Original Articles

Dialysis Facility Profit Status and Early Steps in Kidney Transplantation in the Southeastern United States

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Abstract

Background and objectives Dialysis facilities in the United States play a key role in access to kidney transplantation. Previous studies reported that patients treated at for-profit facilities are less likely to be waitlisted and receive a transplant, but their effect on early steps in the transplant process is unknown. The study's objective was to determine the association between dialysis facility profit status and critical steps in the transplantation process in Georgia, North Carolina, and South Carolina.

Design, setting, participants, & measurements In this retrospective cohort study, we linked referral and evaluation data from all nine transplant centers in the Southeast with United States Renal Data System surveillance data. The cohort study included 33,651 patients with kidney failure initiating dialysis from January 1, 2012 to August 31, 2016. Patients were censored for event (date of referral, evaluation, or waitlisting), death, or end of study (August 31, 2017 for referral and March 1, 2018 for evaluation and waitlisting). The primary exposure was dialysis facility profit status: for profit versus nonprofit. The primary outcome was referral for evaluation at a transplant center after dialysis initiation. Secondary outcomes were start of evaluation at a transplant center after referral and waitlisting.

Results Of the 33,651 patients with incident kidney failure, most received dialysis treatment at a for-profit facility (85%). For-profit (versus nonprofit) facilities had a lower cumulative incidence difference for referral within 1 year of dialysis (−4.5%; 95% confidence interval, −6.0% to −3.2%). In adjusted analyses, for-profit versus nonprofit facilities had lower referral (hazard ratio, 0.84; 95% confidence interval, 0.80 to 0.88). Start of evaluation within 6 months of referral (−1.0%; 95% confidence interval, −3.1% to 1.3%) and waitlisting within 6 months of evaluation (1.0%; 95% confidence interval, −1.2 to 3.3) did not meaningfully differ between groups.

Conclusions Findings suggest lower access to referral among patients dialyzing in for-profit facilities in the Southeast United States, but no difference in starting the evaluation and waitlisting by facility profit status.

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Introduction

Total and permanent kidney failure affects >700,000 adults in the United States (1). Kidney transplantation improves patient survival and quality of life compared with dialysis and reduces total cost of care (2–4). Despite the demonstrated long-term benefits of transplantation over dialysis, <15% of all patients with kidney failure have completed the necessary steps to be waitlisted for a kidney transplant (5). To determine why the majority of patients with kidney failure are not waitlisted, earlier steps in the kidney transplantation process, including referral to a kidney transplant center to undergo a medical and psychosocial evaluation, must be studied.

Nearly 90% of patients with incident kidney failure receive treatment in a dialysis facility (1). National guidelines from the Organ Procurement and Transplantation Network require education about transplantation as a treatment option within 90 days of kidney failure start and recommend referring patients for evaluation if a clinician is uncertain of transplant eligibility (4). Several studies have shown that patients treated in for-profit facilities have lower rates of waitlisting and kidney transplantation (6–10). However, the effect of for-profit status on steps prior to waitlisting remains unknown because national surveillance databases do not routinely collect these data (6,7).

The purpose of this study was to examine the association between dialysis facility profit status, referral from a dialysis facility to a transplant center, and start of evaluation at the transplant center. We focused on Georgia, North Carolina, and South Carolina (ESRD Network 6), a region with the highest burden of kidney failure in the country but also the lowest standardized transplantation rates (11), where an existing early transplant access registry documents these critical first steps to transplant.

Materials and Methods

Data Source

Patient-level clinical and demographic data were obtained from the United States Renal Data System (USRDS) database, a publicly available national database that includes information on almost all of the patients with kidney failure in the United States. USRDS collects data at the patient's initiation of dialysis using the Centers for Medicare & Medicaid Services (CMS) CMS-2728 form (1).

Dialysis facility–level data were obtained from Dialysis Facility Compare (DFC; 2016) and Dialysis Facility Report (DFR; 2013–2016). DFC reports information on dialysis facility profit status and corporate ownership (12). DFR captures information on facility-level patient characteristics, mortality, treatment patterns, and transplantation rates (13). Dialysis facility–level data from DFC and DFR were linked to patient-level USRDS data using the dialysis facility's CMS certification number. Neighborhood factors by zip code were determined using the 2010–2014 American Community Survey.

Patient-level referral and start of evaluation data were collected from all transplant centers in Georgia, North Carolina, and South Carolina and linked to USRDS data as previously described (14). This study was approved by the institutional review board at Emory University (IRB00079596).

Study Population

All patients with incident kidney failure registered within USRDS in Georgia, North Carolina, and South Carolina who initiated dialysis between January 1, 2012 and August 31, 2016 were considered for inclusion, and a match merge was made with the Early Transplant Access Registry data of first referrals. There were 40,453 patients with incident kidney failure from 782 facilities eligible for merging. A total of 6252 patients were excluded for preemptive referral (n=5276), preemptive evaluation (n=2966), preemptive waitlisting (n=1548), receiving care in a Veterans Affairs–affiliated facility (n=385), receiving care in a transplant center–based facility (n=59), receiving care in a facility with fewer than ten patients (n=1056), missing profit status (n=5), and missing patient-level information (n=546), leaving 33,651 patients in the final study population (Figure 1). Exclusions on the basis of preemptive referral, evaluation, and waitlisting were defined as having a date of completion for each step prior to the date of dialysis start.

Outcomes and Study Variables

The primary exposure was dialysis facility profit status, defined as for profit or nonprofit within the USRDS database. The primary outcome was incident referral for transplant evaluation at a transplant center. Referral to a transplant center was defined as receipt of the referral form at a transplant center. Patients were censored for referral date, death, or end of study period (August 31, 2017 for referral). In the event that a patient was referred more than once during the study period, the patient's first referral following dialysis initiation was used as the referral date. Secondary outcomes included start of transplant evaluation at a transplant center (among referred patients), defined as the first visit to a transplant center, satellite clinic, or required education class; waitlisting for transplant (among evaluated patients) was defined as placement on the deceased donor kidney transplantation waiting list. For evaluation and waitlisting, patients were followed from referral to date of evaluation/waitlisting, death, or end of study period (March 1, 2018), whichever occurred first. Patients with negative follow-up time from referral to evaluation and/or evaluation to waitlisting were assigned a follow-up time of 1 day for evaluation and waitlisting.

