Predictor variable:

The primary predictor variable for most analyses was black vs. white race. The association of black vs. white race with each study outcome was assessed both in the overall cohort and in analyses stratified by region. Patients were assigned to a hospital referral region (HRR) based on their zip code at onset of ESRD using a zip code-HRR crosswalk from the Dartmouth Atlas of Healthcare (http://www.dartmouthatlas.org/). Patterns of healthcare spending in each HRR were defined using the end-of-life expenditure index (EOI-EI) from the Dartmouth Atlas. The index reflects both physician spending (from the Medicare Carrier File) and acute inpatient hospital spending (from the Medicare Provider Analysis and Review File) during the last six months of life among Medicare beneficiaries who were between the ages of 65 and 100 at the time of death.[33, 34] Only those who were eligible for Medicare during the 6-month period before death and were not enrolled in a health maintenance organization during this time frame were used to develop the index. The index is calculated based on standardized national prices and is adjusted for the demographic characteristics of Medicare beneficiaries in each hospital referral region. As such, it is intended to reflect that component of regional Medicare spending attributable to the overall quantity of medical services provided rather than to local differences in pricing and

demographic structure. Patients were categorized by HRR quintile of EOL-EI to be consistent with prior publications using this index.[25, 33, 34]

Outcome variables:

Measures of end-of-life care included: (1) death within vs. outside the hospital; (2) whether dialysis was discontinued before death among patients who had not received a kidney transplant; and (3) whether the patient was referred to hospice before death.

Statistical Analysis:

We described patient characteristics at onset of ESRD, causes of death and study outcomes among black and white patients using point estimates and 95% confidence intervals. We also described the characteristics of black and white patients living in regions in different quintiles of EOL-EI. Statistical significance was assessed using tests for trend or interaction, as appropriate. We used logistic regression analysis to measure the adjusted association of black race with each outcome. Multivariate analyses were conducted both in the overall cohort and after stratification by quintile of EOL-EI and were adjusted for age, gender, BMI, eGFR, co-morbid conditions, functional status, pre-dialysis nephrology referral, cause of death, dialysis modality and type of vascular access at the time of ESRD onset. We also used logistic regression analysis to compare the frequency of each outcome among patients living in the highest vs. lowest quintile of EOL-EI. These analyses were adjusted for the covariates described above and were stratified by race. Because patterns of end-of-life care may vary depending on how soon patients died after onset of ESRD, we conducted a sub-group analysis among patients who died within six months of ESRD onset.

To determine whether the magnitude of racial differences in each outcome varied by quintile of EOL-EI, we tested for interactions between race and EOL-EI quintile using the likelihood ratio

test for interaction. These analyses were conducted both among the overall cohort, and among the subgroup that died within six months of ESRD onset. In all multivariate analyses, we assessed for evidence of collinearity using the variance inflation factor. All statistical analyses were conducted using Stata SE version 11.0 (StataCorp, College Station, Texas). The study was approved by the Institutional Review Board at the University of Washington.

**Results**

Patient characteristics:

Compared with white patients, black patients were younger, included a higher percentage of women, and had a higher prevalence of diabetes and stroke and a lower prevalence of CHF, CAD, COPD, and cancer. Black patients were less likely to have seen a nephrologist prior to ESRD onset, less likely to have initiated hemodialysis with a fistula, and less likely to have peritoneal dialysis or kidney transplant as their initial modality. Cardiovascular and infectious causes of death were slightly more common among black than among white patients. A lower percentage of black cohort members died within six months of ESRD onset (Table 1).

The percentage of black patients ranged from 7.6% in the lowest quintile of EOL-EI to 30.6% in the highest quintile. Overall, 34.1% of all black patients and 24.4% of all white patients lived in regions in the highest quintile of EOL-EI (Table 1). Among both black and white patients, those living in the highest vs. lowest quintile of EOL-EI were older, had a lower prevalence of most co-morbid conditions, a higher prevalence of functional impairment and were less likely to have been referred to a nephrologist, to have peritoneal dialysis as the initial modality and to initiate hemodialysis with a fistula (Supplemental Tables 2 & 3). A higher percentage of white patients died within six months of ESRD onset (37.1% vs. 33.8%) (Table 1). Cause of death was more likely to be infection-related (11.2% vs. 12.9%) and cardiovascular (46.2% vs. 47.9%) in black as compared with white patients (Table 1).

**Patterns of end-of-life care among black vs. white patients**

Black patients were more likely than white patients to have died in the hospital (68.4% vs. 58.2%), less likely to have discontinued dialysis (16.4% vs. 32.1%), and less likely to have been referred to hospice prior to death (15.5% vs. 28.3%) (Table 2). These differences persisted in adjusted analyses and among patients who died within six months of ESRD onset (Table 3).

