Increased Logistical Burden in Circle-based Kidney Allocation

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A US ORGAN ALLOCATION REVOLUTION

In the United States, organ allocation policy is undergoing major revision to reduce geographic disparity that previously disadvantaged candidates living in some parts of the country.[1] Fixed geographic donor service areas (DSAs) have been replaced with circles that offer organs first to candidates within a certain distance of the donor hospital. Further changes to allocation for all solid organs are mandated to eliminate all boundaries, even circles, in favor of continuously varying geographic allocation priority (continuous allocation). The recently implemented change to circles for kidneys has been disruptive, increasing the number of transplant centers and candidates required to place a kidney and increasing the logistical burden on transplant centers and local organ procurement organizations (OPOs) that handle deceased donors. Furthermore circles increased cold ischemia time (CIT) and distribution time. We believe these burdens should be accounted for as the United States moves toward continuous allocation.

Received 18 February 2022.

Accepted 18 February 2022.

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This work was supported by grant numbers R01DK111233 (PI: D.L.S.) and K24DK101828 (PI: D.L.S.) from the National Institute of Diabetes and Digestive and Kidney Disease (NIDDK). N.L.W., D.N.V., D.L.S., and S.E.G. were supported in part by contract number 75R60220C00011 from the Health Services and Resources and Administration. The analyses described here are the responsibility of the authors alone and do not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products or organizations imply endorsement by the US Government.

The authors declare no conflicts of interest.

N.L.W. participated in study design, data analysis, and article preparation. D.N.V. participated in study design, data analysis, and article preparation. D.L.S. participated in study design and article preparation. S.E.G. participated in study design and article preparation.

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ISSN: 0041-1337/20/0000-00

DOI: 10.1097/TP.0000000000004127

On March 15, 2021, deceased donor kidney allocation transitioned to an allocation system that uses a 250 NM circle around the donor hospital.[2] Previously, each OPO worked primarily with the small set of transplant centers in 1 DSA. Replacing DSAs with circles was predicted to increase the complexity of the allocation system by increasing the number of necessary relationships between transplant centers and OPOs.[3]

Circles were implemented to align kidney allocation with the Final Rule by reducing geographic variation in time on dialysis while waiting for a transplant.[2] The Final Rule requires that allocation "shall not be based on the candidate's place of residence or listing," except to the extent required by other competing interests, among which is to "promote the efficient management of organ placement."[4] Our findings suggest circles have decreased the efficiency of organ placement.

INCREASED BURDEN ANALYSIS METHODS

Using Scientific Registry of Transplant Recipient (SRTR) match run and transplant data for deceased donor kidneys from October 5, 2020, to October 5, 2021, we quantified the change in logistical burden due to circle-based kidney allocation. We compared the median number of transplant centers and candidates required to place a kidney precircles and postcircles. We further stratified this analysis by donor Organ Procurement and Transplantation Network (OPTN) region to determine how the change in logistical burden varied geographically. Finally, we compared mean CIT and mean distribution time precircles and postcircles both nationally and by donor OPTN region.

We defined center number at offer 50 as the number of unique transplant centers that had at least 1 candidate on the match run with an offer number ≤50. We defined distribution time as the duration from the match run submission to organ reperfusion, where organ reperfusion was estimated as the time at crossclamp plus ischemia time. Ischemia time was defined as CIT, plus warm ischemia time when reported.

INCREASED LOGISTICAL BURDEN OF CIRCLES

Compared to the precircles era, kidneys were offered to significantly more candidates and centers before being accepted. In addition, significantly more centers were involved in the match run by offer number 50. Moreover, CIT increased by 1.7 h, and distribution time increased by 2.2 h (Table 1).

TABLE 1.

Increased burden associated with circle-based kidney allocation

	Precircles	Postcircles	*P*
Median offer number at acceptance[a]	5	10	<0.0001
Median center number at acceptance[a]	3	5	<0.0001
Median center number at offer 50[a]	5	11	<0.0001
Mean cold ischemia time (h)	18.0	19.7	<0.0001
Mean distribution time (h)[b]	42.0	44.2	<0.0001

[a]For each match run with at least 1 bypassed offer, we removed all bypassed offers and renumbered the offer and center number throughout the match run, unless all offers were bypassed until an accepted offer, in which case that match run was removed. When considering offer and center number at acceptance, we only considered accepted offers that ultimately resulted in transplant.

[b]Distribution time is defined as the duration from the match run submit date to reperfusion, where reperfusion was estimated as the time at crossclamp plus ischemia time. Ischemia time was defined as cold ischemia time, plus warm ischemia time when reported.