Patient-level demographic, clinical, and socioeconomic characteristics were obtained from USRDS at the time of dialysis initiation. Demographics included age, sex, race/ethnicity, and attributed cause of kidney failure. Clinical characteristics included comorbidities (body mass index [BMI] $\geq$35 kg/m^2, atherosclerotic heart disease, other cardiac disease, cerebrovascular disease, peripheral vascular disease, hypertension, diabetes, chronic obstructive pulmonary disease, tobacco use, and active malignancy), receipt of nephrology care prior to dialysis initiation, and education on transplant as a treatment option (versus not informed due to medical reasons). Patient insurance provider (Medicare, Medicaid, employer coverage, other coverage, or no coverage) was examined as a patient-level socioeconomic factor.

At the neighborhood zip code level, socioeconomic indicators included the percentage of residents living below the poverty line, percentage of Black residents, and percentage of residents with a high school degree. Dialysis facility–level characteristics included facility size and patient-social worker ratio.

Statistical Analyses

A small number of patients (546 patients; 2%) had incomplete CMS-2728 forms; therefore, we conducted a complete patient analysis (15). The cumulative incidence function estimated the probabilities of referral at 6, 12, 24, and 36 months from the initiation of dialysis; evaluation at 6, 12, and 24 months from referral date; and waitlisting at 6 and 12 months from evaluation date (due to limited follow-up on waitlisting) with death treated as a competing risk. The 95% confidence intervals (95% CIs) were calculated with variance estimates. Bootstrapping was used to perform 1000 resamples of the event with replacement to accurately compute the 95% CIs for cumulative incidence differences.

Cause-specific Cox models were used to assess characteristics associated with each outcome. For the main analysis, time to each event (referral, evaluation start, or waitlisting censored for end of study period) was calculated using cause-specific hazard ratios (HRs) and 95% CIs, with death treated as a competing risk. Covariates with known associations between profit status and/or access to transplantation were included in the multivariable models. Robust sandwich variance estimators were used to account for potential clustering within dialysis facilities. The proportional hazard assumption was tested for all outcomes.

As in our prior work, patients who were referred, evaluated, waitlisted, or transplanted prior to starting dialysis were excluded in main analyses because the events occurred prior to the follow-up period. However, because

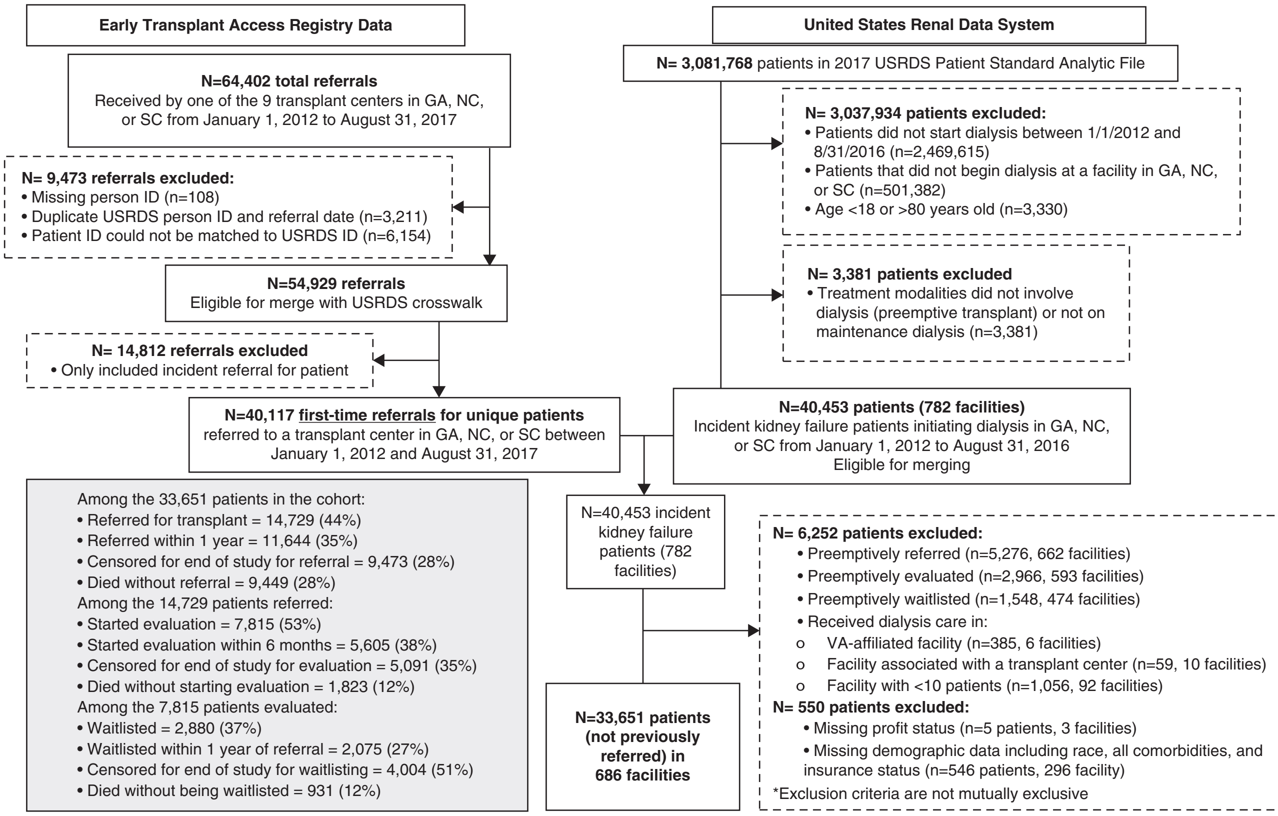


Figure 1. | **Data merge and cohort selection to examine the relationship between dialysis facility profit status and access to kidney transplantation.** GA, Georgia; ID, identification; NC, North Carolina; SC, South Carolina; USRDS, United States Renal Data System; VA, Veterans Affairs.

dialysis facilities still have the opportunity to facilitate patients' access in early steps of transplant, in a sensitivity analysis, we included patients who were preemptively referred and assigned them a follow-up time of 1 day from dialysis initiation for analyses examining referral and 1 day from referral for analyses examining evaluation start and waitlisting.