**Patterns of end-of-life care among black vs. white patients across quintiles of EOL-EI**

In all quintiles of EOL-EI, black patients were more likely than white patients to have died in the hospital and less likely to have discontinued dialysis and been referred to hospice in both unadjusted (Table 2) and adjusted analyses (Table 3). For both races, there were significant linear trends in site of death, discontinuation of dialysis and referral to hospice (Table 2). In adjusted analyses, the odds of dialysis discontinuation and hospice referral for black vs. white patients varied significantly by quintile of EOL-EI ($p < 0.001$ for each interaction). Odds ratios for dialysis discontinuation and hospice referral among black vs. white patients were of greatest magnitude among patients living in the highest quintile of EOL-EI and were progressively more attenuated in HRRs with a lower EOL-EI. The odds of in-hospital death by race also varied significantly by quintile of EOL-EI (interaction p-value < 0.001), but this relationship was non-linear with odds ratios for black vs. white patients ranging from 1.21 (95% CI 1.08-1.35) in the highest quintile of EOL-EI to 1.47 ( 95% CI 1.27-1.71) in the second quintile.

**Patterns of end-of-life care in the highest vs. lowest quintile of EOL-EI by race.**

In adjusted race-stratified analyses examining the extent to which study outcomes differed between patients living in the highest versus lowest quintile of EOL-EI, both black and white patients living in the highest vs. lowest quintile of EOL-EI were more likely to have died in the hospital [OR for black patients 1.82 (95% CI 1.58, 2.10); OR for white patients 1.75 (95% CI

1.66, 1.84)], less likely to have discontinued dialysis [OR for black patients 0.33 (95% CI 0.28, 0.39); OR for white patients 0.45 (95% CI 0.42, 0.47)] and less likely to have been referred to hospice [OR for black patients 0.41 (95% CI 0.34, 0.48); OR for white patients 0.62 (95% CI 0.58, 0.65)] (Table 4). Differences across quintiles of EOL-EI in discontinuation of dialysis and referral to hospice were of greater magnitude for black compared to white patients. Differences in site of death across quintiles of EOL-EI were of similar magnitude among black and white patients(Table 4). Results were similar in sub-group analyses among patients who died within six months of ESRD onset (Table 4).

**Discussion**

Among a national cohort of adults with ESRD, the magnitude of racial differences in patterns of end-of-life care varied substantially across regions. Among both black and white patients, differences across quintiles of EOL-EI in the proportion of patients who discontinued dialysis and who were referred to hospice were as pronounced as those between black and white patients living in regions in the same quintile of EOL-EI. The magnitude of black-white differences in dialysis discontinuation and hospice referral was greatest for patients living in regions in the highest quintile of EOL-EI.

Several prior studies have reported rates of dialysis discontinuation and hospice referral for the overall ESRD population, and among black compared with white dialysis patients.[21-24] Murray and colleagues examined patterns of hospice referral among US dialysis patients who died between January 1, 2000 and December 31, 2002 and had Medicare as the primary payer for dialysis.[21] Using information from Medicare hospice claims and the CMS death notification form, these authors found that 13.5% of patients used hospice, 21.8% withdrew from dialysis and 63% died in the hospital. Even among those who discontinued dialysis, only about one half were referred to hospice.[21] Black race was associated with a lower likelihood of hospice use and there

were large differences in hospice use and dialysis discontinuation across states. However, these authors did not evaluate regional variation in the magnitude of black-white differences in patterns of end-of-life care. Thompson and colleagues conducted a survey among dialysis facility professionals involved in the care of 448 patients from three renal networks who died during a six-month period in 2005-2006 and in whom dialysis was discontinued prior to death.[24] Less than half of these patients were referred to hospice after dialysis discontinuation. The goals of the survey were to assess provider knowledge about hospice and to ascertain whether hospice had been discussed prior to death. These authors identified striking knowledge deficits among dialysis facility staff about hospice benefits for dialysis patients, but found no differences by race in the proportion of decedents with whom hospice had been discussed or in the proportion who chose hospice. While large differences in study populations and design preclude direct comparison with our results, these results do highlight the potential importance of provider-related factors in shaping patterns of end-of-life care among patients with ESRD.

