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KIDNEY TRANSPLANTATION (ML HENRY AND R PELLETIER, SECTION EDITORS)

The New Distance-Based Kidney Allocation System: Implications for Patients, Transplant Centers, and Organ Procurement Organizations

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Abstract

Purpose of Review The goal of deceased donor kidney allocation policy is to provide objective prioritization for donated kidneys, and policy has undergone a series of revisions in the past decade in attempt to achieve equity and utility in access to kidney transplantation. Most recently, to address geographic disparities in access to kidney transplantation, the Kidney Allocation System changed to a distance-based allocation system—colloquially termed "KAS 250"—moving away from donor service areas as the geographic basis of allocation. We review the early impact of this policy change on access to transplant for patients, and on complexity of organ allocation and transplantation for transplant centers and organ procurement organizations.

Recent Findings Broader sharing of kidneys has increased complexity of the allocation system, as transplant centers and OPOs now interact in larger networks. The increased competition resulting from this system, and the increased operational burden on centers and OPOs resulting from greater numbers of organ offers, may adversely affect organ utilization. Preliminary results suggest an increase in transplant rate overall but a trend toward higher kidney discard and increased cold ischemia time.

Summary The KAS 250 allocation policy changed the geographic basis of deceased donor kidney distribution in a manner that is intended to reduce geographic disparities in access to kidney transplantation. Close monitoring of this policy's impact on patients, transplant center behavior, and process measures is critical to the aim of maximizing access to transplant while achieving transplant equity.

Keywords Kidney transplantation · Kidney allocation system · Allocation policy

Introduction

Kidney transplantation is the optimal treatment for end-stage kidney disease, providing superior survival, improved quality of life, and long-term cost savings compared to maintenance dialysis [1–5]. However, in the USA, a severe shortage of available organs limits access to transplantation. As a result, the majority of patients with end-stage kidney disease will never receive a transplant. Despite efforts to increase living kidney donation rates, over three-fourths of kidney transplants in the USA utilize deceased-donor organs [6]. Given the scarcity of these life-saving organs, the goal of deceased donor kidney allocation is to outline objective prioritization for donated kidneys. These allocation rules ultimately play a large role in determining access to transplant, and they are intentionally designed and adjusted to achieve equity and utility.

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Equity Under the Kidney Allocation System

Allocation policy has undergone a series of revisions in the past decade to meet these goals. The most recent major revision was the implementation of the Kidney Allocation System (KAS) in 2014 [7]. KAS sought to reduce disparities in access to kidney transplantation via two major changes: allowing waiting time to begin at dialysis initiation or time of pre-emptive waitlisting in order to circumvent disparities caused by late transplant referral and prioritizing biologic criteria such as sensitization and HLA matching. In addition, KAS introduced a degree of organ-recipient longevity matching to improve transplant utility—accounting for kidney quality [8] and estimated post-transplant survival [9] to preferentially allocate the best 20% of deceased donor kidneys to candidates with the top 20% of estimated post-transplant survival. Overall, KAS was successful in reducing racial disparities in access to kidney transplantation (due to the backdating to dialysis initiation [10, 11]) and in improving transplant rates among highly sensitized patients (because of national prioritization [12]).

However, several important disparities in access to transplant persisted after the implementation of KAS. Geographic variation in access to kidney transplantation remains a longstanding barrier to equity in kidney allocation [13–15]—due in part to differences in local organ supply and differences among transplant centers in both willingness to accept kidney offers [16] and waitlisting practices [17, 18]—and these geographic disparities were not addressed under KAS [19]. Historically, allocation would proceed locally first to candidates listed at transplant centers within donation service areas (DSAs)—the geographical areas overseen by one of the 57 organ procurement organizations (OPOs) responsible for organ recovery and distribution. If a kidney was not accepted for transplant within the DSA from which it originated, it would then be offered to all centers in its Organ Procurement and Transplantation Network (OPTN) region, and lastly nationally. Given the strict allocation borders involved in DSA-based allocation, centers in close geographic proximity to each other but in different DSAs often had markedly different organ availability and transplant rates [20].

The New Distance-Based Kidney Allocation Policy

Efforts to improve organ sharing and reduce these geographic disparities in kidney transplantation had to be reconciled with practical aspects of organ transport: distance (and subsequent travel time) is a necessarily important factor for allocation given the detrimental impact of prolonged cold storage on graft function. The newest iteration of KAS therefore sought to eliminate the arbitrary DSA boundaries, while taking the logistical realities of organ transport into consideration, by instead prioritizing recipients based on the proximity of their listing transplant center to the donor hospital. The new distance-based allocation policy, which is colloquially termed "KAS 250," was implemented in March 2021. Under KAS 250, deceased donor kidney distribution changed from DSAs as the unit of allocation to a distance-based system, giving higher priority to patients listed at centers within 250 nautical mile circles relative to the donor hospital.

