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Clinical Utility in Adopting Race-free Kidney Donor Risk Index

Mona D. Doshi, MD,¹ Douglas E. Schaubel, PhD,² Yuwen Xu, MS,² Panduranga S. Rao, MD,¹ and Randall S. Sung, MD³

Background. Recent events of racial injustice prompted us to study potential impact of removing race from kidney donor risk index (KDRI) calculator. **Methods.** We used Scientific Registry for Transplant Recipients data to analyze outcomes of 66 987 deceased-donor kidney transplants performed in the United States between 2010 and 2016. Graft failure (GF) was defined as death or return to dialysis or requiring repeat transplant. We compared original KDRI and a race-free KDRI (Black donor coefficient zeroed out in the KDRI formula) with respect to recategorization of perceived GF risk (based on KDPI categories: ≤ 20 , 21–34, 35–85, ≥ 86), risk discrimination (using the C statistic) and predictive accuracy (using Brier score), and GF risk prediction (using Cox regression on time-to-GF). We used logistic regression to study the impact of donor race on discard probability. **Results.** There were 10 949 (16.3% of recipients) GF, and 1893 (17% of GFs) were among recipients of kidneys from Black donors. The use of race-free KDRI resulted in reclassification of 49% of kidneys from Black donors into lower GF risk categories. The impact on GF risk discrimination was minimal, with a relative decrease in C statistic of 0.16% and a change in GF predictive accuracy of 0.07%. For a given recipient/donor combination, transplants from Black (compared with non-Black) donors are estimated to decrease predicted graft survival at 1-y by 0.3%–3%, and 5-y by 1%–6%. Kidneys from Black donors are significantly more likely to be discarded (odds ratio adjusted for KDRI except race = 1.24). We estimate that an equal discard probability for Black and non-Black donors would yield 70 additional kidney transplants annually from Black donors. **Conclusions.** Use of race-free KDRI did not impact GF risk discrimination or predictive accuracy and may lower discard of kidneys from Black donors. We recommend use of race-free KDRI calculator acknowledging the possibility of miscalculation of GF risk in small proportion of kidneys from Black donors.

(*Transplantation Direct* 2022;8: e1343; doi: 10.1097/TXD.0000000000001343).

Received 30 September 2021. Revision received 11 April 2022.

Accepted 14 April 2022.

¹Division of Nephrology, Department of Medicine, University of Michigan, Ann Arbor, MI.

²Department of Biostatistics, Epidemiology and Informatics, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA.

³Department of Surgery, University of Michigan, Ann Arbor, MI.

This study was supported in part by grant R01-DK-DK070869 from the National Institutes of Health.

The authors declare no conflicts of interest.

M.D.D. and D.E.S. contributed equally to this work. M.D.D. participated in research design and writing of the article. D.E.S. participated in research design, performance of research, data analysis, and writing of the article. Y.X. participated in the performance of research and data analysis. P.S.R. participated in research design and writing of the article. R.S.S. participated in research design and writing of the article.

Correspondence: Mona D. Doshi, MD, 1500 E Medical Center Dr, 3914 Taubman, SPC 5364, Ann Arbor, MI 48109. (doshimd@med.umich.edu).

The interpretation and reporting of these data are the responsibilities of the authors and in no way should be considered as an official policy of or interpretation by the Scientific Registry of Transplant Recipients or the United States Government.

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ISSN: 2373-8731

DOI: 10.1097/TXD.0000000000001343

The ever-widening gap between supply and demand of kidneys for transplantation prompted the development of a newer tool to better assess organ quality to minimize discard. In 2009, Rao et al¹ developed the Kidney Donor Risk Index (KDRI) to provide a continuous score to predict risk of graft failure (GF) based on deceased-donor characteristics, an improvement from the previously used binary Expanded Criteria Donor indicator of organ quality.^{1,2} KDRI, as developed by Rao, is calculated using 10 donor and 4 transplant characteristics, including donor race. The Kidney Donor Profile Index (KDPI) is derived by mapping KDRI from a relative risk scale to a percentile and is often used as a basis for evaluation of organ quality and to discuss kidney offers with patients. The KDRI displayed in DonorNet is a scaled, donor-only version of the KDRI. Several factors pertaining to the recipient and/or transplant procedure (cold ischemic time, degree of HLA mismatching, single versus double versus en bloc kidneys) can also be used to calculate a full KDRI, but as those factors are not always known at time of match offers, the Organ Procurement and Transplantation Network (OPTN) excludes them. The OPTN has been calculating (donor-only) KDRI and reporting corresponding KDPI values on all kidney offers since March 2012. The KDPI is now being used actively to stratify organ offers under the revised kidney allocation system (KAS).³ From December 2014 onward, under the new KAS, there has been a deliberate attempt to

