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New Kidney Allocation System Associated With Increased Rates Of Transplants Among Black And Hispanic Patients

Taylor A Melanson^{1,2}, Laura C Plantinga³, Mohua Basu¹, Stephen O Pastan⁴, Sumit Mohan⁵, Jason M Hockenberry², David Howard², and Rachel E. Patzer¹

¹Emory Transplant Center

²Department of Health Policy and Management, Rollins School of Public Health, Emory University

³Department of Medicine, Emory University School of Medicine

⁴Renal Division, Department of Medicine, Emory University School of Medicine

⁵Department of Medicine, Division of Nephrology, Columbia University Medical Center, New York, New York

Abstract

Prior to the 2014 implementation of a new kidney allocation system by the United Network for Organ Sharing, white patients were more likely to receive a kidney transplant than black or Hispanic patients. To determine the effect of the new kidney allocation system on these disparities, we examined 179,071 waitlisting events from the United Network for Organ Sharing database from June 2013 to September 2016 and calculated monthly kidney transplantation rates among waitlisted patients. Implementation of the new system was associated with a narrowing of the disparity in the average monthly kidney transplantation rate by 0.29 percentage points for blacks compared to whites ($p < 0.001$) and 0.24 percentage points for Hispanics compared to whites ($p < 0.001$), resulting in both disparities becoming insignificant after implementation of the new system ($p = 0.45$, $p = 0.18$).

The public health burden of kidney failure in the United States is substantial: nearly 700,000 people have end-stage renal disease(1). Once diagnosed, end-stage renal disease patients qualify for Medicare coverage; in 2014, care for these patients cost Medicare \$32.8 billion (1). Kidney transplantation is the preferred treatment for most patients with end-stage renal disease because it offers longer survival, better quality of life, and fewer hospitalizations than dialysis(2, 3). Transplantation also costs about 65 percent less than dialysis annually (1).

Existing policy directives, such as the Health and Human Services Final Rule requiring that differences in wait times among different organ transplantation programs are minimized(4), have aimed to maximize access to kidney transplantation. Despite this, significant disparities persist in transplant access by socioeconomic status(5) and race/ethnicity(6,7). Racial/ethnic

disparities impacting blacks and Hispanics exist at each step of the kidney transplant process, with minorities being, on average, less likely to complete the necessary medical evaluation(8), be placed on the national waiting list(9,10), and be transplanted(11–18,19). There are a number of characteristics of health care systems, patients, and providers that correlate to these disparities, including poverty,(5, 20, 21) limited dialysis facility staff to educate patients about transplant,(17, 22) physician bias,(23) and inequitable federal policies that guide US organ allocation(24, 25).

The United Network for Organ Sharing implemented a new kidney allocation system in December 2014 (26), in part to address the longstanding racial/ethnic disparities in the allocation of deceased donor kidneys. The primary factor for determining a patient's priority level on the kidney transplant waitlist is how long they have been waiting for a transplant. Under the new system, the starting point for calculating waiting time was changed from the time of waitlisting to the earliest of either the first regular dialysis date or the waitlisting date. This change was anticipated to benefit minorities because blacks and Hispanics spend more time on dialysis prior to waitlisting than white patients(27,28). It is important to note that this policy targets the allocation of deceased donor kidneys, not live donor kidneys.

Preliminary results from the United Network for Organ Sharing show an increase in the proportion of blacks receiving transplants following the implementation of the new allocation system (29). Massie et al. (2015) examined data from 2 years prior and 9 months after implementation and found that the percentage of kidneys being allocated to blacks and Hispanics increased after implementation(30). Stewart et al (2016), performed a study using a year of post-implementation data and found that the number of kidney transplants increased among blacks and Hispanics after implementation, and decreased among whites(31). However, it is unknown whether the new system has resulted in equity in access to transplantation among waitlisted patients.

To assess whether the policy was effective in reducing racial/ethnic disparities among waitlisted patients we examined whether a patient's likelihood of receiving a kidney transplant differed depending on race/ethnicity before and after the new system was implemented. In addition, to understand the mechanism through which the policy had its effect and whether we can expect a sustained impact, we examined whether racial/ethnic minorities with the longest wait times were the patients who benefitted most from the policy.