SAS version 9.4 (SAS Institute, Cary, NC) and R (version 3.6.3) were used for cohort development, data management, and statistical analysis. Two-sided P values were used for all analyses, and $P=0.05$ was considered statistically significant.

Results

Baseline Characteristics

We included 33,651 patients with incident kidney failure from Georgia, South Carolina, and North Carolina. Among included patients, most received dialysis care at a for-profit facility (85%) compared with a nonprofit facility (15%). In the overall population, the mean age was 60 years (SD: 13 years), 55% were men, and 56% were non-Hispanic Black patients (Table 1).

There were no significant differences in age, sex, or race/ethnicity between patients at for-profit versus nonprofit facilities. Compared with patients treated in for-profit facilities, patients treated in nonprofit facilities had significantly higher proportions of all 11 assessed comorbidities with the exception of BMI. Differences were observed in attributable cause of kidney failure, with more kidney failure cases attributed to hypertension in for-profit facilities compared with nonprofit facilities (38% versus 33%, respectively). Patients treated in for-profit facilities were more likely to have employer-based insurance (18% versus 15%, respectively) or Medicaid (25% versus 24%, respectively), whereas patients in nonprofit facilities were more likely to lack coverage at kidney failure start (12% versus 10%, respectively) (Table 1).

Of note, among patients excluded, patients referred prior to dialysis start were more likely to be younger, have received nephrology care, have employer insurance, and live in a neighborhood with <20% of residents living below the poverty line compared with the study population; they were also less likely to have nine of the 11 comorbidities compared with patients in the main analysis (Supplemental Table 1).

Referral for Transplantation Evaluation following Initiation of Dialysis

A total of 44% of patients ($n=14,729$) were referred for transplant during the 4-year study period, including 43% in for-profit dialysis facilities versus 47% in nonprofit dialysis facilities ($P<0.001$) (Supplemental Table 2). Among those referred, the median time from dialysis initiation to referral was 4.4 months (interquartile range [IQR], 2.1–10.3),

Table 1. Characteristics of patients with incident kidney failure initiating dialysis between January 1, 2012 and August 31, 2016 in Georgia, North Carolina, and South Carolina followed through March 1, 2018: Overall and stratified by dialysis facility profit status

Population Characteristics	Overall Population	Patients Initiating Dialysis at a For-Profit Facility	Patients Initiating Dialysis at a Nonprofit Facility
Facilities, *n* (%)	686 (100)	582 (85)	104 (15)
Total patients, *n* (%)	33,651 (100)	28,592 (85)	5059 (15)
Patient demographics			
Age, yr, mean (SD)	60 (13)	60 (13)	59 (13)
Age category, yr, *n* (%)			
18–29	914 (3)	769 (3)	145 (3)
30–39	2012 (6)	1700 (6)	312 (6)
40–49	4324 (13)	3666 (13)	658 (13)
50–59	7545 (22)	6408 (22)	1137 (23)
60–69	10,120 (30)	8580 (30)	1540 (30)
≥70	8736 (26)	7469 (26)	1267 (25)
Sex, *n* (%)			
Men	18,498 (55)	15,704 (55)	2794 (55)
Women	15,153 (45)	12,888 (45)	2265 (45)
Race/ethnicity, *n* (%)			
White, non-Hispanic	13,451 (40)	11,459 (40)	1992 (39)
Black, non-Hispanic	18,853 (56)	15,990 (56)	2863 (57)
White, Hispanic	713 (2)	602 (2)	111 (2)
Other race/ethnicity	634 (2)	541 (2)	93 (2)
Patient clinical characteristics			
Attributed cause of kidney failure, *n* (%)[a]			
Diabetes	15,348 (47)	13,028 (47)	2320 (47)
Hypertension	12,216 (37)	10,591 (38)	1625 (33)
GN	2225 (7)	1811 (7)	414 (8)
Other	3216 (10)	2611 (9)	605 (12)
Comorbidities, *n* (%)[b]			
BMI≥35 kg/m²	8519 (26)	7255 (26)	1264 (25)
Congestive heart failure	9406 (28)	7831 (27)	1575 (31)
Atherosclerotic heart disease	3347 (10)	2782 (10)	565 (11)
Other cardiac disease	5894 (18)	4937 (17)	957 (19)
Cerebrovascular disease (stroke)	3156 (9)	2590 (9)	566 (11)
Peripheral vascular disease	3007 (9)	2456 (9)	551 (11)
Hypertension	30,076 (89)	25,446 (89)	4630 (92)
Diabetes	20,320 (60)	17,192 (60)	3128 (62)
Chronic obstructive pulmonary disease	3097 (9)	2538 (9)	559 (11)
Tobacco use	3120 (9)	2467 (9)	653 (13)
Cancer	2081 (6)	1698 (6)	383 (8)
Prekidney failure nephrology care, *n* (%)[c]			
Received	21,090 (71)	17,905 (71)	3185 (71)
Did not receive	8527 (29)	7244 (29)	1283 (29)
Patient informed of transplant as a treatment option, *n* (%)[d]			
Informed of transplant options	32,495 (97)	27,715 (97)	4780 (95)
Not informed of transplant options due to medical reasons	1045 (3)	777 (3)	268 (5)
Patient socioeconomic characteristics			
Primary health insurance provider, *n* (%)			
Medicare	13,774 (41)	11,640 (41)	2134 (42)
Medicaid	8334 (25)	7140 (25)	1194 (24)
Employer group	5899 (18)	5141 (18)	758 (15)
Other coverage	2141 (6)	1793 (6)	348 (7)
No coverage	3503 (10)	2878 (10)	625 (12)
Dialysis initiation pre-KAS (before 12/4/2014) or post-KAS (after/on 12/4/2014), *n* (%)			
Dialysis initiation in pre-KAS era	20,758 (62)	17,7735 (62)	3023 (60)
Dialysis initiation in post-KAS era	12,893 (38)	10,857 (38)	2036 (40)
Patient neighborhood (zip code) factors			
No. of patients living in a zip code where ≥20% of residents live below the poverty line, n *(%)*	10,583 (32)	8994 (32)	1589 (31)
% Black population in patient zip code, mean (SD)[e]	35 (24)	35 (23)	35 (27)
% High school graduates in patient zip code, mean (SD)[f]	83 (7)	83 (7)	82 (7)
Patient dialysis facility characteristics			
No. of patients per facility, mean (SD)[g]	91 (48)	88 (43)	102 (69)
No. of patients per facility by category, *n* (%)[g]			
Very small, 11–25	568 (2)	482 (2)	86 (2)
Small, 26–54	7119 (21)	5661 (20)	1458 (29)
Medium, 55–78	8276 (25)	7498 (26)	778 (15)

