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ORIGINAL ARTICLE

The beneficial effect of providing kidney transplantation information on transplantation status differs between for-profit and nonprofit dialysis centers

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SUMMARY

Informing end-stage kidney disease patients about kidney transplantation options increases the likelihood of kidney transplant waiting list (WL) enrollment and live donor kidney transplant (LDKT) receipt. Patients in for-profit dialysis centers have lower rates of WL enrollment and LDKT receipt. This study examined if the ownership status of dialysis centers modified the association between informing patients about transplantation options and patients' transplantation status. Multilevel analysis using mixed-effect multinomial logistic regression was performed using the United States Renal Data System (USRDS) data (January 2005 to December 2017). The study showed that informing patients improved the odds of WL enrollment and LDKT receipt. However, the effect of informing patients on transplantation status was less pronounced at for-profit as compared with nonprofit centers (Nonprofit: WL enrollment OR: 2.23 [95% CI: 2.07–2.40], and LDKT receipt OR: 3.35 [95% CI: 2.65–4.25]. For-profit: WL enrollment OR: 1.73 [95% CI: 1.66–1.79], and LDKT receipt OR: 2.35 [95% CI: 2.08–2.66]), although the odds of informing patients was higher for for-profit centers, and type of patients informed were similar across both types of centers. Information provided by for-profit centers was potentially less effective than those provided by nonprofit centers. Standardized guidelines for transplantation information provision are needed in order to ensure similar informational quality across centers.

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Key words
dialysis centers, for-profit, kidney transplantation, non-profit, transplantation education, transplantation information

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Introduction

More than 120 000 patients develop end-stage kidney disease (ESKD) in the United States each year [1], and require renal replacement therapies, which include dialysis and/or kidney transplantation (hereafter referred to as transplantation). The transplantation options available to ESKD patients are: (i) enrolling in the deceased

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donor waiting list (WL); or (ii) receiving a Living Donor Kidney Transplant (LDKT). Often transplantation is medically more optimal and cost-effective than dialysis [1–3]. In 2017, the adjusted all-cause mortality rate was 165/1000 and 29/1000 for dialysis and transplantation patients, respectively. In the same year, total Medicare ESKD expenditures/person/year were about $90 600 and $35 800 for dialysis and transplantation patients, respectively [1]. However, in 2016, only 14% of patients enrolled in the WL or received a kidney transplant within 1 year of ESKD onset [1].

Prior studies have shown that informing ESKD patients about transplantation options increased the likelihood of choosing or receiving transplantation options [4–6]. Nevertheless, there is no standardized transplantation information provision guideline for dialysis centers to follow. This has resulted in wide variations in the quality (i.e., details and intensity of informational sessions) and quantity (i.e., number and duration of informational sessions) of transplantation information provided. In a study involving 170 dialysis centers, the variation in quality ranged from oral recommendations for transplantation evaluation, referral to external transplantation information programs, to detailed intensive discussions about transplantation [7]. The study also showed that dialysis centers, which used more intensive informational sessions for patients, had higher proportions of patients enrolling in the WL [7]. A national survey-based study concluded that most nephrologists (81%) believed that the ideal duration for educating patients about transplantation is ≥20 min; however, 57% nephrologists spent <20 min providing transplantation information [8]. The study also showed that the duration of information sessions varied considerably and was positively correlated with the quality of the sessions [8].

Furthermore, studies show that there were differences in transplantation information provided between for-profit and nonprofit dialysis centers. For-profit dialysis centers (hereafter referred to as for-profit centers) were less likely than nonprofit dialysis centers (hereafter referred to as nonprofit centers) to use longer duration and more intensive transplantation information sessions [7–9]. Differences in informational quality may influence transplantation decisions made by patients being served by for-profit versus nonprofit centers. Studies showed a lower rate of choosing or receiving transplantation options among patients in for-profit versus nonprofit centers [5,10–12]. Although there are differences in transplantation information provided between for-profit and nonprofit centers, it remains unknown if provision of differential quality of information between these centers explains the lower rate of choosing or receiving transplantation options among ESKD patients in for-profit centers, or if these differences are a result of the number and type of ESKD patients being informed.

In this study, for the first time, we examined if the ownership status (for-profit versus nonprofit) modified the association between informing patients about transplantation options and patients' transplantation status by using the interaction term between ownership status of a dialysis center and whether or not a patient was informed about transplantation options (informed versus not informed). If the association between informing a patient about transplantation options and the patient's transplantation status differs between for-profit and nonprofit centers, it might indicate (i) a difference in quality of information provided between these centers; (ii) a difference in the extent of effort invested to inform more patients in for-profit versus nonprofit centers; and (iii) a difference in the type of patients being informed in for-profit versus nonprofit centers. Reasons 2 and 3 above can empirically be tested; hence, this study also examined the differential likelihood of patients being informed about transplantation options in for-profit and nonprofit centers to examine if there is a difference in the extent of efforts invested by these centers to inform more patients, and also examined the differences in types of patients being informed by these two types of centers. This study for the first time used nationally representative data to examine these associations.

Methods

University of Texas Health Science Center Institutional Review Board's approval was obtained for this study.

Study design and data source

This study used the United States Renal Data System (USRDS) data from January 2005 to December 2017 [1]. USRDS is a national database that includes information on all patients with ESKD, and all dialysis facilities in the United States. We used the following datasets: Patient Profile, Medical Evidence Form (CMS-2728), Transplant WL (Kidney), Transplant, and ESKD Annual Facility Survey. The CMS-2728 Form is typically completed by the dialysis facility for each patient within 45 days of ESKD service initiation. We also used the U.S. 2010 Census data linked to the USRDS to obtain

zip code-level education and income information [13,14]. The study begins on January 2005 because prior to this month the CMS-2728 Form did not have data on whether the patient was informed about transplantation options.

Since ESKD diagnosis date is not present in the USRDS data, the USRDS researcher's guide utilizes the date of first ESKD service provision as the date of ESKD incidence [15]. In this study, the date of first ESKD service provision was considered the study initiation date for each patient and the patient was followed for a year after study initiation (until December 31st 2017). Dialysis center information for each patient was extracted from the ESKD Annual Facility Survey conducted during the year of study initiation. To be eligible for this study, patients (a) had to be 18–64 years old at study initiation (patients ≥65 years are deemed medically unsuitable for transplantation); (b) had to have the study initiation date between 1st January 2005 and 31st December 2016; and (c) had to have a completed CMS-2728 Form within 45 days of study initiation. Patients were excluded if they (a) enrolled in the transplant WL or received a kidney transplant prior to the study initiation date or prior to completing CMS-2728 Form; (b) had missing CMS-2728 Form date; (c) had a dialysis start date before study initiation date; (d) had missing provider number for their dialysis center (required for data linkage), or missing ownership status or patient informed status; or (e) had a date of death erroneously preceding study initiation, waiting list enrollment, or transplantation dates. A total of 588 550 ESKD patients were included in this study.

Dependent variable

The primary dependent variable, "Transplantation Status", was defined as the first transplantation-related decision that a patient made during the study period (Table 3). However, if the patient enrolled in WL and received LDKT after that, during the study period, the patient was classified as having received LDKT. Transplantation status variable was categorized as: (a) WL enrolled; (b) LDKT received; and (c) Continuing on dialysis (reference category). A second dependent variable capturing whether or not the patient was informed about the transplantation options ("Patient Informed Status") was also analyzed (Table 4). Patient Informed Status was a binary variable measuring whether a patient was informed about transplantation options within 45 days of study initiation. Patient Informed Status was obtained from form CMS-2728, which has the question "Has patient been informed of kidney transplant options?", with "Yes" and "No" as possible responses. Typically, an attending nephrologist or social worker provided this information and completed the CMS 2728 Form, and the form was signed by the attending nephrologist.

Independent variables

The two independent variables of interest were "Ownership Status" and "Patient Informed Status". Ownership Status was a binary variable measuring for-profit versus nonprofit ownership status of a patient's dialysis center. Patient Informed Status is the binary variable described above. The interaction between Ownership Status and Patient Informed Status was used to determine whether the ownership status of a dialysis center modified the association between informing patients and transplantation status.

Other covariates controlled for were patient socio-demographic, clinical, and behavioral characteristics at study initiation date, and dialysis center characteristics. Patient socio-demographic characteristics included age at study initiation (continuous variable in years); gender (male and female); race–ethnicity (non-Hispanic [NH] White, NH-Black, Hispanic, and other); education measured as percent of adults in the patient's residential ZIP code area with some college education or more (continuous variable in percent); income measured as median household income for the patient's residential ZIP code area (continuous variable in USD); employment status at study initiation (unemployed, employed, retired due to age, retired due to disability, and other); and insurance status at study initiation (Medicare, Medicaid, private insurance, other insurance, and uninsured). Past studies show that education and income at the U.S. zip-code-level are valid proxies for patient's socio-economic status [16,17]. Patient clinical characteristics included receipt of nephrology care prior to study initiation (yes, no, and missing); primary cause of ESKD (diabetes, hypertension, glomerulonephritis, polycystic kidney disease, and other); binary variables indicating the presence of comorbidities such as hypertension, diabetes, cardiovascular disease [CVD], cancer, and chronic obstructive pulmonary disease [COPD] at study initiation; presence of disability at study initiation (yes and no); body mass index (BMI) at study initiation (continuous variable); Glomerular Filtration Rate Epidemiology Collaboration [GFR-EPI] at study initiation (continuous variable); GFR Modification of Diet in Renal Disease [GFR-MDRD] at study

initiation (continuous variable); and number of days alive after study initiation (continuous variable in days). If a patient died during the study period, number of days alive was calculated as the number of days from the beginning of the study period to death; if not, it was recorded as 365 days. Patient behavioral characteristics included being a smoker at study initiation (yes, no); alcohol dependence at study initiation (yes, no); and drug dependence at study initiation (yes, no).

Dialysis center characteristics included: the number of dialysis stations in a dialysis center (continuous variable); and the regional ESKD network the dialysis center belonged to (18 network categories). In addition to patient and dialysis center characteristics, year of study initiation (2005–2016) was also controlled for.

Analysis

All analyses were performed using SAS v.9.4 (SAS Institute, Cary, NC, USA). Table 1 illustrates descriptive statistics for all independent variables by transplantation status categories. Table 2 illustrates descriptive statistics for all variables by patient informed status, and further explores if these associations were different between nonprofit and for-profit centers. For performing the descriptive bivariate analyses in both Tables 1 and 2, Kruskal–Wallis test for continuous independent variables and chi-square test for categorical independent variables were used.

Characteristics associated with transplantation status

Multilevel analysis using mixed-effect multinomial logistic regression estimation was performed to evaluate the modifying effect of ownership status on the association between patient informed status and transplantation status, after controlling for other covariates (Table 3). Since the study data are organized at two levels (center and patient level), the mixed-effect regression estimation included random intercepts for the centers.

