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Socioeconomic Factors and Racial and Ethnic Differences in the Initiation of Home Dialysis

Jenny I. Shen, Lucia Chen, Sitaram Vangala, Lynn Leng, Anuja Shah, Anjali B. Saxena, Jeffrey Perl, and Keith C. Norris

Rationale & Objective: Home dialysis has been underused in the United States, especially among minority groups. We investigated whether adjustment for socioeconomic factors would attenuate racial/ethnic differences in the initiation of home dialysis.

Study Design: Retrospective observational cohort study.

Setting & Population: Adult patients in the US Renal Data System who initiated dialysis on day 1 with either in-center hemodialysis (HD), home HD (HHD), or peritoneal dialysis (PD) from 2005 to 2013.

Predictor: Race/ethnicity: non-Hispanic white, Hispanic, black, or Asian.

Outcome: Initiating dialysis with PD versus in-center HD and HHD versus in-center HD for each minority group compared with non-Hispanic whites.

Analytical Approach: Odds ratios and 95% CIs estimated by logistic regression.

Results: Of 523,526 patients, 55% were white, 28% were black, 13% were Hispanic, and 4% were Asian; 8% started dialysis on PD, and 0.1%, on HHD. In unadjusted analyses, blacks and Hispanics were 30% and 19% less likely and Asians were 31% more likely to start on PD than whites. The differences narrowed when fully adjusted for demographic, medical, and socioeconomic factors. Adjustment for socioeconomic factors reduced these differences between white and black, Hispanic, and Asian patients by 13%, 28%, and 1%, respectively. Blacks were just as likely and Hispanics and Asians were less likely to start on HHD than whites. This did not change appreciably when fully adjusted for demographic, medical, and socioeconomic factors.

Limitations: No data for physician and patient preferences or modality education.

Conclusions: Black and Hispanic patients are less likely to start on PD than white patients, attributable partly, though not completely, to socioeconomic factors. Hispanics and Asians are less likely to start on HHD than whites. This was materially unaffected by socioeconomic factors. More research is needed to determine whether urgent-start PD programs and transitional care units in socioeconomically disadvantaged areas might reduce these disparities and increase home dialysis use among all groups.

A lthough the United States has experienced a recent growth in the use of home dialysis, the incidence remains low: only 10% of patients who initiated dialysis started with peritoneal dialysis (PD) or home hemodialysis (HHD) in 2016.[1] The difference is even more striking

among black and Hispanic patients, who make up 41% of the incident dialysis population but only 33% of those starting on home dialysis.[1] Although these disparities have been well documented, it is less clear what factors might be driving the differences.[2-4]

Observational studies have found no systematic differences in the adjusted survival of patients receiving home versus in-center dialysis.[5-9] Modality choice should be the result of an informed decision-making process involving both the physician and the patient because there are few absolute contraindications to either modality.[10,11] However, a number of socioeconomic factors differ between patients receiving home dialysis and those receiving in-center hemodialysis (HD). Home dialysis patients tend to be wealthier, more educated, and more likely to have received predialysis nephrology care than those receiving in-center HD.[2,3,12,13] Notably, many of these same characteristics are less prevalent among minority patients receiving dialysis.

In this study, we tested our hypothesis that adjusting for such individual- and neighborhood-level socioeconomic factors would attenuate the racial and ethnic differences in the initiation of dialysis with home modalities in a cohort of US patients from 2005 to 2013. We also theorized that these racial and ethnic differences would vary regionally, reflecting regional differences in physician and patient preferences, and would be more pronounced when measured on day 1 versus day 90 of dialysis due to a higher likelihood of minorities to start dialysis unplanned on in-center HD.

METHODS

Data Source

We extracted patient- and dialysis facility-level data from the US Renal Data System (USRDS), a national database of

virtually all patients with end-stage kidney disease. Zip code–level socioeconomic factors were abstracted from the American Community Survey 5-year estimates, and hospital service area (HSA)-level variables were derived from the Dartmouth Atlas of Healthcare. Rural/urban status was determined using Rural-Urban Commuting Area Codes, version 3.0.[14]

Study Sample

We identified from the USRDS all adult (≥18 years old) patients with end-stage kidney disease who initiated maintenance dialysis with either PD, in-center HD, or HHD on day 1 of dialysis between January 1, 2005, and December 31, 2013 (Fig S1). We excluded 17,438 patients who were not of Asian, black (African American), or white race because we believed that results from a heterogeneous "other" category would be difficult to interpret clinically. There were also too few Native Americans, Hispanic black, and Hispanic Asians to analyze separately, and we chose to exclude nonwhite Hispanics from the Hispanic white group because they have been found to have different outcomes.[15] We also excluded those with missing length of nephrology care (n = 158,832) because we thought that it was a marker of poor data quality, as well as those missing zip codes because these were used to link to multiple neighborhood variables (n = 54,909). In a sensitivity analysis, we used multiple imputation to analyze 739,872 patients, including those with missing laboratory data. The primary analysis was a complete case analysis of 523,526 patients.

Exposure and Outcome

The primary exposure of interest was race/ethnicity. We categorized patients as either white (non-Hispanic white), Hispanic (Hispanic white), black (non-Hispanic black), or Asian (non-Hispanic Asian) based on the race and ethnicity reported on the Medical Evidence Report (Centers for Medicare & Medicaid Services [CMS] form 2728).

