KI REPORTS
KIReports.org
CLINICAL RESEARCH

Kidney Transplantation Contraindications: Variation in Nephrologist Practice and Training Vintage

Adam S. Wilk[1], Kelsey M. Drewry[2,3,4,5], Cam Escoffery[6], Janice P. Lea[7], Stephen O. Pastan[7,8] and Rachel E. Patzer[2,3,4,5]

[1]Department of Health Policy and Management, Rollins School of Public Health, Emory University, Atlanta, Georgia, USA; [2]Department of Surgery, Division of Transplantation, Emory University School of Medicine, Atlanta, Georgia, USA; [3]Health Services Research Center, Emory University, Atlanta, Georgia, USA; [4]Regenstrief Institute, Indianapolis, Indiana, USA; [5]Department of Surgery, Indiana University School of Medicine, Indianapolis, Indiana, USA; [6]Behavioral Social and Health Education Sciences, Rollins School of Public Health, Emory University, Atlanta, Georgia, USA; [7]Renal Division, Department of Medicine, Emory University School of Medicine, Atlanta, Georgia, USA; and [8]Emory University Transplant Center, Atlanta, Georgia, USA

Introduction: Health system leaders aim to increase access to kidney transplantation in part by encouraging nephrologists to refer more patients for transplant evaluation. Little is known about nephrologists' referral decisions and whether nephrologists with older training vintage weigh patient criteria differently (e.g., more restrictively).

Methods: Using a novel, iteratively validated survey of US-based nephrologists, we examined how nephrologists assess adult patients' suitability for transplant, focusing on established, important criteria: 7 clinical (e.g., overweight) and 7 psychosocial (e.g., insurance). We quantified variation in nephrologist restrictiveness—proportion of criteria interpreted as absolute or partial contraindications versus minor or negligible concerns—and tested associations between restrictiveness and nephrologist age (proxy for training vintage) in logistic regression models, controlling for nephrologist-level and practice-level factors.

Results: Of 144 nephrologists invited, 42 survey respondents (29% response rate) were 85% male and 54% non-Hispanic White, with mean age 52 years, and 67% spent ≥1 day/wk in outpatient dialysis facilities. Nephrologists interpreted patient criteria inconsistently; consistency was lower for psychosocial criteria (intraclass correlation coefficient: 0.28) than for clinical criteria (intraclass correlation coefficient: 0.43; $P < 0.01$). With each additional 10 years of age, nephrologists' odds of interpreting criteria restrictively (top tertile) doubled (adjusted odds ratio [aOR] 1.96; 95% confidence interval [CI]: 0.95–4.07), with marginal statistical significance. This relationship was significant when interpreting psychosocial criteria (aOR: 3.18; 95% CI: 1.16–8.71) but not when interpreting clinical criteria (aOR: 1.12; 95% CI: 0.52–2.38).

Conclusion: Nephrologists interpret evaluation criteria variably when assessing patient suitability for transplant. Guideline-based educational interventions could influence nephrologists' referral decision-making differentially by age.

Kidney Int Rep (2024) **9,** 888–897; https://doi.org/10.1016/j.ekir.2024.01.021
KEYWORDS: clinical practice guidelines; kidney transplantation; nephrology; physician age; physician training

For the 120,000 Americans diagnosed with kidney failure each year, kidney transplantation is associated with improved survival and quality of life (mental well-being, self-efficacy) versus dialysis treatment.[1-5] Despite these benefits, less than 15% of individuals with incident kidney failure receive a kidney transplant or are placed on a kidney transplant waitlist within 1 year of diagnosis.[6] Accordingly, the 2019 Advancing American Kidney Health executive order identified increasing use of kidney transplantation as one of the central goals of kidney disease–related policy reforms in the United States.[7] Among these reforms, Medicare is implementing performance measures that hold dialysis facilities accountable for the proportion of their patients that are on the transplant waitlist,[8] and many health system leaders and researchers have called for routinizing dialysis patient referrals to transplant centers for most patients.[9] To increase access to transplantation without overtaxing transplant center

Correspondence: Adam S. Wilk, Department of Health Policy and Management, Rollins School of Public Health, Emory University, 1518 Clifton Rd, Atlanta, Georgia 30322, USA. E-mail: adam.s.wilk@emory.edu

Received 18 October 2023; revised 8 December 2023; accepted 8 January 2024; published online 19 January 2024

teams,[10] health system leaders and policy makers must work with providers in nephrology clinics and dialysis facilities to identify precisely which patients may be good candidates for transplant and assist those patients in taking the first steps toward transplantation.

A key early step on the patient's pathway to kidney transplantation is referral by a care provider—in dialysis facilities, this is typically a nephrologist or a social worker within a nephrologist-led care team—to a transplant center, where a team will perform a full clinical and psychosocial evaluation and assess the patient's suitability for transplantation. When deciding whether to refer a given patient, community nephrologists may consider many patient characteristics and compare them against various evaluation criteria—the transplant center's (if known), those in Kidney Disease: Improving Global Outcomes guidelines,[11] or the nephrologist's own—to judge whether the patient can be considered a "good potential transplant candidate" and referred, or if transplant is contraindicated. This assessment, including how the nephrologists may interpret and apply evaluation criteria, may vary across nephrologists because of differences in training, engagement with scientific evidence, past experience with patients, use of heuristics, guidance from transplant centers, and potentially conscious or subconscious biases. To date, little is known about these assessments and associated referral decisions. Consequently, we have little insight about how nephrologists' referral decisions may be affected under new incentives to increase referrals, and we cannot anticipate which groups of patients may become more or less likely to be referred, relative to historical trends.

To our knowledge, no previous study has assessed whether there is meaningful variation across nephrologists in how restrictively they interpret different evaluation criteria (i.e., interpreting certain patient characteristics, and perhaps not others, as contraindications versus minor or negligible concerns). In addition, researchers have not examined whether the characteristics of the nephrologist—such as total years in practice (i.e., training vintage)[12-16]—may be associated with more restrictive interpretations. We developed and validated a survey of nephrologists and administered it nationally, analyzing its results to help fill these knowledge gaps. Our findings can inform policies, educational interventions, and communication strategies that may foster the effective translation of evidence on kidney transplantation into nephrologists' referral decisions.

