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Kidney Transplant Fast Track and Likelihood of Waitlisting and Transplant
A Nonrandomized Clinical Trial

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IMPORTANCE Kidney transplant (KT) is the optimal treatment for end-stage kidney disease (ESKD). The evaluation process for KT is lengthy, time-consuming, and burdensome, and racial and ethnic disparities persist.

OBJECTIVE To investigate the potential association of the Kidney Transplant Fast Track (KTFT) evaluation approach with the likelihood of waitlisting, KT, and associated disparities compared with standard care.

DESIGN, SETTING, AND PARTICIPANTS This nonrandomized clinical trial was a prospective comparative cohort trial with a historical control (HC) comparison and equal follow-up duration at a single urban transplant center. Study duration was 2015 to 2018 for KTFT, with follow-up through 2022, and 2010 to 2014 for HC, with follow-up through 2018. Adult, English-speaking patients with ESKD, no history of KT, and a scheduled KT evaluation appointment were included. Among 1472 eligible patients for the KTFT group, 1288 consented and completed the baseline interview and 170 were excluded for not attending an evaluation appointment; among 1337 patients eligible for the HC group, 1152 consented and completed the baseline interview and none were excluded. Data were analyzed from August 2023 through December 2024.

EXPOSURE Streamlined, patient-centered, coordinated-care KT evaluation process.

MAIN OUTCOMES AND MEASURES Time to waitlisting for KT and receipt of KT.

RESULTS The study included 1118 participants receiving KTFT (416 female [37.2%]; mean [SD] age, 57.2 [13.2] years; 245 non-Hispanic Black [21.9%], 790 non-Hispanic White [70.7%], and 83 other race or ethnicity [7.4%]) and 1152 participants in the HC group (447 female [38.8%]; mean [SD] age, 55.5 [13.2] years; 267 non-Hispanic Black [23.2%], 789 non-Hispanic White [68.5%], and 96 other race or ethnicity [8.3%]). After adjusting for demographic and clinical factors, the KTFT compared with the HC group had a higher likelihood of being placed on the active waitlist for KT (subdistribution hazard ratio [SHR], 1.40; 95% CI, 1.24-1.59). Among individuals who were waitlisted, patients in the KTFT vs HC group had a higher likelihood of receiving a KT (SHR, 1.21; 95% CI, 1.04-1.41). Black patients (SHR, 1.54; 95% CI, 1.11-2.14) and White patients (SHR, 1.38; 95% CI, 1.16-1.65) receiving KTFT were more likely to be waitlisted for KT than those in the HC group, but no such difference was found for patients with other race or ethnicity. Among Black patients, those with KTFT were more likely than those in the HC group to undergo KT (SHR, 1.52; 95% CI, 1.06-2.16), but no significant differences were found for White patients or those with other race or ethnicity.

CONCLUSIONS AND RELEVANCE This study found that KTFT was associated with a higher likelihood of waitlisting and KT than standard care. Findings suggest that KTFT may be associated with reduced disparities in KT by race and ethnicity.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT02342119

Editor's Note

Supplemental content

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It is well established that kidney transplant (KT) is the optimal treatment for end-stage kidney disease (ESKD). It reduces mortality, improves quality of life, and is less costly than dialysis.[1-5] Despite these advantages, there are well-documented barriers that prevent otherwise-eligible patients from obtaining KT.[6,7] Numerous studies have demonstrated significant disparities in ESKD and its treatment for members of at-risk groups (eg, racial and ethnic minority and low-income groups), particularly Black patients.[8] ESKD incidence in Black patients is 4 times greater than that in White patients, but Black patients are less than half as likely to undergo KT.[9] Among patients referred for transplant, Black race is associated with a longer evaluation completion time,[10] lower likelihood of KT,[11,12] lower rates of preemptive listing for KT,[13-17] and lower rates of living-donor KT.[18,19]

Most efforts to reduce disparities in KT emphasize educating patients who are receiving dialysis who have not been referred for KT.[20-33] Although modestly successful,[21,23,26,34] patient education does not reduce patient burden, nor does it eliminate external barriers to completing the evaluation process. Similarly, our own and others' data show that changes to the national Kidney Allocation System were not associated with increases in KT for those who were not waitlisted[35,36] or listed inactive.[37] We believe an organizational approach that changes how care is delivered and reduces the burden of care coordination may be an important alternative.

Most patients referred for KT do not get a KT, in part because of the significant patient burden in navigating the KT evaluation process after a referral.[38-42] KT evaluation traditionally requires an initial visit with the transplant team, a battery of tests conducted by multiple specialists, and several follow-up visits before a patient case is presented to the transplant team for a decision about waitlisting the patient for KT.[43] The process is lengthy, time-consuming, and burdensome to the patient.[44] Typically, patients must complete testing on their own and ensure that results are forwarded to the transplant team. This process requires significant effort by patients who may be feeling unwell and can be daunting, especially for those with low health literacy[45] or who experience barriers within the health care system. This exacerbates long-standing racial and ethnic and socioeconomic disparities in KT waitlisting and receipt on a national level.[36-38,46,47]

Thus, we hypothesized that by using the same urgent, health care system–facilitated approach to KT that exists for other end-organ transplant[9,48] and removing the complex coordination of care that patients must complete on their own for KT evaluation, the time to complete evaluation may be reduced. This would be associated with a higher number of patients waitlisted and receiving KT more quickly owing to less time for physical decline as they await testing appointments and delivery of results to the transplant team. Eliminating patient burden in managing the demands of the KT evaluation process may be associated with reduced racial and ethnic disparities in KT waitlisting and subsequently improved KT rates among racial and ethnic minority groups. Support for this approach comes from a retrospective analysis of recipients of KT.[49] However, this work did not examine outcomes associated with the intervention prospectively, and there was no comparison group of patients who did not undergo the intervention.

Key Points

Question Is the Kidney Transplant Fast Track (KTFT) evaluation approach associated with a higher likelihood of waitlisting and kidney transplant?

Findings In this nonrandomized clinical trial of 1118 patients with end-stage kidney disease (ESKD) who underwent KTFT and a historical control group of 1152 patients with ESKD undergoing evaluation for kidney transplant, the KTFT group had a higher likelihood of waitlisting and transplant than the historical control group. Unlike the historical control group, the KTFT group had no significant differences in kidney transplant by race or ethnicity.

Meaning This study found that KTFT was associated with a higher likelihood of waitlisting and kidney transplant. Findings suggest that KTFT may be associated with reduced disparities by race and ethnicity.