The primary outcome of interest was the dialysis modality the patient was using on day 1 of dialysis, either PD, in-center HD, or HHD, as reported in the detailed treatment history file of the USRDS.

Covariates

We ascertained individual-level demographics, comorbid conditions, laboratory values, and socioeconomic factors from the Medical Evidence Report (Tables 1 and 2). These variables have previously been shown to be associated with modality selection.[3]

We used the patient's 5-digit zip code to link to zip code–level neighborhood socioeconomic variables from the American Community Survey 5-year estimates (Table 2; Item S1). Neighborhoods were considered urban if they were categorized as metropolitan using Rural-

Urban Commuting Area codes. We chose covariates that were previously shown to vary among different racial and ethnic groups and to be associated with clinical outcomes in patients receiving dialysis.[16-21]

We accessed the Dartmouth Atlas to determine HSA levels of access to health care (Table 2). We calculated the number of large PD facilities (any facility that has at least 20 patients receiving PD) and the number of HHD units (any unit that offers HHD) in the HSA using the End-Stage Renal Disease Facility Survey (form CMS-2744) from the USRDS.

We considered regional provider culture to be a socioeconomic factor so we categorized the geographic location of patients into 1 of the 9 US census divisions. We also included local trends in health care spending, which the Dartmouth Atlas provides as the total Medicare reimbursement per enrollee in the HSA. We used the Facility Survey to determine whether patients' dialysis facilities were for profit, nonprofit, or unknown.

Statistical Analysis

We tabulated patient characteristics by race/ethnicity using percentages and mean ± standard deviation or median with interquartile range, as appropriate.

We used logistic regression to estimate the ratio of the odds of initiating dialysis with PD (vs in-center HD) and HHD (vs in-center HD) in each of the minority groups to the odds for white patients. We categorized the variables listed in Table S1. The number of large PD programs and the number of HHD units in an HSA were log transformed.

We ran the following models: (1) unadjusted analysis (race/ethnicity only), (2) adjusted for demographics (age, sex, and calendar year of dialysis initiation), (3) model 2 plus medical factors (comorbid conditions and laboratory results), and (4) model 3 plus socioeconomic factors (individual-, zip code–, and HSA-level socioeconomic factors and provider culture). We assessed effect modification by census division by adding an interaction term between the variable of interest and race/ethnicity in the full model.

To quantify the magnitude of change in the odds of PD (vs in-center HD) after adjustment for demographic, medical, and socioeconomic factors, we calculated the percent change in the odds ratio (OR) of PD for each subsequent model relative to the previous model for each race/ethnicity. We conducted bootstrap analyses (with 1,000 replications) to estimate the 95% confidence interval (CI) around this parameter.

Because many patients change modalities in the first 90 days of dialysis, we performed a secondary analysis in which the outcome was the modality on day 90 as determined by the condensed treatment history in the USRDS. To understand the mechanism behind any changes in racial/ethnic differences in modality from day 1 to day 90, we used logistic regression to estimate the

Table 1. Characteristics of Adult Patients Initiating Dialysis From 2005 to 2013 on Day 1 of Dialysis, by Race/Ethnicity

	White (n = 287,291)	Black (n = 145,366)	Hispanic (n = 67,541)	Asian (n = 23,328)
Treatment Modality				
In-center hemodialysis	261,651 (91%)	136,089 (94%)	62,595 (93%)	20,681 (89%)
Peritoneal dialysis	25,189 (9%)	9,060 (6%)	4,878 (7%)	2,624 (11%)
Home hemodialysis	451 (0.2%)	217 (0.1%)	68 (0.1%)	23 (0.1%)
Demographics				
Age, y	69 [58-78]	60 [49-70]	60 [50-70]	64 [53-74]
Male sex	172,428 (60%)	77,087 (53%)	39,151 (58%)	13,113 (56%)
Year of dialysis initiation				
2005-2007	90,865 (32%)	46,651 (32%)	19,376 (29%)	6,555 (28%)
2008-2010	101,146 (35%)	52,317 (36%)	24,082 (36%)	8,406 (36%)
2011-2013	95,280 (33%)	46,398 (32%)	24,083 (36%)	8,367 (36%)
Reported Comorbid Conditions				
Primary cause of kidney failure				
Diabetes	119,906 (42%)	63,946 (44%)	42,314 (63%)	12,321 (53%)
Hypertension	77,304 (27%)	52,355 (36%)	12,099 (18%)	5,362 (23%)
Glomerulonephritis	26,489 (9%)	11,860 (8%)	5,546 (8%)	3,005 (13%)
Cystic kidney disease	8,286 (3%)	1,722 (1%)	1,123 (2%)	415 (2%)
Other cause	44,386 (15%)	11,827 (8%)	4,533 (7%)	1,385 (6%)
Unknown cause	10,920 (4%)	3,656 (3%)	1,926 (3%)	840 (4%)
Diabetes	149,275 (52%)	80,215 (55%)	45,274 (67%)	13,673 (59%)
Hypertension	242,775 (85%)	131,115 (90%)	59,213 (88%)	20,681 (89%)
Atherosclerotic heart disease	77,485 (27%)	20,933 (14%)	11,298 (17%)	4,141 (18%)
Congestive heart failure	99,757 (35%)	43,049 (30%)	17,868 (27%)	5,727 (25%)
Peripheral vascular disease	47,826 (17%)	14,812 (10%)	8,121 (12%)	1,860 (8%)
Cerebrovascular disease	28,852 (10%)	15,041 (10%)	5,051 (8%)	1,861 (8%)
Other cardiac disease	61,317 (21%)	19,512 (13%)	7,913 (12%)	2,910 (13%)
Body mass index, kg/m²	28.7 ± 6.9	29.1 ± 7.2	28.5 ± 6.4	25.9 ± 5.8
Inability to ambulate	19,688 (7%)	8,708 (6%)	3,626 (5%)	990 (4%)
Needs assistance with daily activities	35,062 (12%)	14,986 (10%)	7,210 (11%)	2,101 (9%)
Laboratory Measures				
eGFR, mL/min	12 [9-16]	9 [7-13]	11 [8-14]	12 [9-16]
Hemoglobin, g/dL	10.1 ± 1.6	9.6 ± 1.7	9.8 ± 1.6	9.9 ± 1.7
Serum albumin, g/dL	3.2 ± 0.7	3.1 ± 0.7	3.1 ± 0.7	3.2 ± 0.7

