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Factors leading to the discard of deceased donor kidneys in the United States

Sumit Mohan, MD, MPH^{1,2,3}, Mariana C Chiles, MPH^{1,3}, Rachel E Patzer, PhD, MPH^{4,5}, Stephen Pastan, MD⁶, S Ali Husain, MD, MPH^{1,3}, Dustin Carpenter, MD, MPH⁷, Geoffrey K Dube, MD¹, R John Crew, MD¹, Lloyd E Ratner, MD, MPH⁷, and David J Cohen, MD¹

¹Department of Medicine, Division of Nephrology, Columbia University Medical Center, New York, New York

²Department of Epidemiology, Columbia University Mailman School of Public Health, New York, New York

³The Columbia University Renal Epidemiology (CURE) Group, New York, New York

⁴Department of Surgery, Division of Transplantation, Emory University School of Medicine, Emory University, Atlanta Georgia

⁵Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, Georgia

⁶Department of Medicine, Renal Division, Emory University School of Medicine, Emory University, Atlanta, Georgia

⁷Department of Surgery, Division of Transplantation, Columbia University Medical Center, New York, NY

Abstract

The proportion of deceased donor kidneys procured for transplant but subsequently discarded has been growing steadily in the United States but factors contributing to the rising discard rate remain unclear. To assess the reasons for and probability of organ discard we assembled a cohort of 212,305 deceased donor kidneys recovered for transplant from 2000-2015 in the SRTR registry that included 36,700 kidneys that were discarded. ‘Biopsy Findings’ (38.2%) was the most commonly reported reason for discard. The median Kidney Donor Risk Index of discarded kidneys was significantly higher than transplanted organs (1.78 vs 1.12), but a large overlap in the quality of discarded and transplanted kidneys was observed. Kidneys of donors who were older, female, Black, obese, diabetic, hypertensive or HCV positive experienced a significantly increased

Corresponding Author: Sumit Mohan, MD, MPH, Division of Nephrology, Department of Medicine, Columbia University Medical Center, 622 W. 168th St, PH4-124, New York, NY 10032 Tel (212) 305 5020 Fax (212) 305 6692, sm2206@cumc.columbia.edu.

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odds of discard. Kidneys from donors with multiple unfavorable characteristics were more likely to be discarded while unilaterally discarded kidneys had the most desirable donor characteristics and the recipients of their partner kidneys experienced a one-year death censored graft survival rate over 90%. There was considerable geographic variation in the odds of discard across the United States which further supports the notion that factors beyond organ quality contributed to kidney discard. Thus, while the discard of a small fraction of organs procured from donors may be inevitable, the discard of potentially transplantable kidneys needs to be avoided. This will require a better understanding of the factors contributing to organ discard in order to remove the disincentives to utilize less than ideal organs for transplantation.

Keywords

kidney transplantation; organ discard; allocation; biopsy; deceased donors

Introduction

Kidney transplantation is the treatment of choice for patients with end stage renal disease (ESRD).^{1, 2} However, the supply of kidneys available for transplantation appears to have plateaued in the United States (U.S.). The widening gap between supply and demand for transplantable kidneys has resulted in <35% of patients being transplanted within 5 years of waitlisting, while only 36% of patients on dialysis survive 5 years.³ Nevertheless, the number of deceased donor kidneys that are procured for transplant but subsequently discarded has been growing steadily in the U.S., reaching almost 2,700 kidneys annually.⁴ While the discard of a small fraction of organs procured from deceased donors may be inevitable in the pursuit of optimal patient outcomes, the aging of the population and the increasing burden of comorbidities, such as diabetes and obesity, necessitates an improved ability to use less-than-ideal organs.

It is unclear if the rising discard of kidneys is the result of increasing selectivity of organs due to regulatory scrutiny of transplant centers,⁵ increasing procurement of lower quality organs, or other systemic factors.^{6, 7} Our current understanding of kidney discards is limited to studies that preceded current donor classifications, were restricted to small subgroups of donors or to single donor service areas.^{8–13} The paucity of research and limited understanding of the factors contributing to the high rates of organ discard is a major concern and confounded by the limitations of the data collected by the Organ Procurement and Transplantation Network (OPTN).⁶

To our knowledge, this analysis provides the first complete characterization of all deceased donor kidney discards in the U.S., including an evaluation of unilateral discards that are previously undescribed. We identify discard trends over a 16-year period and identify donor- and organ-specific characteristics associated with discard. Additionally, using the Kidney Donor Risk Index (KDRI) and Kidney Donor Profile Index (KDPI), we compare the estimated organ quality of transplanted kidneys to those discarded and evaluate the outcomes of unilaterally transplanted kidneys.

Methods

Study design and participants

This study used data from the Scientific Registry of Transplant Registry (SRTR). The SRTR data system includes data on all donors, wait-listed candidates, and transplant recipients in the U.S., submitted by the members of the OPTN. The Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors. We utilized the SRTR standard analytical file (2016 Quarter 1) to conduct a retrospective cohort study to analyze deceased donor kidneys recovered for transplantation from 2000-2015. Over the study period, we identified 212,305 deceased donor kidneys procured for transplantation including 36,700 (17.3%) kidneys that were subsequently discarded. The discarded kidneys were one of three types: (1) bilateral discards: both kidneys from a donor were recovered and discarded; (2) unilateral discards: both kidneys from the donor were recovered, one kidney was discarded while the partner kidney was transplanted; and (3) single discards: one kidney was recovered and discarded. The study cohort selection process is illustrated in Figure 1.

Each of the 21 discrete reasons for discard identified in SRTR were mapped to eight overarching categories: (1) Extended Ischemia; (2) Organ Damage; (3) Anatomical Abnormalities; (4) Poor Function; (5) Donor History; (6) Biopsy Findings; (7) No Recipient Located and (8) Other. For unilateral discards, the reasons for discard were aggregated into allocation system-related reasons (cold ischemia time accrued/no recipient located), donor-specific reasons (donor history), organ-specific reasons (organ damage/anatomical abnormality, poor organ function, biopsy findings) or other.

Donors with multiple unfavorable characteristics (e.g. terminal sCr > 2 mg/dL, KDPI >85%, age 50 years etc.) are likely to have more of an impact on the discard rate (and thus the probability of an organ being discarded) than when these characteristics occur in separate donors. To account for this in our multivariable model, we identified 14 donor characteristics deemed to be unfavorable and counted how many of these traits each donor had (Figure 2). These 14 undesirable traits included: age > 50 years, obese (BMI >35 kg/m²), African-American/Black, history of hypertension, history of diabetes, death due to CVA, terminal sCr >2 (mg/dL), DCD, HCV positive, KDPI >85%, smoked >20 cig packs/year, IV drug use, history of drug use (non-IV), history of alcoholism. Thus, the number of unfavorable characteristics in a given deceased donors could range from none to a maximum of 14.