Characteristics associated with whether or not patients were informed about transplantation options

In order to estimate if a dialysis center's ownership status affected the likelihood of patients being informed, as well as to understand if the modifying effect of the ownership status was owing to differences in types of patients being informed in the centers with different ownership status, we performed three multilevel analyses using mixed-effect logistic regressions (Table 4). First the effect of ownership status on the likelihood of a patient being informed was estimated after controlling for other covariates, and then subgroup analyses were performed to see if characteristics of patients being informed differed by the two types of ownership status (nonprofit and for-profit).

For both sets of multivariable regressions described above (Tables 3 and 4), we tested various independent variable functional forms and transformations to improve model fit. Higher-order terms such as square of all continuous variables and interactions (especially interaction of the ownership status with all other variables) were tested, but none were retained in the final model as they were not statistically significant. Year variable was tested as a linear and quadratic continuous variable, spline, and categorical variable, and the categorical variable was included based on model fit. Income was logarithmically transformed in all the regressions to improve the model fit.

Sensitivity analyses

A total of 88 482 patients died during the study period, or were reported to be medically unfit for transplantation. These patients had lesser time or a lower chance of choosing or receiving a transplantation option during the study period compared with the rest of the patients. In addition to these patients, about 8478 patients were informed by transplant centers. These patients had a higher chance of being informed or receiving transplantation. Sensitivity analysis was performed by excluding both groups of patients. A total of 491 590 ESKD patients were included in the sensitivity analysis (Appendices 1 and 2). A second sensitivity analysis was performed by replacing the "number of days alive after study initiation" continuous variable with a binary variable capturing whether or not the patient died during the 365 days of follow-up period (Appendix 3). The sample size stayed the same as the original (Tables 1–4) for this sensitivity analysis.

Results

Characteristics associated with transplantation status

Of the 588 550 patients, 12.26% (72 127) enrolled in WL, 1.40% (8223) received an LDKT, and 86.35% (508 200) remained on dialysis, (Table 1). Less than 80% of patients who chose or received either transplantation options were treated in for-profit centers, but 84% of patients continuing on dialysis were treated in

Table 1. Descriptive statistics illustrating the patient, dialysis center, and other characteristics associated with transplantation status.

	All ESKD patients *N* = 588 550			
	WL enrolled *N* = 72 127 (12.26%)	LDKT received *N* = 8223 (1.40%)	Continuing on dialysis *N* = 508 200 (86.35%)	*P*-value
Ownership Status (%)				
For-profit	80.64	78.03	84.21	<0.0001§
Nonprofit	19.36	21.97	15.79	
Patient Informed Status (%)				
Informed	92.54	95.44	83.51	<0.0001§
Not informed	7.46	4.56	16.49	
Patient socio-demographic characteristics				
Age at study initiation (years)	47.30 (11.71)†	42.76 (13.01)†	51.99 (9.97)†	<0.0001^
Gender (%)				
Male	63.33	64.84	57.70	<0.0001§
Female	36.67	35.16	42.30	
Race–ethnicity (%)				
Non-Hispanic White	42.06	66.60	41.28	<0.0001§
Non-Hispanic Black	28.97	11.99	35.70	
Hispanic	20.64	16.39	17.59	
Other	8.33	5.02	5.43	
Education (percent of some college education & above in ZIP code area)	48.61 (14.56)†	51.26 (14.87)†	46.02 (14.71)†	<0.0001^
Income (median household income in ZIP code area – USD)	52 841 (20 843)†	59 298 (22 718)†	46 893 (18 255)†	<0.0001^
Employment status at study initiation (%)				
Unemployed	30.91	20.58	39.75	<0.0001§
Employed	33.36	50.80	13.93	
Retired due to age	5.45	4.12	7.15	
Retired due to disability	20.40	10.37	33.83	
Other	9.88	14.13	5.34	
Insurance status at study initiation (%)				
Medicare	28.73	16.55	44.24	<0.0001§
Medicaid	17.16	8.79	23.89	
Private insurance	43.68	62.59	21.81	
Other insurance	10.00	11.71	9.29	
Uninsured	0.43	0.36	0.77	
Patient clinical characteristics				
Nephrology care prior to study initiation (%)				
Yes	66.66	68.71	52.65	<0.0001§
No	24.35	24.43	33.71	
Missing	8.99	6.86	13.64	
Primary cause of ESKD (%)				
Diabetes	43.03	25.16	51.33	<0.0001§
Hypertension	22.82	17.62	24.51	
Glomerulonephritis	18.54	34.88	8.37	
Polycystic kidney disease	4.85	7.31	1.67	
Other	10.76	15.03	14.12	
Presence of hypertension at study initiation (%)				
Yes	87.34	83.23	85.68	<0.0001§
No	12.66	16.77	14.32	
Presence of diabetes at study initiation (%)				
Yes	48.40	28.75	59.76	<0.0001§

Table 1. Continued.

	All ESKD patients *N* = 588 550			
	WL enrolled *N* = 72 127 (12.26%)	LDKT received *N* = 8223 (1.40%)	Continuing on dialysis *N* = 508 200 (86.35%)	*P*-value
No	51.60	71.25	40.24	
Presence of CVD* at study initiation (%)				
Yes	25.89	17.21	45.25	<0.0001§
No	74.11	82.79	54.75	
Presence of cancer at study initiation (%)				
Yes	1.68	1.97	4.61	<0.0001§
No	98.32	98.03	95.39	
Presence of COPD at study initiation (%)				
Yes	1.86	1.03	7.26	<0.0001§
No	98.14	98.97	92.74	
Presence of Disability at study initiation (%)				
Yes	4.52	2.02	16.71	<0.0001§
No	95.48	97.98	83.29	
BMI at study initiation (continuous)	29.16 (6.71)†	27.78 (6.20)†	30.96 (8.96)†	<0.0001^
GFR EPI at study initiation (continuous)	8.39 (4.99)†	8.18 (4.92)†	9.62 (6.27)†	<0.0001^
GFR MDRD at study initiation (continuous)	8.66 (4.06)†	8.13 (3.86)†	9.8 (4.71)†	<0.0001^
Number of days alive after study initiation (days)	362.35 (23.57)†	364.47 (10.00)†	336.02 (81.03)†	<0.0001^
Patient behavioral characteristics				
Smoker at study initiation (%)				
Yes	4.57	3.78	9.91	<0.0001§
No	95.43	96.22	90.09	
Alcohol dependence at study initiation (%)				
Yes	1.21	0.29	2.76	<0.0001§
No	98.79	99.71	97.24	
Drug dependence at study initiation (%)				
Yes	0.52	0.28	2.85	<0.0001§
No	99.48	99.72	97.15	
Dialysis center characteristics				
Number of dialysis stations (count)	21.12 (9.79)†	20.33 (9.76)†	21.64 (9.76)†	<0.0001^
Regional ESKD Network (%)				
Network 1 (CT, ME, MA, NH, RI, VT)	4.09	5.85	2.53	<0.0001§
Network 2 (NY)	7.23	8.73	5.23	
Network 3 (NJ, PR, VI)	4.11	4.80	4.16	
Network 4 (DE, PA)	5.22	4.48	3.76	
Network 5 (DC, MD, VA, WV)	6.05	6.58	5.79	
Network 6 (GA, NC, SC)	7.15	4.33	10.44	
Network 7 (FL)	3.85	4.12	6.40	
Network 8 (AL, MS, TN)	5.54	3.94	6.42	
Network 9 (IN, KY, OH)	5.53	8.40	7.62	
Network 10 (IL)	4.54	6.54	3.99	
Network 11 (MI, MN, ND, SD, WI)	6.61	9.30	5.52	
Network 12 (IA, KS, MO, NE)	3.35	4.40	3.59	
Network 13 (AR, LA, OK)	3.10	2.40	4.98	
Network 14 (TX)	10.34	8.61	10.09	
Network 15 (AZ, CO, NV, NM, UT, WY)	4.91	6.57	4.75	
Network 16 (AK, ID, MT, OR, WA)	2.42	3.56	2.84	
Network 17 (AS, Guam, HI, Mariana Islands, Northern CA)	8.88	3.41	4.03	
Network 18 (Southern CA)	7.08	3.98	7.86	

Table 1. Continued.

	All ESKD patients *N* = 588 550			
	WL enrolled *N* = 72 127 (12.26%)	LDKT received *N* = 8223 (1.40%)	Continuing on dialysis *N* = 508 200 (86.35%)	*P*-value
Other variable				
Year of study initiation (%)				
2005	5.16	8.40	4.95	<0.0001§
2006	9.17	12.16	8.11	
2007	8.80	10.31	8.18	
2008	8.75	9.80	8.35	
2009	9.17	9.84	8.61	
2010	8.83	8.18	8.59	
2011	8.98	7.62	8.49	
2012	9.15	7.33	8.49	
2013	8.88	6.91	8.64	
2014	8.23	6.51	8.95	
2015	7.61	6.58	9.34	
2016	7.27	6.36	9.30	

BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; ESKD, end-stage kidney disease; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease; LDKT, live donor kidney transplant; WL, wait list.

*CVD: atherosclerotic heart disease, congestive heart failure, peripheral vascular disease, cerebrovascular disease, and other cardiac problem.

†Mean with standard deviation in parenthesis presented for continuous variables.

§Chi-square test used to compute the *P*-values.

^Kruskal–Wallis test used to compute the *P*-values.

for-profit centers. In addition, 93–95% of patients who chose or received the transplantation options were informed about the transplantation options, but only 84% of patients continuing on dialysis were informed about the transplantation options.

Patients who were younger, were male, were NH-White, belonged to more educated and higher income ZIP code areas, were employed, or had private insurance were more likely to choose or receive either of the transplantation options. Clinically, patients who had nephrology care prior to study initiation, did not have certain chronic ailments such as diabetes, CVD, cancer and COPD, were not disabled, had lower average BMI, had slightly worse glomerular filtration rates at study initiation, or were alive for more days after study initiation were more likely to choose or receive either of the transplantation options. Patients who were smokers, or alcohol/drug dependent were less likely to choose or receive either of the transplantation options. Regionally, patients belonging to the northeastern centers were more likely to choose or receive either of the transplantation options, and patients belonging to the southern centers were less likely to choose or receive either of the transplantation options.

Characteristics associated with whether or not patients were informed about transplantation options

Of the 588 550 patients, 84.78% (498 967) were informed and 15.22% (89 583) were not informed about transplantation options (Table 2). Majority of the patients initiated dialysis at a for-profit center (83.69%), and these patients were more likely to be informed about transplant options compared with patients who initiated dialysis at a nonprofit center (85.63% vs. 80.41%). Informed patients were more likely to enroll in transplant WL (13.38% vs. 6.01%) and to receive an LDKT (1.57% vs. 0.42%) compared with patients who were not informed. Although for-profit centers had a higher proportion of informed patients than nonprofit centers, a lower proportion of informed patients at for-profit centers versus non-profit chose or received either of the transplantation options (14.22% vs. 18.92%).

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Table 2. Descriptive statistics illustrating the patient, dialysis center, and other characteristics associated with patients being informed about transplantation options.