Note: Values expressed as number (percent), median [first quartile-third quartile], or mean ± standard deviation.
Abbreviation: eGFR, glomerular filtration rate estimated using Chronic Kidney Disease Epidemiology Collaboration equation.

OR for patients who were receiving PD on day 1 to still be receiving PD on day 90, as well as the OR for patients who were not receiving PD on day 1 to be receiving PD on day 90, in each of the minority groups versus white patients. We used models analogous to those in the primary analysis. We repeated these analyses in the HHD cohort.

To ensure that missing data did not lead to bias, as sensitivity analyses we used multiple imputation to impute missing variables other than race/ethnicity, length of nephrology care, and zip code for all of the PD analyses.

All analyses were performed using SAS, version 9.4 (SAS Institute). P < 0.05 was considered statistically significant. The Institutional Review Board of the Los Angeles Biomedical Institute at Harbor-UCLA Medical Center approved the study (#040098) and waived the requirement for written consent owing to the deidentified nature of the data.

RESULTS

Patient Characteristics

Of 523,526 patients, 287,291 (55%) were white, 145,366 (28%) were black, 67,541 (13%) were Hispanic white, and 23,328 (4%) were Asian (Table 1). Overall, only 41,751 (8%) initiated dialysis with PD, with lower proportions among black (n = 9,060; 6%) and Hispanic (n = 4,878; 7%) patients. Less than 1% (n = 759) of all patients initiated treatment with HHD, with all racial and ethnic minorities starting on HHD at a lower rate than whites (0.1% vs 0.2%). The minority patients were on average 5 to 9 years younger than white patients. Diabetes was most prevalent among Hispanic patients (n = 45,274; 67%), with white patients having the lowest prevalence (n = 149,275; 52%). All 3 minority groups also had a higher prevalence of hypertension compared with white patients. By contrast, white patients were more likely to have every other comorbid condition. Black patients

Table 2. Socioeconomic Characteristics of Adult Patients Initiating Dialysis From 2005 to 2013 on Day 1 of Dialysis, by Race/Ethnicity