Reasons for the observed racial differences in patterns of end-of-life care are likely complex and reflect a variety of different factors including differences in preferences,[35-38] differences in the hospitals where patients are treated,[39, 40] differential access to care,[41-43] differences in cultural, spiritual and religious beliefs,[44-47] differences in education and health literacy,[48] and mistrust of the medical system.[49] Prior studies evaluating racial differences in patterns of end-of-life care among patients with ESRD have not described the extent to which these may vary geographically. Our results seem to suggest that black-white differences in patterns of end-of-life care among patients with ESRD may be sensitive to regional differences in practice, with the most pronounced differences in rates of dialysis discontinuation and hospice referral occurring in those regions where Medicare beneficiaries tend to receive the highest intensity of inpatient care at the end of life.

The very limited life expectancy of patients with ESRD underlines the special importance of efforts to optimize end-of-life care in this population. While we describe large racial and geographic differences in patterns of end-of-life care, it is unclear whether these differences translate into differences in quality of care without knowing more about the extent to which existing practices are aligned with patient preferences and values.[28, 50] Nevertheless, the disproportionate number African American patients with ESRD who live in regions in the highest quintile of EOL-EI underlines the importance of understanding why there are such large differences in patterns of end-of-life care among black and white patients living in these areas.

Strengths of this study include that it was conducted among a large representative sample of black and white US adults with ESRD and relied on data systematically collected at onset of ESRD and at the time of death. Limitations include first, that the EOL-EI characterizes regional expenditure based on Medicare spending during the last six months of life, and thus may not fully capture spending for patients with ESRD specifically. Second, site of death, dialysis discontinuation and hospice referral as reported on the CMS death notification form have not been validated. Finally, we were limited in our ability to fully account for variables such as socio-economic status, cultural beliefs, and family structure that may contribute to racial variation in patterns of end-of-life care.

In conclusion, there is substantial regional variation in the magnitude of racial differences in patterns of end-of-life care among adults with ESRD. Black-white differences in dialysis discontinuation and hospice referral were most pronounced in those regions with the highest levels of end-of-life Medicare spending. Efforts are needed to understand the underlying reasons for these differences and the extent to which these reflect differences in patient values, goals and preferences.

**Disclosures**

None of the authors of this manuscript claim any affiliations requiring disclosures for this research.

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**Table 1. Demographic characteristics by race**

| | White patients n = 76,972 | Black patients n = 24,359 |
|---|---|---|
| Mean age, years | 70.9 (70.8, 71.0) | 64.0 (63.8, 64.2) |
| Male, % | 57.9 (57.5, 58.2) | 47.3 (46.7, 47.9) |
| Mean eGFR, ml/min/1.73m$^2$ | 11.7 (11.7, 11.8) | 11.4 (11.3, 11.5) |
| Mean body mass index, kg/m$^2$ | 27.9 (27.8, 27.9) | 27.8 (27.7, 27.9) |
| Diabetes, % | 53.3 (53.0, 53.7) | 54.9 (54.2, 55.5) |
| Coronary artery disease, % | 47.8 (47.4, 48.1) | 30.6 (30.0, 31.2) |
| Stroke, % | 12.4 (12.1, 12.6) | 13.8 (13.3, 14.2) |
| Peripheral vascular disease, % | 21.4 (21.1, 21.6) | 14.0 (13.6, 14.5) |
| Congestive heart failure, % | 45.8 (45.4, 46.1) | 38.8 (38.2, 39.4) |
| COPD, % | 15.4 (15.1, 15.6) | 8.7 (8.3, 9.1) |
| Cancer, % | 11.8 (11.5, 12.0) | 8.4 (8.0, 8.7) |
| Unable to walk, % | 10.8 (10.6, 11.0) | 11.9 (11.5, 12.3) |
| Unable to transfer, % | 5.3 (5.2, 5.5) | 6.5 (6.2, 6.8) |
| Prior nephrology care, % | 64.9 (64.5, 65.3) | 56.4 (55.7, 57.0) |
| Hemodialysis initiated with fistula, % | 9.9 (9.7, 10.1) | 7.4 (7.1, 7.7) |
| Peritoneal dialysis, % | 4.7 (4.6, 4.9) | 2.8 (2.6, 3.0) |
| Preemptive transplant, % | 0.11 (0.08, 0.14) | 0.05 (0.02, 0.08) |
| Cardiovascular cause of death, % | 46.2 (45.9, 46.6) | 47.9 (47.3, 48.6) |
| Infection-related cause of death, % | 11.2 (10.9, 11.4) | 12.9 (12.5, 13.4) |
| Other cause of death, % | 42.6 (42.2, 42.9) | 39.1 (38.5, 39.7) |
| Death within 6 months after ESRD onset, % | 37.1 (36.7, 37.4) | 33.8 (33.2, 34.4) |
| Residence zip code in 1st quintile of EOL-EI , % | 17.4 (17.2, 17.7) | 4.6 (4.3, 4.8) |
| Residence zip code in 2nd quintile of EOL-EI , % | 18.5 (18.2, 18.8) | 15.8 (15.4, 16.3) |
| Residence zip code in 3rd quintile of EOL-EI , % | 18.8 (18.6, 19.1) | 21.3 (20.8, 21.8) |
| Residence zip code in 4th quintile of EOL-EI , % | 20.8 (20.5, 21.1) | 24.2 (23.7, 24.8) |
| Residence zip code in 5th quintile of EOL-EI , % | 24.4 (24.1, 24.7) | 34.1 (33.4, 34.7) |

