The weekend effect alters the procurement and discard rates of deceased donor kidneys in the United States

see commentary on page 26

Sumit Mohan[1,2,3], Karl Foley[1], Mariana C. Chiles[1,3], Geoffrey K. Dube[1], Rachel E. Patzer[4,5], Stephen O. Pastan[6], R. John Crew[1], David J. Cohen[1] and Lloyd E. Ratner[7]

[1]Department of Medicine, Division of Nephrology, Columbia University Medical Center, New York, New York, USA; [2]Department of Epidemiology, Columbia University Mailman School of Public Health, New York, New York, USA; [3]The Columbia University Renal Epidemiology (CURE) Group, New York, New York, USA; [4]Department of Surgery, Division of Transplantation, Emory University School of Medicine, Emory University, Atlanta, Georgia, USA; [5]Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, Georgia, USA; [6]Department of Medicine, Renal Division, Emory University School of Medicine, Emory University, Atlanta, Georgia, USA; and [7]Department of Surgery, Division of Transplantation, Columbia University Medical Center, New York, New York, USA

Factors contributing to the high rate of discard among deceased donor kidneys remain poorly understood and the influence of resource limitations of weekends on kidney transplantation is unknown. To quantify this we used data from the Scientific Registry of Transplant Recipients and assembled a retrospective cohort of 181,799 deceased donor kidneys recovered for transplantation from 2000–2013. We identified the impact of the day of the week on the procurement and subsequent utilization or discard of deceased donor kidneys in the United States, as well as report the geographic variation of the impact of weekends on transplantation. Compared with weekday kidneys, organs procured on weekends were significantly more likely to be discarded than transplanted (odds ratio: 1.16; 95% confidence interval: 1.13–1.19), even after adjusting for organ quality (adjusted odds ratio: 1.13; 95% confidence interval: 1.10–1.17). Weekend discards were of a significantly higher quality than weekday discards (Kidney Donor Profile Index: 76.5% vs. 77.3%). Considerable geographic variation was noted in the proportion of transplants that occurred over the weekend. Kidneys available for transplant over the weekend were significantly more likely to be used at larger transplant centers, be shared without payback, and experienced shorter cold ischemia times. Thus, factors other than kidney quality are contributing to the discard of deceased donor kidneys, particularly during weekends. Policy prescriptions, administrative or organizational solutions within transplant programs may potentially mitigate against the recent increase in kidney discards.

Kidney International (2016) **90,** 157–163; http://dx.doi.org/10.1016/j.kint.2016.03.007

KEYWORDS: organ allocation; renal transplantation; outcomes

Correspondence: *Sumit Mohan, Department of Medicine and Epidemiology, Columbia University Medical Center, 622 W 168th Street PH4-124, New York, New York 10032, USA. E-mail: sm2206@cumc.columbia.edu*

Received 15 December 2015; revised 1 March 2016; accepted 17 March 2016; published online 12 May 2016

Weekends are traditionally a period of limited resources at hospitals and numerous studies have demonstrated the adverse impact of weekends on patient outcomes. For example, higher mortality rates have been observed among patients admitted on weekends for diagnoses where outcomes are associated with time-sensitive interventions, such as myocardial infarctions, strokes, and pulmonary embolism.[1–5] Similar analyses for diagnoses requiring urgent surgery, such as ruptured aortic aneurysms, have also demonstrated inferior outcomes.[6] Previous analyses have suggested that outcomes following kidney and liver transplants performed over the weekend are similar to transplants performed during the week.[7–10] However, these analyses examined only the outcomes of organs that were procured and actually transplanted without accounting for the impact of organ selection.