METHODS

Survey Development and Validation

We conducted a survey of US nephrologists during August to October 2019. We developed a novel survey instrument to capture practice and nephrologist characteristics, as well as information about how nephrologists interpret patient evaluation criteria when assessing the appropriateness of recommending transplant, peritoneal dialysis, or home hemodialysis—versus conventional in-center hemodialysis—for an adult patient with incident kidney failure. The instrument was validated through use of items from preexisting, validated instruments where possible, incorporating of extensive subject matter expert input, and iterative cognitive interviewing with survey-eligible nephrologists. In this study we focus on survey items related to assessment for transplantation; these and other relevant survey items are presented in Supplementary Figure S1.

We drafted an initial survey instrument drawing on a review of clinical practice guidelines, peer-reviewed evidence on patient eligibility for kidney transplantation, and previous validated surveys on decision-making among nephrologists related to kidney failure treatment.[17-23] We obtained feedback on the construct validity and relative priority of draft survey items from subject matter experts locally and nationally, including 4 nephrologists, 2 patient advocacy organizations, 2 kidney failure treatment technology manufacturers, and 4 health services researchers with expertise in both access to kidney transplant and survey research methods. Specifically, we asked the experts to identify the constructs that were: (i) the most important for nephrologists' assessment of patient characteristics among potential transplant candidates and (ii) expected to elicit wide variation across survey respondents. Four study team members (AW, KD, JL, SP) reviewed this input and selected which items to include in the instrument through a consensus process.

We then employed iterative retrospective cognitive interviews within a modified Delphi structure to refine the survey instrument.[24] We engaged 8 additional nephrologists to complete the survey, and then interviewed them to solicit their input on the survey's clarity, flow, and burden for completion. We also gathered feedback on the relevance and construct validity of select items identified as of particular interest to the study team or as confusing by the nephrologist. This feedback was incorporated into the survey instrument, and the nephrologists were reengaged to complete the survey and participate in a follow-up interview. This iterative process was completed up to 3 times with participants to maximize the instrument's validity.

Key Measures

The final survey included 14 evaluation criteria that nephrologists may consider when assessing whether

adults with new-onset kidney failure would be candidates for transplantation. The 14 criteria include 7 clinical criteria and 7 psychosocial (or joint clinical-psychosocial) criteria. The clinical criteria included history of lung cancer (chemotherapy within the last 6 months; with lung chosen arbitrarily from among nonkidney cancers), HIV or AIDS, moderate chronic obstructive pulmonary disease, significant cognitive impairment, active or not well-controlled psychiatric disorder, morbid obesity (body mass index >40), and underweight (body mass index <18). The psychosocial criteria comprised regular smoker, regular marijuana or other recreational drug use, absence of a caregiver or limited home support, patient may be unlikely to comply with treatment regimen or diet restrictions or medications, insurance plan offers limited coverage (e.g., high deductible, high out-of-pocket maximum), has not attended a formal patient education program about end-stage kidney disease treatment alternatives, and 1 or more failed kidney transplants previously. These criteria were presented as independent items (termed "patient characteristics") in a grid under the question "When considering whether an adult (age 18+) patient may be a candidate for kidney transplantation, for each of the following patient characteristics, please indicate if you consider it a 'Major Contraindication,' 'Relative Contraindication,' 'Minor Concern,' or 'Not a Concern'?" Definitions were provided for each of these Likert scale response options. Participants could also respond "Not sure" for each item.

In addition, the survey gathered nephrologist-level and practice-level information potentially associated with both how the nephrologist interprets these criteria and the characteristics of the patients that the nephrologist encounters. At the nephrologist level, we collected race or ethnicity (collapsed to non-Hispanic Black, Non-Hispanic Asian, non-Hispanic White, and other race or ethnicity due to small cell sizes), whether they were medical director or dialysis facility owner, and the proportion of clinical practice time spent in an outpatient dialysis facility. Respondents also provided information on practice characteristics, including estimates of the proportions of the practice's patients who are non-Hispanic Black, Hispanic, uninsured, have Medicaid coverage, or have chronic kidney disease stage II or III (vs. later stage kidney disease). We also captured nephrologist age (years; reflecting training vintage) and gender from our sampling frame, a database constructed in July 2019 by HealthLink Dimensions (hereafter "HealthLink data"); HealthLink sourced this information from the American Medical Association Physician Masterfile and multiple marketing databases for all boarded nonpediatric nephrologists in the United States. In addition, county-level median household income for the county associated with the nephrologist's mailing address was merged into our database from the American Community Survey.

Recruitment

We administered the survey in a randomly sampled, geographically stratified (at the End-Stage Renal Disease Network level) population of 169 nonpediatric nephrologists identified as actively practicing medicine. Our HealthLink database sampling frame contained contact information (primary office mailing addresses, telephone numbers, and fax numbers)—found to be valid for 144 sample nephrologists (85%)—as well as other physician and practice information. We updated phone and fax number information for sample nephrologists when this information could be obtained via web search or phone follow-up.

Study participants were recruited using the following evidence-based, multistep approach developed by Van Otterloo *et al*.[25] (i) We made available identical paper and online versions of the survey. (ii) We informed sampled providers via fax that our survey was forthcoming and about the project's goals. (iii) We prepared and sent large FedEx envelopes to disseminate our "survey kits." (iv) We included in the survey kits: a paper copy of the survey—single-sided to facilitate returning the survey by fax—a cover letter, an informed consent form framed as a frequently-asked-questions page, a postage-paid addressed return envelope, a pen, and a $35 Amazon gift card to thank the recipient for their time. And (v) we performed scripted follow up with all nonresponding survey recipients by fax (up to 2 additional faxes) and by phone (up to 3 calls) during 10 weeks after the initial mailing. The cover letter described the survey kit's contents and the survey's objectives, provided the study team's contact information, and highlighted the different ways respondents could return the survey (mail, fax, or online). Data collection was terminated 14 weeks after the initial mailing.

Data Analysis

We tested for nonresponse bias by examining unadjusted, pairwise associations between nonresponse and nephrologist and practice characteristics identified using HealthLink data. Data were entered into Excel for descriptive analysis; statistical analysis was conducted using Stata SE 17 (College Station, TX; 2023).