	White (n = 287,291)	Black (n = 145,366)	Hispanic (n = 67,541)	Asian (n = 23,328)
Individual-Level Socioeconomic Factors				
Length of nephrology care predialysis				
Not referred	84,400 (29%)	52,337 (36%)	25,691 (38%)	6,594 (28%)
<6 mo	42,097 (15%)	20,275 (14%)	9,543 (14%)	3,867 (17%)
6-12 mo	66,732 (23%)	34,654 (24%)	16,750 (25%)	5,987 (26%)
>12 mo	94,062 (33%)	38,100 (26%)	15,557 (23%)	6,880 (30%)
Insurance (not mutually exclusive)				
Employer group health plan	76,430 (27%)	34,943 (24%)	12,796 (19%)	6,307 (27%)
Veterans Affairs	6,632 (2%)	3,832 (3%)	973 (1%)	181 (1%)
Medicaid	46,130 (16%)	47,718 (33%)	26,515 (39%)	8,129 (35%)
Medicare	178,319 (62%)	67,180 (46%)	28,326 (42%)	10,102 (43%)
Other	80,406 (28%)	17,074 (12%)	7,597 (11%)	4,242 (18%)
None	12,746 (4%)	15,744 (11%)	8,628 (13%)	1,550 (7%)
Employment status				
Unemployed	38,892 (14%)	41,568 (29%)	18,997 (28%)	5,633 (24%)
Employed	40,897 (14%)	41,56 (14%)	11,123 (17%)	4,929 (21%)
Retired	143,105 (50%)	40,616 (28%)	17,754 (26%)	8,369 (36%)
Disabled	63,470 (22%)	40,616 (29%)	19,339 (29%)	4,223 (18%)
Other	927 (<1%)	714 (1%)	328 (1%)	174 (1%)
Zip Code–Level Socioeconomic Factors				
Residents living below poverty line	13.7% ± 8.1%	22.2% ± 10.9%	21.1% ± 10.5%	13.5% ± 8.1%
Residents with <HS diploma	12.2% [8.0%-18.1%]	18.9% [13.0%-24.9%]	26.0% [%15.8-36.9%]	13.9% [8.4%-22.4%]
Residents who identify as black/African-American	4.4% [1.6%-12.0%]	40.5% [19.4%-68.5%]	4.9% [1.9%-12.9%]	5.1% [2.6%-13.0%]
Residents who identify as Hispanic or Latino of any race	5.2% [2.1%-13.3%]	5.9% [2.4%-17.1%]	51.4% [26.5%-75.4%]	15.9% [8.3%-33.5%]
Residents who are linguistically isolated	3.0% [1.2%-7.5%]	3.9% [1.6%-10.7%]	20.5% [10.1%-31.8%]	16.2% [7.4%-26.7%]
Expected no. of occupants per room for occupied housing units	1.0 [1.0-1.0]	1.0 [1.0-1.0]	1.1 [1.0-1.1]	1.1 [1.0-1.1]
Urban	219,498 (77%)	126,630 (87%)	60,198 (89%)	22,064 (95%)
HSA-Level Access to Care				
No. of large PD facilities in HSA[a]	1.6 [0.7-3.5]	3.3 [1.4-4.2]	3.2 [1.4-4.3]	3.3 [1.8-4.5]
No. of HHD facilities in HSA	6.0 [1.0-33.0]	27.0 [4.0-69.0]	16.0 [2.0-54.0]	26.0 [5.0-68.0]
Nephrologists per 100,000 residents in HSA	2.0 [1.3-2.7]	2.6 [2.0-3.4]	2.2 [1.6-2.9]	2.1 [1.8-2.9]
Provider Culture				
Annual medical reimbursement/patient in HSA	$9,093 ± $1,452	$9,430 ± $1,436)	$9,729 ± $1,880)	$8,736 ± $1,716)
Census division				
Pacific	31,116 (11%)	8,342 (6%)	20,124 (30%)	13,225 (57%)
East South Central	20,711 (7%)	17,281 (12%)	319 (0.5%)	229 (1%)
West South Central	20,711 (9%)	18,488 (13%)	20,762 (31%)	1,118 (5%)
Mountain	17,800 (6%)	2,086 (1%)	7,647 (11%)	1,157 (5%)
New England	15,563 (5%)	2,677 (2%)	1,347 (2%)	552 (2%)
South Atlantic	48,887 (17%)	47,222 (33%)	4,547 (7%)	1,779 (8%)
West North Central	20,921 (7%)	4,480 (3%)	988 (2%)	544 (2%)
East North Central	53,877 (19%)	20,290 (14%)	3,908 (6%)	1,227 (5%)
Middle Atlantic	51,524 (18%)	20,290 (17%)	3,908 (12%)	3,497 (15%)
For-profit dialysis unit[b]	218,400 (76%)	112,842 (78%)	56,330 (83%)	17,880 (77%)

Note: Values expressed as number (percent), median [first quartile-third quartile], or mean ± standard deviation.
Abbreviations: HHD, home hemodialysis; HS, high school; HSA, hospital service area; PD, peritoneal dialysis.
[a]Large was more than 20 PD patients.
[b]This was unknown for white (n = 5,517; 2%), black (n = 4,505; 3%), Hispanic (n = 1,034; 2%), and Asian patients (n = 362; 2%).
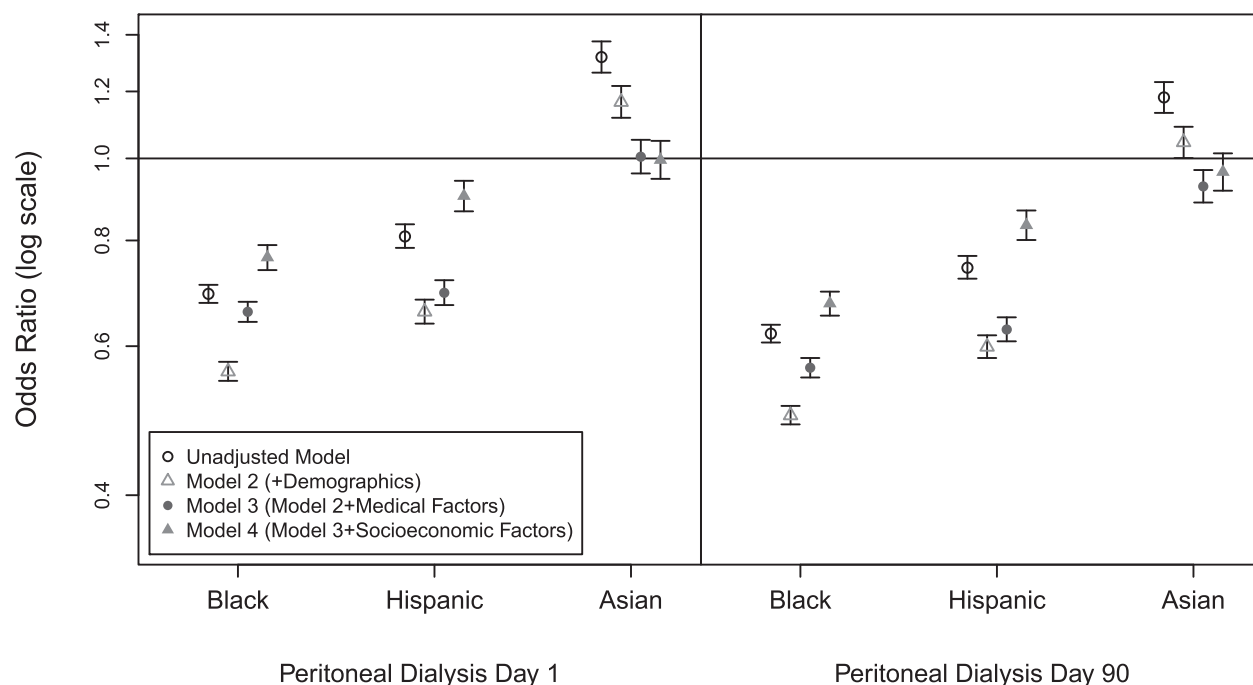
Figure 1. Odds ratios and 95% confidence intervals of initiating dialysis with home modalities (vs in-center hemodialysis) in minority groups (vs whites) by modality defined at day 1 or day 90 of dialysis. Demographics included age, sex, and year of dialysis initiation. Medical factors included body mass index, comorbid conditions, and laboratory values as listed in Table 1. Socioeconomic factors included predialysis nephrologist care, insurance, employment, neighborhood-level poverty, education level, racial/ethnic composition, linguistic isolation, number of home dialysis units and nephrologists, census division, urban/rural, and profit status of facility.