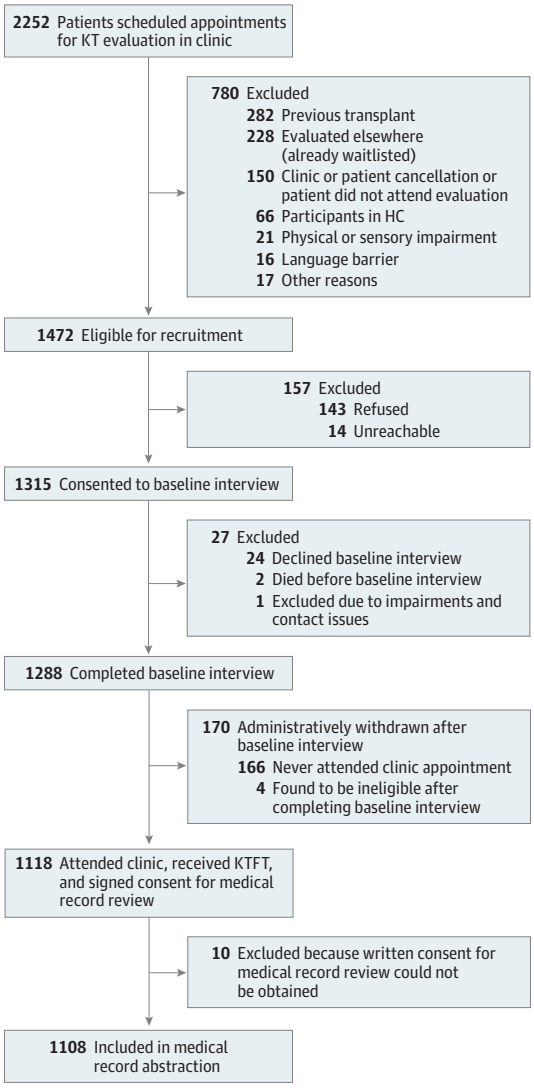
After extensive discussion and review with hospital leadership and clinical and administrative staff, the KT program at the University of Pittsburgh Medical Center Starzl Transplantation Institute (UPMC STI) implemented a streamlined evaluation approach for all patients undergoing KT, dubbed Kidney Transplant Fast Track (KTFT). Ramp up for KTFT started in early 2012 and commenced by December 2012.[50] KTFT has not been systematically compared with previous standard care procedures that existed at UPMC until then. Thus, it presented a unique opportunity to prospectively examine and evaluate the association of a systematic surgical clinic change with patient outcomes. We leveraged participant data from our previous study[36,47] and used those patients as a historical comparison group.[50] Our objective was to investigate whether, compared with standard care, the KTFT streamlined approach was associated with a higher likelihood of KT waitlisting and KT and decreased disparities in time to waitlisting and KT for Black patients and members of other racial and ethnic minority groups compared with White patients.

Methods

Study Design

This study was a nonrandomized clinical trial (ClinicalTrials.gov identifier: NCT02342119) of patients who were scheduled for transplant evaluation at the UPMC STI between May 2015 and June 2018 and followed up via electronic health record (EHR) through August 2022 (see **Figure 1** for a description of patient flow through the study). See Supplement 1 for the trial protocol. The historical control (HC) sample came from a patient cohort scheduled for transplant evaluation at the UPMC STI between March 2010 and October 2012 and followed up via EHR through August 2018 (see Ng et al[36] and Wesselman et al[47] for the study protocol and patient flow). A total of 2473 evaluations were performed during KTFT, which was comparable to the 2126 evaluations in the HC period.

Figure 1. Study Flowchart



Other reasons for exclusion included patient death, pursuit of nonkidney transplant (eg, pancreas), evaluation appointment not completed yet, too well, too ill, missed recruitment, or incarceration. HC indicates historical control; KT, kidney transplant; KTFT, Kidney Transplant Fast Track.

To obtain demographic and clinical information, participants who underwent KTFT completed structured baseline interviews prior to their first KT evaluation clinic appointment. Patients in the HC group completed their baseline interview after attending their initial KT evaluation appointment. For both cohorts, we followed patient progress through transplant evaluation, waitlisting, and time to transplant via EHR review to obtain outcome measures. Per UPMC Institutional Review Board (IRB) requirements, we obtained verbal consent for the interview and written consent for EHR review.

This study was approved by the University of Pittsburgh and University of New Mexico IRBs, and a data use agreement was signed between the 2 institutions. The study was conducted in accordance with the Declaration of Helsinki and is consistent with the Principles of the Declaration of Istanbul.

KTFT Intervention: Brief Overview

For all patients seeking transplant (regardless of donor type), the KTFT intervention involves completing most or all testing on the day of patients' first pretransplant clinic appointment rather than being provided with a list of tests to complete on their own with their referring clinician. The intervention consisted of 4 phases: (1) actions before the evaluation clinic appointment (eg, clinic staff member schedules necessary testing the same day as the evaluation); (2) actions during the evaluation clinic appointment (eg, clinic staff escort patients to testing locations); (3) actions during evaluation clinic discharge (eg, nurse coordinator reminds patients that all testing must be completed before listing can occur); and (4) actions after the evaluation clinic appointment (eg, if patients cannot complete all testing the same day as their evaluation, the nurse coordinator arranges all remaining tests to be completed as soon as possible). See eTable 1 in Supplement 2 and Bornemann et al[50] for the study protocol. Personnel effort was increased (ie, for the scheduler and nurse) to implement the new workflow and related tasks. The original protocol included an education intervention, but this was not discussed because we found no association with outcomes for the intervention.[51]

Study Cohort

For both study samples, patient inclusion criteria were that they were scheduled for a KT appointment, English speaking, aged 18 years or older, without a prior KT, and not waitlisted for KT. During KTFT, 1472 people were eligible and 1288 consented and completed the baseline interview, but 170 patients were excluded for not attending their evaluation appointment. During HC, 1337 people were eligible for the study and 1152 attended their evaluation, consented to participate, and completed the baseline interview (due to a difference in baseline interview timing).

Measures

Outcome Variables

Our main outcome variables were time to transplant waitlisting and, among waitlisted patients, time to KT. Other outcome variables (eg, quality of life and booklet helpfulness) were collected during the study but are beyond the scope of this report.

Demographic, Clinical, and Intervention-Related Characteristics

Our previous work showed that demographic characteristics and clinical factors were associated with the rate of KT evaluation completion.[36,47,52] Thus, we assessed demographics (eg, race and ethnicity, age, income, and education), clinical factors (eg, dialysis, comorbidities, and number of potential living donors), and intervention completion via baseline interviews and EHR review. Race and ethnicity, age, income, and education were all obtained from patient self-report; clinical factors were obtained from EHR data. For race and ethnicity, patients were first asked if they were Hispanic or Latino, and responded yes or no. Then, patients were asked their race, with the following options: American Indian or Alaskan Native; Asian (Chinese, Japanese, Korean, or other), Black or African

American, Native Hawaiian or Other Pacific Islander (Indonesian or other), White, and other race or ethnicity (please specify). In this study, American Indian or Alaskan Native, Asian, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, multiracial or multiethnic (ie, multiple options chosen), and other race or ethnicity not specified were combined owing to small sample size. We calculated the Charlson Comorbidity Index score from EHR information.[53-55]

Statistical Analysis

We examined descriptive data across KTFT and HC cohorts using standard tests for continuous and categorical variables. To visualize the probability of events, we calculated and plotted adjusted cumulative incidence functions for time from evaluation inception to waitlisting and, among patients waitlisted, time from waitlisting to KT.