Methods

Study Population and Data Source

We examined kidney transplant waitlisting events occurring between June 2013 and September 2016 within the United Network for Organ Sharing standard analytic file. When an individual is waitlisted this creates a record, i.e. a waitlisting event, with a unique identifier, separate from the patient identifier. Patients who are listed a second time would create a second waitlisting event with an identifier different from their first instance of waitlisting. We selected patients listed only for kidney transplant (rather than for multi-organ transplants) and excluded patients who received a living donor kidney because the new kidney allocation system was not intended to impact them. We focused on white, black, and

Hispanic patients and excluded other racial/ethnic groups that were less prevalent as our study design was not well-suited to examining trends among smaller sample sizes. Our final cohort included 179,071 waitlisting events for kidney transplant. Summary statistics describing the sample are included in the Appendix Exhibit A2(32).

Because the new kidney allocation system was largely expected to affect the prioritization of patients based on their time on dialysis, we also examined dialysis time among the 34,133 patients in our sample who received a kidney transplant.

Study Variables

The main outcome of interest was the monthly kidney transplantation rate among waitlisted patients by race/ethnicity, defined as the percentage of waitlisted patients in the racial/ethnic subgroup who received a deceased donor kidney transplant in a given month.

Our focus was on how these transplantation rates changed after the new kidney allocation system was implemented. The pre-implementation period was defined as the 18-month time period from June 1, 2013 to November 30, 2014, and the post-implementation period was defined as the 22-month time period from December 1, 2014 to September 30, 2016. Some patients were “at risk” for a transplant in both the pre- and post-implementation eras and were included in both groups; that is, a patient who was waitlisted in the pre-implementation era but received a kidney transplant in the post-implementation era was included in the denominator of the kidney transplantation rate calculation for both eras. Patient race information was obtained at time of waitlisting.

When examining how the mean and distribution of dialysis time among kidney transplant recipients changed after implementation of the new kidney allocation system, time on dialysis was calculated as time from dialysis start until the date of transplant.

Transplantation Rates by Race and Region

We used a difference-in-difference framework to compare racial/ethnic differences in kidney transplantation rates before and after implementation of the new kidney allocation system. This framework is most commonly used to examine treatment effects in quasi-experimental policy evaluation(33,34) where there is a group impacted by a policy, and a group that is not impacted, which acts as a control. In our setting, because the number of deceased donor kidneys is not affected by implementation of the policy, the difference-in-difference estimate measures the narrowing of the racial disparity gap in kidney transplant rates between racial/ethnic groups. We used average national monthly kidney transplantation rates for each racial/ethnic group before and after implementation to determine the amount of change in kidney transplantation rates that could be attributed to the policy, after controlling for pre-existing racial/ethnic differences. We also used *t*-tests to determine if either disparity (black vs. white or Hispanic vs. white) persisted in the post-implementation period.

The new kidney allocation policy also contained a provision which assigned higher priority to highly sensitized patients with calculated panel reactive antibody of 99–100(26). Calculated panel reactive antibody indicates the percentage of donors who are expected to have at least one of a candidate’s indicated unacceptable antigens, so a calculated panel

reactive antibody of 99–100 indicates a patient for whom it is very difficult to find a matching donor(26). The policy also increased the priority of these patients for kidneys donated in other regions(26,29), allowing a broader pool for them to find a suitable donor. Because black patients are more likely to be highly sensitized than whites(35), we conducted sensitivity analyses excluding individuals with calculated panel reactive antibody of 99+ to determine if the results we see are driven by this provision. We also ran a model that split the post-implementation period into two 11-month periods, to examine the possibilities of either a delayed effect, or a bolus effect.

To further explore the robustness of our unadjusted results, we estimated multivariable-adjusted difference-in-difference models which accounted for region-specific differences and seasonal fluctuations. Furthermore, we conducted sensitivity analyses to examine Organ Procurement Organization region-specific effects of kidney allocation system implementation, and the impact of excluding individuals marked inactive on the waitlist at the time of their most recent status update (both using multivariable-adjusted difference-in-difference models). The specification and results of all models are included in Appendix Exhibit A3(32).

Examining Policy Effects By Time on Dialysis

The kidney allocation system was in part intended to reduce racial/ethnic disparities in patient time on dialysis. This could happen in two ways: a small group of patients on dialysis for a very long time could get kidney transplants (with each individual having a large impact on the average dialysis time), or a large number of racial/ethnic minority patients with higher than average time on dialysis could get transplanted (with each individual having a small impact on the average dialysis time). As such we report the distribution of time on dialysis at time of kidney transplantation by graphing the median and interquartile range over time, for each racial/ethnic group to assess which of these channels the policy is having its effect through.

All statistical analyses were performed using Stata 14.2 or SAS 9.4, using a cutoff of $p=0.05$ for statistical significance unless otherwise noted.