Among completed survey responses, we descriptively compared the distributions (mean or percentage) of responses across items. In particular, we used F-tests

Table 1. Unadjusted characteristics of sample nephrologists with complete survey data, overall and comparing those with highest tertile of restrictiveness scores versus peer nephrologists, by index

		Scales								
		Clinical & Psychosocial criteria $\alpha = 0.769$			Psychosocial criteria only $\alpha = 0.718$			Clinical criteria only $\alpha = 0.697$		
Characteristics	All	Less restrictive	Top tertile of restrictive-ness	*P*-value	Less restrictive	Top tertile of restrictive-ness	*P*-value	Less restrictive	Top tertile of restrictive-ness	*P*-value
n (%)[a]	39 (100.0)	30 (76.9)	9 (23.1)		27 (69.2)	12 (30.7)		28 (71.8)	11 (28.2)	
Nephrologist demographics										
Age, years; mean (SD)	52 (11.8)	51 (12)	55 (10)	0.446	50 (12)	58 (10)	0.048	51 (11)	54 (13)	0.537
Female gender; *n* (%)	6 (15.4)	4 (13.3)	2 (22.2)	0.517	3 (11.1)	3 (25)	0.267	4 (14.3)	2 (18.2)	0.762
Race/Ethnicity; *n* (%)				0.139			0.132			0.035
NH Asian	8 (20.5)	4 (13.3)	4 (44.4)		3 (11.1)	5 (41.7)		3 (10.7)	5 (45.4)	
NH Black	2 (5)	1 (3.3)	1 (11.1)		1 (3.7)	1 (8.3)		2 (7.1)	0 (0)	
NH White	21 (53.8)	18 (60)	3 (33.3)		17 (63)	4 (33.3)		15 (53.6)	6 (54.5)	
Other	8 (20.5)	7 (23.3)	1 (11.1)		6 (22.2)	2 (16.7)		8 (28.6)	0 (0)	
1 or more d/wk in dialysis facility; n (%)	26 (66.7)	18 (60)	8 (88.9)	0.107	17 (63)	9 (75)	0.462	15 (53.6)	11 (100)	0.006
Medical director or facility owner; *n* (%)	23 (59)	18 (60)	5 (55.6)	0.812	15 (55.6)	8 (66.7)	0.515	16 (57.1)	7 (63.6)	0.711
Practice-level patient characteristics										
% non-Hispanic Black; mean (SD)	30.7 (19.6)	30.4 (19.2)	31.8 (22.2)	0.86	30.6 (16.1)	31.1 (26.7)	0.944	30.5 (19)	31.3 (22)	0.918
% Hispanic; mean (SD)	18.4 (12.8)	18.4 (19.1)	18.3 (10.1)	0.99	15.7 (15.1)	24.4 (21.2)	0.153	17.7 (19.6)	20 (10.5)	0.724
% Uninsured; mean (SD)	22.7 (18.2)	21.3 (17.2)	27.6 (12.1)	0.314	20.6 (17.8)	27.3 (11.5)	0.241	11.6 (18.3)	23 (10.1)	0.945
% Medicaid beneficiaries; mean (SD)	7.1 (9.3)	6.2 (6.7)	10.2 (15.5)	0.271	6.1 (6.9)	9.5 (13.4)	0.305	7.9 (10.7)	5 (4.2)	0.39
% CKD stage II-III; mean (SD)	56.1 (16.4)	55.3 (16.4)	58.9 (17.1)	0.569	54.6 (15.8)	59.6 (17.8)	0.385	56 (17.3)	56.3 (14.5)	0.954
Median household income, $1000s; mean (SD)	68.7 (16.5)	69.3 (18)	67 (10.7)	0.712	71.4 (17.6)	62.7 (12.1)	0.133	69.5 (17,8)	66.7 (13)	0.633

CKD, chronic kidney disease; NH, non-Hispanic.
[a]% of all $n = 39$ sample with complete data for all study variables; all other reported percentages are column percentages.

to assess differences in both the variance and intraclass correlation of responses for clinical criteria items and psychosocial criteria items.

To score nephrologists' relative restrictiveness in interpreting patient evaluation criteria for transplant (i.e., identifying the criteria as full or partial contraindications vs. minor or negligible concerns), we developed 3 indices using factor analysis methods. The first index included responses for all 14 clinical and psychosocial criteria, the second included the 7 psychosocial criteria only, and the third included the 7 clinical criteria only. A Cronbach's α test was used to test the internal consistency of each.[26] We then tested the association between physician age (continuous measure, a proxy for training vintage) and these measures of restrictiveness (top-tertile index value vs. middle or bottom tertile) in separate logistic regression models, controlling for nephrologist-level (dichotomous indicators: gender, 1 or more days per week [20% or more of clinical time] spent working in a dialysis facility, medical director or facility owner) and practice-level characteristics (continuous measures: percentages of patients who are non-Hispanic Black, Hispanic, uninsured, Medicaid-enrolled, and chronic kidney disease stages II or III, county-level median household income).

RESULTS

Of 169 nephrologists in our sample, 14 (8.3%) had incomplete or incorrect contact information that could not be verified or updated, and 11 (6.5%) indicated that they did not meet study inclusion criteria (e.g., no longer practicing medicine). Among the remaining 144 nephrologists, 42 representing 42 unique practice locations returned a survey that was at least partially complete, for a response rate of 29%. Analyses of nonresponse identified no statistically significant relationships with nephrologist characteristics (Supplementary Table S1).