Abbreviations: eGFR, estimated glomerular filtration rate; COPD, chronic obstructive pulmonary disease; EOL-EI, end-of-life expenditure index
Parentheses contain 95% confidence intervals

**Table 2. Unadjusted patterns of end-of-life care by race and quintile of end-of-life expenditure index**

| | Quintile of end-of-Life expenditure index | | | | | | |
|---|---|---|---|---|---|---|---|
| | **All patients** | 1st (Lowest) | 2nd | 3rd | 4th | 5th (Highest) | P for trend |
| | **n = 76,972** | n = 13,424 | n = 14,242 | n = 14,505 | n = 16,021 | n = 18,780 | |
| | | | | **White patients** | | | |
| Died in | **58.2** | 51.5 | 55.9 | 57.3 | 58.1 | 65.7 | <0.001 |
| Hospital, % | **(57.9, 58.6)** | (50.6, 52.3) | (55.1, 56.7) | (56.5, 58.1) | (57.3, 58.9) | (65.0, 66.4) | |
| Dialysis | **32.1** | **41.5** | **33.9** | **33.2** | **32.7** | **23.1** | <0.001 |
| discontinuation,%* | **(31.6, 32.5)** | **(40.4, 42.6)** | **(32.9, 35.0)** | **(32.2, 34.2)** | **(31.8, 33.7)** | **(22.4, 23.9)** | |
| Hospice | **28.3** | 33.4 | 29.3 | 29.2 | 29.4 | 22.1 | <0.001 |
| referral, % | **(28.0, 28.6)** | (32.6, 34.2) | (28.5, 30.0) | (28.4, 29.9) | (28.7, 30.1) | (21.5, 22.7) | |
| | | | | **Black patients** | | | |
| | **n = 24,359** | n = 1,111 | n = 3,856 | n = 5,196 | n = 5,898 | n = 8,298 | |
| Died in | **68.4** | 57.6 | 66.4 | 66.9 | 68.6 | 71.6 | <0.001 |
| hospital, % | **(67.8, 69.0)** | (54.7, 60.5) | (64.9, 67.9) | (65.7, 68.2) | (67.4, 69.8) | (70.6, 72.6) | |
| Dialysis | **16.4** | 26.7 | 20.2 | 18.4 | 17.4 | 11.2 | <0.001 |
| discontinuation %* | **(15.9, 16.9)** | (24.1, 29.3) | (18.9, 21.5) | (17.3, 19.4) | (16.4, 18.4) | (**10.6**, 11.9) | |
| Hospice | **15.5** | 24.1 | 17.7 | 15.6 | 17.0 | 12.2 | <0.001 |
| referral, % | **(15.0, 16.0)** | (21.6, 26.6) | (16.5, 18.9) | (14.7, 16.6) | (16.0, 17.9) | (11.5, 12.9) | |

Parentheses contain 95% confidence intervals

* Denominator excludes patients who received a kidney transplant

**Table 3. Adjusted association of black vs. white race with patterns of end-of-life care by quintile of end-of-life expenditure index**