Study Cohort Multivariable Analyses

We used Fine-Gray competing risk models with death as a competing event[56-58] to examine the cumulative incidence of each study outcome within KTFT and HC groups. Censored events included not waitlisted, case closed due to incomplete evaluation, KT team declined patient for waitlisting, and patient chose to withdraw from evaluation (eTable 2 in Supplement 2). Our analyses controlled for demographic, clinical, or intervention covariates that showed associations with 1 or more study outcomes (ie, $P < .10$, subdistribution hazard ratio [SHR] > 2, or SHR < 0.5). We assessed proportionality of the hazards assumption for all models. Given our study design, a multivariable model approach was optimal to matched groups and avoided introducing unnecessary bias.[59-62]

We adopted the Fine-Gray approach for our key outcomes because alternative approaches[63,64] are not optimal: the competing risk of death is not random and cannot be ignored. The Cox approach would combine deaths with censored patients who were still undergoing evaluation, who had opted out of undergoing evaluation, or whose cases were closed by the transplant team, resulting in bias due to ignoring informative censoring. Additionally, because our study was not a randomized clinical trial, we sought to identify predictors of outcomes and could not investigate causal relationships. Fine-Gray models are superior to other approaches when prediction rather than causation is the goal. Nevertheless, given limitations of common approaches,[56-58,63,65-69] we conducted a Cox regression as a sensitivity analysis. The level of statistical significance we used for model selection was $P = .10$, so variables with $P < .10$ became model candidates and were dropped only if multicollinearity was an issue. For everything else, our level of statistical significance was $P = .05$. All tests performed were 2-sided, and we used SAS statistical software version 9.4 (SAS Institute) and Stata SE statistical software version 16.1 (StataCorp). Data were analyzed from August 2023 through December 2024.

Study Cohort by Race and Ethnicity Analyses

Because another important concern for our intervention was the potential association of KTFT with racial and ethnic disparities in access to KT, we examined whether unique combinations of study cohort and race and ethnicity were associated with study outcomes. Rather than testing an interaction, we hypothesized that there would be no race or ethnicity differences within KTFT but that there would be race and ethnicity differences within HC. Thus, we cross-classified study cohort (KTFT or HC) by race and ethnicity (non-Hispanic Black [hereafter, *Black*], non-Hispanic White [hereafter, *White*], and other race and ethnicity [including Asian, Hispanic or Latino, Native Hawaiian or Pacific Islander, multiple races or ethnicities, and other not specified for KTFT and Asian, Hispanic or Latino, Native American, and multiple races or ethnicities for HC]). We tested for differences within group pairs according to our hypotheses. We completed these analyses for each key outcome, adjusting for demographic and clinical factors.

Results

Sample Description

The study included 1118 participants in the KTFT group (416 female [37.2%]; mean [SD] age, 57.2 [13.2] years; 245 Black [21.9%]; 790 White [70.7%], and 83 other race or ethnicity [7.4%]) and 1152 participants in the HC group (447 female [38.8%]; mean [SD] age, 55.5 [13.2] years; 267 Black [23.2%], 789 White [68.5%], and 96 other race or ethnicity [8.3%]). For both groups, individuals with other race and ethnicity consisted mostly of individuals who were multiracial (**Table 1**).[70] KTFT and HC groups were similar across most demographics; however, the KTFT cohort's mean age was approximately 2 years older and a higher percentage of participants in the KTFT group relied exclusively on public insurance. On clinical characteristics, the KTFT cohort had a lower percentage of patients with less than 1 year of dialysis but a greater percentage with 1 to 5 years of dialysis and more potential donors. See eTable 2 in Supplement 2 for the numbers of patients experiencing study outcomes and reasons for censoring. We found differences in patient outcomes and censored events and used these data in time-to-event analyses addressing study aims.

Comparison of Study Outcomes by Cohort

After adjusting for demographic and clinical factors, we found that patients in the KTFT group were more likely to be placed on the active waitlist for KT over a 7-year follow-up period than those in the HC group (SHR, 1.40; 95% CI, 1.24-1.59) (**Figure 2**A and **Table 2**).[71] Among patients who were on the active waitlist, patients in the KTFT group were more likely to receive a KT than those in the HC group (SHR, 1.21; 95% CI, 1.04-1.41) after adjusting for demographic and clinical factors (Figure 2B and Table 2). See eFigures 1 and 2 in Supplement 2 for monthly waitlisting and transplant rates across preintervention and study periods for UPMC.

Comparison of Study Outcomes by Cohort and Race and Ethnicity

Likelihood of Waitlisting

Among patients in the KTFT group, Black patients (SHR, 1.54; 95% CI, 1.11-2.14) and White patients (SHR, 1.38; 95% CI, 1.16-1.65) were more likely to be waitlisted for KT than Black and

Table 1. Patient Characteristics

Characteristic	Patients, No. (%) (N = 2270)[a]		Group comparison	
	KTFT (n = 1118)	HC (n = 1152)	Test statistic	*P* value
Demographics				
Race and ethnicity				
Non-Hispanic White	790 (70.7)	789 (68.5)	χ^2 = 1.38	.50
Non-Hispanic Black	245 (21.9)	267 (23.2)		
Other[b]	83 (7.4)	96 (8.3)		
Sex				
Female	416 (37.2)	447 (38.8)	χ^2 = 0.59	.44
Male	702 (62.8)	705 (61.2)		
Age, mean (SD), y	57.2 (13.2)	55.5 (13.2)	*t* = 3.06	.002
Education (≤high school)	519 (46.5)	551 (47.8)	χ^2 = 0.42	.52
Household income (<$50 000)	778 (72.3)	809 (74.2)	χ^2 = 0.94	.33
Insurance status				
Private only	204 (18.3)	233 (20.2)	χ^2 = 9.79	.008
Public only	483 (43.2)	424 (36.8)		
Public and private	430 (38.5)	495 (43.0)		
Employment status (employed)	270 (24.2)	293 (25.5)	χ^2 = 0.54	.46
Marital status (not married)	582 (52.1)	564 (49.0)	χ^2 = 2.24	.13
Clinical characteristics				
BMI				
Without obesity (≤30)	274 (52.2)	354 (54.3)	χ^2 = 1.38	.47
With obesity (>30)	251 (47.8)	298 (45.7)		
Charlson Comorbidity Index score, mean (SD)	4.3 (1.7)	4.2 (1.7)	*t* = 1.29	.20
Type of dialysis				
None	415 (37.2)	397 (36.4)	<0.0001[c]	.13
Hemodialysis	572 (51.3)	573 (52.5)		
Peritoneal dialysis	128 (11.5)	116 (10.6)		
Both	0	5 (0.5)		
Dialysis duration, y				
0	392 (35.1)	395 (34.3)	χ^2 = 10.06	.02
<1	429 (38.4)	504 (43.8)		
1-5	236 (21.1)	192 (16.7)		
>5	61 (5.5)	61 (5.3)		
Kidney disease burden (range, 1-5), median (IQR)	4.0 (3.0,4.7)	4.0 (3.0,4.7)	*t* = 1.35	.18
No. of potential donors, median (IQR)[d]	4.4 (3.4, 5.8)	4.2 (3.4,5.4)	*t* = 2.48	.01
Intervention-related characteristics				
Intermediate step: evaluation completion[e]	810 (73.1)	589 (51.1)	χ^2 = 134.9	<.001
Competing risk: death	13 (1.2)	66 (5.7)		
Censored				
Evaluation ongoing	4 (0.4)	15 (1.3)		
Case closed, incomplete evaluation	253 (22.8)	457 (39.7)		
Patient choice to withdraw from process	19 (1.7)	24 (2.1)		

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); HC, historical control; KTFT, Kidney Transplant Fast Track.