In Table 1, we present characteristics of the 39 respondents with complete information for the variables used in our regression analyses. Among responding nephrologists, the mean age was 52 years, 85% were male, and more than half (54%) identified as non-Hispanic White. Three-fifths of respondents (59%) served as medical directors or full or part owners of a dialysis facility, and two-thirds (67%) spent at least 1 day per week in outpatient dialysis facilities. On

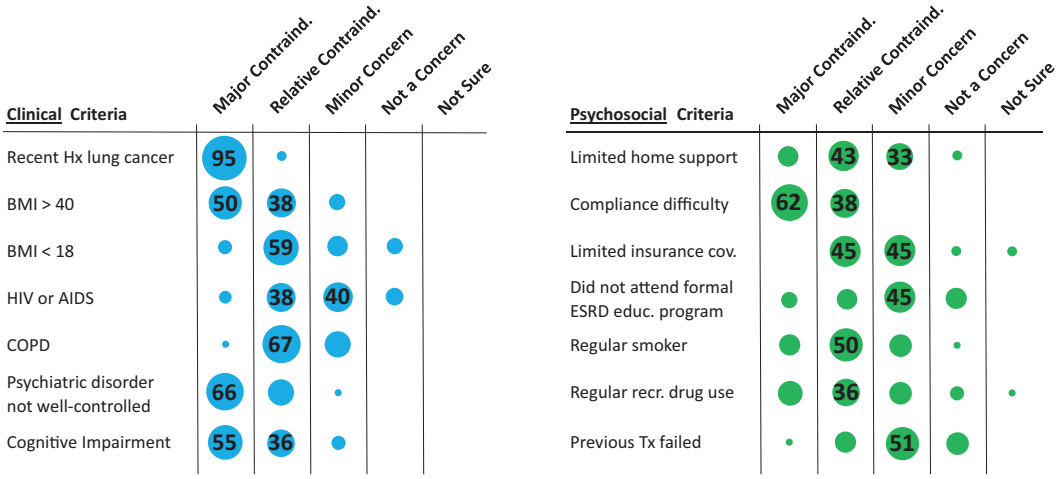

Figure 1. Variation in nephrologists' assessment of patient clinical and psychosocial characteristics with respect to referral for kidney transplantation and proportions of respondents for each response option (%). AIDS, acquired immunodeficiency syndrome; BMI, body mass index; COPD, chronic obstructive pulmonary disease; ESRD, end-stage renal disease; HIV, human immunodeficiency virus; Hx, history; Tx, transplant.
Percentages included for all values ≥33%.

average, respondents characterized their practice's patients as 31% non-Hispanic Black, 23% uninsured, and 56% with chronic kidney disease stage II or III. In the counties of respondents' primary practice location, average median household income was about $68,700.

Nephrologists varied widely in how restrictively they interpreted both clinical and psychosocial patient evaluation criteria (Figure 1). The variance in nephrologists' restrictiveness in interpreting psychosocial criteria ($\sigma^2 = 0.87$) was significantly greater than the variance with respect to interpreting clinical criteria ($\sigma^2 = 0.70$; $P < 0.01$). Moreover, there was low consistency in interpretations across nephrologists in general. Respondent nephrologists' consistency was lower when interpreting psychosocial criteria (intraclass correlation coefficient: 0.28) than when interpreting clinical criteria (intraclass correlation coefficient: 0.43; $P < 0.01$).

Cronbach's alpha statistics for our indices of restrictiveness—for clinical and psychosocial criteria, for psychosocial criteria only, and for clinical criteria only—ranged between 0.70 and 0.77 (Table 1), reflecting acceptable internal consistency. In unadjusted analyses, when interpreting both clinical and psychosocial criteria, nephrologists in the top tertile of restrictiveness and nephrologists in lower tertiles were different with respect to age (55 vs. 51 years, respectively; $P = 0.446$) and spending 1 or more days per week in a dialysis facility (89% vs. 60%, respectively; $P = 0.107$), on average; yet these differences were not statistically significant. When interpreting psychosocial criteria only, nephrologists in the top tertile of restrictiveness were significantly older than nephrologists in lower tertiles (58 vs. 50, respectively; $P = 0.048$), and there was no statistical difference in spending 1 or more days per week in a dialysis facility (75% vs. 63%, respectively; $P = 0.462$). When interpreting clinical criteria only, there was no significant difference in age between nephrologists in the top tertile of restrictiveness and other nephrologists (54 vs. 51, respectively; $P = 0.537$), though more restrictive nephrologists were more likely to spend 1 or more days in a dialysis facility (100% vs. 54%, respectively; $P = 0.006$).

Adjusted analytic results are presented in Table 2. Controlling for other factors, older nephrologists were more likely than younger nephrologists to be in the top tertile of restrictiveness when interpreting both clinical and psychosocial criteria. For each additional 10 years of age, nephrologists had twice the odds of being in the top tertile of restrictiveness (vs. lower tertiles; aOR 1.96; 95% CI: 0.95–4.07); this finding was of marginal statistical significance ($P = 0.070$). In addition, increasing age was significantly associated with restrictiveness in interpreting psychosocial criteria only (aOR for 10 additional years of age: 3.18; 95% CI: 1.16–8.71; $P = 0.024$), but not in interpreting clinical criteria only (aOR: 1.12; 95% CI: 0.52–2.38; $P = 0.765$). No other factors were statistically significantly associated with being in the top tertile of restrictiveness for any of our three indices.

DISCUSSION

Following on the 2019 Advancing American Kidney Health executive order and subsequent payment reforms implemented by Medicare,[7] there is considerable interest in increasing access to kidney

Table 2. Adjusted odds of being in the top tertile of restrictiveness, versus less restrictive, by index

	Scales					
	Clinical & Psychosocial criteria		Psychosocial criteria only		Clinical criteria only	
Characteristic	aOR (95% CI)	*P*-value	aOR (95% CI)	*P*-value	aOR (95% CI)	*P*-value
Nephrologist characteristics						
Age (10 yr)	1.96 (0.95–4.07)	0.070	3.18 (1.16–8.71)	0.024	1.12 (0.52–2.38)	0.765
Female gender (ref. male)	1.24 (0.23–6.74)	0.807	6.21 (0.67–57.7)	0.109	1.50 (0.19–11.7)	0.698
1 or more d/wk in dialysis facility	10.90 (0.60–199)	0.106	2.70 (0.28–26.3)	0.392	Omitted due to collinearity	
Medical director or facility owner	0.56 (0.08–3.77)	0.548	1.38 (0.17–11.4)	0.763	1.55 (0.29–8.14)	0.604
Practice-level patient characteristics						
% non-Hispanic Black	1.00 (0.96–1.04)	0.993	0.99 (0.95–1.04)	0.750	1.00 (0.96–1.04)	0.973
% Hispanic	0.98 (0.93–1.03)	0.418	1.01 (0.97–1.06)	0.541	1.00 (0.96–1.05)	0.958
% Uninsured	1.02 (0.96–1.10)	0.469	1.03 (0.97–1.08)	0.362	1.03 (0.97–1.09)	0.348
% Medicaid beneficiaries	1.03 (0.94–1.12)	0.522	1.02 (0.94–1.12)	0.632	0.90 (0.77–1.05)	0.166
% CKD stage II–III	1.01 (0.94–1.08)	0.804	1.02 (0.95–1.09)	0.652	1.00 (0.96–1.05)	0.949
Median household income, $1000s (1 SD)	0.71 (0.27–1.82)	0.470	0.39 (0.11–1.30)	0.124	0.70 (0.33–1.49)	0.355

aOR, adjusted odds ratio; CI, confidence interval; CKD, chronic kidney disease.
Logistic regression model results. Adjusted odds of having the highest tertile of restrictiveness (vs. second and third tertiles of restrictiveness) with 1-unit change in covariates.