Limitations

There are several limitations to this study. First, we are limited by the small amount of follow-up time in the post-implementation period. Second, our analyses were conducted at an aggregate level which may obscure effects occurring at the individual patient level. Furthermore, our main analysis does not account for the possibility that the policy may have taken some time to be fully implemented. However, this should produce a conservative bias, meaning our results are potentially understated.

Results

Racial/Ethnic Disparities in Kidney Transplantation Rates

Prior to the kidney allocation system's implementation, the average national monthly kidney transplantation rate was significantly higher among whites (1.07 percent) compared to

blacks or Hispanics (0.80 percent and 0.79 percent, respectively). This represented a 0.27 percentage point white-black transplant rate gap and a 0.28 percentage point white-Hispanic transplant rate gap prior to the policy. After implementation, average national monthly kidney transplantation rates changed significantly way all race/ethnicity groups: the monthly rates were 0.95 percent, 0.96 percent, and 0.91 percent for whites, blacks, and Hispanics, respectively. Comparing the overall mean monthly kidney transplantation rates before (0.90) and after (0.95) the policy change shows that the average rate of kidney transplantation among all waitlisted patients changed in a statistically significant way. Additionally, *t*-tests comparing the average monthly kidney transplantation rate after implementation for whites vs. blacks and Hispanics found that neither disparity was significant.

The unadjusted difference-in-difference model showed that the kidney allocation system was associated with a statistically significant narrowing of the gap in rates of kidney transplantation for blacks vs. whites by approximately 0.29 percentage points, representing a complete elimination of the white-black kidney transplantation rate disparity (Exhibit 2). The gap narrowed for Hispanics vs. whites by approximately 0.24 percentage points, resulting in a reduction of the white-Hispanic transplant rate gap to 0.04 percent points (Exhibit 2.)

Results of the sensitivity analyses conducted were consistent with our unadjusted model and are discussed briefly below.

When we excluded individuals with a calculated panel reactive antibody of 99–100 from our analysis, we found that results remained similar: the gap in kidney transplantation rates narrowed by 0.32 percentage for blacks compared to whites, and 0.27 percentage points for Hispanics compared to whites. When we divided the post-implementation period into two 11-month periods to account for a potential bolus effect, we found that the effect sizes are similar, though slightly smaller, in the later 11-month period for blacks and slightly larger for Hispanics. When we ran our analysis including only actively listed patients the results were again consistent with our unadjusted model, as shown in Appendix Exhibit A3(32). When we ran the analysis after adjusting for region-specific differences and seasonal fluctuations we saw a gap narrowing of 0.32 percentage points for blacks compared to whites, and 0.29 for Hispanics compared to whites. Our triple-interaction model examined if the policy impacted disparities differently in different regions and found that the policy had a relatively consistent effect across regions with the exception of regions 9, which has a smaller improvement for blacks, and 6 which has a larger improvement for Hispanics. For full results of these sensitivity analyses, see Appendix Exhibit A3(32).

Time on Dialysis Prior to Kidney Transplantation

Time on dialysis prior to transplantation increased for white, black, and Hispanic kidney transplant recipients after implementation of the new kidney allocation system (Exhibits 3–5). *T*-tests of the means between the pre- and post-periods confirm that mean time on dialysis for kidney transplant recipients increased in a statistically significant way for all groups(32). For the distribution of time on dialysis for all transplant recipients, see Appendix Exhibit A4(32).

Discussion

Our models indicate that implementation of the new national kidney allocation system in December 2014 led to a substantial increase in the kidney transplantation rate for blacks and Hispanics in the months following the policy change, and a decrease in the rate of kidney transplantation for whites. Our various sensitivity analyses suggest that this result is robust to a variety of specifications and that the kidney allocation system's impact on blacks and Hispanics was relatively uniform across Organ Procurement Organization regions. Our analysis excluding highly sensitized individuals suggests that such individuals are not driving our results. This policy change appears to have at least temporarily eliminated racial/ethnic disparities in access to kidney transplantation for waitlisted black and Hispanic patients.