[a] The following variables had missing values (percentages in the table are given among those with data): 42 patients for household income, 10 patients for BMI and Charlson Comorbidity Index, 9 patients for intermediate step evaluation completion, 3 patients for dialysis type, and 1 patient for sex, age, education, insurance, employment status, marital status, and burden of kidney disease in the KTFT group and 61 patients for household income and dialysis type, 1 patient for intermediate step evaluation completion, 4 patients for age, and 3 patients for employment in the HC group.

[b] Other race and ethnicity included 7 Asian, 25 Hispanic or Latino, 1 Native Hawaiian or Pacific Islander, 38 multiracial or multiethnic, and 7 other not specified for KTFT and 13 Asian, 21 Hispanic or Latino, 8 American Indian, and 54 multiracial or multiethnic for HC.

[c] Fisher exact test statistic.

[d] Patient-reported number of potential living donors available for evaluation was determined by asking participants to indicate how many living relatives and friends they had aged 18 to 75 years who would be considered among the patient's network of potential donors (range, 0-150 donors). This variable was then transformed (square root transformation after capping at 101 donors)[70] to address skewness and nonnormality.

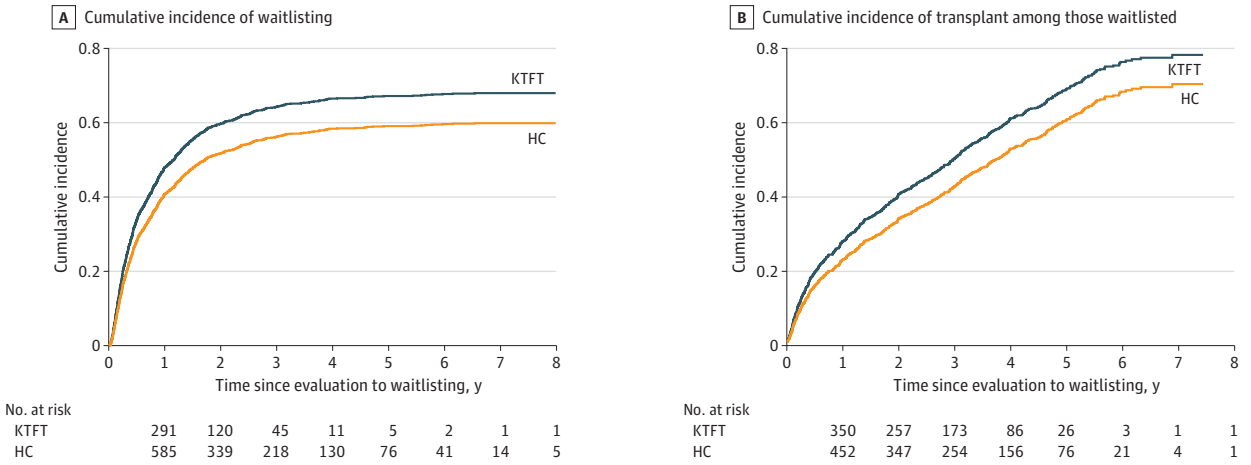
[e] Evaluation completion includes everyone who completed evaluation testing regardless of being found eligible or ineligible for transplant.

White patients, respectively, in the HC group; however, there was no statistically significant difference for patients with other race or ethnicity by cohort (SHR, 1.28; 95% CI, 0.83-1.98). As hypothesized, we found no significant differences in likelihood of waitlisting between Black and White patients in the KTFT group (SHR, 0.79; 95% CI, 0.61-1.01) or between patients with other race or ethnicity and White patients in the KTFT group (SHR, 0.77; 95% CI, 0.51-1.15). In contrast, Black patients were significantly less likely to be waitlisted than White patients in the HC group (SHR, 0.71; 95% CI, 0.58-0.87) (**Figure 3**A and Table 2).

Likelihood of Receiving a Transplant After Waitlisting

Black patients in the KTFT group were more likely to receive a KT after waitlisting than Black patients in the HC group (SHR, 1.52; 95% CI, 1.06-2.16). Results for White patients (SHR, 1.14; 95% CI, 0.96-1.36) and patients with other race or ethnicity (SHR, 1.22; 95% CI, 0.72-2.07) in the KTFT group were not sig-

Figure 2. Cumulative Incidence of Waitlisting and Transplant



Cumulative incidence is shown for waitlisting overall (A) and, among individuals waitlisted, for transplant (B) adjusted for demographics and medical factors. HC indicates historical control; KTFT, Kidney Transplant Fast Track.

nificantly different than those of the respective populations in the HC group. There were no significant KT differences between Black and White patients in the KTFT group (SHR, 1.06; 95% CI, 0.80-1.40); such differences between Black and White patients in the HC group were more pronounced, although also not statistically significant (SHR, 0.80; 95% CI, 0.60-1.06) (Figure 3B and Table 2). Results from sensitivity analyses using Cox modeling were comparable to those of our primary analyses in identifying statistically significant outcomes (eTable 3 in Supplement 2).

Discussion

Our health care system–level changes in the clinical approach to KT evaluation created a naturalistic before and after experiment of the KTFT. Inspired by results from our previous descriptive work at the Department of Veterans Affairs[72] and others' retrospective findings,[49] we sought to test the advantage of using a comprehensive, patient-centered, system-level fast-track KT evaluation process for patients with ESKD over standard care in the likelihood of waitlisting and KT. We believe our nonrandomized clinical trial is superior to secondary data analysis using Scientific Registry of Transplant Recipients data to compare centers because our approach examined the intervention prospectively. Additionally, our comparison group came from the same center, allowing for the control of factors such as similar clinical structure, hospital policies, and geographic region of patients served. Although there was some turnover in transplant clinicians and office staff, the number of clinicians was consistent and the required testing for evaluation during the 2 periods was uniform.

Over a 7-year follow-up period, results showed that KTFT was associated with a higher likelihood of waitlisting and KT. Patients in the KTFT group had a higher likelihood of being placed on the active waitlist and of undergoing KT than patients in the HC group. Notably, these advantages persisted after controlling for sociodemographic and medical factors, indicating the advantage of our intervention regardless of patients' varying social determinants of health, such as income or education level. These findings are particularly important because they are a substantial departure from previous interventions focused on patient education, which neither alleviated the logistical burden for patients nor were associated with improved waitlisting or KT outcomes.[21,23,26,29] We believe that the KTFT intervention reduced patient burden and focuses on what the health care system can do for all patients regardless of their social determinants of health.