	All ESKD patients *N* = 588 550			ESKD patients at For-profit dialysis centers *N* = 492 555 83.69%			ESKD patients at Nonprofit dialysis centers *N* = 95 995 16.31%		
	Informed *N* = 498 967 (84.78%)	Not informed *N* = 89 583 (15.22%)	*P*-value	Informed *N* = 421 775 (85.63%)	Not informed *N* = 70 780 (14.37%)	*P*-value	Informed *N* = 77 192 (80.41%)	Not informed *N* = 18 803 (19.59%)	*P*-value
Transplantation status (%)									
WL enrolled	13.38	6.01	<0.0001§	12.77	6.07	<0.0001§	16.68	5.79	<0.0001§
LDKT received	1.57	0.42		1.45	0.42		2.24	0.41	
Continuing on dialysis	85.05	93.57		85.78	93.51		81.08	93.80	
Ownership status (%)									
For-profit	84.53	79.01	<0.0001§	100	100	<0.0001§	0.00	0.00	<0.0001§
Nonprofit	15.47	20.99		0.00	0.00		100	100	
Patient socio-demographic characteristics									
Age at study initiation (years)	51.05 (10.5) †	52.59 (9.79) †	<0.0001^	51.14 (10.43) †	52.62 (9.77) †	<0.0001^	50.57 (10.89) †	52.49 (9.89) †	<0.0001^
Gender (%)									
Male	58.69	57.42	<0.0001§	58.55	57.16	<0.0001§	59.42	58.40	0.01§
Female	41.31	42.58		41.45	42.84		40.58	41.60	
Race-ethnicity (%)									
Non-Hispanic White	41.14	44.98	<0.0001§	40.71	44.33	<0.0001§	43.50	47.42	<0.0001§
Non-Hispanic Black	34.72	33.60		34.89	33.82		33.76	32.76	
Hispanic	18.31	15.91		18.96	17.01		14.79	11.77	
Non-Hispanic other	5.83	5.51		5.44	4.84		7.96	8.04	
Education (percent of some college education & above in ZIP code area)	46.44 (14.68)†	46.22 (14.97)†	<0.0001^	46.12 (14.57)†	45.60 (14.81)†	<0.0001^	48.18 (15.14)†	48.59 (15.36)†	0.01^
Income (median household income in ZIP code area – USD)	47 951 (18 937)†	46 925 (18 073)†	<.0001^	47 696 (18 723)†	46 389 (17 612)†	<.0001^	49 348 (20 007)†	48 943 (19 582)†	0.15^
Employment status at study initiation (%)									
Unemployed	37.99	40.65	<0.0001§	38.15	40.67	<0.0001§	37.16	40.54	<0.0001§
Employed	17.93	10.70		17.72	10.77		19.04	10.40	
Retired due to age	6.81	7.41		6.91	7.41		6.27	7.42	
Retired due to disability	31.04	36.37		31.08	36.33		30.84	36.49	
Other	6.23	4.87		6.14	4.80		6.69	5.15	
Insurance status at study initiation (%)									

Table 2. Continued.

	All ESKD patients N = 588 550			ESKD patients at For-profit dialysis centers N = 492 555 83.69%			ESKD patients at Nonprofit dialysis centers N = 95 995 16.31%		
	Informed N = 498 967 (84.78%)	Not informed N = 89 583 (15.22%)	*P*-value	Informed N = 421 775 (85.63%)	Not informed N = 70 780 (14.37%)	*P*-value	Informed N = 77 192 (80.41%)	Not informed N = 18 803 (19.59%)	*P*-value
Medicare	41.30	45.55	<0.0001§	41.57	45.73	<0.0001§	39.87	44.88	<0.0001§
Medicaid	22.47	25.01		22.40	24.90		22.80	25.42	
Private insurance	26.09	19.31		26.33	19.97		24.81	16.83	
Other	9.44	9.26		9.04	8.65		11.62	11.55	
Uninsured	0.70	0.87		0.66	0.75		0.90	1.32	
Patient clinical characteristics									
Nephrology care prior to study initiation (%)*									
Yes	56.39	44.58	<0.0001§	55.52	43.73	<0.0001§	61.11	47.80	<0.0001§
No	31.16	39.54		31.17	38.26		31.12	44.34	
Missing	12.45	15.88		13.31	18.01		7.77	7.86	
Primary cause of ESKD (%)									
Diabetes	50.21	48.43	<0.0001§	50.52	49.51	<0.0001§	48.52	44.34	<0.0001§
Hypertension	24.59	22.07		25.40	23.32		20.20	17.37	
Glomerulonephritis	10.36	7.91		9.86	7.49		13.05	9.50	
Polycystic kidney disease	2.32	1.15		2.25	1.15		2.70	1.15	
Other	12.52	20.45		11.97	18.53		15.54	27.64	
Presence of hypertension at study initiation (%)									
Yes	86.45	82.50	<0.0001§	86.40	82.81	<0.0001§	86.73	81.34	<0.0001§
No	13.55	17.50		13.60	17.19		13.27	18.66	
Presence of diabetes at study initiation (%)									
Yes	57.89	58.16	0.13§	58.28	59.01	0.0003§	55.78	54.98	0.04§
No	42.11	41.84		41.72	40.99		44.22	45.02	
Presence of CVD* at study initiation (%)									
Yes	41.39	48.63	<0.0001§	41.00	47.94	<0.0001§	43.50	51.25	<0.0001§
No	58.61	51.37		59.00	52.06		56.50	48.75	
Presence of cancer at study initiation (%)									
Yes	3.76	6.71	<0.0001§	3.66	6.16	<0.0001§	4.31	8.81	<0.0001§
No	96.24	93.29		96.34	93.84		95.69	91.19	
Presence of COPD at study initiation (%)									
Yes	6.09	8.82	<0.0001§	5.97	8.42	<0.0001§	6.77	10.30	<0.0001§
No	93.91	91.18		94.03	91.58		93.23	89.70	
Presence of Disability at study initiation (%)									
Yes	13.49	23.47	<0.0001§	13.51	22.93	<0.0001§	13.37	25.47	<0.0001§

Table 2. Continued.

	All ESKD patients N = 588 550			ESKD patients at For-profit dialysis centers N = 492 555 83.69%			ESKD patients at Nonprofit dialysis centers N = 95 995 16.31%		
	Informed N = 498 967 (84.78%)	Not informed N = 89 583 (15.22%)	*P*-value	Informed N = 421 775 (85.63%)	Not informed N = 70 780 (14.37%)	*P*-value	Informed N = 77 192 (80.41%)	Not informed N = 18 803 (19.59%)	*P*-value
No	86.51	76.53		86.49	77.07		86.63	74.53	
BMI at study initiation (continuous)	30.69 (8.61) †	30.73 (9.26) †	<0.0001^	30.76 (8.63) †	30.83 (9.25) †	<0.0001^	30.30 (8.49) †	30.36 (9.27) †	0.0004^
GFR EPI at study initiation (continuous)	9.33 (5.97) †	10.10 (6.91) †	<0.0001^	9.37 (5.99) †	10.16 (6.94) †	<0.0001^	9.15 (5.84) †	9.89 (6.79) †	<0.0001^
GFR MDRD at study initiation (continuous)	9.55 (4.58) †	10.10 (4.94) †	<.0001^	9.59 (4.59) †	10.14 (4.95) †	<.0001^	9.37 (4.49) †	9.93 (4.89) †	<.0001^
Patient behavioral characteristics									
Smoker at study initiation (%)									
Yes	8.94	10.47	<0.0001§	8.67	9.74	<0.0001§	10.37	13.25	<0.0001§
No	91.06	89.53		91.33	90.26		89.63	86.75	
Alcohol dependence at study initiation (%)									
Yes	2.29	3.90	<0.0001§	2.21	3.71	<0.0001§	2.73	4.59	<0.0001§
No	97.71	96.10		97.79	96.29		97.27	95.41	
Drug dependence at study initiation (%)									
Yes	2.30	3.75	<0.0001§	2.18	3.14	<0.0001§	2.98	6.07	<0.0001§
No	97.70	96.25		97.82	96.86		97.02	93.93	
Dialysis center characteristics									
Number of dialysis stations (count)	21.58 (9.74) †	21.4 (9.96) †	<.0001^	21.51 (9.25) †	21.46 (9.32) †	<.0001^	21.99 (12.04) †	21.18 (12.07) †	<0.0001^
Regional ESKD Network (%)									
Network 1 (CT, ME, MA, NH, RI, VT)	2.62	3.60	<0.0001§	2.46	3.22	<0.0001§	3.50	5.02	<0.0001§
Network 2 (NY)	5.60	5.13		3.88	3.12		14.97	12.69	
Network 3 (NJ, PR, VI)	4.35	3.13		4.00	2.07		6.26	7.13	
Network 4 (DE, PA)	3.89	4.32		3.86	4.13		4.06	5.03	
Network 5 (DC, MD, VA, WV)	5.75	6.28		5.77	6.60		5.64	5.11	
Network 6 (GA, NC, SC)	9.70	11.33		9.87	11.99		8.73	8.88	
Network 7 (FL)	6.17	5.42		6.75	6.17		3.00	2.57	
Network 8 (AL, MS, TN)	6.23	6.50		6.46	7.19		5.00	3.91	
Network 9 (IN, KY, OH)	7.30	7.83		7.64	8.24		5.44	6.31	
Network 10 (IL)	4.16	3.72		4.46	4.36		2.51	1.29	

Table 2. Continued.

	All ESKD patients N = 588 550			ESKD patients at For-profit dialysis centers N = 492 555 83.69%			ESKD patients at Nonprofit dialysis centers N = 95 995 16.31%		
	Informed N = 498 967 (84.78%)	Not informed N = 89 583 (15.22%)	*P*-value	Informed N = 421 775 (85.63%)	Not informed N = 70 780 (14.37%)	*P*-value	Informed N = 77 192 (80.41%)	Not informed N = 18 803 (19.59%)	*P*-value
Network 11 (MI, MN, ND, SD, WI)	5.73	5.57		4.79	4.59		10.85	9.25	
Network 12 (IA, KS, MO, NE)	3.53	3.79		3.26	3.38		5.02	5.36	
Network 13 (AR, LA, OK)	4.77	4.37		5.28	4.81		1.97	2.75	
Network 14 (TX)	10.57	7.53		12.04	8.95		2.51	2.11	
Network 15 (AZ, CO, NV, NM, UT, WY)	4.74	5.05		4.70	5.64		4.97	2.85	
Network 16 (AK, ID, MT, OR, WA)	2.52	4.33		2.15	2.71		4.56	10.42	
Network 17 (AS, Guam, HI, Mariana Islands, Northern CA)	4.66	4.40		4.22	3.57		7.08	7.51	
Network 18 (Southern CA)	7.71	7.70		8.40	9.27		3.93	1.81	
Other variable									
Year of study initiation (%)									
2005	4.69	6.91	<0.0001§	4.39	6.73	<0.0001§	6.31	7.58	<0.0001§
2006	7.65	11.88		7.18	11.69		10.19	12.63	
2007	7.66	11.77		7.30	11.78		9.59	11.79	
2008	7.89	11.38		7.64	11.45		9.24	11.14	
2009	8.41	10.23		8.25	10.22		9.31	10.29	
2010	8.42	9.66		8.35	9.91		8.81	8.70	
2011	8.48	8.86		8.51	9.07		8.29	8.07	
2012	8.86	6.85		8.99	6.73		8.12	7.28	
2013	9.12	5.99		9.41	5.79		7.55	6.71	
2014	9.35	5.90		9.72	6.07		7.36	5.27	
2015	9.76	5.41		10.15	5.35		7.63	5.62	
2016	9.71	5.16		10.10	5.22		7.61	4.91	

BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; ESKD, end-stage kidney disease; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease; LDKT, live donor kidney transplant; WL, wait list.