Each year over 5000 people die waiting for a kidney transplant, whereas annually, nearly 2700 kidneys that are procured for transplantation are subsequently discarded.[11] This high rate of discard is concerning especially given the worsening organ shortage in the United States, yet the factors contributing to organ discard remain poorly understood. Although the most commonly cited reason for organ discard is biopsy results (despite growing evidence that these findings are not predictive of outcomes), recent analyses suggest that even kidneys of acceptable quality are being discarded at an increasing rate.[9,10,12] Poor donor kidney function, anatomic abnormalities, and concern regarding donor medical/social history are other highly cited reasons for the discard of deceased donor kidneys procured for transplant.[9,13,14] It is important to note that currently no universal guidelines exist in the United States to recommend which kidneys should be utilized and which should be discarded. As a result, we hypothesize that there is a significant degree of transplant center-to-center variability, suggesting that factors external to the donor organ, or recipient, may contribute to transplant centers' decisions not to transplant an organ. However, whether resource limitations at transplant centers contribute to the discard of deceased donor kidneys has not been studied. In this study, our objective was to analyze whether the

procurement and utilization of deceased donor kidneys in the United States varied by day of the week, specifically, if it was different on weekends than on weekdays.

RESULTS

In the United States from 2000 to 2013, approximately 202,000 deceased donor kidneys were available for procurement ($n = 201,956$), of which ~90% were procured for transplant ($n = 181,799$) (Table 1, Supplementary Figure S1). The number of deaths in the United States during that period varied by day of the week and peaked on Friday and Saturday.[15] Similarly, the total number of kidneys available for procurement varied by day of the week but the highest numbers were available on Tuesdays (15.1%) and Wednesdays (15.1%), whereas the lowest numbers were available on Sunday and Monday (13.5% and 13.4%, respectively) (Table 1). The average quality of kidneys available for procurement, as measured by the Kidney Donor Profile Index (KDPI), also varied significantly by day of the week ($P < 0.001$). Fridays were associated with the lowest rate of procurement of kidneys from the available donor pool (89.3%) and the procured kidneys had the highest average KDPI (value of 53.7%), that is, the lowest quality, for kidneys procured on any single day of the week. In contrast, Sundays and Mondays were associated with having the highest rates of procurement of donor kidneys but these kidneys also had the lowest KDPI, suggesting that the procured kidneys were of a significantly better quality on average (Table 1).

Nearly 80% of kidneys transplanted on the weekend were procured from deceased donors on Fridays and Saturdays (Supplementary Table S1). Kidneys procured on Fridays experienced the highest rate of organ discard for the week (Table 1). The rate of kidney procurement on Saturday was marginally higher than that seen on Friday (89.7% vs. 89.3%, $P < 0.001$), whereas the discard rate for kidneys procured on Saturday (18.4%) was the second highest for the week after kidneys procured on Friday (18.8%). The discard rate was lowest on Monday and increased over the course of the week to peak on Friday ($P < 0.001$) (Table 1). The odds of discard of a kidney after procurement tended to increase over the course of the week (reference = Monday), that is, as the weekend neared, there was an increase in the odds of discard for kidneys procured on Friday and Saturday (Figure 1, Table 2). The quality of discards also showed an uptrend during the course of the week and peaked on Friday. As a result, the odds of kidney discard on Friday and Saturday remained significantly elevated even after adjustment for the KDPI (adjusted odds ratio [aOR]: 1.19; 95% confidence interval [CI]: 1.13–1.26; $P < 0.001$, and aOR: 1.18; 95% CI: 1.11–1.24; $P < 0.001$, respectively) (Figure 1, Table 2). The percentage of kidneys being shared without payback between donor service areas increased from Monday to a peak on Saturday ($P = 0.003$) (Table 1). Additionally, kidneys procured on weekends (Friday and Saturday) were more likely to be transplanted at larger transplant centers than kidneys procured on a weekday (Sunday–Thursday; $P = 0.037$).