Prior to implementation of the new kidney allocation system, Israni and colleagues conducted simulations and predicted that the new system would lead to increased numbers of kidney transplants for blacks and Hispanics and decreased numbers for whites(36), which our findings confirm. The results of our study are consistent with national reports showing that the percentage of total transplants that went to blacks has been increasing in the recent years(14). Consistent with the policy's intention to prioritize individuals who have spent longer time on dialysis, implementation of the kidney allocation system increased access to kidney transplantation for patients with extensive time on dialysis. After the new system was implemented, those who received kidney transplants had been on dialysis for longer, on average, among whites, blacks, and Hispanics. It is not yet clear how this trend will change with additional follow-up time. Some have predicted a bolus effect(30,31), where patients with the most extensive times on the waitlist received transplants. They suggest that kidney transplantation rates will likely revert to previous levels. We find that dialysis time among kidney transplant recipients is trending downward, and that the impact of the new system is smaller for blacks in the most recent period when the post-implementation period is divided into two periods, which supports this concern. Whether this regression to the mean will undo the narrowing of the transplant rate gaps remains to be seen. Following the effects of this policy will be important to fully understand the consequences of the changes made. This is particularly salient given the long periods of time that most patients have historically spent on the kidney transplant waitlist.

Previous studies examining the percentage of donated kidneys that were transplanted into black patients were unable to determine if the increase in kidney transplants for blacks is due to greater access among those waitlisted. For example, a larger number of transplants going to blacks could be the result of more blacks developing end-stage renal disease. In this case, the increase would not be a positive effect of the policy, but rather an indication of worsening health among this subpopulation. However, our finding of greater access to transplant among waitlisted patients suggests that the kidney allocation system was responsible for this observed change. Examining rates is also important because whites are the largest group on the waitlist, so a kidney transplant that would have gone to a white patient before the kidney allocation system would make a larger impact on the racial/ethnic specific kidney transplantation rate if given to a black or Hispanic patient as a result of the kidney allocation system.

Kidney transplantation is the preferred treatment for most end-stage renal disease patients, yet many individuals do not complete the medical evaluation process necessary to be put on the waitlist(2, 3). In 2014, only about 100,000 patients completed the many steps necessary to reach the kidney transplant waiting list and only 17,914 patients on the waitlist received a kidney transplant (1), due to limited supply. Minorities are even less likely than whites to complete the medical evaluation (8), be placed on the waiting list (9,10), or receive a kidney transplant (11–18,19). Equitable access to deceased donor kidneys for waitlisted patients is a laudable achievement, but continued efforts are needed to address the disparities that exist in the steps leading up to the waitlist.

In addition, the fact remains that the need for kidneys far surpasses the current supply. Without an increase in the supply of deceased donor kidneys, the gains in equity for blacks and Hispanics come at the cost of decreasing the likelihood of receiving a transplant for white patients. It is clear that national policies regarding kidney transplantation can have strong and immediate effects. Increasing kidney donation rates – while ensuring equitability in access to transplant – should be the next policy targets.

Conclusions

The implementation of the new kidney allocation system was associated with increases in the rates of kidney transplantation among black and Hispanic patients on the waitlist and at least a temporary elimination of racial/ethnic disparities in kidney transplantation among waitlisted patients.

The new kidney allocation system represents an important step towards achieving equitable access to kidney transplantation, but continued monitoring is crucial to maintaining and improving upon the disparity reductions we observed. If the disparity reduction is sustained, the kidney allocation system will serve as a valuable example of how health policy can be shaped to immediately reduce racial/ethnic disparities in our health care system.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Notes

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EXHIBIT 1.

Average Monthly Kidney Transplantation Rates in the United States, June 2013–March 2016

Source: Author's analysis of data from United Network for Organ Sharing standard analytic file(June 2013–September 2016)

EXHIBIT 3.

Average Time On Dialysis Among White Kidney Transplant Recipients, June 2013 to September 2016 Source: Author's analysis of data from United Network for Organ Sharing standard analytic file(June 2013–September 2016)

EXHIBIT 4.

Average Time On Dialysis Among Black Kidney Transplant Recipients, June 2013 to September 2016 Source: Author's analysis of data from United Network for Organ Sharing standard analytic file(June 2013–September 2016)

EXHIBIT 5.

Average Time On Dialysis Among Hispanic Kidney Transplant Recipients, June 2013 to September 2016 Source: Author's analysis of data from United Network for Organ Sharing standard analytic file(June 2013–September 2016)

Exhibit 2
Difference-In-Difference in Average National Monthly Kidney Transplantation Rates For Whites, Blacks, and Hispanics

	Pre-Kidney Allocation System Kidney Transplantation Rate	Post-Kidney Allocation System Kidney Transplantation Rate	Difference Post-Pre	Difference-in-Difference (White vs. nonwhite)	P-value
White	1.07	0.95	-0.12		
Black	0.80	0.96	0.16	0.29	<0.001
Hispanic	0.79	0.91	0.12	0.24	<0.001

Source: Author's analysis of data from United Network for Organ Sharing standard analytic file (June 2013–September 2016)

Note: The kidney transplantation rate represents transplants per 100 waitlisting events.