*CVD: atherosclerotic heart disease, congestive heart failure, peripheral vascular disease, cerebrovascular disease, and other cardiac problem

†Mean with standard deviation in parenthesis presented for continuous variables

§Chi-square test used to compute the p-values

^Kruskal–Wallis test used to compute the p-values

Table 3. Adjusted odds ratios demonstrating the effect of patient, dialysis center, and other characteristics on transplantation status.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Informed versus not informed comparison:		
For For-profit	1.73 (1.66, 1.79)**	2.35 (2.08, 2.66)**
For Nonprofit	2.23 (2.07, 2.40)**	3.35 (2.65, 4.25)**
Patient socio-demographic characteristics		
Age at study initiation	0.97 (0.97, 0.97)**	0.94 (0.94, 0.94)**
Gender (Reference: Male)		
Female	0.82 (0.81, 0.84)**	0.78 (0.74, 0.82)**
Race–ethnicity (Reference: Non-Hispanic White)		
Non-Hispanic Black	0.77 (0.75, 0.79)**	0.22 (0.20, 0.24)**
Hispanic	1.05 (1.02, 1.08)**	0.67 (0.62, 0.72)**
Non-Hispanic Other	1.09 (1.05, 1.13)**	0.39 (0.35, 0.44)**
Education	1.01 (1.01, 1.01)*	1.01 (1.01, 1.01)**
Logarithm of Income	1.50 (1.46, 1.55)**	2.10 (1.94, 2.27)**
Employment status at study initiation (Reference: Unemployed)		
Employed	1.64 (1.60, 1.68)**	2.47 (2.31, 2.65)**
Retired due to age	1.28 (1.23, 1.34)**	1.69 (1.49, 1.93)**
Retired due to disability	1.07 (1.04, 1.09)**	1.06 (0.97, 1.16)
Other	1.34 (1.30, 1.39)**	1.80 (1.65, 1.96)**
Insurance status at study initiation (Reference: Medicare)		
Medicaid	0.89 (0.87, 0.91)**	0.74 (0.67, 0.82)**
Private insurance	1.78 (1.74, 1.82)**	2.90 (2.70, 3.12)**
Other	1.27 (1.23, 1.31)**	2.06 (1.88, 2.25)**
Uninsured	0.45 (0.39, 0.50)**	0.41 (0.28, 0.60)**
Patient clinical characteristics		
Nephrology care prior to study initiation (Reference: No)		
Yes	1.76 (1.73, 1.80)**	2.02 (1.91, 2.14)**
Missing	1.11 (1.07, 1.15)**	1.13 (1.02, 1.25)*
Primary cause of ESKD (Reference: Diabetes)		
Hypertension	1.00 (0.97, 1.03)	1.14 (1.03, 1.25)**
Glomerulonephritis	1.34 (1.30, 1.38)**	2.19 (2.00, 2.40)**
Polycystic kidney disease	1.77 (1.68, 1.86)**	2.13 (1.89, 2.41)**
Other	0.80 (0.77, 0.83)**	1.04 (0.94, 1.15)
Presence of hypertension at study initiation (Reference: No)		
Yes	1.16 (1.12, 1.19)**	1.12 (1.05, 1.20)**
Presence of diabetes at study initiation (Reference: No)		
Yes	0.96 (0.93, 0.98)**	0.74 (0.68, 0.80)**
Presence of CVD at study initiation (Reference: No)		
Yes	0.66 (0.65, 0.68)**	0.60 (0.56, 0.64)**
Presence of Cancer at study initiation (Reference: No)		
Yes	0.43 (0.41, 0.46)**	0.42 (0.35, 0.49)**
Presence of COPD at study initiation (Reference: No)		
Yes	0.54 (0.51, 0.58)**	0.46 (0.38, 0.57)**
Presence of Disability at study initiation (Reference: No)		
Yes	0.47 (0.45, 0.49)**	0.38 (0.32, 0.44)**
BMI at study initiation	0.97 (0.97, 0.97)**	0.95 (0.95, 0.95)**
GFR EPI at study initiation	0.98 (0.98, 0.99)**	0.98 (0.98, 0.99)**
GFR MDRD at study initiation	0.99 (0.99, 0.99)**	0.98 (0.97, 0.99)**
Number of days alive after study initiation	1.01 (1.01, 1.01)**	1.01 (1.01, 1.02)**
Patient behavioral characteristics		
Smoker at study initiation (Reference: No)		
Yes	0.51 (0.49, 0.53)**	0.42 (0.37, 0.47)**

Table 3. Continued.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Alcohol dependence at study initiation (Reference: No)		
Yes	0.94 (0.87, 1.01)	0.29 (0.20, 0.42)**
Drug dependence at study initiation (Reference: No)		
Yes	0.26 (0.24, 0.29)**	0.25 (0.17, 0.37)**
Dialysis center characteristics		
Number of dialysis stations	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**
Regional ESKD Network (Reference: Network 14 – TX)		
Network 1 (CT, ME, MA, NH, RI, VT)	1.39 (1.27, 1.53)**	1.65 (1.39, 1.96)**
Network 2 (NY)	1.27 (1.17, 1.38)**	1.65 (1.41, 1.92)**
Network 3 (NJ, PR, VI)	1.06 (0.97, 1.16)	1.26 (1.06, 1.49)**
Network 4 (DE, PA)	1.51 (1.39, 1.64)**	1.39 (1.17, 1.64)**
Network 5 (DC, MD, VA, WV)	0.96 (0.88, 1.03)	1.15 (0.98, 1.34)
Network 6 (GA, NC, SC)	0.73 (0.68, 0.78)**	0.57 (0.48, 0.66)**
Network 7 (FL)	0.59 (0.54, 0.63)**	0.63 (0.54, 0.75)**
Network 8 (AL, MS, TN)	1.02 (0.95, 1.10)	1.04 (0.88, 1.23)
Network 9 (IN, KY, OH)	0.83 (0.77, 0.89)**	1.21 (1.05, 1.39)**
Network 10 (IL)	1.16 (1.06, 1.26)**	1.77 (1.51, 2.07)**
Network 11 (MI, MN, ND, SD, WI)	1.34 (1.24, 1.45)**	1.85 (1.60, 2.14)**
Network 12 (IA, KS, MO, NE)	0.92 (0.84, 1.01)	1.03 (0.87, 1.23)
Network 13 (AR, LA, OK)	0.72 (0.66, 0.79)**	0.68 (0.56, 0.83)**
Network 15 (AZ, CO, NV, NM, UT, WY)	0.88 (0.82, 0.96)**	1.03 (0.88, 1.20)
Network 16 (AK, ID, MT, OR, WA)	0.68 (0.61, 0.75)**	0.75 (0.62, 0.91)**
Network 17 (AS, Guam, HI, Mariana I, N. CA)	1.75 (1.62, 1.90)**	0.84 (0.70, 1.01)
Network 18 (Southern CA)	0.79 (0.74, 0.86)**	0.42 (0.36, 0.50)**
Other variable		
Year of study initiation (Reference: 2005)		
2006	1.13 (1.07, 1.18)**	0.95 (0.85, 1.05)
2007	1.10 (1.05, 1.16)**	0.83 (0.74, 0.92)**
2008	1.09 (1.04, 1.14)**	0.81 (0.72, 0.90)**
2009	1.12 (1.07, 1.18)**	0.82 (0.73, 0.91)**
2010	1.11 (1.06, 1.17)**	0.71 (0.63, 0.80)**
2011	1.13 (1.08, 1.19)**	0.66 (0.59, 0.74)**
2012	1.14 (1.08, 1.19)**	0.65 (0.57, 0.73)**
2013	1.06 (1.01, 1.11)*	0.58 (0.52, 0.66)**
2014	0.89 (0.85, 0.94)**	0.49 (0.44, 0.56)**
2015	0.77 (0.73, 0.80)**	0.46 (0.41, 0.52)**
2016	0.71 (0.68, 0.75)**	0.42 (0.37, 0.48)**

ESKD, end-stage kidney disease; WL, wait list; LDKT, live donor kidney transplant; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease.

*Significant at $P < 0.05$, **Significant at $P < 0.01$.

Overall, patients who were younger, were male, were not NH White, belonged to higher income ZIP code areas, were employed, or were privately insured were more likely to be informed. Education, although significant, did not have a meaningful group difference. Clinically, patients who had nephrology care prior to study initiation, had no comorbidities such as CVD, cancer and COPD, but had hypertension, were not disabled, or had worse GRF values were more likely to be informed. The difference in BMI, between patients who were informed and not informed, was statistically significant but not clinically meaningful. Behaviorally, smokers, or drug/alcohol dependent patients were less likely to be informed. The likelihood of being informed increased over time during these 12 years (2005–2016).

Table 4. Adjusted odds ratios demonstrating the effect of patient, dialysis center, and other characteristics on patients being informed about transplantation options.