When considered together, kidneys procured on Friday and Saturday, that is, kidneys available for transplant on the weekend, were much more likely to be discarded (18.6% vs. 16.4%, $P < 0.001$); these discarded kidneys were more likely to be of a higher quality, that is, lower KDPI, (76.5% vs. 77.3%, $P = 0.018$) than those discarded during the rest of the week (Table 1). Compared with weekday kidneys, organs procured for transplantation on weekends were approximately 1.2 times more likely to be discarded than transplanted (OR: 1.16; 95% CI: 1.13–1.19; $P < 0.001$), even after adjusting for organ quality (aOR: 1.13; 95% CI: 1.10–1.17; $P < 0.001$) (Table 3). Kidneys available for transplant over the weekend were also more likely to be used at larger transplant centers ($P = 0.037$), be shared without payback ($P = 0.001$), and experienced shorter cold ischemia times ($P = 0.002$) (Table 1). However, the majority of transplanted kidneys, regardless of weekday period or day of the week distinction, were transplanted the day after they were procured (Supplementary Table S2), resulting in relatively similar mean cold ischemia times (Supplementary Table S2).

Transplants performed on the weekend were not evenly distributed across the country (Figure 2). Uniform transplantation rates and preferences suggest that, on average, 28.6% (2 of 7) of all deceased donor kidney transplants in any large geographic area would occur on weekends or, though unlikely, that the proportion of total kidneys transplanted during that time period equaled the proportion of kidneys offered. Considerable geographic variation was noted in the proportion of transplants that occurred over the weekend (Figure 2). The Southeast (e.g., Arkansas, Alabama, South Carolina, Kentucky, West Virginia, Virginia) and Midwest (e.g., Minnesota, Iowa, Ohio) regions performed a greater than expected share of their deceased donor renal transplants on weekends. States located within the Rocky Mountains (e.g., Wyoming, Utah, Colorado, and Nevada) and Southeast regions (e.g., Arizona and Oklahoma) performed the smallest share of their transplants on the weekend (28.58%–33.51% vs. 18.98%–25.55%).

Due to the broad study period, covering 2000 to 2013, we also analyzed both the percentage of kidneys discarded and the odds of discard over 3 contiguous time periods (2000–2004, 2005–2009, and 2010–2013) (Supplementary Figure S2). Additionally, we examined whether the probability of discard by day of the week was observed across time (Supplementary Figure S3). Both subanalyses confirmed that the observed phenomena were not limited to only a part of the study period. Recent studies have also suggested that kidney discard is on the rise, following the introduction of the new kidney allocation system in the United States in 2014.[16]

A sensitivity analysis was performed to understand the impact of adjusting our logistic regression models, shown in Tables 2 and 3, for the 10 individual components of the KDPI measure (e.g., donor age, weight, height, serum creatinine) instead of the KDPI summary measure. The coefficient estimate for the primary exposure (day of the week) and

Table 1 | Deceased donor kidneys that are available for procurement, were procured, transplanted, or discarded by day of the week or by weekday versus weekend, 2000–2013