Increased logistical burden is geographically heterogeneous, with a higher burden on OPOs and transplant centers in the northeast and a lesser burden for kidneys recovered in the less densely populated west (Figures 1 and 2). Kidneys recovered in the densely populated Region 9, which includes New York State and New York City, were offered to significantly more candidates and centers before being accepted. Median center number at offer number 50 on the match run increased in every region, with the greatest increases being in Region 2, containing Maryland, New Jersey, Delaware, Pennsylvania, and West Virginia, in addition to Region 10, containing Michigan, Indiana, and Ohio.

CONTINUOUS ALLOCATION

Circle-based allocation, like DSA-based allocation, uses hard geographic boundaries that determine which transplant centers will initially receive offers. Continuous allocation, which assigns a numerical score to each candidate according to their medical priority and proximity to the donor hospital, uses no hard geographic boundaries.[5] Under continuous allocation, a candidate at any transplant center could, in principle, be ranked highly on a match run regardless of location of listing or donor recovery. Consequently, continuous allocation might further disrupt the relationships between OPOs and transplant centers.

Circle sizes, like previous OPTN policies, were chosen ad hoc from a set of plausibly reasonable policies. In contrast, an optimization approach[6-8] would apply computational tools to design circles or continuous allocation scores that maximize transplant benefits while enforcing constraints that limit logistical complexity while distributing organs equitably. Because increased burden varies greatly by geography, we could design a geographically heterogeneous continuous allocation score.[9,10] Before implementation of any continuous allocation system, policymakers could examine the median center number by offer number 50, as we have done, to estimate the potential increase in logistical burden. We recommend approaches like these to carefully design continuous allocation scores to avoid further increased logistical burden in kidney allocation.

CONCLUSIONS

Circle-based kidney allocation increased logistical burden by increasing the number of transplant centers