Another unique and important study finding was the association of KTFT with reduced racial and ethnic disparities in access to KT. Although prior research demonstrated racial and ethnic disparities in KT referral among patients undergoing dialysis,[6,29,34,73,74] to our knowledge, few studies examined disparities occurring after KT referral but before KT acceptance[75] and none developed a transplant center–based intervention to reduce disparities at this point. This period, however, is clearly a critical point preceding KT in which disparities may occur.[8,37] Thus, increasing the representation of at-risk groups at this point may increase their access to KT. Our results demonstrated that KTFT may have contributed to significantly higher likelihoods of waitlisting for Black patients. Among Black patients, those in the KTFT cohort were more likely to be waitlisted for KT and more likely to undergo KT compared with those in the HC cohort. Our conclusions are buffered by the finding that there were no significant differences in waitlisting between Black and White patients in the KTFT group, despite significant differences between Black and White patients in the HC group. To our knowledge, this is the first study to demonstrate such a remarkable change in KT waitlisting disparities for Black and White patients. Although we did not find similar significant differences for patients with other race or ethnicity, we suspect differences may be obscured because of small group sizes and more heterogenous

Table 2. Group Comparison of Waitlisting and Kidney Transplant Outcomes

Group	SHR (95% CI)[a]	
	Waitlisted for transplant[b]	Received transplant[c]
Cohort (KTFT vs HC)[d]	1.40 (1.24-1.59)	1.21 (1.04-1.41)
Cohort by race and ethnicity group: key comparisons[e]		
Black individuals (KTFT compared with HC)	1.54 (1.11-2.14)	1.52 (1.06-2.16)
White individuals (KTFT compared with HC)[f]	1.38 (1.16-1.65)	1.14 (0.96-1.36)
Individuals with other race (KTFT compared with HC)	1.28 (0.83-1.98)	1.22 (0.72-2.07)
Black individuals compared with White individuals (KTFT)	0.79 (0.61-1.01)	1.06 (0.80-1.40)
Individuals with other race compared with White individuals (KTFT)	0.77 (0.51-1.15)	0.82 (0.53-1.28)
Black individuals compared with White individuals (HC)	0.71 (0.58-0.87)	0.80 (0.60-1.06)
Covariates		
Age, per 1-y increase	0.98 (0.98-0.99)	0.98 (0.97-0.99)
Education (≤high school)	0.92 (0.81-1.04)	0.80 (0.68-0.94)
Income (≤$50 000)	0.79 (0.68-0.92)	0.75 (0.63-0.90)
Marital status (married or partnered)	1.21 (1.06-1.39)	NA
Employed (yes)	1.26 (1.08-1.46)	1.11 (0.93-1.32)
Insurance		
Public	1 [Reference]	1 [Reference]
Private	1.60 (1.33-1.93)	1.24 (0.99-1.55)
Both	1.47 (1.25-1.74)	1.14 (0.91-1.42)
Kidney disease burden	0.95 (0.90-1.01)	NA
Charlson Comorbidity Index score, per 1-unit increase	0.87 (0.84-0.91)	0.92 (0.88-0.97)
Dialysis duration, y		
None	1 [Reference]	1 [Reference]
<1	0.63 (0.54-0.73)	0.78 (0.66-0.93)
1-5	0.68 (0.57-0.83)	1.33 (1.06-1.66)
>5	0.61 (0.45-0.83)	1.13 (0.71-1.79)
BMI[g]		
Without obesity	NA	1 [Reference]
With obesity	NA	0.84 (0.72-0.97)
Network of potential donors, per 1-donor increase	NA	1.03 (0.99-1.08)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); HC, historical control; KTFT, Kidney Transplant Fast Track; NA, not applicable; SHR, subdistribution hazards ratio.

[a] Comparisions were done using multivariable competing risk models and resulting SHRs.

[b] BMI and network of potential donors did not meet criteria in univariable selection and were therefore excluded from the waitlist model; evaluation completion was conflated with the accepted for waitlisting outcome and thus excluded from final multivariable analyses.

[c] Marital status and kidney disease burden did not meet criteria in univariable selection and were therefore excluded from the received transplant model.

[d] The number of events included in analyses was as follows: 1130 events for active waitlisting, 469 events for competing risk, and 555 censored events in the waitlisting model and 689 events for kidney transplant, 190 events for competing risk, and 250 censored events in the received transplant model.

[e] We adjusted CIs for multiple comparisons of race and ethnicity groups and cohorts using false discovery rate adjustment.[71]

[f] Schoenfeld residual and hazard plots did not suggest pronounced violation of the proportional hazard assumption. However, Cox test suggested a borderline deviation of the assumption between non-Hispanic White individuals in the KTFT and HC groups for waitlisting (correlation = −0.07; $P = .03$) and transplant (correlation = −0.12; $P = .003$). Exclusive censoring (including death) beyond year 4 for waitlisting and 100% transplant by year 6 of active listing in the non-Hispanic White individuals in the KTFT group were likely responsible for potential deviations. The proportional hazard assumption was satisfactory between all other cohort and race and ethnicity groups. Small values of the correlation suggested a negligible to small impact of deviations on hazard ratios.

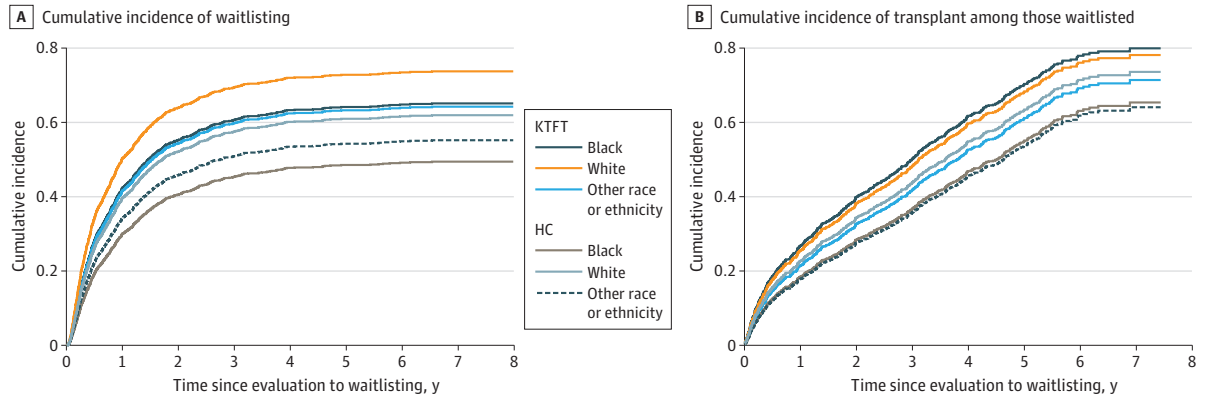
[g] The Cox proportional hazard test indicated possible deviations from the proportional hazard assumption between groups with obesity and without obesity (correlation = 0.09; $P = .01$). However, the small value of the correlation and inclusion of obesity as an adjustment suggested limited impact of this deviation on hazard ratios.

patient groups compared with those in Black and White patient groups.