Complexity of Broader Distribution

Deceased donor kidney allocation became operationally more complex under the new KAS 250 policy. Transplant centers previously only had one "local" OPO and now have a median of 9 (interquartile range [IQR] 5–12) OPOs within 250 nautical miles from whom they may receive organ offers in the primary local allocation sequence [21]. Meanwhile, OPOs have a ten-fold increase in the median number of transplant centers within their local jurisdiction (34 [IQR 20-55] vs. 3 [2–5]) [21]. For a given donor hospital, a median of 23 (11–40) transplant centers fall within a 250 mile radius (vs. 5 [3–9] under DSA-based allocation) [21]. This heightened complexity of broader distribution raises many concerns, such as the volume of organ offers transplant centers must now process and the efficiency with which organs will be placed.

The complexity of this system therefore has potential to add cost to allocation, increase the incidence of delayed graft function (DGF) related to prolonged cold ischemia time (CIT), and ultimately increase the likelihood of organ discard. Conversely, increased competition among transplant centers and broader sharing of organs may lead to overall improved utilization if competition leads centers to become more aggressive in their organ offer acceptance practices, or if marginal quality kidneys are made more easily accessible to the centers willing to use them [22]. Given these concerns, the transplant community has been closely monitoring the discard rate and ischemia times of kidneys allocated under KAS 250, and the recent National Academies of Sciences, Engineering, and Medicine report has recognized the need to increase offer acceptance and utilization of deceased donor kidneys [23].

Early Observations Under KAS 250

A summary of key findings from the literature is presented in Table 1. An analysis of single-center data from Reddy et al. reported a 191% increase in volume of kidney offers received in the early months following

Table 1 Summary of key references

Reference	Summary of findings
Geographic disparities in access to deceased-donor kidney transplantation: rationale for the new distance-based allocation ("KAS 250")	
[19] Zhou et al. (2018)	• Geographic disparities in deceased-donor kidney transplant rate remained prevalent across donor service areas since the introduction of the Kidney Allocation System in 2014
Anticipating effects of KAS 250	
[21] Adler et al. (2021)	• Kidney allocation becomes operationally more complex under KAS 250
	• Transplant centers now have median 9 OPOs considered "local"
	• OPOs have 10-fold increase in "local" transplant centers
	• Concerns raised over volume of kidney offers and efficiency of organ placement
[27] DuBay et al. (2021)	• Modeling of predicted deceased-donor kidney transplant rates across states, relative to end-stage kidney disease burden
	• Greatest increase in transplant volume expected for states with higher transplant access at baseline
	• Based on these predictions, KAS 250 has potential to worsen geographic disparities
Early observations of KAS 250's impact on kidney offer volume and workload	
[24] Reddy et al. (2022)	• Single-center analysis of kidney offer volume received, and time spent on offer-related work, since KAS 250
	• 191% increase in kidney offers received per month
	• Median time spent per kidney offer: 68 min (center coordinators), 9 min (surgeons)
	• 97% increase in offer-related workload for transplant centers

KAS250—reflective of the increased complexity of this new system [24]. This increased offer volume—much of which is offers for kidneys that were ultimately discarded—poses considerable increased workload for transplant centers, coordinators, and surgeons. Given the recency of this policy change, there are few peer-reviewed reports to-date using national data to evaluate the impact of KAS 250 on metrics related to deceased donor kidney utilization or recipient outcomes. A preliminary analysis from the OPTN reported an overall increase in transplant rate after the implementation of KAS 250 (37.7 vs. 32.6 per 100 active patient-years), particularly among highly sensitized candidates [25]. Another preliminary report found increased utilization of donation after circulatory death kidneys (29% vs. 25%), increased CIT for transplanted kidneys (median 19 vs. 17 h), and a modestly increased rate of both discard (23% vs. 21%) and DGF (30% vs. 28%) [26].

Analyzing data from the Scientific Registry of Transplant Recipients (SRTR; unpublished) allows us to visualize trends over time in deceased donor kidney discard, CIT, and DGF in the KAS 250 era (Fig. 1). Of kidneys recovered from January 1, 2019, to February 28, 2022, the discard rate has increased over time, with a steeper rise starting just before KAS 250 implementation, and discards reached a peak of 27% during the last quarter of 2021 (compared to 20% during the first quarter of 2019). Median CIT has also increased steadily over time (13.0 h [IQR 3.1–20.2; 2019 quarter 1] to 18.0 hours [9.8–23.3; 2022 quarter 1]). Incidence of DGF has fluctuated with a less discernable overall trend. Importantly, the COVID-19 pandemic, for which a national emergency was declared on March 13, 2020, confounds the majority

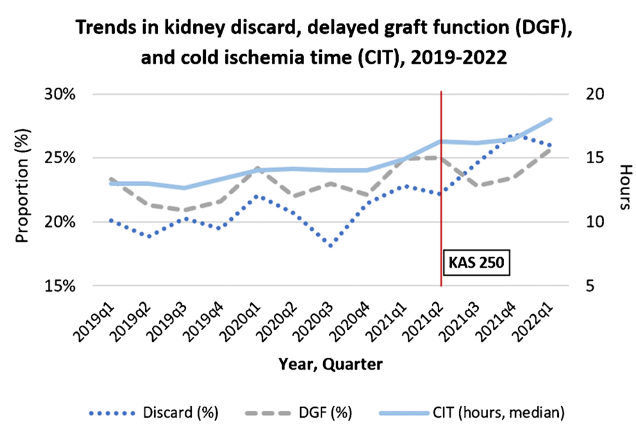

Fig. 1 Trends in kidney discard, delayed graft function (DGF), and cold ischemia time (CIT), 2019 to 2022. The graph shows the unadjusted proportion of procured kidneys discarded, incidence of DGF, and median CIT by quarter between January 2019 and February 2022. The vertical dashed line indicates the date of KAS 250 implementation (March 2021)

of this time period and complicates the ability to isolate the true causal effect of recent allocation policies from the effect of the pandemic on organ quality and supply, recipient outcomes, and transplant center and OPO practices.