	Day of the week organ was procured									Weekday versus weekend		
	Total	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	*P*-value	Sun–Thurs	Fri–Sat	*P*-value
Kidney availability and utilization												
Available for procurement	201,956	27,127	30,451	30,580	29,506	28,794	28,219	27,279	—	144,943	57,013	—
% Available for procurement	100.0	13.4	15.1	15.1	14.6	14.3	14.0	13.5		(71.8)	(28.2)	
Procured for transplant	181,799	24,620	27,528	27,451	26,377	25,713	25,320	24,790	**<0.001**	130,766	51,033	**<0.001**
% Procured for transplant each day/period	90.0	90.8	90.4	89.8	89.4	89.3	89.7	90.9		90.2	89.5	
Discarded	30,977	3,749	4,497	4,645	4,578	4,835	4,647	4,026	**<0.001**	21,495	9,482	**<0.001**
% Discarded from each day/period	17.0	15.2	16.3	16.9	17.4	18.8	18.4	16.2		16.4	18.6	
Transplanted	150,822	20,871	23,031	22,806	21,799	20,878	20,673	20,764	**<0.001**	109,271	41,551	**<0.001**
% Transplanted	100.0	13.8	15.3	15.1	14.5	13.8	13.7	13.8		72.5	27.5	
% Transplanted from each day/period	83.0	84.8	83.6	83.1	82.6	81.2	81.6	83.8		83.6	81.4	
Estimated organ quality by KDPI (mean ± SD)												
Available for procurement	52.2 ± 30.2	50.2 ± 30.3	51.5 ± 30.3	53.0 ± 30.0	53.5 ± 30.1	53.7 ± 30.1	52.9 ± 30.3	50.7 ± 30.2	**<0.001**	51.8 ± 30.2	53.3 ± 30.2	**<0.001**
Procured for transplant	49.5 ± 29.5	47.6 ± 29.5	48.8 ± 29.6	50.2 ± 29.4	50.6 ± 29.4	50.8 ± 29.4	50.2 ± 29.6	48.3 ± 29.4	**<0.001**	49.1 ± 29.5	50.5 ± 29.5	**<0.001**
Transplanted	43.7 ± 27.5	42.3 ± 27.4	43.2 ± 27.5	44.7 ± 27.4	44.9 ± 27.4	44.9 ± 27.5	44.2 ± 27.6	42.8 ± 27.4	**<0.001**	49.1 ± 29.5	50.5 ± 29.5	**<0.001**
Discarded	77.1 ± 22.6	77.2 ± 22.5	77.3 ± 22.7	77.7 ± 22.2	77.7 ± 22.3	76.5 ± 22.9	76.6 ± 23.0	76.5 ± 22.6	**0.013**	77.3 ± 22.5	76.5 ± 22.9	**0.018**
Characteristics of transplanted kidneys												
Transplanted at a large center[a] (%)	50.9	50.4	50.4	50.6	50.4	50.9	51.5	51.1	0.174	50.6	51.2	**0.037**
Shared without payback (%)	12.4	11.9	12.1	12.0	12.3	12.5	13.1	12.6	**0.003**	12.2	12.8	**0.001**
Cold ischemia time (h), median (IQR)	16.0 (11.0–22.0)	16.3 (11.2–22.4)	16.3 (11.0–22.3)	16.0 (11.0–22.0)	16.0 (11.0–22.0)	16.0 (11.0–22.0)	16.0 (11.0–22.6)	16.4 (11.0–23.0)	**<0.001**	16.2 (11.0–22.3)	16.0 (11.0–22.0)	**0.002**

Bold *P*-values are statistically significant.
IQR, interquartile range; KDPI, Kidney Donor Profile Index.
[a]Defined as transplant centers that performed, on average, ≥100 living or deceased donor transplants per year over from 2000 to 2013.