Limitations

Despite our significant findings, our study has limitations because it was not a randomized clinical trial. Temporal changes or other unmeasured confounders occurring after the HC recruitment period or during the KTFT period (eg, national Medicare policy changes, secular changes due to transplant center-specific policy changes, and changes in hospital staff personnel) may have influenced KT outcomes or contaminated associations that we observed with KTFT. However, data on UPMC waitlisting rates strongly suggest that the increase in waitlisting rates coincided with the implementation of KTFT in 2012. We also acknowledge that additional unmeasured confounders may have contributed to the association between the KTFT intervention and the receipt of a transplant in light of the relatively short duration of the intervention and the multiple interim steps

Figure 3. Cumulative Incidence of Waitlisting by Race and Ethnicity



KTFT								
Black	86	44	16	3	2	1	1	1
White	193	73	27	10	4	2	1	1
Other race or ethnicity	25	7	5	1	1	1	1	1
HC								
Black	191	108	82	51	29	19	6	2
White	380	214	124	70	42	21	7	3
Other race or ethnicity	55	41	30	23	12	4	3	2

KTFT								
Black	69	56	40	29	8	1	1	1
White	270	189	121	54	18	2	1	1
Other race or ethnicity	26	19	16	6	3	2	1	1
HC								
Black	90	74	54	33	14	2	1	1
White	339	257	188	118	58	18	3	1
Other race or ethnicity	40	30	24	13	6	3	3	1

Cumulative incidence is shown for waitlisting overall (A) and, among individuals waitlisted, for transplant (B) in 6 study groups defined by race and ethnicity in combination with study cohort adjusted for demographics and medical factors. HC indicates historical control; KTFT, Kidney Transplant Fast Track.

between the more proximal outcome of waitlisting and the transplant. Given the intuitive systemwide benefits associated with KTFT for all patients, conducting a randomized clinical trial may have raised ethical concerns of depriving clinical benefits to some patients. As an optimal alternative, we conducted this longitudinal cohort study with an HC group. Given the complex nature of transplant centers and organizational settings, we argue that our pragmatic trial approach[76] improves the value of our research for decision-making in clinical and health policy, which is the ultimate goal of this research.

Additionally, our study did not address potential disparities occurring before referral for transplant given that this issue has been examined in previous literature.[6-9] Furthermore, our study was limited to 1 transplant center. Although a single site, UPMC STI is one of the largest of 42 transplant centers in United Network for Organ Sharing Region 2,[77] making it an ideal location to test this intervention. It is, however, very well-resourced, and most patients are well insured via private or public insurance. Thus, although our multivariable modeling accounted for patient-level differences in income and insurance status, future research should investigate whether KTFT can succeed in a variety of health care settings. For example, it would be important to test KTFT in health care settings with limited operational funds or clinical shortages serving a patient population that is predominantly underinsured or uninsured (eg, state-funded, safety-net hospitals).

Conclusions

Although it is a seemingly intuitive solution to enabling more patients to complete the evaluation process and be added to the waitlist, to our knowledge, few transplant centers use a health care system–facilitated approach like KTFT to complete the transplant evaluation process.[49,78] Indeed, as noted by Schold et al, "[D]espite wide recognition, policy reforms, and extensive research, rates of waitlisting following ESKD onset did not seem to improve in more than two decades and were consistently reduced among vulnerable populations. Improving access to transplant may require more substantial interventions."[7] Our nonrandomized clinical trial answers this call for a more substantial intervention among patients referred to KT. In addition, our intervention may have contributed to significantly reduced KT waitlisting disparities. We believe that KTFT should be implemented as standard care across transplant centers to the greatest extent possible. We hope that clinicians at various health care systems can use the results of our work to make a case for implementing a similar approach in their respective transplant centers. Additionally, we encourage appropriate insurance and Medicare reimbursement to enable institutions across the income spectrum regardless of profit status to implement the appropriate health care system changes.

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REFERENCES

1. Evans RW, Manninen DL, Garrison LP Jr, et al. The quality of life of patients with end-stage renal disease. *N Engl J Med*. 1985;312(9):553-559. doi:10.1056/NEJM198502283120905

2. Hunsicker LG. A survival advantage for renal transplantation. *N Engl J Med*. 1999;341(23):1762-1763. doi:10.1056/NEJM199912023412310

3. Wolfe RA, Ashby VB, Milford EL, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med*. 1999;341(23):1725-1730. doi:10.1056/NEJM199912023412303

4. Eggers PW. Effect of transplantation on the Medicare end-stage renal disease program. *N Engl J Med*. 1988;318(4):223-229. doi:10.1056/NEJM198801283180406

5. Port FK, Wolfe RA, Mauger EA, Berling DP, Jiang K. Comparison of survival probabilities for dialysis patients vs cadaveric renal transplant recipients. *JAMA*. 1993;270(11):1339-1343. doi:10.1001/jama.1993.03510110079036

6. Alexander GC, Sehgal AR. Why hemodialysis patients fail to complete the transplantation process. *Am J Kidney Dis*. 2001;37(2):321-328. doi:10.1053/ajkd.2001.21297

7. Schold JD, Mohan S, Huml A, et al. Failure to advance access to kidney transplantation over two decades in the United States. *J Am Soc Nephrol*. 2021;32(4):913-926. doi:10.1681/ASN.2020060888

8. Ladin K, Rodrigue JR, Hanto DW. Framing disparities along the continuum of care from chronic kidney disease to transplantation: barriers and interventions. *Am J Transplant*. 2009;9(4):669-674. doi:10.1111/j.1600-6143.2009.02561.x

9. Lentine KL, Smith JM, Hart A, et al. OPTN/SRTR 2020 annual data report: kidney. *Am J Transplant*. 2022;22(S2)(suppl 2):21-136. doi:10.1111/ajt.16982

10. Weng FL, Joffe MM, Feldman HI, Mange KC. Rates of completion of the medical evaluation for renal transplantation. *Am J Kidney Dis*. 2005;46(4):734-745. doi:10.1053/j.ajkd.2005.06.011

11. Young CJ, Gaston RS. African Americans and renal transplantation: disproportionate need, limited access, and impaired outcomes. *Am J Med Sci*. 2002;323(2):94-99. doi:10.1097/00000441-200202000-00007

12. Hall YN, Choi AI, Xu P, O'Hare AM, Chertow GM. Racial ethnic differences in rates and determinants of deceased donor kidney transplantation. *J Am Soc Nephrol*. 2011;22(4):743-751. doi:10.1681/ASN.2010080819

13. Hall EC, James NT, Garonzik Wang JM, et al. Center-level factors and racial disparities in living donor kidney transplantation. *Am J Kidney Dis*. 2012;59(6):849-857. doi:10.1053/j.ajkd.2011.12.021

14. Keith D, Ashby VB, Port FK, Leichtman AB. Insurance type and minority status associated with large disparities in prelisting dialysis among candidates for kidney transplantation. *Clin J Am Soc Nephrol*. 2008;3(2):463-470. doi:10.2215/CJN.02220507

15. Kutner NG, Zhang R, Huang Y, Johansen KL. Impact of race on predialysis discussions and kidney transplant preemptive wait-listing. *Am J Nephrol*. 2012;35(4):305-311. doi:10.1159/000336891

16. Kasiske BL, London W, Ellison MD. Race and socioeconomic factors influencing early placement on the kidney transplant waiting list. *J Am Soc Nephrol*. 1998;9(11):2142-2147. doi:10.1681/ASN.V9112142

17. Kasiske BL, Snyder JJ, Matas AJ, Ellison MD, Gill JS, Kausz AT. Preemptive kidney transplantation: the advantage and the advantaged. *J Am Soc Nephrol*. 2002;13(5):1358-1364. doi:10.1097/01.ASN.0000013295.11876.C9