transplantation among individuals with kidney failure. There is particular interest in understanding why many patients do not progress through early steps of the process to obtaining a transplant, including nephrologists' initial assessments of whether a patient may be a good candidate for transplant. This study used a novel, validated survey instrument to build understanding of how nephrologists interpret key patient evaluation criteria when assessing a patient's suitability for transplant. Among our survey's respondents, we found considerable variation in how restrictively nephrologists interpret patient evaluation criteria, especially those related to a patient's psychosocial characteristics, when assessing patient eligibility for transplant. We also found that, compared to their younger counterparts, older nephrologists were more likely to interpret patient evaluation criteria restrictively.

Our finding that nephrologists vary substantially in how restrictively they interpret criteria for transplantation referral is consistent with evidence across multiple clinical disciplines showing that physicians often interpret clinical criteria heterogeneously.[27] Previous studies have observed variation in the interpretation of clinical guidelines and their application in patient care for a range of conditions, including HIV/AIDS,[28,29] cardiovascular disease,[30,31] and coronary artery disease,[32] and for patients needing obstetrics and gynecology services.[33] Within nephrology, previous studies have observed that nephrologists are more likely to refer for transplant evaluation patients who have certain characteristics (e.g., younger age, limited noncompliance) than other patients (e.g., older age, history of noncompliance).[34] A few studies have observed that rural nephrologists and nephrologists involved in transplantation may place different emphasis on different patient characteristics when considering whether to recommend transplant.[34–36] However, this is the first study to observe variation among nephrologists in how restrictively they interpret clinical and psychosocial patient characteristics when weighing a patient's suitability for kidney transplantation. To our knowledge, ours is also the first study to demonstrate greater inconsistency in how nephrologists interpret psychosocial evaluation criteria versus clinical evaluation criteria. Our findings highlight specific components of nephrologists' referral decision process on which delivery system and provider-level interventions (e.g., education, clinical decision support tools) can focus when seeking to improve equity in transplant access across nephrologists.

Indeed, this variation may have important implications for patients' access to kidney transplant downstream. Like all physicians, nephrologists differ from one another with respect to the demographic, clinical, and socioeconomic characteristics of the patients they serve, and these differences may make some nephrologists' patients better candidates for transplant than other nephrologists' on average (e.g., if assessed by an objective third party). However, our survey approach effectively controls for patient characteristics by singling out clinical and psychosocial characteristics of interest and analyzing them *ex situ*, that is, outside the context of fully complex patient cases. Thereby, we observe meaningful variation in how nephrologists think about each of these patient characteristics and demonstrate that different nephrologists may make different transplant-related care decisions for the same patients. This represents a distinct advantage of our approach versus analyses of administrative or other observational data.

Moreover, the variation we observed may contribute to observed geographic and racial or ethnic disparities in access to kidney transplantation and downstream outcomes,[37,38] including where these disparities persist after controlling for patients' comorbid conditions, including known contraindications to transplant.[39] Variation in local transplant center criteria and in clinical practice guidelines themselves[40-43] will also contribute to geographic variation in kidney transplant access, both independently and through their influence on the referral behaviors of nephrologists and their care teams. Notably, because our survey focuses on the earliest step on the pathway to transplant—the nephrologist's prereferral assessment of the patient's suitability for transplant—it may be that factors at work in other downstream steps (e.g., transplant center evaluation) could accentuate or mitigate associations between the referring nephrologists' application of evaluation criteria and downstream patient waitlisting and transplant receipt outcomes. To inform where intervention investments should be concentrated to improve equity in transplant access, future studies should test whether the patients treated by nephrologists who are more restrictive when interpreting patient evaluation criteria are less likely to receive a referral to a transplant center for full evaluation, to start or complete that evaluation, to be placed on a transplant waiting list, and to receive a transplant. Future studies should also examine whether patients referred by more restrictive nephrologists have better or worse health outcomes and to what extent other factors at the care team level (e.g., patient review frequency, social worker role, family involvement) or health system level (e.g., transplant center criteria and communication strategies) moderate these relationships.

We also found that older nephrologists are more likely than younger nephrologists to interpret patient evaluation criteria restrictively, a relationship that held more strongly when focusing on psychosocial patient characteristics. This result is consistent with evidence that physicians' decision making and the quality of their clinical practices varies by age and training vintage;[30,31,44-48] though notably, the evidence on the direction of this relationship in the context of specialty care referrals is mixed.[46] Within nephrology, our finding significantly broadens the extant evidence (limited to unadjusted analyses), which has shown that younger nephrologists may be more likely to view transplant as a treatment option for older patients.[49] Several possible mechanisms may help to explain this age-restrictiveness relationship in the context of assessing a patient's candidacy for transplant. Our preliminary conceptual model held age as a proxy for training vintage, recognizing that nephrologists may rely on knowledge and practices that were emphasized during training when interpreting and applying patient evaluation criteria.[50] Although the evidence underlying some key patient evaluation criteria has not changed meaningfully over time (e.g., recent cancer treatment,[23] attending a patient education program[51]), for others, the evidence has evolved meaningfully (e.g., recreational drug use[52,53]). Classifying how significantly and recently the evidence basis of different patient evaluation criteria has evolved, and testing whether the relationship between restrictiveness and training vintage is moderated by the timing of advancements in evidence or continuing education activities, is beyond the scope of this study; however, this hypothesis should be examined in future research. In addition, it may be that younger physicians may more regularly use clinical information aids (e.g., UpToDate) that would reflect the evolving evidence. However, studies to date have found no association between nephrologist age and patterns of using online information sources.[54]