tended to have the highest body mass index and Asian patients had the lowest body mass index of all the racial/ethnic groups.

Individual-level socioeconomic factors varied by race/ethnicity (Table 2). Black and Hispanic patients were much less likely to have been referred to a nephrologist before starting dialysis. All 3 minority groups were more likely to be unemployed and qualify for Medicaid insurance, while almost two-thirds of white patients were covered by Medicare, far higher than the other groups and likely due to their older average age. Black and Hispanic patients had higher rates of being uninsured.

When examining zip code–level neighborhood socioeconomic factors, black and Hispanic patients tended to live in poorer neighborhoods with lower levels of educational attainment. Hispanic and Asian patients lived in more linguistically isolated neighborhoods. The vast majority of minority patients lived in urban areas, while about a quarter of white patients resided in rural areas.

In terms of access to care, non-Hispanic white patients had less access to large PD programs, HHD facilities, and nephrologists in their HSA compared with minority patients, likely due to their greater rates of rural residence.

The geographic distribution of the groups differed, with more blacks living in the South Atlantic and Hispanic and Asian patients more heavily represented in the Pacific census division. Total Medicare reimbursement costs were

highest in the HSAs that served black and Hispanic patients and lowest in the areas that served Asians.

Socioeconomic Factors and Racial/Ethnic Differences in Initiation of Dialysis With PD

The rate of PD initiation was 8.8 per 100 incident patients among white patients. In unadjusted analyses, black and Hispanic patients were 30% and 19% less likely (6.2 and 7.2/100 patients, respectively) and Asian patients were 30% more likely (11.3/100 patients) to start on PD than white patients (Fig 1; Table 3). The disparity for black and Hispanic patients increased and the advantage for Asian patients decreased when we accounted for age, sex, and calendar year of dialysis initiation.

Adjustment for medical factors narrowed the difference in PD initiation rates for black and Hispanic patients and closed the gap between Asian and white patients. Additionally adjusting for socioeconomic factors further narrowed the disparities for black and Hispanic patients. However, these groups were still statistically significantly less likely to initiate dialysis with PD compared with white patients in the fully adjusted model (blacks: OR, 0.76; 95% CI, 0.74-0.79; Hispanics: OR, 0.90; 95% CI, 0.87-0.94). Accounting for socioeconomic factors did not appreciably change the essentially equal likelihood of initiating PD for Asian and white patients. ORs associated with initiating PD for all variables in the fully adjusted model are listed in

Table 3. Percent Change in ORs and 95% CIs for Initiating Peritoneal Dialysis (vs in-center hemodialysis) on Day 1 for Minority Groups (vs whites) After Adjustment for Factors

Model	White Patients	Black Patients OR (95% CI)	Hispanic Patients OR (95% CI)	Asian Patients OR (95% CI)
1; unadjusted	Reference	0.69 (0.68 to 0.71)	0.81 (0.78 to 0.84)	1.32 (1.26 to 1.38)
2; model 1 + demographics	Reference	0.56 (0.55 to 0.58)	0.66 (0.64 to 0.68)	1.17 (1.12 to 1.22)
% change in OR from model 1 after adjustment for demographics		−19% (−20% to −18%)	−19% (−19% to −18%)	−12% (−12% to −11%)
3; model 2 + medical factors	Reference	0.66 (0.64 to 0.68)	0.69 (0.67 to 0.72)	1.01 (0.96 to 1.05)
% change in OR from model 2 after adjustment for medical factors		18% (16% to 19%)	6% (5% to 8%)	−14% (−16% to −12%)
4; model 3 + socioeconomic factors	Reference	0.76 (0.74 to 0.79)	0.90 (0.87 to 0.94)	1.00 (0.95 to 1.05)
% change in OR from model 3 after adjustment for socioeconomic factors		13% (13% to 14%)	29% (25% to 33%)	1% (−4% to 5%)

Abbreviations: CI, confidence interval; OR, odds ratio.

Table S2. The strongest correlate of PD initiation other than albumin level was length of nephrology care predialysis.

The degree to which demographic, medical, and socioeconomic factors changed the racial/ethnic differences in initiating PD is shown in Table 3. For blacks, adjustment for socioeconomic factors reduced the disparity by a similar proportion (13%; 95% CI, 13%-14%) as medical factors (18%; 95% CI, 16%-19%). For Hispanics, adjustment for socioeconomic factors changed the difference much more (29%; 95% CI, 25%-33%) than medical factors (6%; 95% CI, 5%-8%). For Asians, adjustment for socioeconomic factors did not significantly change the odds of PD use.