18. Lunsford SL, Shilling LM, Chavin KD, et al. Racial differences in the living kidney donation experience and implications for education. *Prog Transplant*. 2007;17(3):234-240. doi:10.1177/152692480701700312

19. Lunsford SL, Simpson KS, Chavin KD, et al. Racial disparities in living kidney donation: is there a lack of willing donors or an excess of medically unsuitable candidates? *Transplantation*. 2006;82(7):876-881. doi:10.1097/01.tp.0000232693.69773.42

20. Barnieh L, McLaughlin K, Manns BJ, et al; Alberta Kidney Disease Network. Evaluation of an education intervention to increase the pursuit of living kidney donation: a randomized controlled trial. *Prog Transplant*. 2011;21(1):36-42. doi:10.1177/152692481102100105

21. Boulware LE, Hill-Briggs F, Kraus ES, et al. Effectiveness of educational and social worker interventions to activate patients' discussion and pursuit of preemptive living donor kidney transplantation: a randomized controlled trial. *Am J Kidney Dis*. 2013;61(3):476-486. doi:10.1053/j.ajkd.2012.08.039

22. Neyhart CD. Education of patients pre and post-transplant: improving outcomes by overcoming the barriers. *Nephrol Nurs J*. 2008;35(4):409-410.

23. Patzer RE, Perryman JP, Pastan S, et al. Impact of a patient education program on disparities in kidney transplant evaluation. *Clin J Am Soc Nephrol*. 2012;7(4):648-655. doi:10.2215/CJN.10071011

24. Pradel FG, Suwannaprom P, Mullins CD, Sadler J, Bartlett ST. Short-term impact of an educational program promoting live donor kidney transplantation in dialysis centers. *Prog Transplant*. 2008;18(4):263-272. doi:10.1177/152692480801800409

25. Rodrigue JR, Cornell DL, Lin JK, Kaplan B, Howard RJ. Increasing live donor kidney transplantation: a randomized controlled trial of a home-based educational intervention. *Am J Transplant*. 2007;7(2):394-401. doi:10.1111/j.1600-6143.2006.01623.x

26. Rodrigue JR, Cornell DL, Kaplan B, Howard RJ. A randomized trial of a home-based educational approach to increase live donor kidney transplantation: effects in Blacks and Whites. *Am J Kidney Dis*. 2008;51(4):663-670. doi:10.1053/j.ajkd.2007.11.027

27. Schweitzer EJ, Yoon S, Hart J, et al. Increased living donor volunteer rates with a formal recipient family education program. *Am J Kidney Dis*. 1997;29(5):739-745. doi:10.1016/S0272-6386(97)90128-1

28. Schweitzer J, Seidel-Wiesel M, Verres R, Wiesel M. Psychological consultation before living kidney donation: finding out and handling problem cases. *Transplantation*. 2003;76(10):1464-1470. doi:10.1097/01.TP.0000084320.57817.32

29. Waterman AD, Hyland SS, Goalby C, Robbins M, Dinkel K. Improving transplant education in the dialysis setting: the "explore transplant" initiative. *Dial Transplant*. 2010;39(6):236-241. doi:10.1002/dat.20452

30. Waterman AD, Hyland SS, Stanley S, Barrett AC, Millinger R. Improving education increases dialysis patients' pursuit of transplant: Explore Transplant RCT findings. *Am J Transplant*. 2009;9(S2):360. American Transplant Congress 2009.

31. Waterman AD, Rodrigue JR, Purnell TS, Ladin K, Boulware LE. Addressing racial and ethnic disparities in live donor kidney transplantation: priorities for research and intervention. *Semin Nephrol*. 2010;30(1):90-98. doi:10.1016/j.semnephrol.2009.10.010

32. Waterman AD, Stanley SL, Covelli T, Hazel E, Hong BA, Brennan DC. Living donation decision making: recipients' concerns and educational

needs. *Prog Transplant*. 2006;16(1):17-23. doi:10.1177/152692480601600105

33. Weng FL, Brown DR, Peipert JD, Holland B, Waterman AD. Protocol of a cluster randomized trial of an educational intervention to increase knowledge of living donor kidney transplant among potential transplant candidates. *BMC Nephrol*. 2013;14:256. doi:10.1186/1471-2369-14-256

34. Waterman AD, Barrett AC, Stanley SL. Optimal transplant education for recipients to increase pursuit of living donation. *Prog Transplant*. 2008;18(1):55-62. doi:10.1177/152692480801800111

35. Zhang X, Melanson TA, Plantinga LC, et al. Racial/ethnic disparities in waitlisting for deceased donor kidney transplantation 1 year after implementation of the new national kidney allocation system. *Am J Transplant*. 2018;18(8):1936-1946. doi:10.1111/ajt.14748

36. Ng YH, Pankratz VS, Leyva Y, et al. Does racial disparity in kidney transplant waitlisting persist after accounting for social determinants of health? *Transplantation*. 2020;104(7):1445-1455. doi:10.1097/TP.0000000000003002

37. Kulkarni S, Ladin K, Haakinson D, Greene E, Li L, Deng Y. Association of racial disparities with access to kidney transplant after the implementation of the new kidney allocation system. *JAMA Surg*. 2019;154(7):618-625. doi:10.1001/jamasurg.2019.0512

38. Patzer RE, Perryman JP, Schrager JD, et al. The role of race and poverty on steps to kidney transplantation in the Southeastern United States. *Am J Transplant*. 2012;12(2):358-368. doi:10.1111/j.1600-6143.2011.03927.x

39. Kucirka LM, Purnell TS, Segev DL. Improving access to kidney transplantation: referral is not enough. *JAMA*. 2015;314(6):565-567. doi:10.1001/jama.2015.8932

40. Kucirka LM, Grams ME, Balhara KS, Jaar BG, Segev DL. Disparities in provision of transplant information affect access to kidney transplantation. *Am J Transplant*. 2012;12(2):351-357. doi:10.1111/j.1600-6143.2011.03865.x

41. Patzer RE, Plantinga LC, Paul S, et al. Variation in dialysis facility referral for kidney transplantation among patients with end-stage renal disease in Georgia. *JAMA*. 2015;314(6):582-594. doi:10.1001/jama.2015.8897

42. Patzer RE. Quality metrics in transplantation—a new emphasis on transplant access. *Am J Transplant*. 2018;18(6):1301-1302. doi:10.1111/ajt.14764

43. Kasiske BL, Cangro CB, Hariharan S, et al; American Society of Transplantation. The evaluation of renal transplantation candidates: clinical practice guidelines. *Am J Transplant*. 2001;1(suppl 2):3-95.