Uncertainty tolerance theory offers another possible mechanism, suggesting that older, more experienced nephrologists may more rapidly sense when a given patient case may reflect a previously identified pattern.[55-57] For example, an older nephrologist may infer more quickly than a younger nephrologist that a patient with significant cognitive impairment also is likely to have other characteristics (e.g., frailty, risk of medication nonadherence) that may make the patient unsuitable for transplant. Thus, an older nephrologist may interpret many given patient evaluation criteria more restrictively because of these ingrained associations. This theory may be especially well-positioned to help explain our finding that older clinician age was significantly associated with restrictiveness in interpreting psychosocial characteristics but not in interpreting clinical characteristics. This is because many psychosocial characteristics of patients are less routinely and more subjectively measured than clinical characteristics in dialysis facility settings, and so nephrologists may be more accustomed to inferring additional psychosocial information about their patients and relying on previously identified patterns of associated psychosocial patient profiles to support making treatment recommendations. Although there is some evidence that supports this hypothesis in other specialties, such as emergency medicine,[57] the hypothesis has not been tested among nephrologists. If shown to hold among nephrologists, this theory would point to strategies of enhancing more experienced nephrologists' emotional regulation skills and confidence when interacting with socially dissimilar patients as opportunities to enhance transplant access among patients with certain characteristics potentially indicative of higher risk among transplant candidates.[58]

This study has some notable limitations. The survey's response rate (29%), though in line with contemporary response rates among specialist physicians,[59] could threaten the external validity of our findings; yet our analysis suggests survey respondents and nonrespondents are not meaningfully different in important respects, limiting potential bias. Relatedly, the survey's sample size inhibits the inclusion of potentially relevant covariates in our statistical models due to overfitting. For example, though our analysis accounts for important facility-level factors (e.g., percent of patients uninsured), other external factors that may influence how nephrologists interpret patient evaluation criteria in practice (e.g., hospital affiliation, training in transplant nephrology, patient evaluation criteria used by the nearest transplant center) could not be included in our analysis. The vintage of our survey—conducted during 2019—and evolving policy and practice in transplant evaluation may inhibit generalizing findings to contemporary judgments about patients' transplant candidacy or appropriate health system reforms. In addition, the set of evaluation criteria captured in our survey may omit criteria that are important to some nephrologists when assessing patients' candidacy for transplant. However, our survey's 14 criteria cover a diverse array of clinical and psychosocial characteristics and were identified through a rigorous multidisciplinary process as important in contemporary assessments of patients' candidacy for transplant. Moreover, through its emphasis of psychosocial patient characteristics, this survey significantly extends beyond the 10 demographic and clinical criteria examined in Thamer's 1997 to 1998 survey of nephrologists on treatment recommendations, the most comprehensive previous survey of nephrologists on this topic.[17] In settings where social workers or other team members have greater responsibility for referral decisions, our findings on the perspectives of nephrologists may apply to clinical decision-making more indirectly, operating through the nephrologist's influence on the care team. Finally, and related, because we are unable to verify that all surveys were completed by nephrologists themselves rather than appointed staff persons, some of our inferences may be more appropriately applied to the teams that the nephrologists lead versus the nephrologists themselves.

Conclusion

In a national survey of US nephrologists, we found wide variations in how restrictively nephrologists interpret patient evaluation criteria—and especially criteria related to a patient's psychosocial characteristics—when assessing whether a patient should be referred for evaluation as a transplant candidate. We also found that older nephrologists, relative to younger nephrologists, were more likely to interpret psychosocial patient evaluation criteria restrictively. This evidence points to potential opportunities for interventions that foster alignment with transplant center evaluation criteria and limit variation in referral decision-making. The implications could include jointly improving access to kidney transplantation among adults with end-stage kidney disease while avoiding misuse of transplant centers resources.

DISCLOSURE

All the authors declared no competing interests.

ACKNOWLEDGMENTS

AW received support from the Georgia Clinical and Translational Science Alliance (National Institutes of Health award UL1TR002378) and from the National Institute for Diabetes and Digestive and Kidney Diseases (K01DK128384). The authors are grateful for the input of the Southeastern Kidney Transplant Coalition, whose members provided feedback on an earlier version of this work.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1. Survey instrument, relevant items.

Table S1. Unadjusted comparison of respondent versus nonrespondent nephrologists.

STROBE Statement.

REFERENCES

1. Ogutmen B, Yildirim A, Sever M, et al. Health-related quality of life after kidney transplantation in comparison intermittent hemodialysis, peritoneal dialysis, and normal controls. *Transplant Proc*. 2006;38:419–421. https://doi.org/10.1016/j.transproceed.2006.01.016
2. Neipp M, Karavul B, Jackobs S, et al. Quality of life in adult transplant recipients more than 15 years after kidney transplantation. *Transplantation*. 2006;81:1640–1644. https://doi.org/10.1097/01.tp.0000226070.74443.fb
3. Port FK, Wolfe RA, Mauger EA, Berling DP, Jiang K. Comparison of survival probabilities for dialysis patients vs cadaveric renal transplant recipients. *JAMA*. 1993;270:1339–1343.
4. 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;341:1725–1730. https://doi.org/10.1056/NEJM199912023412303
5. Tonelli M, Wiebe N, Knoll G, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. *Am J Transplant*. 2011;11:2093–2109. https://doi.org/10.1111/j.1600-6143.2011.03686.x