There was a high degree of regional variation in the racial/ethnic differences in PD. At one end of the spectrum, minority patients in New England were 25% to 84% more likely to use PD than white patients, while those in the Mountain census division were the least likely to use PD at rates comparable to white patients (28%-38% less likely; Fig 2; Table S3).

To study whether the high rate of change in modality during the first few months of dialysis might influence results, we repeated the analysis defining modality at day 90 of dialysis (Table S4). The trend in the attenuation of the OR after adjustment for socioeconomic factors was the same, but the use of PD was even lower among minority patients compared with white patients when measured at day 90 (fully adjusted models: blacks: OR, 0.67; 95% CI, 0.65-0.70; Hispanics: OR, 0.83; 95% CI, 0.80-0.87; Fig 1; Table S5). To understand these trends, we examined changes in modality from day 1 to day 90. In unadjusted analyses, minorities who were receiving PD on day 1 were more likely to still be receiving PD on day 90 than white patients, though this was not statistically significant in the fully adjusted model (Fig S2; Tables S6 and S7). Conversely, black and Hispanic patients who had not been receiving PD on day 1 were 26% to 48% less likely to be receiving PD on day 90 than whites, even in adjusted analyses.

All analyses were repeated using multiple imputation for missing data and were not materially different (Tables S8-S12).
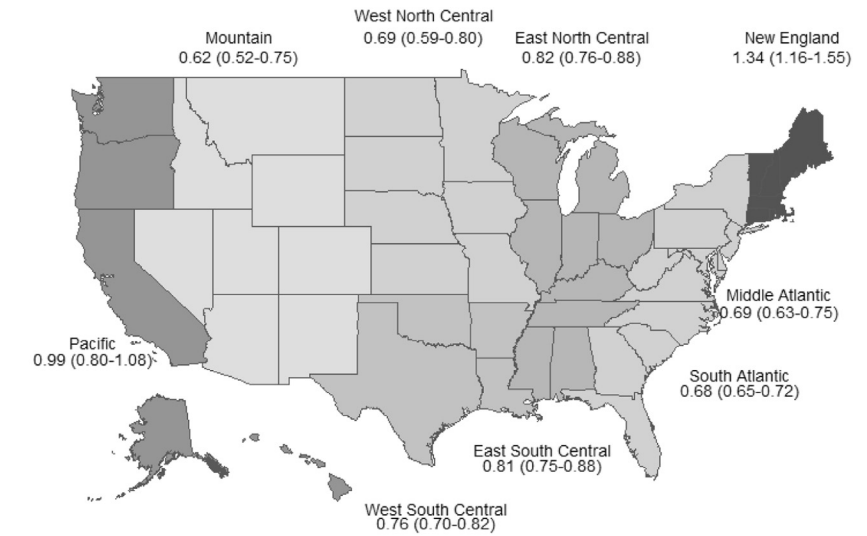
Socioeconomic Factors and Racial/Ethnic Differences in Initiation of Dialysis With HHD

In unadjusted analyses, the minority groups were 7% to 35% less likely to initiate dialysis with HHD compared with white patients, though the difference for blacks was not statistically significant (Table S13). None of the multivariable-adjusted results were materially different from the unadjusted analyses. ORs for the initiation of HHD associated with each of the variables in the fully adjusted model are listed in Table S14.
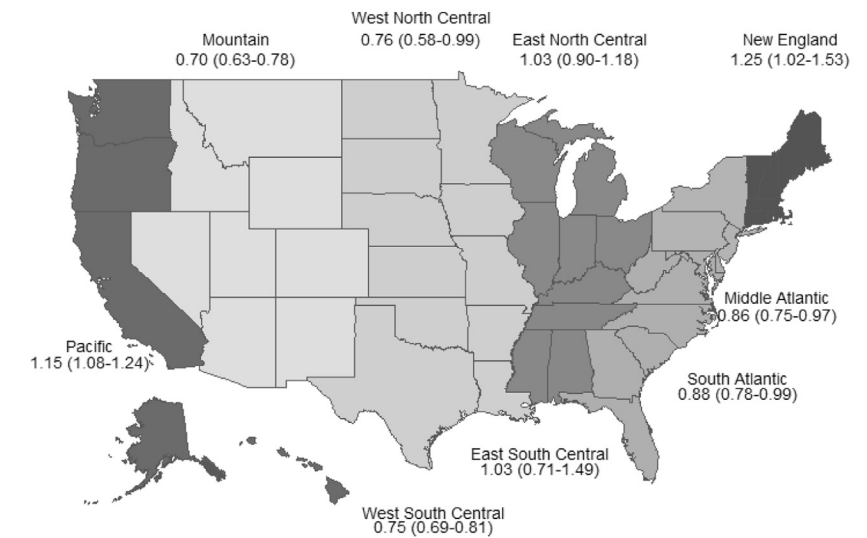
When we defined modality at day 90 of dialysis, the total number of HHD patients more than doubled, from 759 to 1,947 (Table S4). However, the disparity in HHD use among minority patients was even larger than when measured on day 1, with minority patients 61% to 70% less likely to use HHD (Table S15). Although there was no significant racial/ethnic difference in the likelihood of patients who had been receiving HHD on day 1 still receiving HHD on day 90, minority patients who had not been receiving HHD on day 1 were 30% to 50% less likely to be receiving HHD on day 90 than their white counterparts (Tables S6 and S16). Adjusted analyses yielded similar results.
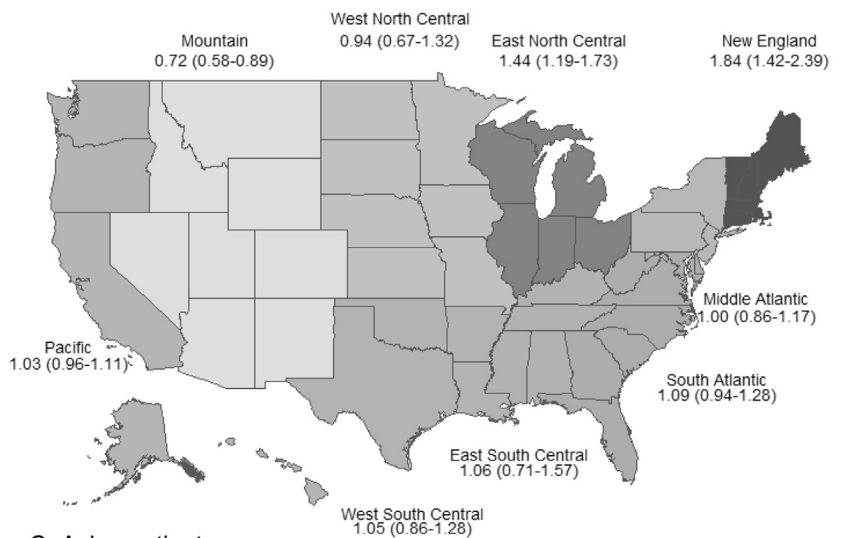
DISCUSSION