Table 1. (Continued)

Population Characteristics	Overall Population	Patients Initiating Dialysis at a For-Profit Facility	Patients Initiating Dialysis at a Nonprofit Facility
Large, >79	17,688 (53)	14,951 (52)	2737 (54)
No. of social workers per facility, mean (SD)	1 (0.7)	1 (0.7)	1 (0.6)
Ratio of patients to social workers per facility, mean (SD)[h]	104 (40.3)	104 (40.5)	107 (39)

BMI, body mass index; KAS, Kidney Allocation System.
[a]Attributable cause of kidney failure information missing for 646 patients (2%).
[b]Patient BMI information missing for 243 patients (1%); removed patients missing all comorbidities.
[c]Information on patients who received nephrology before dialysis initiation missing for 4034 patients (12%).
[d]Information on patients who were informed of transplant as a treatment option missing for 31 patients (0.1%).
[e]Average percentage of Black residents in zip code of patient neighborhood was missing for 455 patients (1%).
[f]Average percentage of high school graduates in zip code of patient neighborhood was missing for 461 patients (1%).
[g]Determined by averaging the number of patients for each facility across all study years when the facility was in operation. Data are from the National Coordinating Center.
[h]Number of patients for every one social worker. This was calculated only for patients (n=31,120) who had at least one social worker at their facility and not for patients with zero social workers at their facility or missing information (n=2531).

with a longer median time to referral for patients treated at for-profit facilities (4.6 months; IQR, 2.1–10.5 months) versus nonprofit facilities (3.8 months; IQR, 2.0–9.1 months; $P<0.001$).

A total of 11,272 patients died during the follow-up period, including similar proportions of patients in for-profit (34%) and nonprofit (33%) facilities. In cumulative incidence analysis with death treated as a competing risk, patients treated in for-profit facilities had lower cumulative incidence of referral at 6 months and 1 year compared with patients treated in nonprofit facilities (cumulative incidence difference, −5.1%; 95% CI, −6.5% to −3.8% and −4.5%; 95% CI, −6.0% to −3.2%, respectively). The lower incidence of referral among patients treated in for-profit versus nonprofit facilities remained consistent over time (Figure 2A).

In the unadjusted cause-specific Cox model, patients treated at for-profit facilities were less likely to receive a referral for transplant evaluation (HR, 0.87; 95% CI, 0.78 to 0.97). In multivariable analysis, after adjusting for age, sex, race/ethnicity, primary cause of kidney failure, the presence of selected comorbidities, facility size, pre-/post-Kidney Allocation System era, insurance status, and not informed of transplant options due to medical reasons, patients treated at a for-profit facility were less likely to receive a referral compared with patients treated at a nonprofit facility (HR, 0.84; 95% CI, 0.76 to 0.93) (Table 2).

Profit Status and Evaluation Start at a Transplant Center

Among patients referred for evaluation at a transplant center, 53% started evaluation (23% of all patients with kidney failure), and among those who were evaluated, the median follow-up time was 2.3 months (IQR, 1.5–3.6) from referral to evaluation. Of total referred, 38% started the evaluation within 6 months of the referral (n=5605) (Figure 1). Of the 12,343 patients referred for transplant from for-profit facilities, 53% started the evaluation versus 55% of the 2386 patients referred from nonprofit facilities (Supplemental Table 2). The median times from referral to evaluation were similar between for-profit facilities (2.3 months; IQR, 1.4–3.6 months) versus nonprofit facilities (2.4 months; IQR, 1.5–3.6 months; P=0.18).

