




Deceased Donor Kidneys Are Harder to Place on the Weekend

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Weekends and holidays have been shown to negatively affect patient outcomes across a variety of health care settings (1). Although transplant outcomes are a possible exception, we have previously reported a significant increase in the discard of deceased donor kidneys during the weekend in the United States even after adjusting for organ quality (2). This phenomenon also affects deceased donor liver utilization (3). However, given that most deceased donor kidneys are offered to multiple candidates before acceptance (4), it is unclear if these findings are truly the result of greater reluctance on the part of the transplant centers to accept organs that are eventually used for transplant.

We used data from the United Network for Organ Sharing Potential Transplant Recipient dataset to examine match run data for all transplanted deceased donor kidneys from January 1, 2008 to December 31, 2015 to determine whether organs transplanted during the weekend were offered to a greater number of candidates before eventual acceptance for transplantation. Discarded kidneys and their associated match run data were excluded. To remain consistent with our prior analysis, Monday was used as a reference, and weekend kidneys were defined as those that were first offered on either Friday or Saturday (*i.e.*, those that would, if accepted, actually reach transplant centers and be transplanted over the weekend). We used the Scientific Registry of Transplant Recipients definition of a “hard to place” deceased donor kidney as one that needed to be offered to >100 candidates before it was accepted for transplantation (*i.e.*, the kidney was accepted for a candidate with sequence number >100). Our primary analysis excluded all individual offers coded as system bypasses, including bypasses due to predetermined center minimum acceptance criteria (because those offer declines are automated and have no active human intervention, thus precluding there being a difference by day of the week), while maintaining other offers in the match run for these kidneys. We performed a sensitivity analysis that also included all bypassed offers. We compared the sequence number for accepted offers for deceased donor kidneys (*i.e.*, the number of offers made to matched candidates before a given kidney was ultimately

accepted for transplantation, with a smaller acceptance sequence number indicating fewer declined offers before acceptance) on the basis of the day of first offer using the Kruskal–Wallis test as well as the odds ratio of becoming a hard to place kidney by day of the week using logistic regression adjusting for Kidney Donor Profile Index (KDPI), a measure of donor kidney quality.

Our final cohort included 14,684,328 offers for 94,654 deceased donor kidneys that were transplanted over the 8-year study period; 250 centers (96%) declined one or more offers due to a center minimum criteria bypass. When we excluded offers that were automatically bypassed for any reason ($n=6,910,140$ bypasses), deceased donor kidneys offered on Monday had the lowest mean sequence number for accepted offer (135 ± 469). Compared with deceased donor kidneys offered on Mondays, those offered on Friday (151 ± 485), Saturday (155 ± 532), or Sunday (155 ± 521) had meaningfully higher mean sequence numbers for accepted offer ($P<0.001$). Similarly, deceased donor kidneys offered on Friday (odds ratio, 1.16; 95% confidence interval, 1.09 to 1.24), Saturday (odds ratio, 1.19; 95% confidence interval, 1.11 to 1.27), and Sunday (odds ratio, 1.15; 95% confidence interval, 1.08 to 1.23) were significantly more likely to be hard to place than those offered on Mondays even after adjusting for the KDPI (Figure 1). There were no secular trends in our findings when comparing individual years during the study period. Hard to place kidneys had significantly longer cold ischemia time (mean: 24.5 ± 10.8 hours) than kidneys that were accepted within the first 100 offers (16.3 ± 8.5 hours; t test $P<0.001$). Furthermore, kidneys were offered to a greater number of unique transplant centers before acceptance on the weekend versus weekdays (6 ± 12 versus 7 ± 12 ; $P<0.001$).

After including bypassed offers, kidneys first offered on Monday were accepted at mean sequence number 234 ± 942 , with notably higher mean sequence numbers for acceptance on Friday (256 ± 1009), Saturday (256 ± 1006), and Sunday (250 ± 959 ; $P<0.001$). The odds of a deceased donor kidney being hard to place were lowest for kidneys offered on Monday and significantly higher for kidneys offered on Friday (odds ratio, 1.12; 95% confidence interval, 1.06 to 1.20),