Estimating Deceased Donor Organ Quality: KDRI and KDPI—For the purposes of this analysis, organ quality was estimated by calculating the KDRI and KDPI, with lower values suggestive of better quality. The KDRI/KDPI are currently used as part of the OPTN allocation system for deceased donor kidneys in the U.S. and have been validated as reliable measures of organ quality in the U.S. and other developed countries.^{14–18} The KDPI is derived from the KDRI, a measure used to estimate the relative risk of post-transplant allograft failure. We calculated the KDRI as described by the OPTN, using 10 donor specific characteristics: age, height, weight, ethnicity, history of hypertension, history of diabetes, cause of death, serum creatinine, Hepatitis C virus (HCV) status, and donation after cardiac death (DCD) status.¹⁹ To generate the KDPI, we mapped the calculated KDRI values onto a

cumulative percentage scale. Because our analysis identified kidneys recovered from 2000 to 2015, as recommended by the OPTN, the 2015 scaling factor for converting KDRI Rao to KDRI median was used.^{19, 20} For our multivariable models, we chose to include KDRI rather than KDPI because the incremental change in the KDRI per change in the unit change of KDPI is not linear.

Statistical analysis

Pearson's chi-square tests, student t-tests and the nonparametric Wilcoxon/Kruskal-Wallis tests were performed for categorical and continuous variables, respectively. All continuous values are expressed as medians and interquartile range (IQR) or means and standard deviation (SD) where appropriate. Logistic regression models were used to identify predictors of discard (vs. transplant). Transplant, recipient and donor characteristics were viewed as being potential model parameters. Bivariable analysis of each potential covariate was performed; any variable having a significant Wald test was considered a potential candidate for the multivariable analysis. Additionally, in an effort to avoid overfitting, a cluster analysis was performed to understand variable sub-groups. Known clinical relevance also contributed to the final selection of model parameters.

Overall graft failure was considered a composite of both patient death and graft failure. Death-censored graft failure was defined as graft survival censored for death with a functioning graft. Time-to-event was calculated as the number of days from the transplant date to the event, date of censoring (e.g. loss of follow-up), or the end of the study period (3/6/2016). The extent of the overlap in the quality of the transplanted and discarded kidneys was measured using the Bhattacharya coefficient²¹. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC) and Stata 14.1 (StataCorp, College Station, TX). Statistical significance was identified by a p-value<0.05.

Results

From 2000-2015, we identified 212,305 kidneys that were procured for transplantation (Figure 1), of which 17.3% were discarded (n=36,700; Table 1). The number of deceased donor kidneys being discarded increased 91.5% from 2000 to 2015 (1,561 to 2,990, p<0.001; Figure 3) while the quality of organs being recovered for transplant has remained relatively stable (median KDPI 47% to 50%). The increase in kidney discards outpaced the increase in the total number of kidneys recovered, raising the discard rate from 14.9% (2000) to 19.0% (2015) (Figure 3). Kidneys with higher KDPIs were more likely to be discarded; about half (50.6%) of deceased donor discards had KDPIs ≥ 85% (Figure 4).

Among the 36,700 kidneys that were discarded, 7,873 (21.5%) were unilateral discards, 1,285 (3.5%) represented single discards and the remaining were bilateral discards (75.0%; Table 1; Figure 1). A higher proportion of discarded kidneys were from older and heavier donors; they had higher KDRI/KDPI scores (i.e. were of lower quality) and higher terminal creatinine (sCr) levels (p-values <0.001). Additionally, discarded were observed to have a higher prevalence of donors who were female (47.2% vs 39.2%), diabetic (20.8% vs 5.8%) and hypertensive (60.0% vs. 24.1%). Discarded kidneys also had a higher proportion of organs that had been biopsied (77.1% vs. 36.1%; p-values <0.001; Table 1). While the

median KDRI of discarded kidneys was higher than that of transplanted organs (1.12 vs. 1.78, $p < 0.001$), a large overlap (Bhattacharya coefficient 0.83) in the quality of discarded and transplanted kidneys was observed (Figure 5). The donors with discarded organs had a significantly higher number of unfavorable donor characteristics than for those associated with organs that were transplanted (4.0 ± 1.9 versus 2.1 ± 1.7 , $p < 0.001$).

Unilaterally discarded kidneys had more desirable donor characteristics than bilateral discards (Table 1), with a lower proportion of diabetic (12.9%), hypertensive (45.7%), and Black donors (14.0%). Unilateral discards had the lowest mean terminal serum creatinine and KDRI/KDPI of all discard types (all p -values < 0.001). However, a higher proportion of these kidney discards were attributed to organ damage (10.2%) or anatomical abnormalities (12.4%) when compared to bilateral discards (Table 2).

'Biopsy Findings' (38.2%) was the most commonly reported reason for discard (Table 2). 'Poor organ function' (9.6%), inability to locate a recipient (14.6%) and 'Other' (16.3%) were the other leading reasons for organ discard. The highest proportion of unilateral discards was attributed to 'Other' (23.8%) while 'Biopsy Findings' was the most reported reason for bilateral discards (43.7%; all p -values < 0.001). Regardless of discard type, extended ischemia was the least likely reason for discard, representing only 2.5% of discards.

Odds of Discard

On bivariable analysis, kidneys from donors who were older, female, obese, and Black, as well as donors who were diabetic, hypertensive, HCV positive, had elevated creatinine, or died due to a cerebrovascular accident experienced an increased odds of discard (all p -values < 0.001 ; Table 3). The relationship between kidney discard and donor age, gender, diabetes status, hypertension status, elevated terminal creatinine and HCV status all persisted on multivariable analysis (all p -values < 0.001). Having had a biopsy performed increased the probability of discard almost 6-fold ($OR = 5.95$, $p < 0.001$) on bivariable analysis. Additionally, kidneys from donors who had negative social behavior (IV/non-IV drug users, chronic smokers or alcoholics) significantly increased discard odds (all p -values < 0.001 ; Table 3); these relationships persisted even after adjusting for donor demographics and clinical factors. On bivariable analysis, kidneys with higher KDRI/KDPIs were more likely to be discarded: every 1% unit increase in KDPI corresponded to a 5% increase in the odds of discard (odds ratio [OR] = 1.05, $p < 0.001$) while every 0.05 KDRI unit increase corresponded to a 14.0% increase ($OR = 1.14$, $p < 0.001$). Kidneys with KDPI scores $> 85\%$ experienced a near 10-fold increase in the odds of being discarded ($OR = 9.81$, $p < 0.001$); while this relationship persisted on multivariable analysis, the odds reduced to a near 2-fold increase (adjusted OR [aOR] = 1.98, $p < 0.001$). The more unfavorable characteristics a donor had, the higher the likelihood of discard (Table 3). Compared to donors with no potentially unfavorable qualities, those who possessed 1 experienced anywhere from an 1.41 (for 1 trait) to 21.42 (for 5 traits) times increase in odds of discard (all p -values < 0.001).