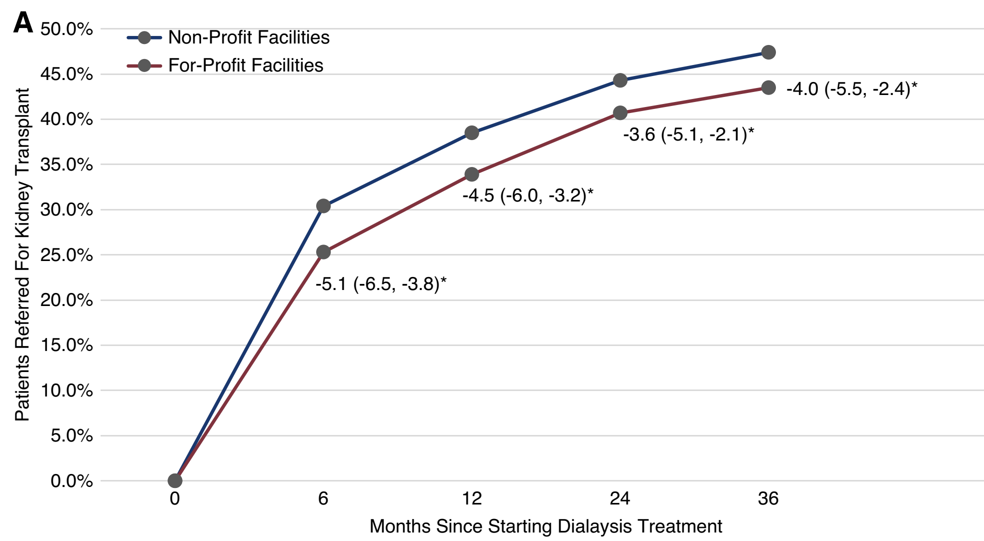
Patients referred from for-profit facilities had similar 6-month cumulative incidence of starting evaluation compared with patients in nonprofit facilities (cumulative incidence difference, −1.0%; 95% CI, −3.1% to 1.3%). Trends remained consistent at 1 and 2 years (cumulative incidence differences, −1.4%; 95% CI, −3.5% to 0.8% and −1.9%; 95% CI, −4.1% to 0.3%, respectively) (Figure 2B).

In the unadjusted cause-specific Cox model, there was no difference in evaluation start among patients referred between for-profit and nonprofit groups (HR, 0.95; 95% CI, 0.85 to 1.06), and results were consistent after adjustment for various demographic, clinical, and socioeconomic factors (HR, 0.92; 95% CI, 0.83 to 1.03) (Table 3).

Profit Status and Placement on the Deceased Donor Waitlist for Transplant

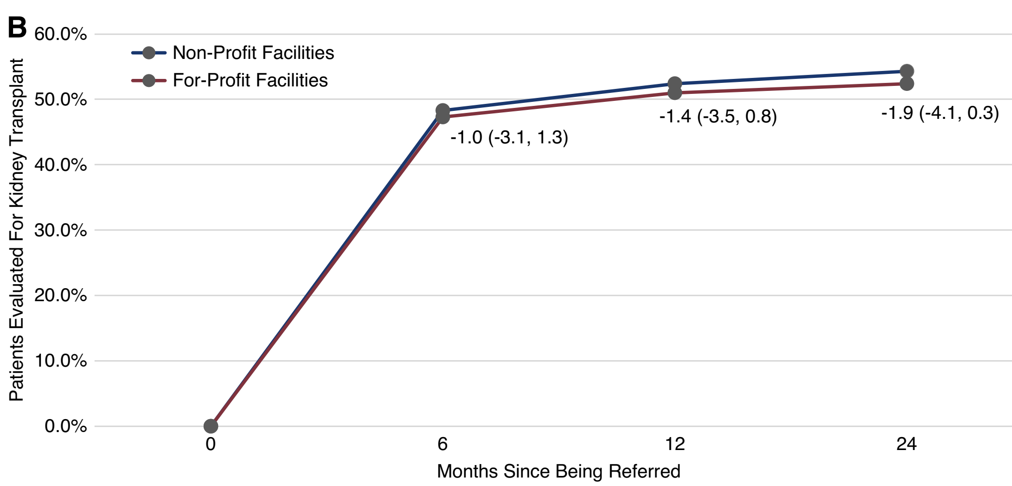
Among patients evaluated at a transplant center, 37% were waitlisted (9% of all evaluated patients). Among those who were waitlisted, the median time from evaluation to waitlisting was 5.3 months (IQR, 3.1–9.4). Of the 7815 patients evaluated for transplant, 1307 (55%) and 6508 (53%) were from nonprofit and for-profit facilities, respectively. Among those evaluated at a nonprofit facility, 454 (35%) were waitlisted. Similarly, among those evaluated at a for-profit facility, 2426 (37%) were waitlisted (Supplemental Table 2). There was no difference in median time from evaluation to waitlisting between for-profit facilities (5.3 months; IQR, 3.1–9.4 months) and nonprofit facilities (5.5 months; IQR, 3.3–9.6 months; P=0.44). Patients dialyzing at for-profit facilities had similar 6-month cumulative incidence of being waitlisted compared with patients in nonprofit facilities (cumulative incidence differences, 1.0; 95% CI, −1.2% to 3.3%) (Figure 2C).

In the unadjusted cause-specific Cox model, there was no significant difference in waitlisting among patients evaluated for transplant between for-profit and nonprofit groups (HR, 1.11; 95% CI, 0.96 to 1.28), and results were attenuated after adjustment for selected demographic,



Cumulative Incidence Difference[a] (95% CI)[b]		-5.1 (-6.5, -3.8)	-4.5 (-6.0, -3.2)	-3.6 (-5.1, -2.1)	-4.0 (-5.5, -2.4)
Number of patients at risk (row %)	33,651 (100)	22,532 (67)	17,605 (52)	9859 (29)	5574 (17)
Non-profit facility	5059 (100)	3174 (63)	2498 (49)	1408 (28)	769 (15)
For-profit facility	28,592 (100)	19,358 (68)	15,107 (53)	8451 (30)	4805 (17)