match organ-recipient longevity to maximize the number of life years after transplant and minimize the need for retransplant. This was accomplished by offering the highest-quality kidneys (KDPI \leq 20) to the candidates with best expected posttransplant survival score (ie, 0%-20%) and by offering marginal quality kidneys (KDPI \geq 85) to selected candidates such as those of older age and those with projected long wait times at the discretion of transplant center. The new KAS has resolved the past disparities in rates of deceased-donor kidney transplants between Black and White waitlisted candidates.⁴ The recent conversation around the use of race in clinical calculators prompted us to assess the impact of removing race from KDRI.

In the current KDRI calculator, Black deceased-donor race is associated with a 20% increase in risk of GF. Recent studies have provided a genetic basis to explain the increased risk of GF in kidneys from Black donors.⁵ The presence of 2 *APOL1* kidney risk variants in the Black deceased donors (found in \approx 15% of Black donors) is associated with premature allograft failure, and a \approx 2-fold increased risk of GF compared with kidneys from donors with 1 or 0 *APOL1* kidney risk variants.⁶ Kidneys transplanted from Black donors carrying 1 or no *APOL1* risk alleles have outcomes similar to those from non-Black deceased donors. The National Institutes of Health initiated the prospective multicenter study *APOL1* Long-term Kidney Transplantation Outcomes Network to help understand the impact of *APOL1* kidney risk variants on long-term recipient outcomes.⁷ This investigation will guide if the *APOL1* genotype of the donor should replace race in KDRI calculation to predict the risk of GF more accurately. However, the result of this study will not be available for a few years and the incorporation of *APOL1* genotype status in organ allocation may perhaps take even longer.

The discovery of the *APOL1* gene and its association with premature GF exemplifies that race is not a reliable proxy for biological differences. Recent international attention to racial injustice has prompted physicians to reexamine use of race in medical decision-making.⁸ Removing donor race from the KDRI calculation will lower KDRI values on all kidneys procured from Black deceased donors. As KDRI is known to have less discriminatory power among donors scoring in the middle ranges (with a C statistic of 0.58 for pairs restricted to middle 2 quartiles of KDRI in the original study),¹ we hypothesize that removing race from KDRI will have a minimal clinical impact upon the prediction of GF. In addition, to the extent that KDRI values influence organ acceptance behavior, we hypothesize that a lower KDRI for Black donors would increase utilization of kidneys from Black donors and reduce discards. In the present study, we investigated the potential impact of using race-free KDRI on graft outcomes and kidney utilization.

MATERIALS AND METHODS

Data Source and Study Population

Scientific Registry for Transplant Recipients (SRTR) data were used for the study. The SRTR data system includes data on all donors, waitlisted candidates, and transplant recipients in the United States, submitted by the members of the OPTN. The Health Resources and Services Administration, US Department of Health and Human Services provides

oversight to the activities of the OPTN and SRTR contractors. The study was deemed exempt by the University of Michigan Institutional Review Board.

Our study population included 66 987 adult first-time deceased-donor kidney-only transplants between January 1, 2010, and December 31, 2016, in the United States patients were followed from the time of kidney transplant to GF (earliest of return to dialysis, requiring repeat transplantation, or death), loss to follow-up, or the conclusion of the observation period (December 31, 2016). Patients who were lost to follow-up were censored at the date of last follow-up and were not assumed to have GF. OPTN collects information on ethnicity and race of the donor and creates categories from this to include Black. We used it for our analyses.