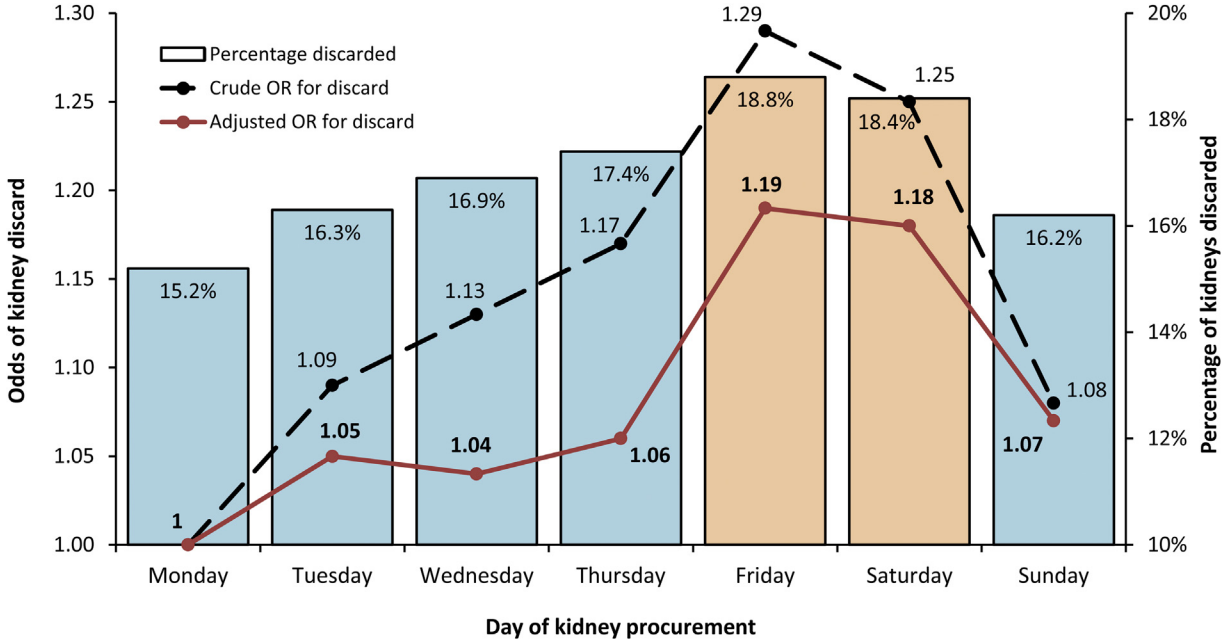

Figure 1 | Rate and odds of discard of deceased donor kidneys over the course of the week, 2000–2013. OR, odds ratio.

outcome (discard) relationship was not significantly altered when comparing both approaches and are shown in Supplementary Table S3.

DISCUSSION

Weekends are classically associated with limitations on resource availability and appear to negatively impact outcomes for several conditions.[1,3–5] Outcomes following transplantation over the weekend appear to be a notable exception to these phenomena.[7,8] However, because organ transplantation has a potentially elective component that requires acceptance of an organ by the medical/surgical team, outcomes of transplants performed over the weekend may be biased by potential differences in selection criteria between weekdays and weekends.

Our analysis demonstrates a temporal trend during the week for procurement and discard of kidneys, as well as utilization patterns that reflect how organs are distributed and where they are utilized. We also demonstrated a dramatic adverse impact of weekends on the procurement of, and subsequent discard of, kidneys from deceased donors that were determined to be transplantable at the time of procurement. Kidneys that were procured but not subsequently transplanted over the weekend appear to be of higher quality than kidneys that were procured and similarly discarded during the weekday, suggesting that factors beyond the quality of the kidney were influencing the decision to accept/decline the offer of a deceased donor kidney. This finding, coupled with the increased utilization of deceased donor kidneys at large transplant centers on the weekend, would suggest the contribution of resource limitations that often occur on weekends is a contributing factor. Large transplant centers tend to have more resources, including manpower, and while they may also experience resource constraints over the weekend, the impact may be smaller.

Notably, cold ischemia times for transplanted organs on the weekend were shorter than they were during the weekday, suggesting perhaps an awareness of the increased difficultly in organ acceptance during the weekend and the development of organ offer strategies to mitigate this effect. Alternatively, transplant centers may use lower thresholds for cold ischemia time for accepting a deceased donor kidney over the weekend. For example, centers that routinely accept kidneys with long cold ischemia time and are willing to accept the attendant increased risk of delayed graft function may be less willing to do so on weekends if there are resource limitations that limit the availability of hemodialysis postoperatively. Additionally, we hypothesize that limited surgical manpower on weekends

Table 2 | Odds of kidney discard after procurement by day of the week

Day of procurement	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Monday	Ref		Ref	
Tuesday	1.09 (1.04–1.14)	**0.001**	1.05 (0.99–1.10)	0.087
Wednesday	1.13 (1.08–1.19)	**<0.001**	1.04 (0.99–1.10)	0.123
Thursday	1.17 (1.12–1.23)	**<0.001**	1.06 (1.01–1.12)	**0.024**
Friday	1.29 (1.23–1.35)	**<0.001**	1.19 (1.13–1.26)	**<0.001**
Saturday	1.25 (1.19–1.31)	**<0.001**	1.18 (1.11–1.24)	**<0.001**
Sunday	1.08 (1.03–1.13)	**0.002**	1.07 (1.01–1.13)	**0.013**
KDPI (per 1% increase)	1.05 (1.05–1.05)	**<0.001**	1.05 (1.05–1.05)	**<0.001**

Bold values are statistically significant.
CI, confidence interval; KDPI, Kidney Donor Profile Index; OR, odds ratio; Ref, reference.