6. USRDS. USRDS 2017 Annual Data Report. Published 2017. Accessed June 14, 2021. https://www.niddk.nih.gov/about-niddk/strategic-plans-reports/usrds/prior-data-reports/2017
7. U.S. Department of Health and Human Services. Advancing American kidney health. Published 2019. Accessed June 14, 2021. https://aspe.hhs.gov/system/files/pdf/262046/AdvancingAmericanKidneyHealth.pdf
8. Centers for Medicare and Medicaid Services. ESRD quality incentive program. Accessed July 28, 2023. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/ESRDQIP
9. Huml AM, Sedor JR, Poggio E, Patzer RE, Schold JD. An opt-out model for kidney transplant referral: the time has come. *Am J Transplant*. 2021;21:32–36. https://doi.org/10.1111/ajt.16129
10. Cheng XS, Han J, Braggs-Gresham JL, et al. Trends in cost attributable to kidney transplantation evaluation and waiting list management in the United States, 2012-2017. *JAMA Netw Open*. 2022;5:e221847. https://doi.org/10.1001/jamanetworkopen.2022.1847
11. Chadban SJ, Ahn C, Axelrod DA, et al. KDIGO clinical practice guideline on the evaluation and management of candidates for kidney transplantation. *Transplantation*. 2020;104(4):S11–S103. https://doi.org/10.1097/TP.0000000000003136
12. Samanez-Larkin GR, Knutson B. Decision making in the ageing brain: changes in affective and motivational circuits. *Nat Rev Neurosci*. 2015;16:278–289. https://doi.org/10.1038/nrn3917
13. McKinlay JB, Lin T, Freund K, Moskowitz M. The unexpected influence of physician attributes on clinical decisions: results of an experiment. *J Health Soc Behav*. 2002;43:92–106.
14. Kenny SJ, Smith PJ, Goldschmid MG, Newman JM, Herman WH. Survey of physician practice behaviors related to diabetes mellitus in the U.S. Physician adherence to consensus recommendations. *Diabetes Care*. 1993;16:1507–1510. https://doi.org/10.2337/diacare.16.11.1507
15. Reyna VF, Lloyd FJ. Physician decision making and cardiac risk: effects of knowledge, risk perception, risk tolerance, and fuzzy processing. *J Exp Psychol Appl*. 2006;12:179–195. https://doi.org/10.1037/1076-898X.12.3.179
16. Elstad EA, Lutfey KE, Marceau LD, Campbell SM, Von Dem Knesebeck O, McKinlay JB. What do physicians gain (and lose) with experience? Qualitative results from a cross-national study of diabetes. *Soc Sci Amp Med*. 2010;70:1728–1736. https://doi.org/10.1016/j.socscimed.2010.02.014
17. Thamer M, Hwang W, Fink NE, et al. US nephrologists' recommendation of dialysis modality: results of a national survey. *Am J Kidney Dis*. 2000;36:1155–1165. https://doi.org/10.1053/ajkd.2000.19829
18. Jager KJ, Korevaar JC, Dekker FW, Krediet RT, Boeschoten EW, Group NC. SotAoDS. The effect of contraindications and patient preference on dialysis modality selection in ESRD patients in the Netherlands. *Am J Kidney Dis*. 2004;43:891–899. https://doi.org/10.1053/j.ajkd.2003.12.051
19. Absolute contraindications to kidney transplantation. Provincial Health Services Authority. Accessed July 27, 2018. http://www.bcrenalagency.ca/resource-gallery/Documents/Absolute%20Contraindications%20to%20%20Kidney%20Transplantation.pdf
20. Schiller B, Munroe H, Neitzer A. Thinking outside the box—identifying patients for home dialysis. *NDT Plus*. 2011;4(suppl 3):iii11–iii13. https://doi.org/10.1093/ndtplus/sfr123
21. Fluck RJ, Fouque D, Lockridge RS. Nephrologists' perspectives on dialysis treatment: results of an international survey. *BMC Nephrol*. 2014;15:16. https://doi.org/10.1186/1471-2369-15-16
22. Kasiske BL, Neylan JF III, Riggio RR, et al. The effect of race on access and outcome in transplantation. *N Engl J Med*. 1991;324:302–307. https://doi.org/10.1056/NEJM199101313240505
23. Kasiske BL, Ramos EL, Gaston RS, et al. The evaluation of renal transplant candidates: clinical practice guidelines. Patient care and education committee of the American society of transplant physicians. *J Am Soc Nephrol*. 1995;6:1–34.
24. De Villiers MR, De Villiers PJT, Kent AP. The Delphi technique in health sciences education research. *Med Teach*. 2005;27:639–643. https://doi.org/10.1080/13611260500069947
25. Van Otterloo J, Richards JL, Seib K, Weiss P, Omer SB. Gift card incentives and non-response bias in a survey of vaccine providers: the role of geographic and demographic factors. *PLOS ONE*. 2011;6:e28108. https://doi.org/10.1371/journal.pone.0028108
26. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika*. 1951;16:297–334. https://doi.org/10.1007/BF02310555
27. Hajjaj FM, Salek MS, Basra MK, Finlay AY. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. *J R Soc Med*. 2010;103:178–187. https://doi.org/10.1258/jrsm.2010.100104
28. Bogart LM, Kelly JA, Catz SL, Sosman JM. Impact of medical and nonmedical factors on physician decision making for HIV/AIDS antiretroviral treatment. *J Acquir Immune Defic Syndr*. 2000;23:396–404. https://doi.org/10.1097/00126334-200004150-00006
29. Bogart LM, Catz SL, Kelly JA, Benotsch EG. Factors influencing physicians' judgments of adherence and treatment decisions for patients with HIV disease. *Med Decis Making*. 2001;21:28–36. https://doi.org/10.1177/0272989X0102100104
30. Christian AH, Mills T, Simpson SL, Mosca L. Quality of cardiovascular disease preventive care and physician/practice characteristics. *J Gen Intern Med*. 2006;21:231–237. https://doi.org/10.1111/j.1525-1497.2006.00331.x
31. Doroodchi H, Abdolrasulnia M, Foster JA, et al. Knowledge and attitudes of primary care physicians in the management of patients at risk for cardiovascular events. *BMC Fam Pract*. 2008;9:42. https://doi.org/10.1186/1471-2296-9-42
32. van Ryn M, Burgess D, Malat J, Griffin J. Physicians' perceptions of patients' social and behavioral characteristics and race disparities in treatment recommendations for men with coronary artery disease. *Am J Public Health*. 2006;96:351–357. https://doi.org/10.2105/AJPH.2004.041806
33. Epstein AJ, Nicholson S. The formation and evolution of physician treatment styles: an application to cesarean sections. *J Health Econ*. 2009;28:1126–1140. https://doi.org/10.1016/j.jhealeco.2009.08.003
34. Tong A, Hanson CS, Chapman JR, et al. The preferences and perspectives of nephrologists on patients' access to kidney transplantation: a systematic review. *Transplantation*. 2014;98:682–691. https://doi.org/10.1097/TP.0000000000000336

35. Tandon A, Wang M, Roe KC, Patel S, Ghahramani N. Nephrologists' likelihood of referring patients for kidney transplant based on hypothetical patient scenarios. *Clin Kidney J*. 2016;9:611–615. https://doi.org/10.1093/ckj/sfw031

36. Bartolomeo K, Gandhir AT, Lipinski M, Romeu J, Ghahramani N. Factors considered by nephrologists in excluding patients from kidney transplant referral. *Int J Organ Transplant Med*. 2019;10:101–107.