Geographic Variation

From 2000 to 2015, there was a wide variance in the probability of kidney discard across the United States; with the odds ranging from 0.73 to 1.28 across the 11 UNOS Regions (Regions) (Table 4; Figure 6). When adjusting for donor demographics, clinical factors and social histories, organs recovered in the Southeast (Regions 11 and 3), the Southwest (Region 4) and part of the Midwest (Regions 8 and 10) experienced an increased odd of being discarded when compared to the rest of the United States (all p-values = 0.007; Table 4). Being procured in the Southeast increased the likelihood of a kidney being discarded by 6-14% (Region 3: aOR=1.06 and Region 11: aOR=1.14) while kidneys from the Southwest experienced a 12% increase (Region 4: aOR=1.12). UNOS regions 8 and 10 in the Midwest showed an increased odd of 8% and 28% (aOR=1.08 and aOR=1.28, respectively). Region 2 in the Northeast and Region 6 in the Pacific Northwest illustrated no significant difference in discard odds when compared to the rest of the United States. Kidney procurement in the West (Region 5), region 7 in the Midwest, or in Regions 9 and 1 in the Northeast proved to be protective against discard (all aOR p-values <.001; Table 4). Kidneys recovered in Region 1 were 27% less likely to go unused compared to those recovered in the other UNOS Regions (aOR=0.73), while kidneys from Regions 5, 7 and 9 saw a 16%, 17% and 19% decreased probability of discard, respectively.

Unilateral Transplant Outcomes

The number of deceased donor kidneys that were transplanted while their partner kidneys were discarded is increasing (Figure 1); contributing to 7,873 discards from 2000-2015. Unilateral transplants had a median follow-up time of 3.0 years (IQR=5.0). Kidneys of partners discarded due to donor-specific reasons experienced the longest follow-up times (median=4.0 years; IQR=6.1) while kidneys with partners discarded as a result of allocation system related reasons experienced the shortest (median=2.0 years; IQR=3.7; Table 5).

Recipients of unilateral transplants, irrespective of the cause of the unilaterally discarded partner kidneys, experienced a 1-year death-censored graft survival rate > 90% (Table 5), while recipients of the kidney whose partner kidneys were discarded due to allocation system related reasons (e.g. extended ischemia and no recipient located) experienced a 1-year graft survival rate of 96.5%. Failure rates for transplanted kidneys for other discard categories were also low (Organ Specific: 6.2%; Donor Specific: 5.7%; Other: 5.1%; Table 5). Even among recipients with data at the 5-year mark (n=2,755), failure rates were very low (Organ Specific: 12.9%; Donor Specific: 14.1%; allocation Specific: 11.4; Other: 11.9%).

Overall graft survival rates at 1-year post-transplant ranged from 85.0% to 87.9% (Table 5). Recipients of kidneys whose partner kidneys were discarded due to allocation system specific reasons experienced the lowest 1- and 3-year graft failure rate (12.1% and 23.9%, respectively); those whose partner kidney belonged to the organ specific discard group experienced the highest overall 1 year graft failure rates (15.0%). The percentage of transplanted partners of unilateral discarded kidneys, at the 3-year mark, was relatively low independent of the reason for discard: organ specific: 26.4%; donor specific: 26.7%; allocation system specific: 23.9%; other: 24.5% (Table 5).

Discussion

The U.S. discard rate for deceased donor kidneys is high compared to that of other developed countries like the U.K. (12%)¹⁶ and adversely impacts transplantation rates and waitlist times.^{22–24} With the average 5-year survival for all patients on dialysis (36%) being substantially lower than the estimated 5-year graft survival rate (41.1%) for the worst quality kidneys (i.e. those with a KDPI of 99%), the high and apparently rising discard is of concern (average annual mortality rate in 2014 for waitlisted patients was 53.7 per 1000 dialysis patient years at risk). While half the kidneys being discarded had a KDPI >85%, the increasing number and quality of discards over the study period (Figure 4) suggests increasing selectivity by providers and transplant centers – potentially in response to regulatory pressures on transplant centers^{5, 23, 25–29}. Understanding the factors contributing to the discard of organs is essential if utilization rates are to be improved, and examining these factors provides an opportunity for cross-pollination of ideas across different systems that have implemented various strategies to improve utilization rates.^{30, 31}

Preliminary data (within the first 6 months) following implementation of the new Kidney Allocation System (KAS) in the U.S. (in December 2014) suggests a further recent uptick in the discard of deceased donor kidneys to 20.2%.³² A similar increase in the discard rate occurred after the introduction of the ECD nomenclature and did not abate, suggesting the more recent uptick in discards is not completely unexpected and may persist in the absence of additional efforts to improve organ utilization rates.²³ A recent analysis by Stewart, et al. highlighted the temporal association between the introduction of program specific reports and an increase in discard rates, as well as the detrimental impact of procurement biopsies while underscoring the beneficial impact of machine perfusion.²³

Our results confirm the significant overlap (Figure 5) in the quality of the kidneys that are transplanted with those that are discarded. While the discard of some kidneys may be unavoidable due to reasons not captured by the KDRI, such as extreme biopsy findings and anatomical variations that pose technical challenges (e.g. multiple arteries), this overlap suggests that there are opportunities for improving organ allocation to facilitate increased utilization. Discarded organs were more likely to come from older, heavier donors who were black, female, diabetic, hypertensive, with undesirable social behavior and higher terminal creatinine. Biopsy findings remain the most commonly reported reason for discard (Table 2) despite growing evidence that questions the role/value of preimplantation biopsy findings, in part because of the poor predictive value of results provided by on-call pathologists with limited or no specific training in renal pathology.^{24, 32–40} Similarly, other leading causes of organ discard including donor history (that would adversely impact allograft function) and poor organ function even though these factors are largely accounted for by the KDRI. Donors of discarded kidneys had a mean of 4 or more unfavorable characteristics – which was significantly greater than those donors whose kidneys were accepted.