44. Crenesse-Cozien N, Dolph B, Said M, Feeley TH, Kayler LK. Kidney transplant evaluation: inferences from qualitative interviews with African American patients and their providers. *J Racial Ethn Health Disparities*. 2019;6(5):917-925. doi:10.1007/s40615-019-00592-x

45. Warsame F, Haugen CE, Ying H, et al. Limited health literacy and adverse outcomes among kidney transplant candidates. *Am J Transplant*. 2019;19(2):457-465. doi:10.1111/ajt.14994

46. Navaneethan SD, Singh S. A systematic review of barriers in access to renal transplantation among African Americans in the United States. *Clin Transplant*. 2006;20(6):769-775. doi:10.1111/j.1399-0012.2006.00568.x

47. Wesselman H, Ford CG, Leyva Y, et al. Social Determinants of health and race disparities in kidney transplant. *Clin J Am Soc Nephrol*. 2021;16(2):262-274. doi:10.2215/CJN.04860420

48. OPTN/SRTR 2022 annual data report: preface. *Am J Transplant*. 2024;24(2S1):S1-S9. doi:10.1016/j.ajt.2024.01.010

49. Formica RN Jr, Barrantes F, Asch WS, et al. A one-day centralized work-up for kidney transplant recipient candidates: a quality improvement report. *Am J Kidney Dis*. 2012;60(2):288-294. doi:10.1053/j.ajkd.2012.04.008

50. Bornemann K, Croswell E, Abaye M, et al. Protocol of the KTFT-TALK study to reduce racial disparities in kidney transplant evaluation and living donor kidney transplantation. *Contemp Clin Trials*. 2017;53:52-59. doi:10.1016/j.cct.2016.11.011

51. Loor J, Leyva Y, Croswell EJ, Dew MA, Boulware L, Myaskovsky L. Testing an education only intervention to increase willingness and pursuit of living donor kidney transplantation. *Am J Transplant*. 2022;22(S3):549.

52. Myaskovsky L, Almario Doebler D, Posluszny DM, et al. Perceived discrimination predicts longer time to be accepted for kidney transplant. *Transplantation*. 2012;93(4):423-429. doi:10.1097/TP.0b013e318241d0cd

53. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383. doi:10.1016/0021-9681(87)90171-8

54. Sullivan MK, Rankin AJ, Jani BD, Mair FS, Mark PB. Associations between multimorbidity and adverse clinical outcomes in patients with chronic kidney disease: a systematic review and meta-analysis. *BMJ Open*. 2020;10(6):e038401. doi:10.1136/bmjopen-2020-038401

55. Glasheen WP, Cordier T, Gumpina R, Haugh G, Davis J, Renda A. Charlson Comorbidity Index: *ICD-9* update and *ICD-10* translation. *Am Health Drug Benefits*. 2019;12(4):188-197.

56. Austin PC, Lee DS, Fine JP. Introduction to the analysis of survival data in the presence of competing risks. *Circulation*. 2016;133(6):601-609. doi:10.1161/CIRCULATIONAHA.115.017719

57. Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. *J Am Stat Assoc*. 1999;94(446):496-509. doi:10.1080/01621459.1999.10474144

58. Noordzij M, Leffondré K, van Stralen KJ, Zoccali C, Dekker FW, Jager KJ. When do we need competing risks methods for survival analysis in nephrology? *Nephrol Dial Transplant*. 2013;28(11):2670-2677. doi:10.1093/ndt/gft355

59. Shinozaki T, Nojima M. Misuse of regression adjustment for additional confounders following insufficient propensity score balancing. *Epidemiology*. 2019;30(4):541-548. doi:10.1097/EDE.0000000000001023

60. Iwagami M, Shinozaki T. Introduction to matching in case-control and cohort studies. *Ann Clin Epidemiol*. 2022;4(2):33-40. doi:10.37737/ace.22005

61. Brazauskas R, Logan BR. Observational studies: matching or regression? *Biol Blood Marrow Transplant*. 2016;22(3):557-563. doi:10.1016/j.bbmt.2015.12.005

62. Rose S, Laan MJ. Why match: investigating matched case-control study designs with causal effect estimation. *Int J Biostat*. 2009;5(1):1. doi:10.2202/1557-4679.1127

63. Lau B, Cole SR, Gange SJ. Competing risk regression models for epidemiologic data. *Am J Epidemiol*. 2009;170(2):244-256. doi:10.1093/aje/kwp107

64. Buzkova P. Competing risk of mortality in association studies of non-fatal events. *PLoS One*. 2021;16(8):e0255313. doi:10.1371/journal.pone.0255313

65. Sapir-Pichhadze R, Pintilie M, Tinckam KJ, et al. Survival analysis in the presence of competing risks: the example of waitlisted kidney transplant candidates. *Am J Transplant*. 2016;16(7):1958-1966. doi:10.1111/ajt.13717

66. Koller MT, Raatz H, Steyerberg EW, Wolbers M. Competing risks and the clinical community: irrelevance or ignorance? *Stat Med*. 2012;31(11-12):1089-1097. doi:10.1002/sim.4384

67. Jiang Y, Fine JP, Mottl AK. Competing risk of death with end-stage renal disease in diabetic kidney disease. *Adv Chronic Kidney Dis*. 2018;25(2):133-140. doi:10.1053/j.ackd.2018.01.008

68. Austin PC, Latouche A, Fine JP. A review of the use of time-varying covariates in the Fine-Gray subdistribution hazard competing risk regression model. *Stat Med*. 2020;39(2):103-113. doi:10.1002/sim.8399

69. Crowder MJ. *Multivariate survival analysis and competing risks*. Chapman and Hall/CRC; 2012. . doi:10.1201/b11893

70. Tabachnick BG, Fidell LS. *Using Multivariate Statistics*. 5th ed. Allyn and Bacon; 2007.

71. Benjamini Y, Yekutieli D. False discovery rate–adjusted multiple confidence intervals for selected parameters. *J Am Stat Assoc*. 2005;100(469):71-81. doi:10.1198/016214504000001907

72. Myaskovsky L, Kendall K, Li X, et al. Unexpected race and ethnicity differences in the US National Veterans Affairs kidney transplant program. *Transplantation*. 2019;103(12):2701-2714. doi:10.1097/TP.0000000000002905

73. Alexander GC, Sehgal AR. Barriers to cadaveric renal transplantation among Blacks, women, and the poor. *JAMA*. 1998;280(13):1148-1152. doi:10.1001/jama.280.13.1148

74. Ayanian JZ, Cleary PD, Weissman JS, Epstein AM. The effect of patients' preferences on racial differences in access to renal transplantation. *N Engl J Med*. 1999;341(22):1661-1669. doi:10.1056/NEJM199911253412206

75. Murphy KA, Jackson JW, Purnell TS, et al. Association of socioeconomic status and comorbidities with racial disparities during kidney transplant evaluation. *Clin J Am Soc Nephrol*. 2020;15(6):843-851. doi:10.2215/CJN.12541019

76. Tunis SR, Stryer DB, Clancy CM. Practical clinical trials: increasing the value of clinical research for decision making in clinical and health policy. *JAMA*. 2003;290(12):1624-1632. doi:10.1001/jama.290.12.1624

77. Organ Procurement and Transplantation Network; Scientific Registry of Transplant Recipients. Regional data. Accessed January 20, 2023. https://optn.transplant.hrsa.gov/data/view-data-reports/regional-data/

78. Mayo Clinic. Kidney transplant: Mayo Clinic's approach. Accessed February 4, 2025.. https://www.mayoclinic.org/tests-procedures/kidney-transplant/care-at-mayo-clinic/pcc-20384782