In this study, we found that black and Hispanic patients were 31% and 19% less likely to start dialysis with PD compared with white patients despite being younger. Accounting for differences in medical factors, such as the higher body mass index and higher prevalence of diabetes in these groups, attenuated the differences. When we further adjusted for various individual- and neighborhood-level socioeconomic factors, the gap in PD initiation further narrowed but did not close: black patients were still 24% and Hispanic patients were 10% less likely to start

Figure 2. Geographic variation in the initiation of peritoneal dialysis (PD), by census division. Darker areas represent higher odds ratios of initiating PD in minorities versus white patients.

A: Black patients

B: Hispanic patients

C: Asian patients

dialysis with PD. However, Asian patients were just as likely to use PD as their initial modality as white patients after factoring in differences in demographic and medical factors. Socioeconomic factors did not seem to change this estimate.

Trends in HHD initiation were different. Hispanic patients were 37% less likely to start with HHD than whites, but black and Asian patients were just as likely to start on this modality as white patients. Accounting for socioeconomic factors did not change these inferences, in part because the analysis was underpowered given the low number of patients using HHD.

Disparities in PD use among black and Hispanic patients were reported in a cohort of 162,000 patients from a large dialysis organization.[4] In our analysis, we chose to adjust for demographic, medical, and socioeconomic factors in a stepwise fashion to quantify the extent to which each adjustment for each set of factors changes the disparities in home dialysis use. Although Mehrotra et al[4] adjusted for health insurance and geographic region, we were able to incorporate a wider range of socioeconomic factors, including measures of poverty, education, employment, and segregation. We also incorporated measures of access to care beyond insurance status, including predialysis nephrology care. We found that adjustment for socioeconomic factors reduced the disparity in PD initiation among black and Hispanic patients by as much as, if not more than, adjustment for medical factors. However, socioeconomic factors did not appreciably change the odds of PD use in Asians compared with whites, implying that the comparable rate of PD use is in part because Asians' socioeconomic situations are more comparable to those of whites.

Modality choice should be primarily based on patient preference. There are legitimate reasons that patients of a certain socioeconomic background might prefer a particular modality. For instance, patients who are employed tend to appreciate the flexibility of scheduling home dialysis around their work schedules.[22,23] However, patients with lower incomes might live in smaller quarters that do not easily accommodate the equipment needed for home dialysis.[24,25]

Issues of access to care may influence or even limit patients' choices. In our study, the strongest correlate of initiating dialysis with PD was receipt of predialysis nephrologist care. Previous studies have demonstrated that patients are more likely to choose PD when they receive adequate education about home dialysis.[26-29] Such high-quality counseling, which requires multiple sessions and time for the patient to consider how these options may fit into his or her new life as a patient receiving dialysis, is less likely to happen when the patient is started urgently on dialysis. Most patients who "crash into" dialysis are also started on HD because of acute complications, and until recently, PD was deemed less able to stabilize the patient emergently.[30] Furthermore, it is usually far more convenient to place an HD rather than PD catheter emergently.[31]

Later referral to a nephrologist is an important contributor to the racial/ethnic disparity in home dialysis use because black and Hispanic patients are more likely than white patients to have been referred later. This highlights the potential that urgent-start PD programs might have to not just increase PD use overall, but also close the disparity in late referral patients who are disproportionately black and Hispanic.

Adjusting for socioeconomic factors may also have attenuated racial/ethnic differences in home dialysis initiation because they capture potential physician or patient bias against using PD.[22,32,33] For instance, we confirmed the findings of a previous study that found that patients living in areas with higher percentages of black patients are less likely to start on PD regardless of their race.[19] Black patients may be trapped in a cycle in which few of them choose PD because they live in largely black neighborhoods in which PD is not widely used or promoted, leading to continued low uptake of the modality in these communities. We similarly found that living in linguistically isolated communities was associated with a lower rate of PD use. Other studies have found analogous links between linguistic isolation and a lower rate of being waitlisted and undergoing transplantation.[18,20] This suggests that language barriers may play a role in dialysis modality education and affect modality choice for groups with high percentages of patients with limited English proficiency, such as Hispanics and Asians.