While the presence of anatomical abnormalities or damage during organ procurement cannot be easily incorporated into any broad quality score such as the KDRI, the relatively rapid increase in the use of “anatomical abnormality” (from 125 kidneys in 2000 to 202 kidneys annually by 2015) suggests either a rapid increase in the prevalence of anatomical

abnormalities among deceased donors or perhaps, an increasing reluctance to use organs with anatomic variations. Further, while organ damage that occurs at the time of procurement appears to be an infrequent and unfortunate reason for organ discard, it should be noted that inadvertent organ damage at the time of procurement from a living donor is likely to result in organ repair and transplantation rather than discard..

Donor-specific factors, including biopsy findings or donor history, can be controlled for since these factors equally impact both kidneys of a donor; and yet we note that with the exception of an increase in organ damage (from 1.6% of bilateral discards to 10.2% of unilateral discards), the reasons for unilateral discard were very similar to that of bilateral discards. This, coupled with the category “no recipient located” being the second most common reason for an organ discard, further supports the notion that factors beyond organ quality appear to influence utilization decisions.⁷ Similarly, the unilateral discard of organs due to extended ischemia suggests a system failure to appropriately place a kidney quickly enough with an accepting transplant center. Given recent data suggesting the positive impact of perfusion pumps during cold storage on discards, this is potentially a category of discards that could be eliminated with optimization of post-procurement organ management.⁴¹

While the KDRI is a reasonable and reproducible measure of organ quality, there are several factors within the score that appear to contribute to a far greater extent to the discard of organs. Most notable is that kidneys from HCV positive donors are 5 times more likely to be discarded than not; however, this may be a reflection of the small numbers of potential HCV positive recipients available to accept these kidneys currently.⁴² Consistent with prior analyses, we confirmed that DCD status, donor diabetes and terminal serum creatinine are factors that are all independently associated with an increased risk of discard.^{43, 44} However, recent evidence suggesting excellent outcomes from diabetic deceased donor kidneys and from organs that have elevated terminal creatinine from acute renal failure do not support these practices.^{45–48} Similarly, the increased risk of discard of kidneys from smokers, independent of organ quality, may reflect theoretical concerns about increased glomerulosclerosis secondary to smoking; nevertheless, there does not appear to be any evidence that this trait has an adverse impact on allograft outcomes in the long-term.^{49, 50} A history of IV drug use by the donor, as well as other factors that are included in the CDC high-risk organ designation, are associated with a higher likelihood of discard despite evidence of extremely low rates of disease transmission and the excellent outcomes seen with these kidneys.⁵¹ There are systematic and policy opportunities to lower the discard of these organs. For example, the widespread adoption of nucleic acid test testing to allay fears of transmission and perhaps changing the labeling to better reflect the level of risk from “high risk” to “known risk” would change patient and provider perceptions and concerns.^{52, 53} The influence of labels, at least early after introduction, may at least partially explain the recent increase in discards in the KAS in the U.S. especially at the lower end of the quality spectrum.⁵⁴ Labels may also lead to the double counting of factors such as the duplicative consideration of donor diabetes status and the KDPI. However, quality-specific labels also provide a potential opportunity to increase the utilization of dual renal transplant for recipients rather than completely discarding these kidneys.^{43, 55}

The most concerning reported reason for discard is “no recipient located,” which suggests a failure of the allocation system to appropriately allocate kidneys to centers or patients willing to accept more marginal organs, especially given recent evidence that even the lowest quality kidneys can be safely transplanted to achieve outcomes far superior to what one can expect with dialysis.^{56–58} Additionally, older kidney transplant candidates gain a survival benefit by accepting high KDPI kidneys and reducing their time on the waitlist, as compared to waiting for kidney with a lower KDPI, or in some instances even waiting for a living donor kidney.¹⁴ This category has grown to the second leading cause of discard, representing 25% of all discards in 2015 and 55% of the total increase in the number of discarded kidneys from 2000-2015 and underscores the need for more granular data capture in order to be able to better understand the factors driving the increase in discard rates.

Unilateral kidneys discards are also rising and of particular concern given that their partner kidneys appear to be associated with excellent post-transplant outcomes and that these kidneys are frequently being discarded for reasons unrelated to organ quality. The unilateral discard of kidneys underscores the contribution of systemic factors to the eventual discard of deceased donor organs that were otherwise potentially transplantable.

The discard of deceased donor organs across the country varied considerably and the factors that contribute to this geographic variation, while unclear at present, likely represent another opportunity to identify factors that are contributing to the phenomenon of organ discard.

While this analysis has the limitations commonly associated with the use of registry data, the absence of more granular data submitted by the OPTN on the reason for discard is significant and is reflected in just how large the “other” category is.⁵⁹ Frequently, centers decline an organ for a combination of reasons – for example, long cold ischemia time for a high KDPI kidney when the same cold ischemia time would have been deemed acceptable for a lower KDPI organ. However, the current system does not allow centers to provide this level of detail, which may in turn preclude a more precise assessment of the contribution of secondary factors to discards; or an understanding of systemic and organizational factors that are contributing to the current high and rising rates of discard.^{7, 59}

We found that “No Recipient Located” is a frequently listed cause of discard; however, given the tremendous shortage of organs, this seems improbable for such a large number of kidneys annually. Although some of the procured but discarded kidneys analyzed in this study could have potentially been successfully transplanted with good outcomes, the quality of the data makes a more precise estimate difficult. While this study provides the first comprehensive characterization of kidney discards in the U.S. and gives insight into why discards are occurring, more sophisticated analyses cannot occur until the OPTN collects more granular data regarding the factors that contribute to organ discard. Our analysis identified a novel description of the significant overlap in the quality of organs transplanted and discarded, donor factors that increase the odds of discards, and the potential for the successful utilization of organs that are currently being discarded. Our findings suggest the need for improvement in the identification, understanding, and recoding of the reasons that result in procured kidneys being declined by transplant programs and eventually discarded as a first step towards becoming better stewards of this scarce and valuable resource.