| | Quintile of end-of-life expenditure index | | | | | | |
|---|---|---|---|---|---|---|---|
| | All patients | | | | | | |
| | **All patients n = 101,331** | 1st (lowest) n = 14,535 | 2nd n = 18,098 | 3rd n = 19,701 | 4th n = 21,919 | 5th (Highest) n = 27,078 | P for interaction |
| Died in hospital, OR (95% CI) | **1.43 (1.38, 1.48)** | 1.15 (1.00, 1.32) | 1.48 (1.33, 1.58) | 1.40 (1.30, 1.51) | 1.43 (1.32, 1.54) | 1.24 (1.16, 1.33) | <0.001* |
| Dialysis discontinuation, OR (95% CI) † | **0.47 (0.45, 0.49)** | 0.63 (0.54, 0.74) | 0.57 (**0.51**, 0.63) | 0.51 (0.46, 0.56) | 0.50 (0.46, 0.55) | 0.47 (0.43, 0.51) | <0.001* |
| Hospice Referral, OR (95% CI) | **0.53 (0.51, 0.56)** | 0.81 (0.69, 0.96) | 0.59 (0.53, 0.65) | 0.49 (0.45, 0.54) | 0.56 (0.52, 0.62) | 0.55 (0.50, 0.60) | <0.001* |
| | **Patients** who died within six months | | | | | | |
| | **All patients n = 36,781** | 1st (lowest) n = 5,029 | 2nd n = 6,295 | 3rd n = 6,998 | 4th n = 8,058 | 5th (Highest) n = 10,401 | P for interaction |
| Died in hospital, OR (95% CI) | **1.42 (1.33, 1.51)** | 1.39 (1.08, 1.80) | 1.47 (1.26, 1.71) | 1.38 (1.20, 1.57) | 1.37 (1.21, 1.56) | 1.21 (1.08, 1.35) | 0.18 |
| Dialysis discontinuation, OR (95% CI) † | **0.45 (0.42, 0.49)** | 0.63 (0.47, 0.84) | 0.51 (0.43, 0.61) | 0.47 (0.40, 0.55) | 0.46 (0.40, 0.54) | 0.48 (0.42, 0.56) | 0.40 |
| Hospice referral, OR (95% CI) | **0.50 (0.46, 0.54)** | 0.82 (0.61, 1.10) | 0.47 (0.39, 0.57) | 0.46 (0.39, 0.55) | 0.51 (0.44, 0.60) | 0.55 (0.47, 0.64) | 0.03* |

Abbreviations: OR, odds ratio; CI, confidence interval

* indicated statistical significance of a p for interaction value of <0.05

P for interaction indicates whether the association of race and the outcome of interest differs by EOL-EI

All analyses adjusted for age, gender, body mass index, eGFR, coronary artery disease, peripheral arterial disease, diabetes mellitus, congestive heart failure, stroke, cancer, chronic obstructive pulmonary disease, ability to walk, ability to transfer, treatment modality, prior nephrology care, preemptive transplantation, hemodialysis access, and cause of death

The referent group for this analysis is white patients

† Denominator excludes patients who received a kidney transplant

**Table 4. Adjusted patterns of end-of-life care for patients living in the highest vs. lowest quintile of end-of-life expenditure index stratified by race**

| Odds ratio (95% CI) for patients living in the highest vs. lowest quintile of EOL-EI | **White patients** | | **Black patients** | |
|---|---|---|---|---|
| | **n = 76,972** | **n = 28,543** | **n = 24,359** | **n = 8,238** |
| | **All patients** | **6-month decedents** | **All patients** | **6 month decedents** |
| **Died in hospital** | 1.75 (1.66, 1.84) | 1.85 (1.70, 2.01) | 1.82 (1.58, 2.10) | 1.51 (1.16, 1.96) |
| **Dialysis Discontinuation*** | 0.45 (0.42, 0.47) | 0.43 (0.39, 0.47) | 0.33 (0.28, 0.39) | 0.33 (0.25, 0.45) |
| **Hospice referral** | 0.62 (0.58, 0.65) | 0.63 (0.57, 0.69) | 0.41 (0.34, 0.48) | 0.41 (0.30, 0.57) |

Abbreviations: OR, odds ratio; CI, confidence interval; EOL-EI, end-of-life expenditure index

All analyses adjusted for age, gender, body mass index, eGFR, coronary artery disease, peripheral arterial disease, diabetes mellitus, congestive heart failure, stroke, cancer, chronic obstructive pulmonary disease, ability to walk, ability to transfer, treatment modality, prior nephrology care, preemptive transplantation, hemodialysis access, and cause of death

* Denominator excludes patients who received a kidney transplant

Supplemental Materials:

Table 1: Characteristics of patients included in and excluded from the analytic cohort in relation to the source population
Table 2: Characteristics of white patients by quintile of the end-of-life expenditure index
Table 3: Characteristics of black patients by quintile of the end-of-life expenditure index

**Supplemental Table 1. Characteristics of patients included in and excluded from the analytic cohort in relation to the source population**

| Source Population | Black and white patients with ESRD onset from June 1st, 2005 to September 31st, 2008 | Patients who did not die during follow-up | Decedents missing covariate or outcome information | Analytic cohort |
|---|---|---|---|---|
| **n = 366,022** | **n = 344,715** | **n = 201,859** | **n = 41,525** | **n = 101,331** |
| **Mean age**, years | 63.01 | 58.6 | 69.2 | 69.2 |
| | (63.0, 63.1) | (58.5, 58.7) | (69.1, 69.4) | (69.2, 69.3) |
| **Male, %** | 56.0 | 56.4 | 55.6 | 55.3 |
| | (55.9, 56.2) | (56.2, 56.7) | (55.1, 56.1) | (55.0, 55.6) |
| **Black, %** | 30.1 | 34.0 | 26.2 | 24.0 |
| | (30.0, 30.3) | (33.8, 34.2) | (25.8, 26.6) | (23.8, 24.3)* |