However, it is important to note that regional differences in disparities suggest that such racially/ethnically specific attitudes are not universal or insurmountable.[34] For instance, black and Hispanic patients were more likely than non-Hispanic patients to use PD in the New England census regions. Further research is needed to understand the drivers behind these regional variations.

Our study found disparities to be less pronounced than those in the study of Mehrotra et al[4] (for blacks: OR, 0.53; 95% CI, 0.50-0.56; for Hispanics: OR, 0.57; 95% CI, 0.53-0.61). This is likely because our study focused on incident rather than prevalent dialysis patients. We chose to focus on the modality that patients used on day 1 of dialysis because there is a high rate of transfer from home modalities to in-center HD in the first 90 days of dialysis. We also wished to capture differences that might reflect varying rates of urgent-start dialysis across racial and ethnic groups. When we redefined modality at day 90 of dialysis, the disparities increased from day 1 of dialysis and were similar to those reported by Mehrotra et al.[4] These differences were not driven by a higher rate of technique failure among minority patients receiving home dialysis on day 1, but rather by the increased likelihood of white patients (as compared with minority patients) who had not been receiving home dialysis on day 1 to transfer to home dialysis by day 90. Further work is needed to understand these patterns and whether interventions such as increasing the use of transitional

care units, which provide unbiased modality education to those new to dialysis, in areas that serve minority patients might close the racial/ethnic gap in early transitions from in-center HD to home dialysis.

This study has limitations. We did not have data for physician and patient attitudes toward certain modalities, what kind of modality education they received, or individual-level educational attainment, income, and language. We also excluded patients with missing zip codes and data for predialysis nephrology care, which may have led to selection bias. Although we examined differences in PD use among census divisions, certain aspects of dialysis care may differ by End-Stage Renal Disease Networks, which do not follow the same geographical borders. These results may not be generalizable to other countries, which may have different racial and ethnic groups and distinct barriers to home dialysis.[35-37] For instance, in Australia, lower socioeconomic status is associated with higher rates of home dialysis use.[38] We also note that this was not a formal mediation analysis. Some of the analyses, particularly the ones for HHD and the geographic subanalyses for Asians, were not well powered. These limitations should be balanced against the strengths of this study, which include a nationally representative cohort of patients and a detailed examination of socioeconomic factors at both the individual and neighborhood levels.

In conclusion, we found that black and Hispanic patients initiate dialysis with PD at lower rates than non-Hispanic patients and that socioeconomic factors account for much but not all of these disparities. These disparities vary regionally and increase from day 1 to day 90 of dialysis. The United States aims to have 80% of incident patients with end-stage kidney disease be either on home dialysis or undergo transplantation by 2025.[39] A combination of an increase in the culturally-competent education of patients and practitioners to dispel myths about home dialysis and growth in urgent-start PD programs and transitional care units in socioeconomically disadvantaged neighborhoods could lead not only to significant gains in closing racial/ethnic gaps in home dialysis use, but also to meeting the goal of increased use of home modalities in all groups.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Study population selection from the US Renal Data System. We identified a cohort of adult patients who were initiated on dialysis from 2005-2013, who were either of Asian, black, or white race.

Figure S2: Odds ratios of being on peritoneal dialysis on day 90 of dialysis, stratified by day 1 modality.

Item S1: Calculation of expected number of occupants per room.

Table S1: Numeric variables that were categorized for analysis.

Table S2: Odds ratio for initiating peritoneal dialysis on day 1 by variable from fully adjusted model.

Table S3: Peritoneal dialysis initiation rates and ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 1 for minority groups (vs whites) by region.

Table S4: Characteristics of adults initiating dialysis from 2005-2013, by modality on day 90 of dialysis.

Table S5: Peritoneal dialysis initiation rates and ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 90 for minority groups (vs whites).

Table S6: ORs and 95% CIs for being on a particular modality on day 90 for minority groups (vs whites).

Table S7: Status on day 90 of patients, stratified by whether they had been on peritoneal dialysis (PD) on day 1.

Table S8: ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 1 for minority groups (vs whites), using multiple imputation for missing data.

Table S9: Percent change in ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 1 for minority groups (vs whites) after adjustment for factors, using multiple imputation for missing data.

Table S10: ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 1 for minority groups (vs whites) by region, from fully adjusted model, using multiple imputation for missing data.

Table S11: ORs and 95% CIs for initiating peritoneal dialysis (vs in-center hemodialysis) on day 90 for minority groups (vs whites), using multiple imputation for missing data.

Table S12: ORs and 95% CIs for being on home dialysis on day 90 for minority groups (vs whites), using multiple imputation for missing data.

Table S13: Home hemodialysis initiation rates and odds ratios for initiating home hemodialysis (vs in-center hemodialysis) on day 1 for minority groups (vs whites).

Table S14: Odds ratio for initiating home hemodialysis on day 1 by variable from fully adjusted model.

Table S15: Home hemodialysis initiation rates and odds ratios for initiating home hemodialysis (vs in-center hemodialysis) on day 90 for minority groups (vs whites).

Table S16: Status on day 90 of patients, stratified by whether they had been on home hemodialysis (HHD) on day 1.

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