Objectives

Our goal was to evaluate the impact of removal of Black donor race indicator from the original KDRI formula (without refitting) on perceived GF risk (as implied by KDPI categorization), GF risk discrimination and predictive accuracy, and organ discard probability.¹

Race-free KDRI/KDPI

We created a race-free KDRI by zeroing out the Black donor coefficient (0.179) from the donor-only version of KDRI formula, which is available in DonorNet at the time of donor offer. We did not refit the original KDRI formula. KDPI was computed using the OPTN's 2020 lookup table, which reflects deceased donors recovered in the calendar year 2019. Similarly, a race-free KDPI was calculated by applying the KDPI lookup table to the race-free KDRI. Note that KDRI and race-free KDRI are equivalent for non-Black donors since, in such cases, the Black donor coefficient does not apply; therefore, it makes no difference if it is zeroed out. The same is true, hence, for KDPI. For transplants from Black donors ($n = 9945$), we first computed the difference, race-free KDPI minus KDPI. This difference will always be negative because the Black donor parameter in the KDRI formula results in KDRI being multiplied by $\exp(0.179) = 1.2$. Note that the difference will not be equal across all Black donors because KDRI is a nonlinear function of the Black donor coefficient, and KDPI is a percentile mapping of KDRI.

GF Risk Reclassification

To evaluate the impact of the Black donor race coefficient on GF risk classification, we cross-classified deceased-donor transplants from Black donors ($n = 9945$) by KDPI and race-free KDPI grouping (Table 1). We grouped based on KDPI values as \leq 20, 21–34, 35–85, and \geq 86 reflecting the KAS allocation sequence and risk of GF. Although we know that race-free KDPI cannot exceed KDPI, we do not know in advance how many donors cross from one cell to another.

GF Risk Discrimination and Predictive Accuracy

To assess the impact of deleting Black donor race from the KDRI on GF risk discrimination, we compared the observed C index (Index of Concordance) for 2 Cox models. The first model included $\log(\text{KDRI})$, whereas the second model instead included $\log(\text{race-free KDRI})$. Both models adjusted for recipient factors, including age, race, gender, body mass index, need for pretransplant dialysis and its vintage, blood type, cause of end-stage kidney disease (polycystic kidney disease, diabetes,

TABLE 1.

Cross-classification of KDPI and race-free KDPI categories for deceased-donor kidney transplants (n = 9945) during 2010–2016 from Black donors

	Race-free KDPI ^a 0–20	Race-free KDPI 21–34	Race-free KDPI 35–85	Race-free KDPI 86–100	Total
KDPI ^b 0–20	1277 (12.8%)	0	0	0	1277 (12.8%)
KDPI 21–34	1952 (19.6%)	0	0	0	1952 (19.6%)
KDPI 35–85	441 (4.4%)	1366 (13.7%)	3116 (31.3%)	0	4923 (49.5%)
KDPI 86–100	0	0	1070 (10.8%)	723 (7.3%)	1793 (18.0%)
Total	3670 (36.9%)	1366 (13.7%)	4186 (42.1%)	723 (7.3%)	9945 (100%)

^aRace-free KDPI was obtained by zeroing out the Black donor coefficient from the KDRI formula in Rao et al¹ and race-free KDPI was mapped to KDPI using the 2020 lookup table published by the OPTN.

^bKDRI (Rao et al¹) was mapped to KDPI using the 2020 lookup table published by the OPTN.

KDPI, Kidney Donor Profile Index; KDRI, Kidney Donor Risk Index; OPTN, Organ Procurement and Transplantation Network.

TABLE 2.

Comparing KDRI and race-free KDRI with respect to graft failure risk discrimination and predictive accuracy

Measure	KDRI ^a	Race-free KDRI ^b	Relative change
C statistic (higher is better)	0.640	0.639	−0.16%
Brier score (lower is better)	0.1525	0.1526	0.07%

^aKDRI was based on Rao et al.¹

^bRace-free KDRI was obtained by zeroing out the Black donor coefficient from the KDRI formula in Rao et al.¹

KDRI, Kidney Donor Risk Index.

hypertension, glomerulonephritis), insurance type, and indicators for the following comorbidities: diabetes, hepatitis C serostatus, chronic obstructive pulmonary disease, previous malignancy and drug-treated hypertension, and transplant year as well as transplant center through fixed effects. The C index (Table 2) represents the proportion of patient pairs for which the order of GF times is consistent with the fitted model; therefore, higher values correspond to better risk discrimination. To assess the impact of race on predictive accuracy, we compared the Brier score (survival analysis analog to a sum of squared residuals) for each of the 2 aforementioned models (Table 2). For the Brier score, lower values indicate better predictive accuracy.