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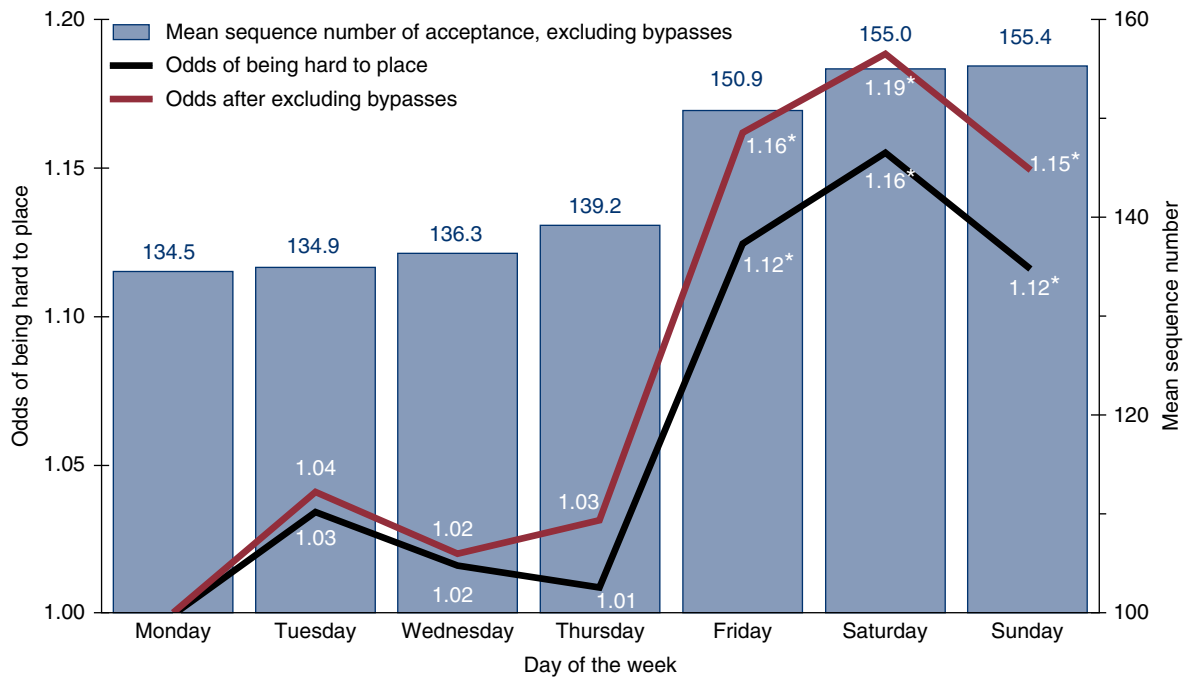


Figure 1. | Mean sequence number of accepted offer and adjusted odds of becoming a hard to place kidney (acceptance sequence number >100) were higher on the weekend for transplanted deceased donor kidneys from 2008 to 2015. Day of the week refers to the day of the first offer for the kidney. Automatically bypassed offers are not included in the “excluding bypasses” calculations. Compared with kidneys offered on Mondays, kidneys offered on Fridays, Saturdays, and Sundays had a higher mean sequence number of accepted offer and adjusted odds of becoming a hard to place kidney (reference is Monday; adjusted for Kidney Donor Profile Index). * $P \leq 0.001$.

Saturday (odds ratio, 1.16; 95% confidence interval, 1.09 to 1.23), or Sunday (odds ratio, 1.12; 95% confidence interval, 1.05 to 1.19) after adjusting for the KDPI (Figure 1).

Our findings underscore the effect of low-resource time periods, such as weekends, on the current kidney allocation system. Even after adjustment for organ quality, kidneys needed to be offered to more individuals before they were accepted, and they were significantly more likely to be harder to place. Resource limitations, including the added burden of the on-call surgical staff coupled with logistical complexities associated with obtaining hemodialysis on weekends, may serve as a deterrent to accepting an offer for an otherwise reasonable organ, thereby resulting in greater difficulty in placing organs and higher discard rates (2,5).

Providing feedback on patterns of organ offer acceptance to centers and even patients could help identify modifiable center-level behavior and provide incentives to reallocate resources to prevent disadvantaging waitlisted patients over the weekends. Additional potential policy changes include prioritization of transplant centers with adequate resources over weekends in the match run and allowing centers to be skipped over in the match run for short time periods when they self-identify that surgical staff members are not available. These changes could improve efficiency in the match run process and minimize the cold ischemia time that accumulates as an organ is offered and declined many times. These proposed policy changes to improve transparency and allocation efficiency could potentially

improve deceased donor kidney offer acceptance, utilization, and outcomes.

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Disclosures

Dr. Cohen, Dr. Husain, Dr. King, and Dr. Mohan have nothing to disclose.

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