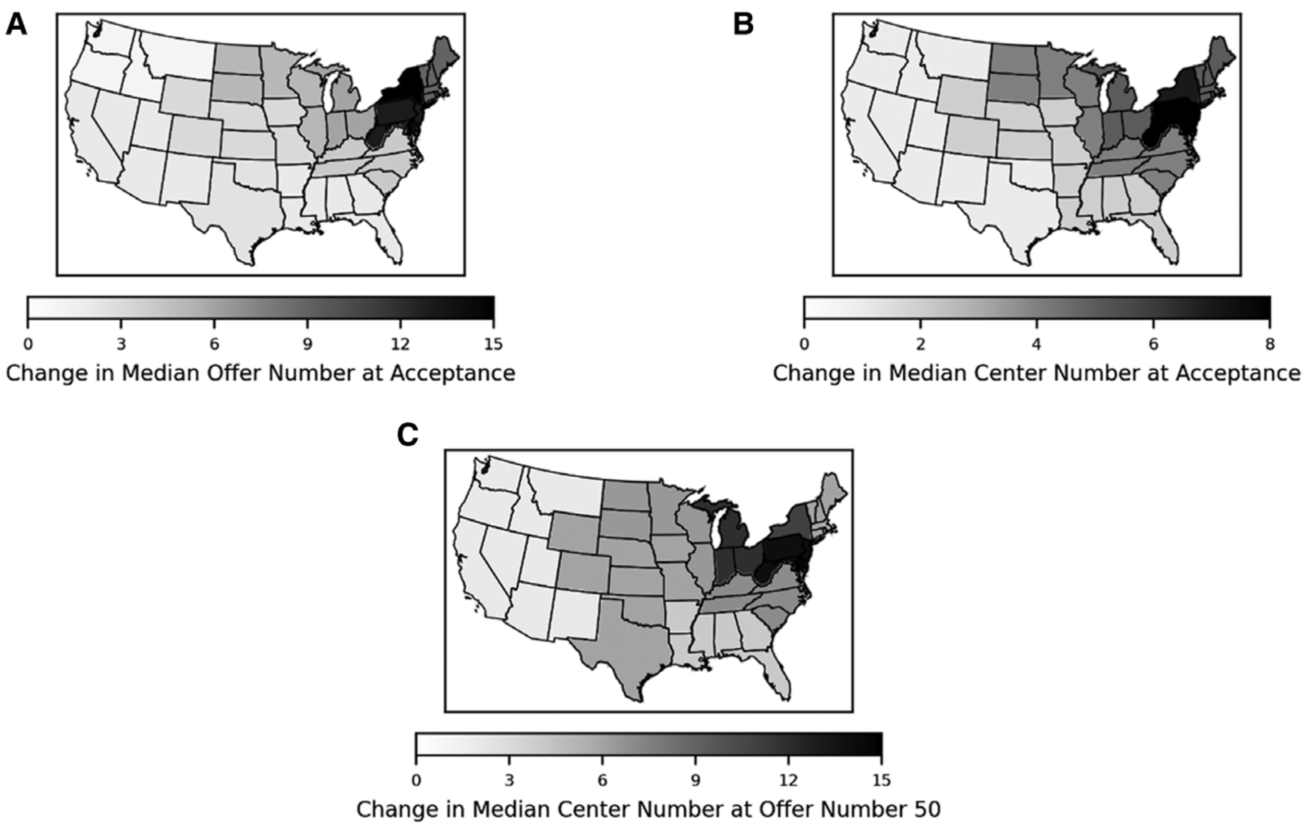

FIGURE 1. Geographic variation of changes in logistical complexity by donor region after circle-based kidney allocation. A, Median offer number at acceptance. B, Median center number at acceptance. C, Median center number at offer number 50 on the match run.

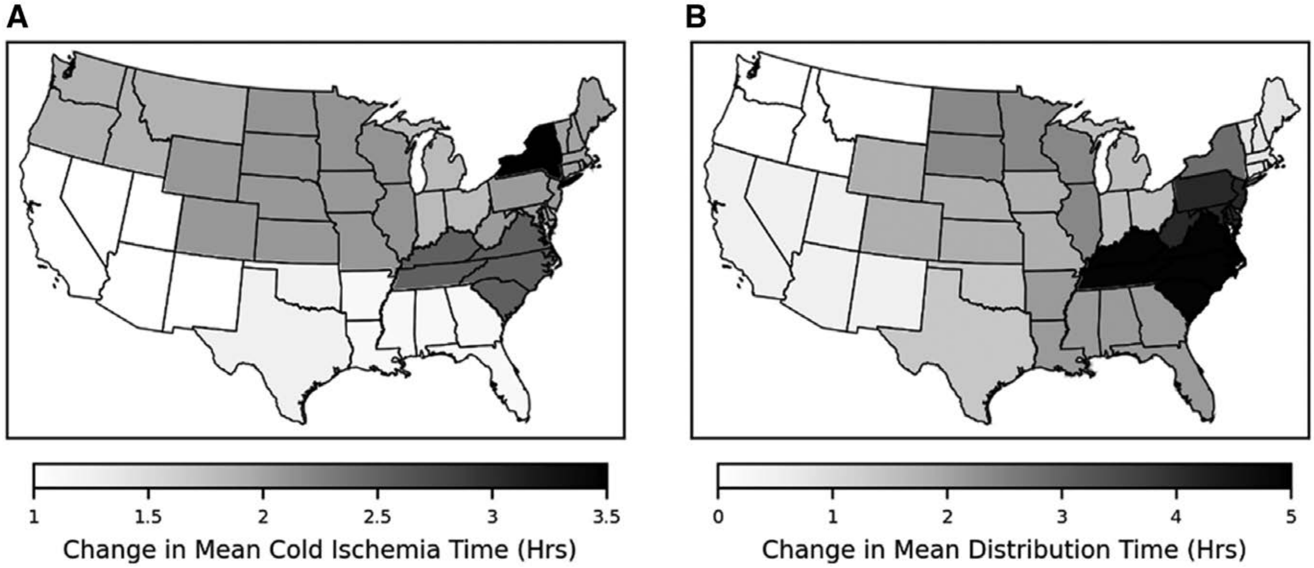

FIGURE 2. Geographic variation of changes in allocation efficiency by donor region after circle-based kidney allocation. A, Mean cold ischemia time. B, Mean distribution time.

and candidates responding to offers before acceptance. The increased burden is likely greater than we estimated because some transplant centers regularly evaluate offers before becoming primary and would have evaluated offers beyond those accounted for in our analysis. Circle-based kidney allocation is additionally associated with an increase of 1.7 h in mean CIT and an increase of 2.2 h in mean distribution time. These delays are plausibly caused by the increased number of centers required to place an organ. We encourage the OPTN to attend to the logistical complexity of match runs in moving toward continuous allocation systems by using optimization and design approaches to limit complexity while simultaneously reducing geographic disparity.

ACKNOWLEDGMENTS

The data reported here have been supplied by the Hennepin Healthcare Research Institute as the contractor for the SRTR. The interpretation and reporting of these data are the responsibility of the author and in no way should be seen as an official policy of or interpretation by the SRTR or the US Government. Our analysis used data from the SRTR. 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.

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