Absolute Effect of Race on Graft Survival

The effect of Black (versus non-Black) donor race is a single number (hazard ratio [HR], 1.2) only when contrasting GF hazards (ie, rates). The HR often provides little information on difference in survival based on donor race; such issues are discussed by He et al.⁹ Therefore, we sought to describe the effect of Black donor race in terms of difference in graft survival (Table 3). To carry this out, GF risk was estimated based on predicted graft survival curves generated by a Cox regression model fitted to transplants from non-Black donors. Using the parameters estimated by this model (ie, HRs and estimated baseline survival), one can compute an estimated survival curve for each transplant from a non-Black donor (ie, 1 fitted graft survival curve per transplant). From each of these curves, we can extract fitted 1-y and 5-y GF risk (pulling these 2 points off each curve). We can then rank the 1-y GF and 5-y GF risks to yield percentiles (Table 3; non-Black donor columns). To estimate what each of these 1- and 5-y graft survival probabilities would have been had, contrary to fact, the donor been Black, we then apply the Black versus non-Black donor HR = 1.2 (Table 3, Black donor columns).

Discard Probability

To study the impact of donor race on discard, we included every deceased donor during the study period who had at least 1 kidney procured for transplantation. We first compared the baseline donor characteristics by race (Table 4), summarizing continuous variables by the median (and interquartile range) and categorical variates by percentages. We used Chi-square tests to test for differences between Black versus non-Black donor percentages. For continuous variables, the Wilcoxon test was used to test for differences by race. We modeled the discard probability using logistic regression. For each kidney, the response variable was discard (1 = yes; 0 = no). Several logistic regression models were created to determine probability of discarding of kidneys from Black relative to non-Black deceased donors (model 1: unadjusted, model 2: adjusted for all other KDRI components except race, model 3: restricted to highest KDRI quartile, and model 4: adjusting for all KDRI components including race of the donor).

Finally, we estimated the number of kidneys from Black donors that would have been utilized if kidneys from Black donors had (all other factors being equal) discard probability equal to that of non-Black donors. For this part of the analysis, we fitted a logistic regression model to non-Blacks. We then applied the estimated parameters (intercept and odds ratio) from this model to the kidney from Black donors. Summing the predicted discard probabilities across all Black donor kidneys yields the expected number of discarded kidneys if, contrary to fact, Black donor kidneys had the same discard probability as non-Blacks. The observed number of discarded Black donor kidneys, minus the afore-described expected count, equals the additional number of Black donor kidneys that would be transplanted if kidneys from Black donors had, all else equal, discard probability equal to that of non-Black donors.

All statistical analyses were carried out in SAS (v9.4; Cary, NC).

RESULTS

Our study population consisted of 66 987 adult primary deceased-donor kidney transplant recipients, of which 9945 were from a Black donor. There were 10 949 (16.3%) GF events: 5430 deaths (49.6%), 5495 return to dialysis (50.2%), and 24 receiving a repeat kidney transplant (0.2%). Of these, there were 1893 (17%) GF among recipients of kidneys from Black donors. In total, 56 038 (83.7%) of the study population had a functioning graft at the end of the 6-y study period.