Table 3 | Odds of kidney discard after procurement by period of the week procurement

	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Weekday (Monday–Thursday)	Ref		Ref	
Weekend (Friday–Saturday)	1.16 (1.12–1.19)	**<0.001**	1.13 (1.10–1.17)	**<0.001**
KDPI (per 1% increase)	1.05 (1.05–1.05)	**<0.001**	1.05 (1.05–1.05)	**<0.001**

Bold values are statistically significant.
CI, confidence interval; KDPI, Kidney Donor Profile Index; OR, odds ratio; Ref, reference.

may be a contributing factor, particularly for smaller transplant programs. Surgeons may have to cover multiple services (e.g., liver and kidney), perform organ procurements, and deal with emergencies without the luxury of other attending transplant surgeons for backup on weekends. This may result in an increased reluctance, if not a complete inability to accept organs for transplant during these periods. Increased rates of decline at transplant centers on the weekend may also contribute to longer cold ischemia times accrued on kidneys while attempting to place them, which in turn would adversely affect the likelihood of organ acceptance even at centers with less stringent acceptance criteria. Geographic variation in the percentage of decreased donor transplants that occur on the weekend would suggest systemic factors are contributing to the acceptance/decline of kidneys for transplantation. Whereas center-specific resource allocation issues adversely impact organ acceptance on the weekends, transplant surgeons who are engaged in significant elective nontransplant surgeries during the workweek may find themselves more willing or able to accept organ offers on the weekend for transplant resulting in centers that do a greater than expected share of their transplants on the weekend.

Although there are many strengths of our study, our analysis has some of the limitations that are inherent in observational studies analyzing registry data. First, whereas Scientific Registry of Transplant Recipients (SRTR) data capture reasons for organ discard and disposition, the reporting is subjective. In addition, certain organ and transplant center-level characteristics, such as cold ischemia time for discarded organs, detailed kidney biopsy findings, and a center's academic affiliation, were not available in the dataset. Thus, the contributions of these factors to organ discard were not measurable in our analysis. Also, although the KDPI has been validated as a reasonable measure of deceased donor organ quality in the United States, it is an imperfect measure with only moderate predictive power (KDPI *C*-statistic = 0.60). KDPI, as currently formulated, does not include certain organ characteristics that would influence the ability to use the organ such as anatomical abnormalities, injury during procurement, or even biopsy findings when a biopsy is performed. Lastly, because the SRTR dataset does not include a precise date/time that a kidney is discarded, we chose to define weekend kidneys as organs that would have been transplanted on the weekend rather than those procured on the weekend. Deceased donor kidneys are often transplanted with more than 24 hours of cold storage and as a result, the majority of kidneys procured for transplantation are transplanted on the following day (Supplementary Table S1). Thus, most kidneys transplanted on the weekend (Saturday/Sunday) are procured on Friday or Saturday.

In conclusion, our analysis demonstrates a variation in procurement and discard rates that vary over the course of the week and strongly suggest that deceased donor kidneys are more likely to be discarded over the weekend independent of organ quality. This suggests that organizational and systemic factors that extend beyond the quality of the available organ appear to be contributing to the high rate of discard of kidneys from deceased donors in the United States. Further investigation into the short- and long-term outcomes of recipients transplanted at centers that are high weekend utilizers could potentially provide an opportunity for quality improvement efforts, as well as changes in policy, to improve organ utilization.