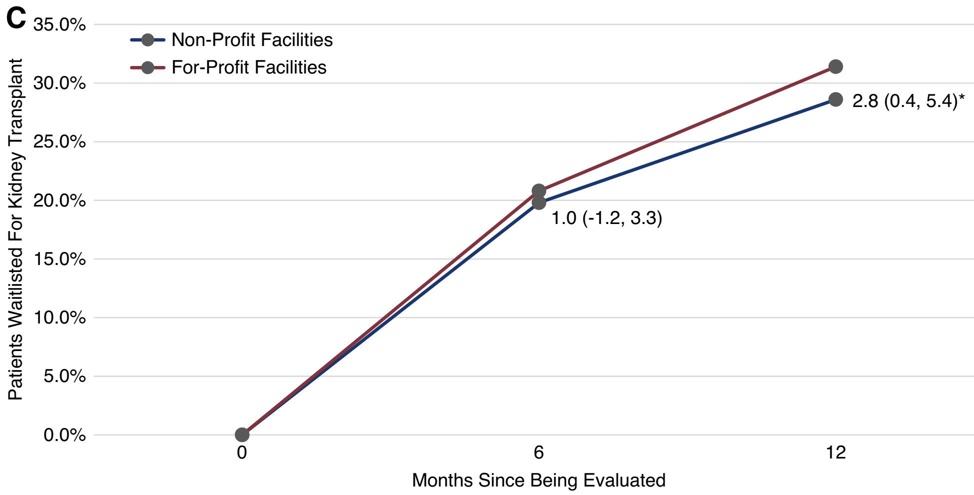
*Indicate that the cumulative incidence difference between for-profit and non-profit facilities was significant
[a]Calculated using cumulative incidence function and adjusted for competing risk of death (logrank <0.001)
[b]Confidence intervals estimated by bootstrap method



Cumulative Incidence Difference[a] (95% CI)[b]		-1.0 (-3.1, 1.3)	-1.4 (-3.5, 0.8)	-1.9 (-4.1, 0.3)
Number of patients at risk (row %)	14,729 (100)	7347 (50)	6157 (42)	4209 (29)
Non-profit facility	2386 (100)	1166 (49)	955 (40)	593 (25)
For-profit facility	12,343 (100)	6181 (50)	5202 (42)	3616 (29)

[a]Calculated using cumulative incidence function and adjusted for competing risk of death (logrank <0.001)
[b]Confidence intervals estimated by bootstrap method
No significant cumulative incidence differences were observed between patients at for-profit vs. non-profit facilities in starting evaluation at 6, 12, and 24 months after being referred.

Figure 2. | **Patients receiving dialysis at for-profit (versus nonprofit) facilities had a lower cumulative incidence difference for referral within 1 year of dialysis**. There was no meaningful difference between cumulative incidence of starting the evaluation within 6 months of referral (among referred patients) and being waitlisted within 6 months of evaluation (among evaluated patients) by dialysis facility profit status. (A) Cumulative incidence and cumulative incidence difference of referral for kidney transplantation by profit status among patients with incident kidney failure between January 1, 2012 and December 31, 2016. (B) Cumulative incidence and cumulative incidence difference of starting evaluation at a transplant center among patients with incident kidney failure between January 1, 2012 and December 31, 2016 who were referred. No significant cumulative incidence differences were observed between patients at for-profit versus nonprofit facilities in starting evaluation at 6, 12, and 24 months after being referred. (C) Cumulative incidence and cumulative incidence difference of waitlisting among *cont.*



Cumulative Incidence Difference[a] (95% CI)[b]		1.0 (-1.2, 3.3)	2.8 (0.4, 5.4)
Number of patients at risk (row %)	7815 (100.0)	5929 (76)	4636 (59)
Non-profit facility	1307 (100.0)	1007 (77)	814 (62)
For-profit facility	6508 (100.0)	4922 (76)	3822 (59)

*Indicate that the cumulative incidence difference between for-profit and non-profit facilities was significant
[a]Calculated using cumulative incidence function and adjusted for competing risk of death (logrank <0.001)
[b]Confidence intervals estimated by bootstrap method

Figure 2. | *Continued.* patients with incident kidney failure between January 1, 2012 and December 31, 2016 who were evaluated at a transplant center. *The cumulative incidence difference between for-profit and nonprofit facilities was significant. [a]Cumulative incidence was calculated using cumulative incidence function and adjusted for competing risk of death (logrank,0.001); [b]95% CIs for cumulative incidence difference were estimated by bootstrap method. 95% CIs, 95% confidence intervals.

clinical, and socioeconomic factors (HR, 1.05; 95% CI, 0.92 to 1.19) (Table 4).

In a sensitivity analysis including patients who were preemptively referred, before they started dialysis, we found that our results were slightly attenuated for the outcome of referral (HR, 0.87; 95% CI, 0.79 to 0.97), and among patients referred, there was a small (approximately 12%) difference in evaluation start among those referred between patients treated at for-profit versus nonprofit facilities in the adjusted model (HR, 0.88; 95% CI, 0.79 to 0.98). Similar to main results, there was no difference in waitlisting by profit status (HR, 1.03; 95% CI, 0.91 to 1.17) (Supplemental Table 3).

Although the goal of this manuscript was to examine the overall effect of dialysis facility profit status on early transplant access, in a *post hoc* analysis, we did test for interaction effects between patient age and profit status in the referral model to better contextualize our findings (Supplemental Table 4). We found that patients ≥65 years (less likely to be medically eligible for transplant due to older age) are less likely to be referred in for-profit facilities compared with nonprofit facilities. However, this finding should be interpreted with caution as the power to detect an interaction effect may be limited by study size.

Discussion

Among adult patients with kidney failure treated in dialysis facilities within Georgia, North Carolina, and South Carolina, patients in for-profit dialysis facilities had lower referral for transplant compared with patients in nonprofit dialysis facilities. However, in this population in the Southeast, after patients were referred from a dialysis facility, there were no significant differences in the start of the transplant evaluation or waitlisting by profit status. To our knowledge, this was the first study to examine the relationship between dialysis facility profit status and early steps in the transplantation process in a multistate region.