TABLE 3.
Impact of Black donor race on 1-y and 5-y graft survival probability

Percentile ^a	1-y graft survival			5-y graft survival		
	Non-Black donor	Black donor ^b	Difference	Non-Black donor	Black donor	Difference
99	0.984	0.981	0.003	0.944	0.933	0.011
95	0.974	0.969	0.005	0.913	0.896	0.016
75	0.956	0.948	0.008	0.854	0.828	0.026
50	0.937	0.926	0.012	0.797	0.762	0.035
25	0.913	0.896	0.016	0.725	0.680	0.044
5	0.863	0.838	0.025	0.595	0.537	0.058
1	0.816	0.785	0.032	0.490	0.426	0.064

^aPercentiles are based on predicted graft survival for deceased-donor transplants during 2010–2016 with non-Black donors. The percentiles are not Kidney Donor Profile Index values. Graft survival curves were estimated using Cox regression, then ranked and percentiled for non-Black deceased-donor transplants.

^bPredicted graft survival in the Black donor column was obtained by applying the Black donor hazard ratio; hazard ratio = 1.20 to the non-Black column.

TABLE 4.
Characteristics of deceased donors during 2010–2016 with kidney(s) procured for transplantation (although not necessarily transplanted)

Donor characteristic	Non-Black (n = 46 110)	Black (n = 8667)
KDRI	1.18 (0.93–1.51)	1.44 (0.09–1.87)
Race-free KDRI	1.18 (0.93–1.51)	1.20 (0.91–1.56)
Age, y	41 (25–53)	38 (22–52)
Height, cm	170.2 (162.6–178.0)	170.2 (162.6–178.0)
Weight, kg	78.3 (65.3–93.0)	78.3 (65.0–94.5)
Donation after circulatory death	17.4%	7.7%
HCV positivity	4.3%	7.7%
Terminal serum creatinine, mg/dL	0.9 (0.7–1.3)	1.1 (0.8–1.6)
Hypertension	29.9%	40.8%
Diabetes	9.2%	11.4%
Stroke as cause of death	30.6%	38.6%

Median (interquartile range) is reported for continuous variables; percentages are reported for categorical variables. Chi-square tests were used to compare categorical variables and Wilcoxon rank-sum test was used to determine differences in continuous variables. All differences were significant ($P < 0.05$), except donor weight ($P = 0.67$). HCV, hepatitis C virus; KDRI, Kidney Donor Risk Index.

GF Risk Reclassification

A histogram of the difference, race-free KDPI minus KDPI, is presented in Figure 1 for the 9945 deceased-donor transplants from Black donors. After eliminating the Black donor component of KDRI, the median decrease in (the race-free) KDPI was 17 (interquartile range: 13–18).

In Table 1, we cross-classify KDPI and race-free KDPI risk categories. Of the 9945 deceased-donor kidneys from Black donors, 51.4% have the same category (ie, allocation category) for KDPI and race-free KDPI, as evidenced by summing the cell percentages along the table's main diagonal. This means that approximately half of the kidneys from Black donors were placed in a lower risk category based on race-free KDPI compared with a categorization based on KDPI. Of the 1952 kidneys from Black donors in the $21 \leq \text{KDPI} \leq 34$ category, all were moved to the $\text{KDPI} \leq 20$ category when Black race was eliminated from the KDPI calculation. Of the 1793 Black donor kidneys originally with $\text{KDPI} \geq 86$, 1070 (59.7%) switched to the $21 \leq \text{KDPI} \leq 85$ category after applying race-free KDPI.

In Table 2, we compare risk discrimination and predictive accuracy for 2 Cox models of time-to-GF. The GF risk discrimination is shown to be very similar between the original and race-free KDRI models. Specifically, the race-free KDRI

($C = 0.639$) performed nearly identically to the original KDRI ($C = 0.640$), for a relative decrease of 0.16%. With respect to predictive accuracy, the original and race-free KDRI are almost identical, with a relative change of 0.07% in Brier score.