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References

1. Merion RM, Ashby VB, Wolfe RA, et al. Deceased-donor characteristics and the survival benefit of kidney transplantation. *JAMA*. Dec 7; 2005 294(21):2726–2733. [PubMed: 16333008]
2. 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*. Dec 2; 1999 341(23):1725–1730. [PubMed: 10580071]
3. U.S. Renal Data System, USRDS 2010 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2010.
4. Matas AJ, Smith JM, Skeans MA, et al. OPTN/SRTR 2011 Annual Data Report: kidney. *Am J Transplant*. Jan; 2013 13(Suppl 1):11–46.
5. Schold JD, Buccini LD, Srinivas TR, et al. The association of center performance evaluations and kidney transplant volume in the United States. *Am J Transplant*. Jan; 2013 13(1):67–75.
6. Matas AJ, Smith JM, Skeans MA, et al. OPTN/SRTR 2012 Annual Data Report: Kidney. *Am J Transplant*. Jan; 2014 14(Suppl 1):11–44.
7. Mohan S, Foley K, Chiles MC, et al. The weekend effect alters the procurement and discard rates of deceased donor kidneys in the United States. *Kidney Int*. Jul; 2016 90(1):157–163. [PubMed: 27182001]
8. Stratta RJ, Rohr MS, Sundberg AK, et al. Increased kidney transplantation utilizing expanded criteria deceased organ donors with results comparable to standard criteria donor transplant. *Ann Surg*. May; 2004 239(5):688–695. discussion 695–687. [PubMed: 15082973]
9. Sung RS, Christensen LL, Leichtman AB, et al. Determinants of discard of expanded criteria donor kidneys: impact of biopsy and machine perfusion. *Am J Transplant*. Apr; 2008 8(4):783–792. [PubMed: 18294347]
10. Sung RS, Galloway J, Tuttle-Newhall JE, et al. Organ donation and utilization in the United States, 1997-2006. *Am J Transplant*. Apr; 2008 8(4 Pt 2):922–934. [PubMed: 18336696]
11. Cho YW, Shah T, Cho ES, et al. Factors associated with discard of recovered kidneys. *Transplant Proc*. May; 2008 40(4):1032–1034. [PubMed: 18555108]
12. Singh SK, Kim SJ. Epidemiology of kidney discard from expanded criteria donors undergoing donation after circulatory death. *Clinical Journal of the American Society of Nephrology*. 2015 CJN. 07190715.
13. Messina M, Diena D, Dellepiane S, et al. Long-term outcomes and discard rate of kidneys by decade of extended criteria donor age. *Clinical Journal of the American Society of Nephrology*. 2017; 12(2):323–331. [PubMed: 27979977]
14. Schold JD, Meier-Kriesche HU. Which renal transplant candidates should accept marginal kidneys in exchange for a shorter waiting time on dialysis? *Clin J Am Soc Nephrol*. May; 2006 1(3):532–538. [PubMed: 17699256]
15. Pine J, Goldsmith P, Ridgway D, et al. Validation of the kidney donor risk index (KDRI) score in a UK single centre DCD cohort. *Transplantation*. 2010; 90:196.

16. Callaghan CJ, Harper SJ, Saeb-Parsy K, et al. The discard of deceased donor kidneys in the UK. *Clin Transplant*. Mar; 2014 28(3):345–353. [PubMed: 24506794]
17. Rao PS, Schaubel DE, Guidinger MK, et al. A comprehensive risk quantification score for deceased donor kidneys: the kidney donor risk index. *Transplantation*. Jul 27; 2009 88(2):231–236. [PubMed: 19623019]
18. Watson CJ, Johnson RJ, Birch R, Collett D, Bradley JA. A simplified donor risk index for predicting outcome after deceased donor kidney transplantation. *Transplantation*. Feb 15; 2012 93(3):314–318. [PubMed: 22179407]
19. Services USDoHH. , editor. The Organ Procurement and Transplantation Network, United Network for Organ Sharing. A Guide to Calculating and Interpreting the Kidney Donor Profile Index (KDPI). 2016.
20. The Organ Procurement and Transplantation Network UNfOS. KDRI to KDPI Mapping Table. 2016
21. Bhattacharyya A. On a Measure of Divergence between Two Multinomial Populations. *Sankhya: The Indian Journal of Statistics (1933-1960)*. 1946; 7(4):401–406.
22. Reese PP, Harhay MN, Abt PL, Levine MH, Halpern SD. New Solutions to Reduce Discard of Kidneys Donated for Transplantation. *J Am Soc Nephrol*. Apr 1; 2016 27(4):973–980. 2016. [PubMed: 26369343]
23. Stewart DE, Garcia VC, Rosendale JD, Klassen DK, Carrico BJ. Diagnosing the decades-long rise in the deceased donor kidney discard rate in the United States. *Transplantation*. 2017; 101(3):575–587. [PubMed: 27764031]
24. Wang CJ, Wetmore JB, Crary GS, Kasiske BL. The Donor Kidney Biopsy and Its Implications in Predicting Graft Outcomes: A Systematic Review. *Am J Transplant*. Jul; 2015 15(7):1903–1914. [PubMed: 25772854]
25. Schold JD, Nicholas LH. Considering potential benefits and consequences of hospital report cards: what are the next steps? *Health Serv Res*. Apr; 2015 50(2):321–329. [PubMed: 25756733]
26. Kasiske BL, McBride MA, Cornell DL, et al. Report of a consensus conference on transplant program quality and surveillance. *Am J Transplant*. Aug; 2012 12(8):1988–1996. [PubMed: 22682114]
27. VanWagner LB, Skaro AI. Program-specific reports: implications and impact on program behavior. *Curr Opin Organ Transplant*. Apr; 2013 18(2):210–215. [PubMed: 23481412]
28. Abecassis MM, Burke R, Klintmalm GB, et al. American Society of Transplant Surgeons Transplant Center Outcomes Requirements—A Threat to Innovation. *Am J Transplant*. 2009; 9(6): 1279–1286. [PubMed: 19392984]
29. Schold JD, Arrington CJ, Levine G. Significant alterations in reported clinical practice associated with increased oversight of organ transplant center performance. *Prog Transplant*. Sep; 2010 20(3): 279–287. [PubMed: 20929114]
30. White AD, Roberts H, Ecuyer C, et al. Impact of the new fast track kidney allocation scheme for declined kidneys in the United Kingdom. *Clin Transplant*. 2015; 29(10):872–881. [PubMed: 26094680]
31. Vinkers MT, Smits JM, Tieken IC, de Boer J, Ysebaert D, Rahmel AO. Kidney donation and transplantation in Eurotransplant 2006-2007: minimizing discard rates by using a rescue allocation policy. *Prog Transplant*. Dec; 2009 19(4):365–370. [PubMed: 20050462]
32. Lee AP, Abramowicz D. Is the Kidney Donor Risk Index a step forward in the assessment of deceased donor kidney quality? *Nephrol Dial Transplant*. Aug; 2015 30(8):1285–1290. [PubMed: 25282158]
33. Azancot MA, Moreso F, Salcedo M, et al. The reproducibility and predictive value on outcome of renal biopsies from expanded criteria donors. *Kidney Int*. May; 2014 85(5):1161–1168. [PubMed: 24284518]
34. Kayler LK, Garzon P, Magliocca J, et al. Outcomes and Utilization of Kidneys from Deceased Donors with Acute Kidney Injury. *Am J Transplant*. 2009; 9(2):367–373. [PubMed: 19178415]
35. Bajwa M, Cho YW, Pham PT, et al. Donor biopsy and kidney transplant outcomes: an analysis using the Organ Procurement and Transplantation Network/United Network for Organ Sharing (OPTN/UNOS) database. *Transplantation*. Dec 15; 2007 84(11):1399–1405. [PubMed: 18091515]