	All dialysis centers OR Estimate (95% CI)	For-profit dialysis centers OR Estimate (95% CI)	Nonprofit dialysis centers OR Estimate (95% CI)
Ownership status (Reference: Nonprofit)			
For-profit	1.32 (1.21, 1.44)**		
Patient socio-demographic characteristics			
Age at study initiation	0.98 (0.98, 0.98)**	0.98 (0.98, 0.98)**	0.98 (0.98, 0.98)**
Gender (Reference: Male)			
Female	0.97 (0.95, 0.99)**	0.97 (0.95, 0.99)**	0.96 (0.92, 0.99)*
Race–ethnicity (Reference: Non-Hispanic White)			
Non-Hispanic Black	0.95 (0.93, 0.98)**	0.96 (0.93, 0.99)**	0.93 (0.88, 0.98)**
Hispanic	0.97 (0.94, 0.99)*	0.97 (0.94, 1.01)	0.96 (0.89, 1.03)
Non-Hispanic other	0.94 (0.90, 0.98)*	0.94 (0.90, 0.99)*	0.96 (0.88, 1.05)
Education	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**
Logarithm of Income	1.18 (1.14, 1.22)**	1.20 (1.15, 1.24)**	1.15 (1.07, 1.23)**
Employment status at study initiation (Reference: Unemployed)			
Employed	1.47 (1.42, 1.51)**	1.43 (1.38, 1.48)**	1.65 (1.53, 1.77)**
Retired due to age	1.11 (1.07, 1.15)**	1.12 (1.07, 1.16)**	1.06 (0.98, 1.15)
Retired due to disability	1.04 (1.02, 1.06)**	1.04 (1.01, 1.06)**	1.10 (1.05, 1.16)**
Other	1.23 (1.18, 1.28)**	1.23 (1.18, 1.28)**	1.23 (1.12, 1.35)**
Insurance status at study initiation (Reference: Medicare)			
Medicaid	0.96 (0.94, 0.99)**	0.97 (0.94, 0.99)*	0.94 (0.89, 0.99)*
Private insurance	1.24 (1.20, 1.27)**	1.24 (1.21, 1.27)**	1.28 (1.20, 1.36)**
Other	1.10 (1.06, 1.14)**	1.08 (1.04, 1.12)**	1.15 (1.08, 1.23)**
Uninsured	0.61 (0.55, 0.67)**	0.63 (0.56, 0.70)**	0.53 (0.44, 0.64)**
Patient clinical characteristics			
Nephrology care prior to study initiation (Reference: No)			
Yes	1.69 (1.66, 1.72)**	1.64 (1.60, 1.67)**	1.92 (1.84, 2.01)**
Missing	0.93 (0.91, 0.96)**	0.90 (0.87, 0.93)**	1.09 (1.01, 1.19)*
Primary cause of ESKD (Reference: Diabetes)			
Hypertension	0.93 (0.91, 0.96)**	0.94 (0.91, 0.97)**	0.91 (0.85, 0.97)**
Glomerulonephritis	0.99 (0.96, 1.03)	1.00 (0.96, 1.05)	0.94 (0.87, 1.02)
Polycystic kidney disease	1.51 (1.40, 1.63)**	1.49 (1.37, 1.62)**	1.56 (1.32, 1.83)**
Other	0.62 (0.60, 0.64)**	0.65 (0.63, 0.67)**	0.55 (0.51, 0.58)**
Presence of hypertension at study initiation (Reference: No)			
Yes	1.12 (1.10, 1.15)**	1.11 (1.08, 1.14)**	1.17 (1.11, 1.24)**
Presence of diabetes at study initiation (Reference: No)			
Yes	1.00 (0.97, 1.02)	1.00 (0.97, 1.03)	0.98 (0.93, 1.04)
Presence of CVD at study initiation (Reference: No)			
Yes	0.86 (0.85, 0.88)**	0.87 (0.85, 0.89)**	0.83 (0.80, 0.87)**
Presence of Cancer at study initiation (Reference: No)			
Yes	0.57 (0.55, 0.59)**	0.60 (0.57, 0.63)**	0.49 (0.45, 0.53)**
Presence of COPD at study initiation (Reference: No)			
Yes	0.86 (0.84, 0.89)**	0.87 (0.84, 0.91)**	0.82 (0.77, 0.88)**
Presence of Disability at study initiation (Reference: No)			
Yes	0.52 (0.51, 0.53)**	0.53 (0.51, 0.54)**	0.48 (0.46, 0.50)**
BMI at study initiation	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**
GFR EPI at study initiation	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**
GFR MDRD at study initiation	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	0.99 (0.98, 0.99)**
Patient behavioral characteristics			
Smoker at study initiation (Reference: No)			
Yes	0.97 (0.95, 1.00)	0.99 (0.96, 1.03)	0.93 (0.87, 0.99)*
Alcohol dependence at study initiation (Reference: No)			
Yes	0.77 (0.73, 0.80)**	0.74 (0.70, 0.78)**	0.82 (0.74, 0.91)**
Drug dependence at study initiation (Reference: No)			
Yes	0.76 (0.72, 0.79)**	0.81 (0.77, 0.78)**	0.65 (0.59, 0.72)**

Table 4. Continued.

	All dialysis centers OR Estimate (95% CI)	For-profit dialysis centers OR Estimate (95% CI)	Nonprofit dialysis centers OR Estimate (95% CI)
Dialysis center characteristics			
Number of dialysis stations	1.01 (1.01, 1.01)**	1.01 (1.01, 1.01)**	0.99 (0.99, 0.99)**
Regional ESKD Network (Reference: Network 14 – TX)			
Network 1 (CT, ME, MA, NH, RI, VT)	0.57 (0.47, 0.70)**	0.56 (0.45, 0.71)**	0.70 (0.42, 1.16)
Network 2 (NY)	0.76 (0.64, 0.90)**	0.76 (0.62, 0.93)**	0.99 (0.64, 1.53)
Network 3 (NJ, PR, VI)	1.03 (0.85, 1.26)	1.21 (0.96, 1.51)	0.99 (0.62, 1.59)
Network 4 (DE, PA)	0.75 (0.63, 0.89)**	0.79 (0.65, 0.95)*	0.94 (0.59, 1.51)
Network 5 (DC, MD, VA, WV)	0.79 (0.67, 0.92)**	0.78 (0.66, 0.93)**	1.12 (0.70, 1.78)
Network 6 (GA, NC, SC)	0.76 (0.66, 0.88)**	0.73 (0.63, 0.85)**	1.24 (0.80, 1.94)
Network 7 (FL)	0.85 (0.72, 0.99)*	0.84 (0.71, 0.98)*	1.19 (0.72, 1.95)
Network 8 (AL, MS, TN)	0.82 (0.70, 0.96)*	0.77 (0.65, 0.90)**	1.47 (0.92, 2.37)
Network 9 (IN, KY, OH)	0.85 (0.74, 0.99)*	0.88 (0.75, 1.03)	1.01 (0.64, 1.58)
Network 10 (IL)	0.85 (0.71, 1.01)	0.84 (0.70, 1.01)	1.63 (0.94, 2.81)
Network 11 (MI, MN, ND, SD, WI)	0.77 (0.65, 0.90)**	0.78 (0.65, 0.93)**	1.02 (0.66, 1.56)
Network 12 (IA, KS, MO, NE)	0.73 (0.62, 0.87)**	0.74 (0.61, 0.90)**	0.99 (0.62, 1.56)
Network 13 (AR, LA, OK)	0.86 (0.74, 1.01)	0.88 (0.74, 1.04)	0.79 (0.46, 1.33)
Network 15 (AZ, CO, NV, NM, UT, WY)	0.69 (0.60, 0.80)**	0.68 (0.58, 0.80)**	1.11 (0.72, 1.71)
Network 16 (AK, ID, MT, OR, WA)	0.60 (0.50, 0.73)**	0.71 (0.57, 0.88)**	0.64 (0.41, 0.98)*
Network 17 (AS, Guam, HI, Mariana I, N. CA)	0.74 (0.63, 0.89)**	0.79 (0.65, 0.96)*	0.98 (0.64, 1.52)
Network 18 (Southern CA)	0.67 (0.57, 0.79)**	0.67 (0.57, 0.79)**	1.25 (0.76, 2.07)
Other variable			
Year of study initiation (Reference: 2005)			
2006	0.95 (0.91, 0.99)*	0.95 (0.90, 0.99)*	0.94 (0.86, 1.03)
2007	0.98 (0.94, 1.02)	0.98 (0.93, 1.03)	0.98 (0.89, 1.07)
2008	1.07 (1.03, 1.12)**	1.09 (1.04, 1.14)**	1.04 (0.95, 1.15)
2009	1.34 (1.28, 1.40)**	1.38 (1.31, 1.44)**	1.22 (1.11, 1.34)**
2010	1.48 (1.42, 1.55)**	1.51 (1.44, 1.59)**	1.40 (1.27, 1.54)**
2011	1.62 (1.55, 1.69)**	1.67 (1.59, 1.75)**	1.48 (1.34, 1.64)**
2012	2.40 (2.29, 2.52)**	2.68 (2.54, 2.82)**	1.62 (1.46, 1.79)**
2013	2.85 (2.71, 2.99)**	3.30 (3.12, 3.48)**	1.64 (1.48, 1.82)**
2014	2.96 (2.82, 3.10)**	3.27 (3.10, 3.45)**	1.97 (1.77, 2.20)**
2015	3.52 (3.35, 3.69)**	3.96 (3.75, 4.19)**	2.11 (1.89, 2.36)**
2016	3.69 (3.51, 3.88)**	4.00 (3.78, 4.23)**	2.59 (2.31, 2.91)**

BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; ESKD, end-stage kidney disease; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease; LDKT, live donor kidney transplant; WL, wait list.

*Significant at $P < 0.05$, **Significant at $P < 0.01$

Characteristics associated with being informed (versus not) were examined separately for patients at for-profit and nonprofit centers (Table 2). These associations were similar irrespective of the ownership status, and were in the same direction as described above for the overall sample.

Multiple regression examining characteristics associated with transplantation status

Given individual patients were nested within centers, intraclass correlation coefficients (ICCs) were computed to examine the extent of clustering in the data. We found that 11% (ICC = 0.11, WL enrolled versus continuing on dialysis) and 21% (ICC = 0.21, LDKT received versus continuing on dialysis) of variations were explained by clustering. Regressions with random slope and intercept parameters were first estimated. However, we were not able to compute the parameter estimates because of lack of convergence. Consequently, a random intercept model was used for the final regressions.

The regression analysis (Table 3) established that ownership status modified the effect of patient informed

status on transplantation status. Overall informing patients statistically increased the odds of WL enrollment and LDKT receipt, as compared with not informing patients. Nevertheless, the adjusted odds were significantly lower for patients at for-profit centers versus patients at nonprofit centers (Nonprofit centers: (1) WL enrolled OR: 2.23 [95% CI: 2.07–2.40]; and (2) LDKT received OR: 3.35 [95% CI: 2.65–4.25]. For-profit centers: (1) WL enrolled OR: 1.73 [95% CI: 1.66–1.79]; and (2) LDKT received OR: 2.35 [95% CI: 2.08–2.66]). The patient socio-demographic, clinical, behavioral, dialysis center, and other characteristics were similarly associated with choosing or receiving either of the two transplantation options in the adjusted regression (Table 3), as they were in the descriptive unadjusted analyses above (Table 1).

Sensitivity analysis performed after excluding patients who died/were deemed medically unfit for transplantation during the study period, or patients who were informed by transplant centers, provided statistically equivalent results (Appendices 1 and 2). In addition, sensitivity analysis performed after replacing the "number of days alive after study initiation" continuous variable with a binary variable capturing whether or not the patient died during the 365 days of follow-up period also yielded statistically equivalent results (Appendix 3).