* P <0.05 from comparison with decedents missing information on covariates or outcomes

**Supplemental Table 2. Characteristics of white patients by quintile of the end-of-life expenditure index**

| | Quintile of end-of-life expenditure index | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Total** | 1st (lowest) | 2nd | 3rd | 4th | 5th(Highest) | |
| | **n = 76,972** | **n= 13,424** | **n= 14,242** | **n= 14,505** | **n= 16,021** | **n= 18,780** | **P for trend** |
| Mean age, years | **70.9 (70.8, 71.0)** | 70.9 (70.7, 71.1) | 70.5 (70.3, 70.7) | 70.0 (69.8, 70.3) | 70.6 (70.4, 70.8) | 72.1 (72.0, 72.3) | <0.001 |
| Male, % | **57.9 (57.5, 58.2)** | 58.4 (57.5, 59.2) | 57.0 (56.2, 57.8) | 58.8 (58.0, 59.6) | 57.5 (56.7, 58.3) | 57.8 (57.1, 58.6) | 0.70 |
| eGFR, ml/min/1.73m$^2$ | **11.7 (11.7, 11.8)** | 11.9 (11.8, 12.0) | 11.8 (11.7, 11.9) | 11.4 (11.4, 11.5) | 11.8 (11.7, 11.9) | 11.8 (11.8, 11.9) | 0.89 |
| Body mass index, kg/m$^2$ | **27.9 (27.8, 27.9)** | 28.2 (28.1, 28.3) | 28.2 (28.0, 28.3) | 28.0 (27.9, 28.1) | 27.9 (27.8, 28.0) | 27.3 (27.2, 27.4) | <0.001 |
| Diabetes, % | **53.3 (53.0, 53.7)** | 52.7 (51.9, 53.6) | 54.7 (53.9, 55.5) | 54.3 (53.4, 55.1) | 53.5 (52.7, 54.3) | 51.8 (51.1, 52.5) | 0.004 |
| Coronary artery disease, % | **47.8 (47.4, 48.1)** | 48.4 (47.5, 49.2) | 48.1 (47.3, 49.0) | 46.7 (45.8, 47.4) | 48.5 (47.7, 49.3) | 47.3 (46.6, 48.0) | 0.15 |
| Stroke, % | **12.4 (12.1, 12.6)** | 13.1 (12.6, 13.7) | 12.3 (11.7, 12.8) | 12.4 (11.8, 12.9) | 12.8 (12.1, 13.1) | 11.8 (11.3, 12.2) | 0.003 |
| Peripheral vascular disease, % | **21.4 (21.1, 21.6)** | 22.5 (21.8, 23.3) | 21.4 (20.7, 22.1) | 21.2 (20.6, 21.9) | 22.2 (21.5, 22.8) | 19.9 (19.3, 20.4) | <0.001 |
| Congestive heart failure, % | **45.8 (45.4, 46.1)** | 44.0 (43.1, 44.8) | 45.5 (44.7, 46.4) | 44.8 (44.0, 45.6) | 47.0 (46.2, 47.8) | 46.8 (46.1, 47.5) | <0.001 |
| COPD, % | **15.4 (15.1, 15.6)** | 15.7 (15.0, 16.3) | 16.2 (15.6, 16.8) | 15.8 (15.2, 16.4) | 17.2 (16.6, 17.7) | 12.7 (12.2, 13.1) | <0.001 |
| Cancer, % | **11.8 (11.5, 12.0)** | 12.9 (12.4, 13.5) | 12.2 (11.6, 12.7) | 11.3 (10.8, 11.8) | 11.2 (10.7, 11.7) | 11.4 (11.0, 11.9) | <0.001 |
| Unable to walk, % | **10.8 (10.6, 11.0)** | 9.2 (8.7, 9.7) | 10.0 (9.5, 10.5) | 9.9 (9.4, 10.4) | 11.4 (10.9, 11.9) | 12.8 (12.3, 13.3) | <0.001 |
| Unable to transfer, % | **5.3 (5.2, 5.5)** | 3.5 (3.2, 3.8) | 4.5 (4.2, 4.8) | 4.9 (4.5, 5.2) | 5.7 (5.4, 6.1) | 7.4 (7.0, 7.8) | <0.001 |
| Peritoneal dialysis, % | **4.7 (4.6, 4.9)** | 5.4 (5.1, 5.8) | 5.4 (5.0, 5.8) | 5.8 (5.5, 6.2) | 5.1 (4.8, 5.5) | 2.6 (2.3, 2.8) | <0.001 |
| Nephrology referral, % | **64.9 (64.5, 65.3)** | 67.9 (67.0, 68.7) | 66.6 (65.8, 67.4) | 66.6 (65.7, 67.4) | 66.0 (65.2, 66.8) | 58.9 (58.1, 59.6) | <0.001 |
| Hemodialysis initiation with fistula, % | **9.9 (9.7, 10.1)** | 13.0 (12.5, 13.6) | 9.9 (9.4, 10.4) | 9.6 (9.1, 10.1) | 9.6 (9.1, 10.0) | 8.3 (7.9, 8.7) | <0.001 |
| Preemptive transplant, % | **0.11 (0.09, 0.14)** | 0.19 (0.11, 0.3) | 0.08 (0.04, 0.13) | 0.05 (0.01, 0.08) | 0.09 (0.04, 0.14) | 0.14 (0.09, 0.19) | 0.41 |
| Cardiovascular cause of death, % | **46.2 (45.9, 46.6)** | 41.3 (40.5, 42.2) | 44.9 (44.1, 45.7) | 46.2 (45.3, 47.0) | 45.7 (44.9, 46.4) | 51.4 (50.7, 52.1) | <0.001 |
| Infection-related cause of death, % | **11.2 (10.9, 11.4)** | 11.5 (10.9, 12.0) | 11.1 (10.6, 11.6) | 10.3 (9.8, 10.8) | 10.1 (9.6, 10.5) | 12.6 (12.1, 13.0) | 0.03 |
| Cause of death, other, % | **42.6 (42.2, 42.9)** | 47.2 (46.3, 48.0) | 44.0 (43.2, 44.8) | 43.6 (42.8, 44.4) | 44.3 (43.5, 45.0) | 36.1 (35.4, 36.7) | <0.001 |
| Death within 6 months of ESRD onset % | **37.1 (36.7, 37.4)** | 35.0 (34.2, 35.8) | 35.5 (34.7, 36.3) | 36.2 (35.3, 36.9) | 37.8 (37.0, 38.5) | 39.9 (39.2, 40.6) | <0.001 |