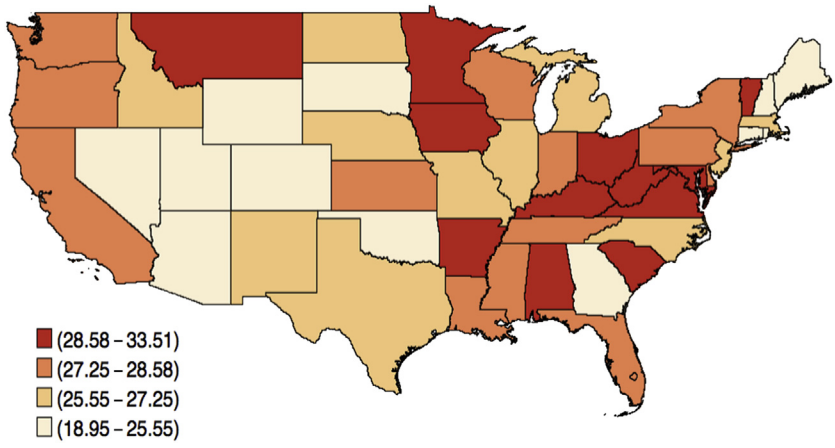

Figure 2 | Geographic variation in the proportion of deceased donor kidney transplants performed over the weekend by state, 2000–2013.

MATERIALS AND METHODS

Study design and participants

This observational cohort study used data from the SRTR and the United Network for Organ Sharing from 2000 to 2013. The SRTR data system includes data on all donor, wait-listed candidates, and transplant recipients in the United States, which are submitted by the members of the Organ Procurement and Transplantation Network (OPTN). The Health Resources and Services Administration, U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were used to ensure the reporting of this observational study.[17]

We utilized the SRTR standard analytical file (2014 quarter 1) to conduct a retrospective cohort study to analyze variation in kidney procurement and utilization during the calendar week (Monday–Sunday) from 2000 to 2013 and measure the impact of weekends, that is, periods traditionally associated with lower resource availability. After including only deceased donor transplants and excluding donors and recipients <18 years in age, we identified a cohort of 201,956 deceased donor kidneys. For our analysis, we excluded kidneys from donors for whom we were unable to calculate the KDPI ($n = 306$) such as those with missing height or serum creatinine data. Kidneys of donors with a body mass index >50 ($n = 1{,}338$) were also excluded due to concerns about the validity of anthropometric measurements that could affect the KDPI calculations.

Given that nearly 80% (78.7%) of the organs used for kidney transplants performed on the weekend were procured on Friday and Saturday (Supplementary Table S1), we defined weekend kidneys as those that were procured for transplant on either a Friday or Saturday and subsequently discarded. We measured organ quality by calculating the KDPI, which is currently part of the new OPTN allocation policy for kidneys in the United States. KDPI is derived from the Kidney Donor Risk Index (KDRI), a measure used to estimate the relative risk of posttransplant kidney graft failure. KDRI is calculated using 10 donor-specific characteristics (age, height, weight, ethnicity, history of hypertension, history of diabetes, cause of death, serum creatinine, hepatitis C virus status, and donation after cardiac death status) and has been validated as a reasonable measure of organ quality in the United States as well as in other developed countries.[15,18–21] After calculating the KDRI score, we mapped the values onto a cumulative percentage scale to create the KDPI. Because our analysis identified kidneys recovered from 2000 to 2013, as described by the OPTN, the KDRI was scaled to the median donor from 2013.[15] Large transplant centers were defined as those that performed, on average, ≥100 living or deceased donor transplants per year over the duration of the study.

Geographic variation in the percentage of transplants that occurred on the weekends was estimated using the national OPTN Standard Transplant Analysis and Research file (based on OPTN data as of June 30, 2014). The spatial representation of the proportion of weekend transplants is limited to recipients whose state of residence was known as of June 2014.