37. Ashby V, Kalbfleisch J, Wolfe R, Lin M, Port F, Leichtman A. Geographic variability in access to primary kidney transplantation in the United States, 1996-2005. *Am J Transplant*. 2007;7:1412–1423. https://doi.org/10.1111/j.1600-6143.2007.01785.x

38. 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;22:743–751. https://doi.org/10.1681/ASN.2010080819

39. Ku E, Lee BK, McCulloch CE, et al. Racial and ethnic disparities in kidney transplant access within a theoretical context of medical eligibility. *Transplantation*. 2020;104:1437–1444. https://doi.org/10.1097/TP.0000000000002962

40. Batabyal P, Chapman JR, Wong G, Craig JC, Tong A. Clinical practice guidelines on wait-listing for kidney transplantation: consistent and equitable? *Transplantation*. 2012;94:703–713. https://doi.org/10.1097/TP.0b013e3182637078

41. Urbanski M, Browne T, Ghanta M, et al. Transplant professionals' perceptions of long-term care residents' candidacy for kidney transplantation. *Prog Transplant*. 2017;27:146–151. https://doi.org/10.1177/1526924817699968

42. Urbanski M, Inaganti S, Agu C, Sarwer D, Gardiner H. Body mass index as a patient selection criterion for kidney transplant. *Commonhealth*. 2020;1:1–11. https://doi.org/10.15367/ch.v1i1.302

43. Mandelbrot DA, Fleishman A, Rodrigue JR, Norman SP, Samaniego M. Practices in the evaluation of potential kidney transplant recipients who are elderly: a survey of US transplant centers. *Clin Transplant*. 2017;31:e13088. https://doi.org/10.1111/ctr.13088

44. Choudhry NK, Fletcher RH, Soumerai SB. Systematic review: the relationship between clinical experience and quality of health care. *Ann Intern Med*. 2005;142:260–273. https://doi.org/10.7326/0003-4819-142-4-200502150-00008

45. Reschovsky JD, Rich EC, Lake TK. Factors contributing to variations in physicians' use of evidence at the point of care: A conceptual model. *J Gen Intern Med*. 2015;30(suppl 3):555–561. https://doi.org/10.1007/s11606-015-3366-7

46. Mehrotra A, Reid RO, Adams JL, Friedberg MW, McGlynn EA, Hussey PS. Physicians with the least experience have higher cost profiles than do physicians with the most experience. *Health Aff (Millwood)*. 2012;31:2453–2463. https://doi.org/10.1377/hlthaff.2011.0252

47. Hartz AJ, Kuhn EM, Pulido J. Prestige of training programs and experience of bypass surgeons as factors in adjusted patient mortality rates. *Med Care*. 1999;37:93–103. https://doi.org/10.1097/00005650-199901000-00013

48. Schaars CF, Denig P, Kasje WN, Stewart RE, Wolffenbuttel BHR, Haaijer-Ruskamp FM. Physician, organizational, and patient factors associated with suboptimal blood pressure management in Type 2 diabetic patients in primary care. *Diabetes Care*. 2004;27:123–128. https://doi.org/10.2337/diacare.27.1.123

49. Ghahramani N, Karparvar ZY, Ghahramani M, Shrivastava P. Nephrologists' perceptions of renal transplant as treatment of choice for end-stage renal disease, preemptive transplant, and transplanting older patients: an international survey. *Exp Clin Transplant*. 2011;9:223–229.

50. Carthy P, Harvey I, Brawn R, Watkins C. A study of factors associated with cost and variation in prescribing among GPs. *Fam Pract*. 2000;17:36–41. https://doi.org/10.1093/fampra/17.1.36

51. 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;7:648–655. https://doi.org/10.2215/CJN.10071011

52. Pondrom S. Transplantation and marijuana use. *Am J Transplant*. 2016;16:1–2. https://doi.org/10.1111/ajt.13679

53. Fabbri KR, Anderson-Haag TL, Spenningsby AM, Israni A, Nygaard RM, Stahler PA. Marijuana use should not preclude consideration for kidney transplantation. *Clin Transplant*. 2019;33:e13706. https://doi.org/10.1111/ctr.13706

54. Shariff SZ, Bejaimal S, Sontrop JM, et al. Searching for medical information online: a survey of Canadian nephrologists. *J Nephrol*. 2011;24:723–732. https://doi.org/10.5301/JN.2011.6373

55. De Jong T. Cognitive load theory, educational research, and instructional design: some food for thought. *Instr Sci*. 2010;38:105–134. https://doi.org/10.1007/s11251-009-9110-0

56. Ericsson KA, Kintsch W. Long-term working memory. *Psychol Rev*. 1995;102:211–245. https://doi.org/10.1037/0033-295x.102.2.211

57. Schubert CC, Denmark TK, Crandall B, Grome A, Pappas J. Characterizing novice-expert differences in macrocognition: an exploratory study of cognitive work in the emergency department. *Ann Emerg Med*. 2013;61:96–109. https://doi.org/10.1016/j.annemergmed.2012.08.034

58. Burgess D, Van Ryn M, Dovidio J, Saha S. Reducing racial bias among health care providers: lessons from social-cognitive psychology. *J Gen Intern Med*. 2007;22:882–887. https://doi.org/10.1007/s11606-007-0160-1

59. Cunningham CT, Quan H, Hemmelgarn B, et al. Exploring physician specialist response rates to web-based surveys. *BMC Med Res Methodol*. 2015;15:32. https://doi.org/10.1186/s12874-015-0016-z