Looking Ahead

Early evaluation of the KAS 250 allocation policy is critical to ensure the policy is achieving the goal of decreasing geographic disparities and improving equity, while also closely monitoring for unintended consequences of the policy [21]. Kidneys are distributed under KAS 250 based on distance relative to the donor hospital, and while this is likely to improve the geographical disparities that resulted under the DSA-based allocation system, there remains potential for kidneys to be redistributed away from areas of high need or areas with more marginalized populations. For example, certain states with below-average access to kidney transplant are expected to receive a decreased share of deceased donor kidneys under KAS 250 [27]. Care must be taken to avoid creating or worsening other disparities under this system, which would become most apparent in how the wait times for patients vary across the country.

A shared concern among the transplant community is the increased volume of kidney offers under the new policy. While improving offer acceptance rates is one method to reduce donor kidney discard, the additional burden of this higher offer volume on both OPO and transplant center personnel must be considered [28]. The cognitive load associated with processing multiple offers is significant, forcing both OPOs and transplant centers to adjust how they process offers, which could adversely affect organ utilization. For example, reliance on heuristics to aid decision-making in the face of increased offer burden may bias transplant center personnel toward declining offers, potentially increasing discard of usable kidneys [29]. Additional staffing, or increased utilization of third party coordinator services, may also be required of OPOs and transplant centers to accommodate higher volumes of offers. One technologic improvement, the newly available offer filters [30], are a significant improvement over the prior filters available in Unet [31], and allow more fine-tuning of kidneys likely to be accepted by transplant centers based on both historical acceptance patterns and current practice and preferences.

The trend toward higher discard rates is a concern. It is unclear whether this is due to changes in donor quality, differences in practices related to the COVID-19 pandemic, changes in kidney acceptance practices, increased recovery due to different OPO incentives under new CMS regulations [32], or the greater complexity of organ allocation and placement under KAS 250. Reducing deceased donor kidney discard remains critical to improving access to kidney transplantation. The trend toward higher CIT deserves further investigation so strategies can be devised to optimize efficiency of allocation under this system of broader sharing. This may also open the door to more systematic study of longer, machine perfusion-based methods of storage for kidneys. Finally, many centers are now faced with more competition due to the broader distribution of organs, and it remains to be seen if increased competition will lead centers to be more aggressive with their use of suboptimal quality kidneys [33].

Continuous distribution is the future of organ allocation [34], and ultimately, KAS 250 is a necessary intermediate policy change step on the way to continuous distribution. Under continuous distribution for deceased donor kidneys, a number of candidate attributes—including distance to donor, medical urgency, pediatric candidate, high sensitization, among others—will be weighted and used to compute the overall priority for a candidate. The exact weighting of these factors has yet to be determined. The elimination of the somewhat arbitrary boundaries of DSAs under KAS 250 was a necessary first step to pave the way for continuous distribution, and understanding the positive and negative consequences of the elimination of these allocation borders will provide valuable insight into the potential impact of continuous distribution policies.

Conclusion

In conclusion, the KAS 250 allocation policy changed the geographic basis of deceased donor kidney distribution in a manner that is intended to reduce geographic disparities in access to kidney transplantation. Peer-reviewed reports on the impact of this policy change are lacking to-date, but early preliminary data suggests an overall increase in transplant rate, though with a concerning trend toward higher CIT and more frequent kidney discard. Although KAS 250 is a necessary step on the way to continuous distribution, close monitoring of this policy's impact on patients, transplant center behavior, and process measures is critical to the aim of maximizing access to transplant while achieving transplant equity.

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The analysis of transplant registry data included in this manuscript was approved by the Mass General Brigham Institutional Review Board. The data presented here are a retrospective review of national registry data, and thus, informed consent is not applicable. No research involving animals was performed.

Declarations

Disclosures This study used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes data on all donor, wait-listed candidates, and transplant recipients in the USA, submitted by the members of the Organ Procurement and Transplantation Network (OPTN). The Health Resources and Services Administration (HRSA), US Department of Health and Human Services, provides oversight to the activities of the OPTN and SRTR contractors. The data reported here have been supplied by the Hennepin Healthcare Research Institute (HHRI) as the contractor for the Scientific Registry of Transplant Recipients (SRTR). The interpretation and reporting of these data are the responsibility of the author(s) and in no way should be seen as an official policy of or interpretation by the SRTR or the US Government.

Conflict of Interest The authors declare no competing interests.

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