There are several explanations for our findings. First, it is possible that for-profit facilities are under-referring some patients who could be good candidates for transplant. Patients' health status can delay the process of accessing transplant, as evidenced by increased comorbidities associated with decreased odds of waitlisting (16). We found that although patients treated in for-profit facilities were less likely to have comorbidities that may limit their medical eligibility for transplant at the initiation of dialysis, they were less likely to receive a referral at all time points compared with patients treated in a nonprofit facility. Another explanation for these findings is that for-profit dialysis facilities are more selective in identifying patients more likely eligible for transplantation and that unmeasured comorbidities that influence medical eligibility could explain the lower referral among for profit dialysis facilities. However, unmeasured comorbidities may differentially affect referral practices and potentially result in unmeasured confounding.

Patient education about all treatment options, a CMS mandate, is crucial for patients with kidney failure to access transplant (8,17). In our study, we found no difference in the

Table 2. Crude and adjusted cause-specific hazard ratios between dialysis facility profit status and referral for kidney transplantation during follow-up among patients with incident kidney failure who initiated dialysis in dialysis facilities in Georgia, North Carolina, and South Carolina (nonprofit facilities: *n*=5059 patients; for-profit facilities: *n*=28,592)

Referral for Transplant (among All Patients)	No. of Referral Events, n=14,729 (44%)	Unadjusted Model Hazard Ratio (95% Confidence Interval), n=33,651	Adjusted Model[a] Hazard Ratio (95% Confidence Interval), n=32,908
Nonprofit facility	n=2386 (47%)	Reference	Reference
For-profit facility	n=12,343 (43%)	0.87 (0.78 to 0.97)	0.84 (0.76 to 0.93)

Patients who initiated dialysis between January 1, 2012 and August 31, 2016 who were followed through August 31, 2017 for referral.
[a]Referral model was adjusted for the following variables: age, sex, race/ethnicity, primary cause of kidney failure, the presence of certain comorbidities (congestive heart failure, atherosclerotic heart disease, other cardiac disease, cerebrovascular disease, peripheral vascular disease, hypertension, diabetes, chronic obstructive pulmonary disease, and cancer), insurance status, facility size, pre-Kidney Allocation System/post-Kidney Allocation System era, and not informed of transplant options due to medical reasons.

proportion of patients educated about transplant as a treatment option by facility profit status. However, little is known about the quality of education that patients receive, and prior reports have reported discrepancies in this measure (18,19). From a financial perspective, patient education has limited reimbursement, which may lead to practices spending minimal time on increasing patient knowledge of transplantation (8).

It is unclear who identifies patients for referrals at dialysis facilities, whether the education and referral process differ by profit status, reasons for nonreferral, differences in patient interest, and how smaller for-profit dialysis facilities may differ from larger ones. Although further research is needed to determine why for-profit dialysis facilities refer fewer patients, our findings suggest that targeted interventions and policies may be needed to incentivize transplant access. This strikingly wide variation in dialysis referral rates in Georgia, North Carolina, and South Carolina—ranging from 0% to 100% (14)—coupled with our findings of lower referral at for-profit facilities further indicates a need for consistent guidelines on referral. The new CMS Percent of Prevalent Patients Waitlisted proposal seeks to encourage dialysis facilities to increase the proportion of prevalent patients waitlisted (20). However, dialysis facilities have little control over who is listed for transplant and who is deemed ineligible, although they may have influence over encouraging referred patients to start or complete the evaluation process. In this study, we found no differences in evaluation start rates among referred patients and no differences in waitlisting rates among patients who started the evaluation across for-profit versus nonprofit dialysis facilities, but we did find substantial attrition across transplant steps. This suggests that dialysis facilities may have the most opportunity to intervene by increasing equitable referrals for transplant. Although the waitlisting metric may have some effect on some facilities, the results of this study highlight the need to improve patient access to transplantation prior to waitlisting. Quality metrics focused on transplant referrals have been developed for both dialysis facilities (21) and transplant centers (22), but national data on referral are needed to implement these quality metrics to ensure equitability in transplant access.

Our work extends recent analyses showing substantial variation in referral and evaluation start across southeastern dialysis facilities and the barriers and facilitators associated with early transplant access (14). Although it is difficult to assess who should be referred, and we do not have data on the reasons patients may not be a candidate, these rates of referral are likely too low. In recent years, several policies have incentivized increased access to transplantation. CMS initiated a targeted goal to increase the number of waitlisted patients with kidney failure to 30% by 2023 (23), and the July 2019 Advancing American Kidney Health Initiative Executive Order aims to double the number of kidney transplants by 2030 in part through new payment models to financially reward nephrologists and

Table 3. Crude and adjusted cause-specific hazard ratios between dialysis facility profit status and evaluation for kidney transplantation during follow-up among referred patients with incident kidney failure who initiated dialysis in dialysis facilities in Georgia, North Carolina, and South Carolina (nonprofit facilities: *n*=5059 patients; for-profit facilities: *n*=28,592)

Evaluation for Transplant (among Those Referred)	No. of Evaluation Events, n=7815 (53%)	Unadjusted Model Hazard Ratio (95% Confidence Interval), n=14,759	Adjusted Model[a] Hazard Ratio (95% Confidence Interval), n=14,370
Nonprofit facility	n=1307 (55%)	Reference	Reference
For-profit facility	n=6508 (53%)	0.95 (0.85 to 1.06)	0.92 (0.83 to 1.03)

Referred patients who initiated dialysis between January 1, 2012 and August 31, 2016 who were followed for evaluation outcome through March 1, 2018.
[a]Evaluation model was adjusted for the same variables as the referral model with the exception of a differing list of comorbidities (body mass index ≥35 kg/m^2, congestive heart failure, atherosclerotic heart disease, other cardiac disease, cerebrovascular disease, peripheral vascular disease, diabetes, chronic obstructive pulmonary disease, smoking, and cancer) and removal of facility size.

