

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



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**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 odds of discard. Kidneys from donors with multiple unfavorable characteristics were more likely to be discarded, whereas 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.**

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**K**idney transplantation is the treatment of choice for patients with end-stage renal disease (ESRD).<sup>1,2</sup> However, the supply of kidneys available for transplantation appears to have plateaued in the United States (US). The widening gap between supply and demand for transplantable kidneys has resulted in <35% of patients being transplanted within 5 years of wait-listing, whereas only 36% of patients on dialysis survive  $\geq 5$  years.<sup>3</sup> Nevertheless, the number of deceased donor kidneys that are procured for transplant but subsequently discarded has been growing steadily in the US, reaching almost 2700 kidneys annually.<sup>4</sup> 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, necessitate an improved ability to use less-than-ideal organs.

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

To our knowledge, this analysis provides the first complete characterization of all deceased donor kidney discards in the US, 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.

## RESULTS

From 2000 to 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 (1561 to 2990,  $P < 0.001$ ; Figure 2), 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% (in 2000) to 19.0% (in 2015) (Figure 2). Kidneys with higher KDPIs and from donors with more undesirable characteristics (Figure 3) were more likely to be discarded; about one-half (50.6%) of deceased donor discards had KDPIs  $\leq 85\%$  (Figure 4).

Among the 36,700 kidneys that were discarded, 7873 (21.5%) were unilateral discards, 1285 (3.5%) represented single discards, and the remaining were bilateral discards (75.0%; Table 1 and Figure 1). A higher proportion of discarded kidneys were from older and heavier donors; they had higher KDRI and/or KDPI scores (i.e., were of lower quality) and higher terminal creatinine levels ( $P < 0.001$ ). Additionally, discarded kidneys 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%;  $P < 0.001$ ; 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 ( $4.0 \pm 1.9$  versus  $2.1 \pm 1.7$ ,  $P < 0.001$ ).

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 and/or 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 with 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%), whereas “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, had positive hepatitis C virus (HCV) status, had elevated creatinine, or died due to a cerebrovascular accident experienced 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 (odds ratio [OR] = 5.95,  $P < 0.001$ ) on bivariable analysis. Additionally, kidneys from donors who had negative social behavior (i.v. or non-i.v. 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 and/or KDPIs were more likely to be discarded: every 1% unit increase in KDPI corresponded to a 5% increase in the odds of discard (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 with donors with no potentially unfavorable qualities, those who possessed  $\geq 1$  experienced anywhere from a 1.41- (for 1 trait) to 21.42- (for  $\geq 5$  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 (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 with the rest of the United States (all  $P$  values  $\leq 0.007$ ; Table 4). Being procured in the Southeast increased the likelihood of a kidney being discarded by 6% to 14% (region 3: aOR = 1.06 and region 11: aOR = 1.14), whereas 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 with 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  $< 0.001$ ; Table 4). Kidneys recovered in region 1 were 27% less likely to go unused compared with those recovered in the other UNOS Regions (aOR = 0.73), whereas kidneys from regions 5, 7, and 9 saw a

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