Multiple regression examining characteristics associated with whether or not patients were informed about transplantation options

Three sets of multilevel analyses using mixed-effect logistic regression estimations were performed to examine characteristics associated with whether or not patients were informed about transplantation options. In the first logistic regression analysis, all patients were included. This analysis showed that patients at for-profit centers were more likely to be informed about transplantation options than patients at nonprofit centers (Table 4) (OR: 1.32 [95% CI: 1.21–1.44]). The second and third logistic regressions were performed to examine characteristics associated with being informed among patients treated at for-profit and nonprofit centers, respectively. These regressions showed that the characteristics of patients associated with being informed were the same between for-profit and nonprofit centers, and the direction of the associations were the same as those estimated in the first logistic regression containing the entire patient sample (Table 4), and also similar to the unadjusted descriptive analyses performed above (Table 2). However, as compared with the descriptive statistics (Table 2), the association of race–ethnicity with being informed reversed in the three adjusted regressions, such that NH Whites were more likely to be informed in the adjusted regressions.

Discussion

This is the first study to use the nationally representative USRDS data to examine the modifying effect of a dialysis center's ownership status on the association between informing a patient about transplantation options and their transplantation status. This study found that informed patients at for-profit centers were less likely to choose or receive either of the transplantation options as compared with informed patients at nonprofit centers. However, the odds of patients being informed at the for-profit centers were higher than nonprofit centers. In addition, the type of patients being informed (based on socio-demographic, clinical, and behavioral characteristics) in centers with either type of ownership status were similar, and not statistically different.

Past studies were consistent with our results and showed that for-profit centers, compared with nonprofit centers, had lower likelihood of patients enrolling in WL or receiving an LDKT [5,10–12]. Moreover, patients who were informed about transplantation options were more likely to choose or receive a transplantation option [4–6]. However, this is the first study, to our knowledge, that has looked at whether patients from for-profit centers had a lower likelihood of choosing or receiving a transplantation option in spite of being informed, as compared with patients from nonprofit centers, thereby possibly indicating a quality difference in the information provided between centers.

This study established that for-profit centers informed more patients, and informed similar type of patients, as compared with nonprofit centers, yet the information provided by for-profit centers was less effective in improving the likelihood of choosing or receiving transplantation options. These findings suggest that although for-profit centers are investing effort in informing more patients about transplantation options, the quality and intensity of information provided is probably lacking. Previous studies support the possibility of differential quality of transplantation information by ownership status, by showing that providers at for-profit centers were less likely to engage in high-quality, more intense informational strategies that improved WL enrollment or LDKT receipt [7–9].

The study findings highlight the challenges associated with lack of guidelines for standardized transplantation information provision. More than 80% of ESKD patients receive care in for-profit centers. The disparity in the effectiveness of transplantation information, overall low rates of patients seeking transplantation options, and the excessive cost burden of ESKD and dialysis on federal funds and the society raise significant concerns about the absence of standardized transplantation information programs. Past studies have evaluated well-designed and intensive informational strategies such as clinical and home-based education, culturally sensitive education, information provided to both patients and family members, one-on-one discussions, and sufficiently long and detailed information programs. The studies show that these strategies have the potential to increase the willingness to receive transplantation, WL enrollment, and LDKT receipt [4–6,18–22]. In 2014, a report on best practices for transplant education for live kidney donations was published based on a consensus conference attended by transplant professionals, patients, and other stakeholders [23]. The importance of providing transplant-related information to reduce transplantation barriers was discussed in this conference report [23]. Nevertheless, more work needs to be done to develop comprehensive guidelines for transplantation information provision for both types of transplantations.

Our study also had other interesting findings about characteristics associated with patients who chose or received transplantation, similar to previous findings. Socio-demographically, past studies also found that patients who were younger [5,6,11,24–26], were male [5,6,11,24], were NH White [24,25,27], had higher education level [25], belonged to a higher socioeconomic status [5,27], were employed [6,25], or were privately insured [5,6,11,25] were more likely to choose or receive transplantation. Clinically, past studies found that patients who had nephrology care before ESKD onset [5,6,11], did not have other chronic comorbid conditions [5,11], were not disabled [5], or had lower BMI [5,11] were more likely to choose or receive transplantation. Behaviorally, past studies found that smokers, or alcohol/drug-dependent patients were less likely to choose or receive transplantation [5,11]. Regional trends of higher likelihood of choosing or receiving transplantation among the northeastern centers and lower likelihood among southern centers were also similar in the literature [10,28].

Few studies investigated factors associated with informing a patient about transplantation options [4,6,29–31]. However, the findings of these studies were similar to our study. These studies also found that younger [4], male [4,29,30], employed [6], or privately insured [4,6] patients were more likely to be informed. Patients who had nephrology care before ESKD onset [4,6], did not have comorbid conditions such as CVD, cancer and COPD [4], had better functional status [31], or were not drug/alcohol dependent [4,6] were more likely to be informed. There was no consensus on the association between race–ethnicity [4,6,29,30] and being informed in the literature.

Our study has some limitations. First, there is no information in the data about the duration, detail, intensity, and content of transplantation information sessions provided to the ESKD patients. Hence, this study only controlled for a binary variable indicating whether or not a patient was informed about transplantation options, and does not control for the quality of the transplantation information, which could vary between different centers and providers. Second, patients who are not informed of the transplantation options according to study data (form CMS-2728) could have obtained transplantation information from personal sources or other providers not involved in completing the form CMS-2728. They could also have obtained the information beyond the first 45 days following the ESKD service initiation date. Hence, there could be patients in the data who are classified as "not informed" but could be aware of the transplantation options. Third, the data did not have information on patient-level education and income, which might be associated with using centers of different ownership status, likelihood of patients being informed about transplantation options, and having access to transplantation. These associations can confound the adjusted effects estimated in this study. However, this study used the U.S. 2010 Census data to control for zip-code-level income and education variables, which have been shown to be consistent proxies for personal socio-economic status [16,17]. Irrespective of the limitations, it is important to understand that the USRDS is a population-based nationally representative data with high-quality clinical, socio-demographic, and dialysis center-level information. Consequently, the findings of this study are critical for understanding the relationship between patient informed status and transplantation status, and the modifying effect of a dialysis center's ownership status.

Future studies, potentially using dialysis center-specific survey data, are needed to capture the duration,

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detail, intensity, and content of information provided to the patients about transplantation options for centers with different ownership status. These studies can then examine how these factors of differential informational quality can affect WL enrollment and LDKT receipt as opposed to continuing on dialysis. Studies examining the effect of transplantation information on WL enrollment and LDKT receipt, after adjusting for patient-level income and education, can further address potential biases resulting from confounding, and possibly provide more evidence about the robustness and generalizability of this study's findings.

In conclusion, this study found a differential effect of informing patients on transplantation status based on the ownership status of the centers. Information provided by for-profit centers was potentially less effective than that provided by nonprofit centers, in spite of for-profit centers informing more patients and informing similar type of patients as compared with nonprofit centers. This study's findings highlight the importance of informing patients about transplantation options, and the need for developing guidelines to standardize transplantation information provided to ensure similar informational quality across centers.

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Conflicts of interest

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APPENDIX 1

Adjusted odds ratios demonstrating the effect of patient, dialysis center, and other characteristics on transplantation status after exclusion of patients who died, were reported to be medically unfit, or were informed by a transplant center

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Informed versus Not informed Comparison:		
For For-profit	1.55 (1.49, 1.61)**	2.16 (1.90, 2.45)**
For Non-Profit	1.85 (1.69, 2.01)**	2.70 (2.05, 3.56)**
Patient Socio-Demographic Characteristics		
Age at study initiation	0.97 (0.97, 0.97)**	0.94 (0.94, 0.94)**
Gender (Reference: Male)		
Female	0.82 (0.80, 0.84)**	0.78 (0.74, 0.82)**
Race-ethnicity (Reference: Non-Hispanic White)		
Non-Hispanic Black	0.77 (0.75, 0.79)**	0.22 (0.20, 0.24)**
Hispanic	1.04 (1.01, 1.07)**	0.67 (0.62, 0.72)**
Non-Hispanic Other	1.09 (1.04, 1.13)**	0.38 (0.34, 0.42)**
Education	1.01 (1.01, 1.01)**	1.01 (1.01, 1.01)**
Logarithm of Income	1.52 (1.47, 1.57)**	2.46 (2.26, 2.66)**
Employment status at study initiation (Reference: Unemployed)		
Employed	1.63 (1.59, 1.67)**	2.45 (2.29, 2.63)**

Appendix 1. Continued.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Retired due to age	1.29 (1.24, 1.35)**	1.71 (1.50, 1.95)**
Retired due to disability	1.07 (1.04, 1.10)**	1.07 (0.98, 1.17)
Other	1.34 (1.29, 1.39)**	1.79 (1.64, 1.96)**
Insurance status at study initiation (Reference: Medicare)		
Medicaid	0.88 (0.86, 0.91)**	0.74 (0.67, 0.82)**
Private insurance	1.77 (1.73, 1.82)**	2.89 (2.68, 3.11)**
Other	1.28 (1.23, 1.32)**	2.05 (1.86, 2.25)**
Uninsured	0.45 (0.40, 0.51)**	0.40 (0.27, 0.59)**
Patient clinical characteristics		
Nephrology care prior to study initiation (Reference: No)		
Yes	1.77 (1.73, 1.81)**	2.02 (1.90, 2.14)**
Missing	1.10 (1.06, 1.14)**	1.12 (1.01, 1.24)*
Primary cause of ESRD (Reference: Diabetes)		
Hypertension	0.99 (0.96, 1.02)	1.14 (1.04, 1.26)**
Glomerulonephritis	1.34 (1.30, 1.39)**	2.21 (2.01, 2.43)**
Polycystic kidney disease	1.75 (1.66, 1.84)**	2.13 (1.88, 2.41)**
Other	0.78 (0.75, 0.81)**	1.05 (0.94, 1.16)
Presence of hypertension at study initiation (Reference: No)		
Yes	1.18 (1.15, 1.21)**	1.13 (1.05, 1.21)**
Presence of diabetes at study initiation (Reference: No)		
Yes	0.95 (0.93, 0.98)**	0.74 (0.68, 0.81)**
Presence of CVD at study initiation (Reference: No)		
Yes	0.67 (0.66, 0.69)**	0.61 (0.57, 0.65)**
Presence of Cancer at study initiation (Reference: No)		
Yes	0.47 (0.44, 0.50)**	0.45 (0.38, 0.53)**
Presence of COPD at study initiation (Reference: No)		
Yes	0.55 (0.52, 0.58)**	0.45 (0.36, 0.57)**
Presence of Disability at study initiation (Reference: No)		
Yes	0.47 (0.45, 0.49)**	0.38 (0.32, 0.45)**
BMI at study initiation	0.97 (0.97, 0.97)**	0.95 (0.94, 0.95)**
GFR EPI at study initiation	0.98 (0.98, 0.99)**	0.98 (0.97, 0.99)**
GFR MDRD at study initiation	0.99 (0.99, 0.99)**	0.98 (0.97, 0.99)**
Patient behavioral characteristics		
Smoker at study initiation (Reference: No)		
Yes	0.51 (0.49, 0.53)**	0.42 (0.37, 0.47)**
Alcohol dependence at study initiation (Reference: No)		
Yes	0.81 (0.75, 0.88)*	0.27 (0.18, 0.40)**
Drug dependence at study initiation (Reference: No)		
Yes	0.27 (0.24, 0.30)**	0.24 (0.16, 0.36)**
Dialysis center characteristics		
Number of dialysis stations	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**
Regional ESRD Network (Reference: Network 14 - TX)		
Network 1 (CT, ME, MA, NH, RI, VT)	1.41 (1.28, 1.56)**	1.61 (1.36, 1.92)**
Network 2 (NY)	1.27 (1.17, 1.38)**	1.62 (1.38, 1.89)**
Network 3 (NJ, PR, VI)	1.05 (0.96, 1.15)	1.23 (1.04, 1.46)*
Network 4 (DE, PA)	1.49 (1.37, 1.62)**	1.35 (1.14, 1.60)*
Network 5 (DC, MD, VA, WV)	0.94 (0.87, 1.01)	1.10 (0.94, 1.29)
Network 6 (GA, NC, SC)	0.73 (0.68, 0.78)**	0.56 (0.48, 0.66)**