Table 4. Crude and adjusted cause-specific hazard ratios between dialysis facility profit status and waitlisting for kidney transplantation during follow-up among evaluated patients with incident kidney failure who initiated dialysis in dialysis facilities in Georgia, North Carolina, and South Carolina (nonprofit facilities: *n*=5059 patients; for-profit facilities: *n*=28,592)

Waitlisting for Transplant (among Those Evaluated)	No. of Waitlisting Events, *n*=2880 (37%)	Unadjusted Model Hazard Ratio (95% Confidence Interval), *n*=7815	Adjusted Model[a] Hazard Ratio (95% Confidence Interval), *n*=6769
Nonprofit facility	*n*=454 (35%)	Reference	Reference
For-profit facility	*n*=2426 (37%)	1.11 (0.96 to 1.28)	1.05 (0.92 to 1.19)

Referred and evaluated patients who initiated dialysis between January 1, 2012 and August 31, 2016 who were referred, evaluated, and followed for waitlisting outcome through March 1, 2018.
[a]Waitlisting model was adjusted for the same variables as the evaluation model with the addition of prekidney failure nephrology care.

dialysis facilities for transplants (24). It is expected that the mandatory CMS ESRD Treatment Choices model, which started in January 2021 and incentivizes waitlisting through a modality performance score, may lead to increased referrals for transplantation (25). Future research should study how these policies may differentially affect transplant access by profit status.

This study has several limitations. First, this study was limited to Georgia, North Carolina, and South Carolina, and outcome data occurring outside of this region are not captured; results may not be generalizable outside of the Southeast. Our findings demonstrate the need for national surveillance data collection on early transplant steps to better understand and address barriers in transplant access.

Second, this study is limited to patients with kidney failure who require dialysis. Patients with CKD were not included, so selection bias is possible. However, in a sensitivity analysis including patients who were referred prior to starting dialysis, we did not find a meaningful difference from our main findings in referral, evaluation start, or waitlisting by profit status.

Third, we have limited follow-up time to examine waitlisting. Although follow-up time is equivalent across profit status to reflect accurate relative rates, absolute event rates for waitlisting are lower than national rates because of limited follow-up time, resulting in wide 95% CIs. Further follow-up may be needed to confirm null associations with respect to waitlisting by profit status.

Finally, transplant centers differ in their criteria for transplant eligibility, and variation in these criteria may affect dialysis facility's choice to refer. Aside from common contraindications for transplant (*e.g.*, high BMI, heart failure, tobacco use, or cancer diagnosis), our dataset is limited in that it lacks information on reasons for patient nonreferrals (such as other medical factors or patient interest), which could differentially affect referral practices by profit status and lead to unmeasured confounding. As our data-sharing agreement removed the transplant center identifiers, differences in individual transplant center criteria for eligibility were not assessed. Among US patients with kidney failure in the Southeast United States, for-profit facility status was associated with lower referral, but not lower evaluation rates or waitlisting, compared with nonprofit facility status. This study emphasizes the importance of studying earlier steps prior to waitlisting to understand and address barriers to transplantation. Further research is needed to understand the mechanisms behind the association and to determine interventions that may reduce this disparity.

Disclosures

T. Browne reports employment with the University of South Carolina and serving as a scientific advisor or member of ESRD Network 6. M.J. Ellis reports employment with Duke University Medical Center; consultancy agreements with Alexion, Bristol Myers Squibb, Genzyme Sanofi, RadMD, Relypsa, and Veloxis; receiving honoraria from Bristol Myers Squibb, MedIQ, RadMD, Relypsa, and Veloxis; serving as a scientific advisor or membership with *American Journal of Transplantation*; and speakers bureau for Bristol Myers Squibb, Genzyme Sanofi, and Relypsa. J.C. Gander reports employment with Kaiser Permanente. L.J. McPherson reports employment with Laney Graduate School. S.O. Pastan reports employment with Emory University School of Medicine; serving as a scientific advisor or member of the board of directors of ESRD Network 6, the board of directors of the National Forum of Networks, and the board of directors and the scientific advisory board of the National Kidney Foundation; and serving as an associate editor of *Kidney International Reports*. R.E. Patzer reports employment with Emory University School of Medicine and serving on the *American Journal of Transplantation* editorial board, on the *CJASN* editorial board, and as chair of the United Network for Organ Sharing Data Advisory Board. R.E. Patzer's spouse has ownership interest in Vital Software. E.R. Walker reports employment with the Medical University of South Carolina. All remaining authors have nothing to disclose.

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Supplemental Material

This article contains the following supplemental material online at http://cjasn.asnjournals.org/lookup/suppl/doi:10.2215/CJN.17691120/-/DCSupplemental.

Supplemental Table 1. Sensitivity analysis of the characteristics of patients with incident ESKD initiating dialysis between January 1, 2012 and August 31, 2016 in Georgia, North Carolina, and South Carolina followed through March 1, 2018; the study population was compared with preemptively referred patients.

Supplemental Table 2. Characteristics and bivariable cause-specific hazard ratios of patients with incident ESKD kidney failure who initiated dialysis between January 1, 2012 and August 31, 2016 in Georgia, North Carolina, and South Carolina who were referred for transplant, who initiated evaluation at a transplant center, and who were waitlisted during follow-up (to August 31, 2017 for referral and to March 1, 2018 for evaluation and waitlisting).

Supplemental Table 3. Sensitivity analysis results of the crude and adjusted cause-specific hazard ratios between dialysis facility profit status and referral, evaluation, and waitlisting for kidney transplantation during follow-up among patients with incident ESKD who initiated dialysis in dialysis facilities in Georgia, North Carolina, and South Carolina.

Supplemental Table 4. Sensitivity analysis results of adjusted cause-specific hazard ratios between dialysis facility profit status and referral for kidney transplantation during follow-up among patients with incident kidney failure who initiated dialysis in dialysis facilities in Georgia, North Carolina, and South Carolina, examining the interaction effect between age and profit status.

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