36. Hall IE, Reese PP, Weng FL, et al. Preimplant histologic acute tubular necrosis and allograft outcomes. *Clin J Am Soc Nephrol.* Mar; 2014 9(3):573–582. [PubMed: 24558049]
37. Kasiske BL, Stewart DE, Bista BR, et al. The role of procurement biopsies in acceptance decisions for kidneys retrieved for transplant. *Clin J Am Soc Nephrol.* Mar; 2014 9(3):562–571. [PubMed: 24558053]
38. Lopes K, Alves R, Neto PA, Macário F, Mota A. The prognostic value of pre-implantation graft biopsy on the outcomes of renal transplantations. *Transplant Proc.* Jan-Feb;2011 43(1):67–69. [PubMed: 21335156]
39. Pokorna E, Vitko S, Chadimova M, Schuck O, Ekberg H. Proportion of glomerulosclerosis in procurement wedge renal biopsy cannot alone discriminate for acceptance of marginal donors. *Transplantation.* Jan 15; 2000 69(1):36–43. [PubMed: 10653377]
40. Mohan S, Campenot E, Chiles MC, et al. Association between Reperfusion Renal Allograft Biopsy Findings and Transplant Outcomes. *J Am Soc Nephrol.* Oct; 2017 28(10):3109–3117. [PubMed: 28684646]
41. Woodside KJ, Merion RM, Leichtman AB, et al. Utilization of kidneys with similar kidney donor risk index values from standard versus expanded criteria donors. *Am J Transplant.* Aug; 2012 12(8):2106–2114. [PubMed: 22702349]
42. Reese PP, Abt PL, Blumberg EA, Goldberg DS. Transplanting Hepatitis C-Positive Kidneys. *N Engl J Med.* Jul 23; 2015 373(4):303–305. [PubMed: 26200976]
43. Tanriover B, Mohan S, Cohen DJ, et al. Kidneys at higher risk of discard: expanding the role of dual kidney transplantation. *Am J Transplant.* Feb; 2014 14(2):404–415. [PubMed: 24472195]
44. Mohan S, Foley K, Patzer R, Cohen D, Pastan S. Characteristics of discarded kidneys from deceased donors in the United States. *Am J Transplant.* Jun.2014 14(S3):587.
45. Cohen JB, Bloom RD, Reese PP, Porrett PM, Forde KA, Sawinski DL. National outcomes of kidney transplantation from deceased diabetic donors. *Kidney Int.* Oct 21; 2015 89(3):636–647.
46. Hall IE, Schroppel B, Doshi MD, et al. Associations of deceased donor kidney injury with kidney discard and function after transplantation. *Am J Transplant.* Jun; 2015 15(6):1623–1631. [PubMed: 25762442]
47. Dube G, Mohan S, Ali N, Ratner L, Cohen D. Kidneys From Older Deceased Donors With Acute Renal Failure Provide Excellent Graft Survival. *Am J Transplant.* 2011; 11:226.
48. Dube G, Mohan S, Ali N, Ratner L, Cohen D. How Much Can One Kidney Take –Should ECD Kidneys With Acute Renal Failure Be Used? *Am J Transplant.* 2011; 11:226.
49. Markowitz GS, Lin J, Valeri AM, Avila C, Nasr SH, D’Agati VD. Idiopathic nodular glomerulosclerosis is a distinct clinicopathologic entity linked to hypertension and smoking. *Hum Pathol.* Aug; 2002 33(8):826–835. [PubMed: 12203216]
50. Underwood PW, Sheetz KH, Cron DC, Terjimanian MN, Englesbe MJ, Waits SA. Cigarette smoking in living kidney donors: donor and recipient outcomes. *Clin Transplant.* Apr; 2014 28(4): 419–422. [PubMed: 24617506]
51. Duan KI, Englesbe MJ, Volk ML. Centers for Disease Control ‘high-risk’ donors and kidney utilization. *Am J Transplant.* Feb; 2010 10(2):416–420. [PubMed: 19958324]
52. Kucirka LM, Namuyinga R, Hanrahan C, Montgomery RA, Segev DL. Provider utilization of high-risk donor organs and nucleic acid testing: results of two national surveys. *Am J Transplant.* May; 2009 9(5):1197–1204. [PubMed: 19422344]
53. Gallagher M, Tsapepas DS, Travis S, et al. CDC High Risk Designation for Deceased Kidney Donors is a Misnomer. *J Am Soc Nephrol.* 2013; 24:361A.
54. Massie AB, Luo X, Lonze BE, et al. Early changes in kidney distribution under the new allocation system. *J Am Soc Nephrol.* 2015 ASN. 2015080934.
55. Stratta RJ, Farney AC, Orlando G, et al. Dual kidney transplants from adult marginal donors successfully expand the limited deceased donor organ pool. *Clin Transplant.* Apr; 2016 30(4):380–392. [PubMed: 26782941]
56. Arce CM, Goldstein BA, Mitani AA, Lenihan CR, Winkelmayer WC. Differences in Access to Kidney Transplantation between Hispanic and Non-Hispanic Whites by Geographic Location in the United States. *Clin J Am Soc Nephrol.* Dec 6; 2013 8(12):2149–2157. [PubMed: 24115195]

57. Patzer RE, Pastan SO. Kidney Transplant Access in the Southeast: View From the Bottom. *Am J Transplant.* Jul; 2014 14(7):1499–1505. [PubMed: 24891223]
58. Gandolfini I, Buzio C, Zanelli P, et al. The Kidney Donor Profile Index (KDPI) of Marginal Donors Allocated by Standardized Pretransplant Donor Biopsy Assessment: Distribution and Association With Graft Outcomes. *Am J Transplant.* Nov; 2014 14(11):2515–2525. [PubMed: 25155294]
59. Singh SK, Kim SJ. The weekend effect: transplantation is not “immune”. *Kidney Int.* Jul; 2016 90(1):26–28. [PubMed: 27312445]

Figure 1.