In Table 3, we switch gears somewhat and turn our attention to evaluating the importance of Black donor race on graft survival probability across a spectrum of GF risk. Here, we fitted a Cox model for time-to-GF to the 57042 transplants from non-Black donors in our study population. For each of these transplants, we predicted a graft survival curve, then extracted the 1-y and 5-y graft survival estimates. We then ranked the 1-y and 5-y graft survival estimates, and report the percentiles given in the first column of Table 3. The second column (labeled non-Black donor) contains the 1-y graft survival estimates that correspond to each of the percentiles. The third column (labeled Black donor) applies the Black versus non-Black donor HR of 1.2 to obtain what each of the graft survival probabilities listed in the second column would be if the donor had been Black. The difference column contains the difference in graft survival (non-Black donor minus Black donor). Based on such differences, all else being equal, the decrease in graft survival associated with Black donor race is slight. For example, at the lowest risk transplant considered (99th percentile of graft survival), predicted survival is 0.3% lower if the non-Black donor had instead been a Black donor. The difference is more pronounced for higher-risk transplants (ie, higher-risk donor/recipient combinations). For instance, predicted 5-y graft survival decreases by $\approx 6\%$ for a transplant at the 5th percentile of 5-y graft survival.

There were 54777 deceased donors from whom kidneys were procured during the study period. Of these, 46 110 (84%) donors were non-Black and 8667 (16%) were Black. Table 4 lists baseline characteristics of all deceased donors by race. All baseline characteristics were statistically significantly different ($P < 0.0001$), except donor weight ($P = 0.67$). Several of these differences were small and not clinically meaningful. The clinically significant differences were younger age, lower proportion of donation after circulatory death donors, and greater proportion of hypertension and stroke in Black versus non-Black donors. The serum creatinine differed by 0.2 m/dL, which is not clinically meaningful as Black individuals are known to have higher serum creatinine than non-Black individuals for same level of renal function.

Of the 106298 kidneys available for transplantation, 25 343 (24%) were discarded. Of the discarded organs,

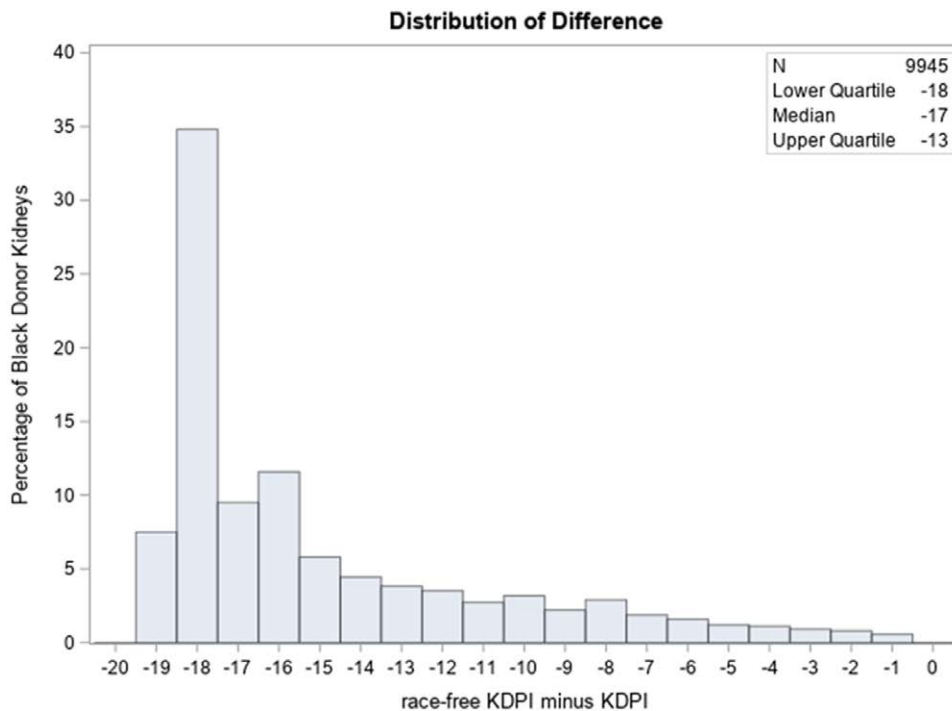


FIGURE 1. Difference in KDPI values among Black donor kidneys using race-free KDPI. KDPI, Kidney Donor Profile Index; KDRI, Kidney Donor Risk Index.