Abbreviations: eGFR, estimated glomerular filtration rate; COPD, chronic obstructive pulmonary disease; EOL-EI, end-of-life expenditure index

Parentheses contain 95% confidence intervals

**Supplemental Table 3. Characteristics of black patients by quintile of end-of-life expenditure index**

| | Quintile of end-of-life expenditure index | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Total** | 1st (lowest) | 2nd | 3rd | 4th | 5th(Highest) | |
| | **n = 24,359** | **n= 1,111** | **n= 3,856** | **n= 5,196** | **n= 5,898** | **n= 8,298** | **P for trend** |
| Mean age, years | **64.0 (63.8, 64.2)** | 63.0 (62.2, 63.9) | 63.9 (63.4, 64.3) | 63.4 (63.0, 63.8) | 63.9 (63.5, 64.3) | 64.6 (64.3, 64.9) | <0.001 |
| Male, % | **47.3 (46.7, 47.9)** | 52.7 (49.8, 55.7) | 48.5 (46.9, 50.1) | 45.5 (44.1, 46.8) | 46.3 (45.0, 47.5) | 47.9 (46.9, 49.0) | 0.19 |
| eGFR, ml/min/1.73m$^2$ | **11.4 (11.3, 11.5)** | 11.2 (11.0, 11.5) | 11.3 (11.2, 11.5) | 11.0 (10.9, 11.2) | 11.6 (11.4, 11.7) | 11.6 (11.5, 11.7) | <0.001 |
| Body mass index (kg/m$^2$) | **27.8 (27.7, 27.9)** | 27.7 (27.3, 28.1) | 27.9 (27.7, 28.2) | 28.2 (28.0, 28.4) | 28.0 (27.8, 28.2) | 27.3 (27.1, 27.5) | <0.001 |
| Diabetes, % | **54.9 (54.2, 55.5)** | 58.4 (55.5, 61.3) | 56.8 (55.3, 58.4) | 57.4 (56.1, 58.8) | 55.2 (53.9, 56.5) | 51.6 (50.5, 52.7) | <0.001 |
| Coronary artery disease, % | **30.6 (30.0, 31.2)** | 33.5 (30.7, 36.3) | 31.1 (29.7, 32.6) | 30.5 (29.2, 31.7) | 29.6 (28.4, 30.7) | 30.7 (29.7, 31.7) | 0.18 |
| Stroke, % | **13.8 (13.3, 14.2)** | 15.7 (13.5, 17.8) | 13.4 (12.3, 14.5) | 14.0 (13.1, 15.0) | 14.0 (13.1, 14.9) | 13.4 (12.6, 14.1) | 0.21 |
| Peripheral vascular disease, % | **14.0 (13.6, 14.5)** | 16.5 (14.3, 18.7) | 15.5 (14.4, 16.7) | 14.4 (13.5, 15.4) | 14.3 (13.4, 15.2) | 12.6 (11.9, 13.3) | <0.001 |
| Congestive heart failure, % | **38.8 (38.2, 39.4)** | 38.3 (35.5, 41.2) | 37.9 (36.4, 39.5) | 38.9 (37.6, 40.2) | 38.4 (37.2, 39.7) | 39.6 (38.5, 40.6) | 0.13 |