Flow chart of the study population, 212,305 deceased donor kidneys recovered for transplant between 2000 and 2015

Figure 2.

Donors with multiple unfavorable characteristics were identified using fourteen unfavorable characteristics including clinical parameters and demographics.

Figure 3.

The frequency, type (single, unilateral, bilateral) and proportion of U.S. deceased donor kidney discards stratified by year of procurement (n = 36,700), 2000-2015

Figure 4. U.S. Organ quality (KDPI) of deceased donor kidney discards stratified by discard type (n =36,700), 2000-2015

Figure 5.
Kidney Donor Risk Index (KDRI) overlap of transplanted and discarded kidneys recovered from 2000 to 2015

Figure 6.
The adjusted odds ratio (aOR) of discard by UNOS region, 2000-2015

Characteristics of deceased donor renal transplants and discards among organs procured from 2000 – 2015

Table 1

Procured for Transplantation (N = 212,305)				Discard Type (N = 36,700)		
% or mean ± SD	Transplanted 175,605 (82.7)	Discarded 36,700 (17.3)	p	Single 1,285 (3.5)	Bilateral 27,542 (75.0)	Unilateral 7,873 (21.5)
<i>Donor Characteristics</i>						
Age (years)	36.5±16.5	52.4±16.0	<.001	40.3±27.0	54.5±14.7	47.0±15.7
Gender (% male)	60.8	52.8	<.001	54.6	52.4	54.1
BMI (kg/m ²)	26.6±6.6	28.3±7.1	<.001	25.2±7.8	28.5±7.1	28.1±6.9
African-American/Black	13.9	16.8	<.001	21.4	17.4	14.1
Death due to CVA	33.3	58.4	<.001	45.9	61.7	48.9
Donor Type (% ECD)	14.6	54.2	<.001	45.8	59.8	36.0
History of diabetes	5.8	20.8	<.001	16.5	23.2	12.9
History of hypertension	24.1	60.0	<.001	47.2	64.6	45.7
Clinical infection	47.5	46.4	<.001	46.2	45.8	48.6
Proteinuria	37.1	46.3	<.001	48.6	47.5	42.1
Terminal sCr (mg/dL)	1.11±0.91	1.52±1.20	<.001	1.34±1.12	1.59±1.24	1.27±1.04
<i>Transplant Characteristics</i>						
Median KDRI (IQR)	1.12 (0.53)	1.78 (0.75)	<.001	1.80 (0.63)	1.86 (0.75)	1.50 (0.64)
Median KDPI (%) ¹ (IQR)	42 (47)	85 (29)	<.001	86 (23)	88 (25)	71 (39)
Biopsy performed	36.1	77.1	<.001	58.9	80.3	68.6

BMI, body mass index; CVA, cerebrovascular accident; ECD, expanded criteria donor; IQR, interquartile range; KDRI, kidney donor risk index; KDPI, kidney donor profile index; sCr, serum creatinine
¹ KDPI is calculated based on a scaling factor of 1.2175005163, a median KDRI value among all deceased donor kidneys procured during 2015

Table 2

Common causes of kidney discard by discard quality and type of organs procured in the U.S. between 2000 and 2015 (N = 36,700)

	Extended Ischemia		Organ Damage	Anatomical Abnormality	Poor Function	Donor History	Biopsy Findings	No Recipient Located	Other	p
	N (Row %)	912 (2.5)	1,333 (3.6)	2,527 (6.9)	3,534 (9.6)	3,019 (8.2)	14,032 (38.2)	5,368 (14.6)	5,975 (16.3)	
Discard Type										
Single		1.9	6.5	9.6	10.0	7.2	29.0	18.0	18.0	<.001
Bilateral		1.8	1.6	5.2	9.8	8.8	43.7	15.1	14.1	
Unilateral		5.0	10.2	12.4	9.2	6.5	20.6	12.4	23.8	
Organ quality										
Median KDRI (IQR)		1.59 (0.61)	1.29 (0.71)	1.66(0.75)	1.73 (0.73)	1.65 (0.74)	1.90 (0.72)	1.83(0.74)	1.64(0.75)	<.001
Median KDPI (IQR) ¹		76.5 (32.5)	57 (54)	80 (37)	84 (31)	80 (35)	89 (22)	87 (25)	79 (36)	<.001
Median terminal sCr (mg/dL) (IQR)		1.10 (0.70)	1.0 (0.70)	1.10 (0.70)	1.40 (1.34)	1.10 (0.80)	1.30 (0.90)	1.20 (0.98)	1.10 (0.90)	<.001
Biopsy performed		2.3	1.8	4.9	9.3	5.8	46.4	15.8	13.9	<.001
Discarded Locally										
Yes		2.0	3.8	7.2	9.0	9.8	37.2	17.2	14.0	<.001
No		4.4	3.5	6.4	11.5	5.0	43.8	3.7	21.7	
Unknown		2.0	3.2	6.4	9.8	6.3	34.8	19.4	18.2	

IQR, interquartile range; KDPI, Kidney Donor Profile Index; KDRI, Kidney Donor Risk Index; sCr, serum creatinine; UNOS, United Network of Organ Sharing

¹ KDPI is calculated based on a scaling factor of 1.2175005163, a median KDRI value among all deceased donor kidneys procured during 2015

Table 3

Bivariable and multivariable logistic regression model predicting the odds of discard among deceased donor kidneys recovered for transplant, 2000-2015