20 625 (81%) were from White donors, and 4718 (19%) were from Black donors. Table 5 presents the effect of race on discard probability based on various logistic regression models. Kidneys from Black deceased donors have an unadjusted 31% increase ($P < 0.0001$) in the odds of discard (model 1). The odds ratio decreases to 1.24 ($P < 0.0001$) upon adjustment for all other KDRI components except race (model 2). Restricting attention to kidneys within the highest KDRI quartile (model 3), there is a 12% increase in the adjusted odds of discard for Black donors. Finally, adjusting for all components of KDRI including race (model 4), odds of discard were 12% less for Black donors (odds ratio, 0.88; $P < 0.001$) relative to non-Black. Thus, comparing a Black and non-Black donor kidney with equal KDRI, the kidney from the Black donor is 12% less likely to be discarded. There were 4718 kidneys discarded from Black deceased donors. Fitting a logistic regression model to non-Blacks, then applying the resulting discard probabilities to the Black donors, only 4231 would have been discarded. The difference, 487 kidneys (≈ 70 additional deceased-donor kidney transplants per y) from Black donors represents the number of kidneys that would have been transplanted if Black deceased-donor kidneys had the same discard probability as non-Blacks.

DISCUSSION

Accurate assessment of the deceased-donor kidney viability has been of a great benefit to the patients, transplant physicians, and organ allocation policymakers. Although KDRI and KDPI offer improved granularity over the dichotomous expanded criteria donor quality indicator, their risk discrimination is at best mediocre (C statistic ≈ 0.6). As anticipated, the use of race-free KDRI calculator resulted in a decline in KDRI/KDPI categories for just under half of kidneys procured from Black deceased donors. Although the KDPI values

declined by 1 to 2 deciles, the impact on overall GF predictive accuracy (C statistic) and discriminatory power (Brier score) was minimal. There are at least 2 possible explanations for our findings. First, because there are 5 \times as many non-Black donors than Black donors, removing Black donor race may have minimal effect on the overall C statistics and Brier scores. Second, but more importantly, graft outcomes are a complex interplay of donor, recipient, and transplant factors. The KDPI available at the time of transplant is derived using donor factors only and therefore will not capture the risk of graft loss in its entirety for a given patient. After accounting for donor, recipient, and transplant factors, we report that removal of race from KDRI equation would not have a significant impact on its GF risk prediction. The predicted impact of including Black donor race is greater for 5-y than 1-y graft survival and predominantly in the high-risk donor-recipient pairs, as anticipated. The 6% difference in 5-y graft survival is at the 5th percentile of graft survival and the difference at the 50th percentile (median) is 3.5% at 5 y. In the light of overall efforts to increase equity and access to transplantation and to deemphasize posttransplant outcomes when assessing both transplant program and transplant system performance and effectiveness, we judge this decrease to be a reasonable tradeoff that needs to be assessed in context of high mortality on dialysis.¹⁰

Use of a race-free KDRI calculator resulted in reclassification of approximately half of Black donor kidneys to a lower (GF) risk KDPI allocation category. We report higher odds of discarding of kidneys procured from Black donors even after adjusting for baseline covariates used in KDRI calculation other than race. Because rates of discard have been reported to rise sharply and progressively beyond KDPI of 60%,¹¹ kidneys from a Black donor may be more likely to get discarded due to perceptions of quality based on KDPI rather than race.¹² Indeed, the finding that this increase is eliminated

TABLE 5.
Discard probability models (logistic regression)

Model number	Donor kidneys included	Model covariates	Odds ratio: Black/non-Black	P
1	All	None (unadjusted)	1.31	<0.0001
2	All	KDRI components, not including race	1.24	<0.0001
3	Top quartile of KDRI	KDRI components, not including race	1.12	<0.0001
4	All	KDRI including race	0.88	<0.0001

KDRI, Kidney Donor Risk Index.

and even reversed when adjusting for all components of KDRI including race (and thus KDPI values communicated with organ offers) suggests that a KDPI labeling effect may account in part for the increased discard rates among Black donor kidneys, as has been noted for high KDPI kidneys in general.¹³ Thus, the reduction of KDPI for Black donors with use of race-free KDRI would be anticipated to reduce the discard of Black donor kidneys by 10%, potentially allowing for 70 additional transplants per year from Black donors. However, since organ quality is assessed only in part by KDPI, at any given KDPI Black race may be discounted as a risk factor in utilization relative to other risk factors in the KDPI, which would explain the lower discard rates of Black kidneys when accounting for KDRI. This effect might lessen the impact of race-free KDRI on discard of Black donor kidneys.