Appendix 1. Continued.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Network 7 (FL)	0.60 (0.55, 0.65)**	0.63 (0.53, 0.74)**
Network 8 (AL, MS, TN)	1.04 (0.96, 1.12)	1.04 (0.88, 1.23)
Network 9 (IN, KY, OH)	0.82 (0.76, 0.89)**	1.19 (1.03, 1.37)*
Network 10 (IL)	1.14 (1.05, 1.24)**	1.66 (1.41, 1.94)**
Network 11 (MI, MN, ND, SD, WI)	1.34 (1.24, 1.45)**	1.83 (1.58, 2.12)**
Network 12 (IA, KS, MO, NE)	0.93 (0.85, 1.02)	1.02 (0.86, 1.22)
Network 13 (AR, LA, OK)	0.72 (0.66, 0.79)**	0.68 (0.56, 0.83)**
Network 15 (AZ, CO, NV, NM, UT, WY)	0.88 (0.81, 0.95)**	1.03 (0.88, 1.20)
Network 16 (AK, ID, MT, OR, WA)	0.70 (0.63, 0.77)**	0.75 (0.62, 0.91)**
Network 17 (AS, Guam, HI, Mariana I, N. CA)	1.77 (1.63, 1.92)**	0.84 (0.70, 1.01)
Network 18 (Southern CA)	0.77 (0.72, 0.83)**	0.42 (0.35, 0.50)**
Other variables		
Year of study initiation (Reference: 2005)		
2006	1.14 (1.08, 1.20)**	0.94 (0.84, 1.05)
2007	1.10 (1.04, 1.15)**	0.84 (0.75, 0.94)**
2008	1.08 (1.03, 1.14)**	0.80 (0.71, 0.90)**
2009	1.12 (1.06, 1.18)**	0.81 (0.72, 0.91)**
2010	1.10 (1.05, 1.16)**	0.72 (0.64, 0.81)**
2011	1.12 (1.07, 1.18)**	0.66 (0.59, 0.75)**
2012	1.14 (1.08, 1.20)**	0.65 (0.58, 0.74)**
2013	1.05 (0.99, 1.11)	0.58 (0.51, 0.66)**
2014	0.89 (0.85, 0.94)**	0.50 (0.44, 0.57)**
2015	0.77 (0.73, 0.81)**	0.47 (0.41, 0.53)**
2016	0.71 (0.68, 0.75)**	0.43 (0.38, 0.49)**

ESRD, end-stage renal disease; WL, wait list; LDKT, live donor kidney transplant; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease.

*Significant at $P < 0.05$, **Significant at $P < 0.01$.

APPENDIX 2

Adjusted odds ratios demonstrating the effect of patient, dialysis center, and other characteristics on patients being informed about transplantation options after exclusion of patients who died, were reported to be medically unfit, or were informed by a transplant center

	All dialysis centers OR Estimate (95% CI)	For-profit dialysis centers OR Estimate (95% CI)	Non-profit dialysis centers OR Estimate (95% CI)
Ownership status (Reference: Non-profit)			
For-profit	1.31 (1.17, 1.46)**		
Patient socio-demographic characteristics			
Age at study initiation	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	0.98 (0.98, 0.98)**
Gender (Reference: Male)			
Female	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)	1.02 (0.96, 1.07)
Race-ethnicity (Reference: Non-Hispanic-White)			

Appendix 2. Continued.

	All dialysis centers OR Estimate (95% CI)	For-profit dialysis centers OR Estimate (95% CI)	Non-profit dialysis centers OR Estimate (95% CI)
Non-Hispanic-Black	0.94 (0.91, 0.96)**	0.94 (0.91, 0.97)**	0.90 (0.84, 0.98)**
Hispanic	0.91 (0.88, 0.95)**	0.91 (0.88, 0.95)**	0.87 (0.79, 0.96)**
Non-Hispanic-other	0.90 (0.86, 0.95)**	0.90 (0.85, 0.96)**	0.87 (0.78, 0.97)*
Education	0.99 (0.99, 0.99)*	0.99 (0.99, 0.99)*	1.00 (0.99, 1.01)
Logarithm of Income	1.22 (1.17, 1.27)**	1.16 (1.11, 1.22)**	1.09 (0.99, 1.20)
Employment status at study initiation (Reference: Unemployed)			
Employed	1.37 (1.32, 1.42)**	1.35 (1.29, 1.40)**	1.51 (1.38, 1.66)**
Retired due to age	1.15 (1.10, 1.20)**	1.15 (1.09, 1.21)**	1.14 (1.02, 1.28)*
Retired due to disability	1.14 (1.11, 1.18)**	1.13 (1.10, 1.17)**	1.29 (1.20, 1.38)**
Other	1.26 (1.20, 1.32)**	1.26 (1.19, 1.33)**	1.28 (1.13, 1.45)**
Insurance status at study initiation (Reference: Medicare)			
Medicaid	0.98 (0.95, 1.01)	0.98 (0.95, 1.01)	0.95 (0.88, 1.02)
Private insurance	1.23 (1.19, 1.27)**	1.23 (1.18, 1.27)**	1.29 (1.19, 1.41)**
Other	1.06 (1.02, 1.10)**	1.06 (1.01, 1.11)*	1.09 (0.99, 1.20)
Uninsured	0.56 (0.50, 0.62)**	0.58 (0.51, 0.66)**	0.48 (0.38, 0.60)**
Patient clinical characteristics			
Nephrology care prior to study initiation (Reference: No)			
Yes	1.68 (1.64, 1.72)**	1.63 (1.58, 1.67)**	1.98 (1.86, 2.10)**
Missing	0.89 (0.86, 0.92)**	0.86 (0.83, 0.89)**	1.09 (0.97, 1.22)
Primary cause of ESRD (Reference: Diabetes)			
Hypertension	0.93 (0.90, 0.96)**	0.93 (0.90, 0.97)**	0.87 (0.80, 0.95)**
Glomerulonephritis	1.04 (0.99, 1.09)	1.04 (0.99, 1.10)	0.98 (0.89, 1.09)
Polycystic kidney disease	1.44 (1.32, 1.57)**	1.40 (1.27, 1.54)**	1.52 (1.24, 1.86)**
Other	0.73 (0.71, 0.76)**	0.75 (0.72, 0.79)**	0.67 (0.61, 0.73)**
Presence of hypertension at study initiation (Reference: No)			
Yes	1.05 (1.02, 1.09)**	1.05 (1.01, 1.08)*	1.07 (0.99, 1.16)
Presence of diabetes at study initiation (Reference: No)			
Yes	0.96 (0.93, 0.99)*	0.97 (0.93, 0.99)*	0.93 (0.86, 1.01)
Presence of CVD at study initiation (Reference: No)			
Yes	0.95 (0.93, 0.98)**	0.96 (0.93, 0.98)**	0.96 (0.90, 1.01)
Presence of Cancer at study initiation (Reference: No)			
Yes	1.13 (1.06, 1.20)**	1.14 (1.07, 1.23)**	1.10 (0.96, 1.27)
Presence of COPD at study initiation (Reference: No)			
Yes	0.98 (0.93, 1.02)	0.98 (0.93, 1.03)	0.98 (0.88, 1.09)
Presence of Disability at study initiation (Reference: No)			
Yes	0.74 (0.72, 0.77)**	0.75 (0.73, 0.78)**	0.65 (0.61, 0.71)**
BMI at study initiation	0.99 (0.99, 0.99)*	0.99 (0.99, 0.99)*	1.00 (0.99, 1.01)
GFR EPI at study initiation	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99)**	1.00 (0.99, 1.01)
GFR MDRD at study initiation	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Patient behavioral characteristics			
Smoker at study initiation (Reference: No)			
Yes	0.92 (0.89, 0.96)**	0.92 (0.88, 0.96)**	0.93 (0.85, 1.01)
Alcohol dependence at study initiation (Reference: No)			
Yes	0.86 (0.81, 0.93)**	0.84 (0.77, 0.90)**	0.94 (0.80, 1.10)
Drug dependence at study initiation (Reference: No)			
Yes	0.78 (0.73, 0.83)**	0.84 (0.78, 0.90)**	0.64 (0.56, 0.73)**
Dialysis center characteristics			
Number of dialysis stations	1.01 (1.01, 1.01)**	1.01 (1.01, 1.02)**	0.99 (0.98, 0.99)**
Regional ESRD Network (Reference: Network 14 - TX)			
Network 1 (CT, ME, MA, NH, RI, VT)	0.59 (0.46, 0.75)**	0.64 (0.49, 0.83)**	0.93 (0.48, 1.77)
Network 2 (NY)	0.99 (0.80, 1.23)	0.89 (0.70, 1.14)	1.59 (0.93, 2.72)
Network 3 (NJ, PR, VI)	1.29 (1.01, 1.65)*	1.40 (1.07, 1.85)*	1.13 (0.62, 2.07)
Network 4 (DE, PA)	0.74 (0.60, 0.92)**	0.83 (0.66, 1.03)	1.21 (0.66, 2.23)
Network 5 (DC, MD, VA, WV)	0.67 (0.55, 0.80)**	0.73 (0.60, 0.89)**	1.18 (0.66, 2.11)

Appendix 2. Continued.