Parameters	Crude OR (95% CI)	P	Adjusted OR (95% CI)	P
Age (year)	1.066 (1.065-1.067)	<.001	1.06 (1.06-1.06)	<.001
Age > 50 years	5.55 (5.42-5.69)	<.001	—	—
Female	1.395 (1.364-1.427)	<.001	1.20 (1.17-1.23)	<.001
BMI (kg/m ²)	1.036 (1.035-1.038)	<.001	—	—
Obese (BMI >35 kg/m ²)	1.64 (1.59-1.70)	<.001	0.92 (0.89-0.96)	<.001
African-American/Black	1.254 (1.217-1.293)	<.001	1.18 (1.13-1.22)	<.001
History of hypertension	4.724 (4.614-4.838)	<.001	1.84 (1.79-1.90)	<.001
History of diabetes	4.287 (4.151-4.428)	<.001	2.00 (1.93-2.08)	<.001
Death due to CVA	2.805 (2.741-2.870)	<.001	1.18 (1.15-1.22)	<.001
Terminal sCr (mg/dL)	1.463 (1.445-1.481)	<.001	1.62 (1.60-1.64)	<.001
Terminal sCr >2 (mg/dL)	3.54 (3.43-3.65)	<.001	—	—
DCD	1.242 (1.200-1.285)	<.001	1.84 (1.77-1.92)	<.001
HCV positive	4.973 (4.750-5.207)	<.001	7.81 (7.40-8.26)	<.001
KDRI (unit = 0.05)	1.136 (1.134-1.137)	<.001	—	—
KDPI (unit = 1% [^])	1.050 (1.49-1.051)	<.001	—	—
KDPI >85%	9.81 (9.56-10.07)	<.001	—	—
Biopsy performed	5.945 (5.791-6.103)	<.001	—	—
Proteinuria	1.462 (1.429-1.496)	<.001	1.28 (1.24-1.31)	<.001
CMV	1.374 (1.342-1.408)	<.001	1.06 (1.03-1.09)	<.001
Smoked >20 cig packs/year (ref = No)				
Yes	1.883 (1.839-1.928)	<.001	1.14 (1.11-1.17)	<.001
Unknown	2.236 (2.050-2.438)	<.001	1.14 (1.02-1.28)	0.022
IV drug use (ref = No)				
Yes	1.950 (1.680-2.264)	<.001	1.39 (1.15-1.68)	<.001
Unknown	1.334 (1.296-1.372)	<.001	0.98 (0.94-1.03)	0.51
History of drug use (non-IV) (ref = No)				
Yes	0.702 (0.685-0.720)	<.001	0.84 (0.81-0.86)	<.001
Unknown	1.093 (0.981-1.218)	0.106	0.86 (0.74-1.01)	0.06
History of alcoholism (ref = No)				
Yes	1.120 (1.088-1.153)	<.001	0.84 (0.81-0.87)	<.001
Unknown	1.242 (1.134-1.361)	<.001	1.00 (0.88-1.13)	0.955
Risk Count (ref = 0)				
1	1.41 (1.31-1.50)	<.001	—	—
2	2.82(2.65-3.00)	<.001	—	—
3	5.31(5.00-5.64)	<.001	—	—
4	10.11(9.52-10.73)	<.001	—	—

Parameters	Crude OR (95% CI)	P	Adjusted OR (95% CI)	P
5	21.42(20.21-22.69)	<.001	—	—
Log summarized risk count	5.54 (5.40-5.68)	<.001	—	—
Recovery year	0.98 (0.97-0.98)	<.001	1.01 (1.01-1.02)	<.001

BMI, body mass index; cig, cigarette; CMV, cytomegalovirus; CVA, cerebrovascular accident; DCD, donation after cardiac death; HCV, hepatitis C; KDPI, kidney donor profile index; KDRI, kidney donor risk index; sCr, serum creatinine

Table 4

Bivariable and multivariable logistic model predicting the odds of discard by geographic variation as described by UNOS regions, 2000–2015

Models [†]	Crude OR (95% CI)	P-value	Adjusted OR [‡] (95% CI)	P-value
Region 1	0.85 (0.79-0.90)	<001	0.76 (0.70-0.81)	<001
Region 2	1.45 (1.40-1.49)	<001	1.02 (0.99-1.06)	0.236
Region 3	1.00 (0.97-1.03)	0.810	1.06 (1.02-1.09)	0.002
Region 4	0.87 (0.84-0.91)	<001	1.12 (1.07-1.18)	<001
Region 5	0.78 (0.76-0.81)	<001	0.84 (0.81-0.87)	<001
Region 6	0.72 (0.67-0.76)	<001	0.94 (0.88-1.02)	0.124
Region 7	0.89 (0.85-0.92)	<001	0.83 (0.79-0.87)	<001
Region 8	0.90 (0.86-0.94)	<001	1.07(1.02-1.13)	0.01
Region 9	1.06 (1.01-1.12)	0.031	0.85 (0.80-0.91)	<001
Region 10	1.16 (1.12-1.21)	<001	1.27 (1.21-1.32)	<001
Region 11	1.13 (1.09-1.17)	<001	1.14 (1.09-1.19)	<001

[†] Referent = all U.S. regions

[‡] adjusted for: Age, Gender, Obesity, African-American/Black, History of hypertension, History of diabetes, Death due to CVA, Terminal sCr, DCD, HCV positive, Proteinuria, CMV, Smoked >20 cig packs/year, IV drug use, History of drug use (non-IV), History of alcoholism, Recovery year

Table 5

Death-censored and overall graft survival for the transplanted partner kidney of unilateral discards between 2000 and 2015, stratified by the leading cause for their partner kidneys discard (N = 7,873)

Year	Organ Specific ¹ Median follow-up = 3.3 years		Donor Specific ² Median follow-up = 4.0 years	
	Survivor Function (95% CI)		Survivor Function (95% CI)	
	Death-censored	Overall	Death-censored	Overall
1	93.78 (92.96-94.52)	84.98 (83.82-86.07)	94.27 (91.75-96.03)	87.31 (84.02-89.96)
3	90.76 (89.74-91.69)	73.58 (72.11-74.98)	89.21 (85.87-91.80)	73.27 (68.99-77.06)
5	87.14 (85.85-88.31)	62.37 (60.67-64.01)	85.86 (81.95-88.97)	60.62 (55.83-65.07)
Year	Transplant Specific ³ Median follow-up = 2.0 years		Other ⁴ Median follow-up = 3.0 years	
	Survivor Function (95% CI)		Survivor Function (95% CI)	
	Death-censored	Overall	Death-censored	Overall
1	96.50 (95.29-97.40)	87.89 (85.95-89.57)	94.89 (94.41-95.34)	86.14 (85.42-86.84)
3	92.25 (90.33-93.80)	76.11 (73.42-78.57)	91.42 (90.77-92.02)	74.48 (73.53-75.40)
5	88.60 (86.05-90.71)	61.30 (57.80-64.60)	88.13 (87.32-88.89)	62.67 (61.55-63.77)

¹ Organ damage, anatomical abnormality, poor organ function, biopsy findings

² Donor history

³ Extended ischemia, no recipient located

⁴ Other

Kaplan Meier survival estimates reported