Such a reduction in discard of kidneys from Black donors will likely benefit Black recipients as they more often receive kidneys from a Black donor due to greater similarities in blood type and better HLA matching.¹⁴ Such a change would immediately benefit an already disadvantaged population who are at the highest risk of developing kidney disease and have less access to transplantation than non-Blacks. However, our findings suggest that there are factors beyond inclusion of Black race in KDRI calculation that result in increased discard of kidneys from Black donors. We understand that using current KDRI calculator without race coefficient (instead of creating a new model with different coefficient) will underestimate risk of graft loss for the 15% of Black donors that carry 2 *APOL1* kidney risk variants but will also provide better estimates for the remaining 85% who are currently assigned a higher KDRI (carrying 1 or no *APOL1* kidney risk variants). Since the risk may be underestimated for only 15% of Black donors (2.25% of all donors) this error may be acceptable from a societal and net-benefit perspective as it rectifies the misclassification of the 85% of Black donor kidneys whose recipients are likely to experience better graft outcomes than that predicted by the current KDRI. Although *APOL1* genetic testing may help risk stratify these kidneys better, it is also not going to be perfect as only 20% of the kidneys from donors with 2 *APOL1* kidney risk variants fail prematurely.⁶ The lack of 100% predictive accuracy will be limitation of any risk prediction tool solely based on donor characteristics as graft survival is a complex interplay of donor, transplant, and recipient characteristics. The increased risk of GF with use of kidneys carrying 2 *APOL1* kidney risk variants must be weighed against high mortality associated with remaining on dialysis.

Limitations of our study include the use of large registry data that, despite their demonstrated utility, were not collected for research purposes. There may be other factors contributing to discard such as higher terminal serum creatinine observed in Black versus White donors for same level of renal function (which also contributes to higher KDRI and KDPI values), and

higher prevalence of comorbidities, such as hypertension, hepatitis C, and stroke. Although we accounted for these comorbidities in our analyses, we cannot capture center-level practices for acceptance of kidneys in presence of multiple donor risk factors (holistic review of the organ offer beyond KDPI) and the intended recipient comorbidities. Also, we assume in our calculations that donor race does not impact clinician's decision to use or discard the kidney. Lastly, the results may change if the race COEFFICIENT was not just zeroed out and the KDRI was redeveloped without the race variable. However, this is outside of the current scope of the analysis.

The KDRI calculator was developed when the association between the donor *APOL1* genotype and kidney transplant outcomes was not well recognized. Subsequent studies have demonstrated an improvement in discriminatory and predictive power of KDRI calculator when *APOL1* status was used instead of donor race. The prospect of substituting race with *APOL1* status to calculate KDRI is intuitively appealing and serves as a step toward eliminating systemic racism in medicine. However, the results of *APOL1* Long-term Kidney Transplantation Outcomes Network study will unfortunately not be available for a few years, and incorporation of the *APOL1* genotype information in kidney allocation may take additional time. Calculators based solely on donor characteristics to predict risk of graft failure will always be suboptimal and imperfect. Both the original and race-free KDRI calculators have unique strengths and weaknesses. We have shown that the use of race-free KDRI did not impact GF risk discrimination or predictive accuracy for majority of kidneys being offered except for a small fraction of kidneys from Black donors. Given the lack of a clear advantage of the current KDRI with race coefficient, the removal of race, a social construct, would be an important step in addressing bias and systematic racism in medicine. We recommend removal of the race coefficient from KDRI calculation as a first step. This could also potentially reduce discard of kidneys from Black donors, which could have an immediate effect in mitigating some of the racial disparities in transplantation.

ACKNOWLEDGMENTS

The data analyzed here have been supplied by the Hennepin Healthcare Research Foundation as the contractor for the Scientific Registry of Transplant Recipients. The authors wish to thank 2 anonymous reviewers for their thoughtful comments and suggestions, which strengthened the article considerably.

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