| COPD, % | **8.7 (8.3, 9.1)** | 10.3 (8.5, 12.0) | 9.7 (8.7, 10.6) | 8.6 (7.9, 9.4) | 8.2 (7.5, 8.9) | 8.5 (7.9, 9.1) | 0.01 |
| Cancer, % | **8.4 (8.0, 8.7)** | 8.7 (7.1, 10.4) | 8.2 (7.4, 9.1) | 7.8 (7.1, 8.6) | 8.5 (7.8, 9.2) | 8.7 (8.1, 9.3) | 0.31 |
| Unable to walk, % | **11.9 (11.5, 12.3)** | 9.4 (7.6, 11.1) | 10.3 (9.3, 11.3) | 12.0 (11.1, 13.0) | 11.7 (10.8, 12.5) | 13.1 (12.4, 13.9) | <0.001 |
| Unable to transfer, % | **6.5 (6.2, 6.8)** | 5.2 (3.9, 6.5) | 5.0 (4.3, 5.6) | 6.1 (5.4, 6.7) | 6.7 (6.0, 7.3) | 7.6 (7.1, 8.2) | <0.001 |
| Peritoneal dialysis, % | **2.8 (2.6, 3.0)** | 3.3 (2.2, 4.3) | 3.0 (2.5, 3.6) | 3.8 (3.3, 4.4) | 3.2 (2.8, 3.7) | 1.7 (1.5, 2.0) | |
| Nephrology referral, % | **56.4 (55.7, 57.0)** | 66.8 (63.9, 69.7) | 63.1 (61.5, 64.7) | 59.7 (58.3, 61.1) | 58.2 (56.8, 59.6) | 47.9 (46.7, 49.1) | <0.001 |
| Dialysis initiation with fistula, % | **74.1 (70.8, 77.5)** | 11.7 (9.8, 13.6) | 7.8 (7.0, 8.7) | 8.2 (7.4, 9.0) | 6.8 (6.1, 7.4) | 6.6 (6.1, 7.1) | <0.001 |
| Preemptive transplant, % | **0.05 (0.02, 0.08)** | 0.09 (-0.09, 0.3) | 0.03 (-0.02, 0.08) | 0.04 (-0.01, 0.09) | 0.03 (-0.01, 0.08) | 0.08 (0.02, 0.15) | 0.41 |
| Cardiovascular cause of death, % | **47.9 (47.3, 48.6)** | 46.1 (43.1, 49.0) | 48.9 (47.3, 50.5) | 48.2 (46.9, 49.6) | 46.8 (45.6, 48.1) | 48.3 (47.2, 49.4) | 0.94 |
| Infection-related cause of death, % | **12.9 (12.5, 13.4)** | 10.9 (9.1, 12.7) | 11.4 (10.4, 12.4) | 12.0 (10.4, 12.4) | 12.4 (11.5, 13.2) | 15.0 (14.2, 15.7) | <0.001 |
| Cause of death, other, % | **39.1 (38.5, 39.7)** | 43.0 (40.1, 45.9) | 39.7 (38.1, 41.2) | 39.8 (38.5, 41.2) | 40.8 (39.5, 42.0) | 36.7 (35.7, 37.7) | <0.001 |
| Death up to 6 months after dialysis initiation | **33.8 (33.2, 34.4)** | 29.8 (27.1, 32.5) | 32.1 (30.6, 33.5) | 33.7 (32.4, 35.0) | 34.1 (32.9, 35.3) | 35.1 (34.0, 36.1) | <0.001 |

Abbreviations: eGFR, estimated glomerular filtration rate; COPD, chronic obstructive pulmonary disease; EOL-EI, end-of-life expenditure index

Parentheses contain 95% confidence intervals