	All dialysis centers OR Estimate (95% CI)	For-profit dialysis centers OR Estimate (95% CI)	Non-profit dialysis centers OR Estimate (95% CI)
Network 6 (GA, NC, SC)	0.71 (0.61, 0.84)**	0.73 (0.61, 0.86)**	1.44 (0.84, 2.47)
Network 7 (FL)	0.80 (0.67, 0.97)*	0.85 (0.70, 1.02)	1.58 (0.85, 2.95)
Network 8 (AL, MS, TN)	0.73 (0.61, 0.87)**	0.75 (0.62, 0.92)**	1.76 (0.98, 3.14)
Network 9 (IN, KY, OH)	0.81 (0.68, 0.97)*	0.92 (0.76, 1.10)	1.10 (0.62, 1.93)
Network 10 (IL)	0.95 (0.77, 1.17)	1.07 (0.86, 1.33)	1.44 (0.74, 2.82)
Network 11 (MI, MN, ND, SD, WI)	0.83 (0.69, 1.01)	0.95 (0.77, 1.17)	1.34 (0.79, 2.28)
Network 12 (IA, KS, MO, NE)	0.71 (0.58, 0.88)**	0.80 (0.63, 0.99)*	1.21 (0.68, 2.13)
Network 13 (AR, LA, OK)	0.80 (0.66, 0.97)*	0.87 (0.71, 1.06)	1.04 (0.53, 2.02)
Network 15 (AZ, CO, NV, NM, UT, WY)	0.65 (0.55, 0.77)**	0.70 (0.59, 0.84)**	1.13 (0.67, 1.90)
Network 16 (AK, ID, MT, OR, WA)	0.57 (0.45, 0.70)**	0.89 (0.69, 1.15)	0.85 (0.50, 1.43)
Network 17 (AS, Guam, HI, Mariana I, N. CA)	0.70 (0.57, 0.85)**	0.89 (0.70, 1.11)	0.90 (0.54, 1.51)
Network 18 (Southern CA)	0.60 (0.50, 0.71)**	0.65 (0.54, 0.78)**	0.98 (0.54, 1.77)
Other variables			
Year of study initiation (Reference: 2005)			
2006	0.85 (0.80, 0.90)**	0.84 (0.79, 0.89)**	0.93 (0.82, 1.06)
2007	0.87 (0.82, 0.91)**	0.86 (0.81, 0.91)**	0.94 (0.83, 1.07)
2008	0.94 (0.89, 0.99)*	0.94 (0.89, 0.99)*	0.98 (0.86, 1.12)
2009	1.19 (1.12, 1.25)**	1.23 (1.16, 1.30)**	1.11 (0.97, 1.26)
2010	1.30 (1.23, 1.37)**	1.33 (1.25, 1.41)**	1.31 (1.15, 1.50)**
2011	1.44 (1.36, 1.52)**	1.47 (1.38, 1.56)**	1.41 (1.23, 1.62)**
2012	2.32 (2.19, 2.46)**	2.50 (2.34, 2.67)**	1.75 (1.51, 2.02)**
2013	2.92 (2.75, 3.11)**	3.27 (3.06, 3.50)**	1.82 (1.58, 2.11)**
2014	2.90 (2.73, 3.09)**	3.11 (2.91, 3.33)**	2.18 (1.88, 2.54)**
2015	3.62 (3.40, 3.86)**	3.97 (3.70, 4.25)**	2.51 (2.15, 2.92)**
2016	3.68 (3.46, 3.92)**	3.92 (3.66, 4.20)**	2.97 (2.54, 3.47)**

ESRD, end-stage renal disease; WL, wait list; LDKT, live donor kidney transplant; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease.

*Significant at $P < 0.05$, **Significant at $P < 0.01$.

APPENDIX 3

Adjusted odds ratios demonstrating the effect of patient, dialysis center, and other characteristics on transplantation status after adjusting for a binary variable capturing patient death during follow-up period

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Informed versus Not informed Comparison:		
For For-profit	1.73 (1.67, 1.79)**	2.40 (2.12, 2.71)**
For Non-Profit	2.23 (2.07, 2.40)**	3.40 (2.68, 4.32)**
Patient socio-demographic characteristics		
Age at study initiation	0.97 (0.97, 0.97)**	0.94 (0.94, 0.94)**
Gender (Reference: Male)		

Appendix 3. Continued.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Female	0.82 (0.81, 0.84)**	0.78 (0.74, 0.82)**
Race-ethnicity (Reference: Non-Hispanic White)		
Non-Hispanic Black	0.77 (0.75, 0.79)**	0.22 (0.21, 0.24) **
Hispanic	1.04 (1.01, 1.07) **	0.67 (0.63, 0.73) **
Non-Hispanic Other	1.09 (1.05, 1.13) **	0.39 (0.34, 0.43) **
Education	1.01 (1.01, 1.01) *	1.01 (1.01, 1.01) **
Logarithm of Income	1.51 (1.46, 1.56) **	2.42 (2.23, 2.62) **
Employment status at study initiation (Reference: Unemployed)		
Employed	1.64 (1.59, 1.68) **	2.48 (2.32, 2.65) **
Retired due to age	1.28 (1.23, 1.33) **	1.68 (1.48, 1.92) **
Retired due to disability	1.07 (1.04, 1.10) **	1.06 (0.97, 1.16)
Other	1.34 (1.30, 1.39) **	1.81 (1.66, 1.97) **
Insurance status at study initiation (Reference: Medicare)		
Medicaid	0.89 (0.87, 0.91) **	0.75 (0.68, 0.82) **
Private insurance	1.77 (1.73, 1.82) **	2.89 (2.69, 3.11) **
Other	1.27 (1.23, 1.31) **	2.05 (1.87, 2.25) **
Uninsured	0.44 (0.39, 0.50) **	0.41 (0.28, 0.60) **
Patient clinical characteristics		
Nephrology care prior to study initiation (Reference: No)		
Yes	1.76 (1.73, 1.80) **	2.03 (1.91, 2.15) **
Missing	1.11 (1.07, 1.15) **	1.13 (1.02, 1.26) *
Primary cause of ESRD (Reference: Diabetes)		
Hypertension	0.99 (0.97, 1.02)	1.14 (1.04, 1.25) **
Glomerulonephritis	1.34 (1.29, 1.38) **	2.20 (2.01, 2.41) **
Polycystic kidney disease	1.76 (1.67, 1.85) **	2.12 (1.88, 2.40) **
Other	0.80 (0.77, 0.83) **	1.04 (0.94, 1.15)
Presence of hypertension at study initiation (Reference: No)		
Yes	1.16 (1.12, 1.19) **	1.13 (1.06, 1.21) **
Presence of diabetes at study initiation (Reference: No)		
Yes	0.96 (0.93, 0.98) **	0.74 (0.68, 0.80) **
Presence of CVD at study initiation (Reference: No)		
Yes	0.66 (0.65, 0.68) **	0.60 (0.57, 0.64) **
Presence of Cancer at study initiation (Reference: No)		
Yes	0.44 (0.41, 0.46) **	0.42 (0.36, 0.50) **
Presence of COPD at study initiation (Reference: No)		
Yes	0.55 (0.51, 0.58) **	0.47 (0.38, 0.58) **
Presence of Disability at study initiation (Reference: No)		
Yes	0.47 (0.45, 0.49) **	0.38 (0.33, 0.44) **
BMI at study initiation	0.97 (0.97, 0.97) **	0.95 (0.95, 0.95) **
GFR EPI at study initiation	0.98 (0.98, 0.99) **	0.98 (0.97, 0.99) **
GFR MDRD at study initiation	0.99 (0.99, 0.99) **	0.98 (0.97, 0.99) **
Patient behavioral characteristics		
Smoker at study initiation (Reference: No)		
Yes	0.51 (0.49, 0.53) **	0.42 (0.37, 0.47) **
Alcohol dependence at study initiation (Reference: No)		
Yes	0.92 (0.86, 0.99) *	0.29 (0.20, 0.42) **
Drug dependence at study initiation (Reference: No)		
Yes	0.92 (0.86, 0.99) **	0.29 (0.20, 0.42) **

Appendix 3. Continued.

	WL enrolled OR Estimate (95% CI) (Reference: Continuing on dialysis)	LDKT received OR Estimate (95% CI) (Reference: Continuing on dialysis)
Dialysis center characteristics		
Number of dialysis stations	0.99 (0.99, 0.99)**	0.99 (0.99, 0.99) **
Regional ESRD Network (Reference: Network 14 - TX)		
Network 1 (CT, ME, MA, NH, RI, VT)	1.39 (1.27, 1.53) **	1.65 (1.39, 1.96) **
Network 2 (NY)	1.27 (1.17, 1.38) **	1.65 (1.41, 1.92) **
Network 3 (NJ, PR, VI)	1.06 (0.97, 1.16)	1.26 (1.06, 1.49) **
Network 4 (DE, PA)	1.51 (1.39, 1.64) **	1.38 (1.17, 1.64) **
Network 5 (DC, MD, VA, WV)	0.95 (0.88, 1.03)	1.14 (0.98, 1.33)
Network 6 (GA, NC, SC)	0.72 (0.68, 0.78) **	0.57 (0.48, 0.66) **
Network 7 (FL)	0.59 (0.54, 0.63) **	0.63 (0.54, 0.75) **
Network 8 (AL, MS, TN)	1.02 (0.95, 1.10)	1.04 (0.88, 1.24)
Network 9 (IN, KY, OH)	0.83 (0.77, 0.89) **	1.21 (1.05, 1.40) **
Network 10 (IL)	1.16 (1.06, 1.26) **	1.77 (1.51, 2.07) **
Network 11 (MI, MN, ND, SD, WI)	1.34 (1.24, 1.44) **	1.85 (1.60, 2.14) **
Network 12 (IA, KS, MO, NE)	0.92 (0.84, 1.01)	1.04 (0.87, 1.23)
Network 13 (AR, LA, OK)	0.72 (0.66, 0.79) **	0.69 (0.56, 0.84) **
Network 15 (AZ, CO, NV, NM, UT, WY)	0.88 (0.82, 0.96) **	1.03 (0.89, 1.20)
Network 16 (AK, ID, MT, OR, WA)	0.68 (0.61, 0.75) **	0.75 (0.62, 0.91) **
Network 17 (AS, Guam, HI, Mariana I, N. CA)	1.76 (1.62, 1.91) **	0.84 (0.70, 1.01)
Network 18 (Southern CA)	0.79 (0.74, 0.85) **	0.42 (0.35, 0.49) **
Other variables		
Year of study initiation (Reference: 2005)		
2006	1.13 (1.07, 1.18) **	0.95 (0.85, 1.05)
2007	1.10 (1.05, 1.16) **	0.83 (0.74, 0.92) **
2008	1.09 (1.04, 1.14) **	0.80 (0.72, 0.90) **
2009	1.12 (1.07, 1.18) **	0.81 (0.73, 0.91) **
2010	1.11 (1.06, 1.17) **	0.71 (0.63, 0.80) **
2011	1.13 (1.08, 1.18) **	0.66 (0.58, 0.74) **
2012	1.13 (1.08, 1.19) **	0.65 (0.57, 0.73) **
2013	1.05 (1.01, 1.10) *	0.58 (0.52, 0.66) **
2014	0.89 (0.85, 0.93) **	0.49 (0.44, 0.56) **
2015	0.76 (0.73, 0.80) **	0.46 (0.41, 0.52) **
2016	0.71 (0.67, 0.74) **	0.42 (0.37, 0.48) **
Patient died during study period		
Yes	0.19 (0.17, 0.20) **	0.11 (0.09, 0.14) **

ESRD, end-stage renal disease; WL, wait list; LDKT, live donor kidney transplant; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; GFR EPI, glomerular filtration rate epidemiology collaboration; GFR MDRD, glomerular filtration rate modification of diet in renal disease.

*Significant at $P < 0.05$, **Significant at $P < 0.01$

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