Statistical analysis

Pearson chi-square tests and the nonparametric Wilcoxon or Kruskal-Wallis tests were performed for categorical and continuous variables, respectively. Chi-square tests were used to test equality of distribution between days of the week. We used univariate and multivariable logistic regression models to identify the odds of discard (vs. transplantation) of kidneys procured on different days of the week. The purposeful selection algorithm was used to evaluate confounding and establish which covariates were included in our regression models. We investigated effect measure modification by transplant center size and kidney procurement era on the relationship between day of the week organ procurement and discard. An interaction term approach, as well as the likelihood ratio test, was used to evaluate the effect mediation. Transplant, recipient, and donor characteristics were viewed as being potential model parameters. Univariate analysis of each potential covariate was performed; any variable having a significant univariate test, based on the Wald test from logistic regression using a *P*-value cutoff of 0.25, was considered a potential candidate for the multivariable analysis.[22,23] Known clinical relevance also contributed to the final selection of model parameters.

Prior to our analysis, the model assumptions for logistic regression testing were evaluated and met (including that there was linearity in the logit for the KDPI measure, the only continuous variable in our model, and the lack of strongly influence outliers). Our final regression models adjusted the KDPI summary measure. Additionally, a sensitivity analysis was performed to understand the impact of adjusting models by the 10 components of the KDPI measure instead of the KDPI summary measure. Analyses were performed using SAS (version 9.4; SAS Institute, Cary, NC) and Stata MP (version 13.1; StataCorp, College Station, TX). The postcovariate selection's statistical significance was identified by a *P* value <0.05.

DISCLOSURE

All the authors declared no competing interests.

ACKNOWLEDGMENTS

This work was supported in part by Health Resources and Services Administration contract 234-2005-37011C. The content is the responsibility of the authors alone and does 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 U.S. government.

The data reported here have been supplied by the Minneapolis Medical Research Foundation as the contractor for the 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 U.S. government.

Part of this analysis was presented at the annual meeting of the American Society of Nephrology in San Diego—Renal Week, November 2015.[24]

SUPPLEMENTARY MATERIAL

Figure S1. Flow chart of study population selection. The gray boxes show the subjects excluded from the study.

Figure S2. The percentage and odds of discard among deceased donor kidneys procured for transplant in the United States, stratified by procurement era, 2000–2013. CI, confidence interval; KDPI, Kidney Donor Profile Index; OR, odds ratio.

Figure S3. Kidney Donor Profile Index adjusted odds of discard among deceased donor kidneys procured for transplant in the United States over the course of a calendar week, stratified by procurement era, 2000–2013. CI, confidence interval.

Table S1. The association between the day of organ procurement and the day of organ transplantation, 2000–2014. [1]Total may not add to 150,822 due to missing variable.

Table S2. Mean cold ischemia time (CIT) of transplanted deceased donor kidneys in the United States, stratified by the day of organ procurement and the day of transplantation, 2000–2013.
Table S3. Odds of kidney discard after procurement by day of the week. CI, confidence interval; COD, cause of death; DCD, donor after cardiac death; HCV, hepatitis C virus; OR, odds ratio.
Supplementary material is linked to the online version of the paper at www.kidney-international.org.

REFERENCES

1. Bell CM, Redelmeier DA. Mortality among patients admitted to hospitals on weekends as compared with weekdays. *N Engl J Med*. 2001;345:663–668.
2. Nanchal R, Kumar G, Taneja A, et al, for the MICCOR Group. Pulmonary embolism: the weekend effect. *Chest*. 2012;142:690–696.
3. Saposnik G, Baibergenova A, Bayer N, Hachinski V. Weekends: a dangerous time for having a stroke? *Stroke*. 2007;38:1211–1215.
4. Kumar G, Deshmukh A, Sakhuja A, et al. Acute myocardial infarction: a national analysis of the weekend effect over time. *J Am Coll Cardiol*. 2015;65:217–218.
5. Pathak R, Karmacharya P, Aryal MR, Donato AA. Weekend versus weekday mortality in myocardial infarction in the United States: data from healthcare cost and utilization project nationwide inpatient sample. *Int J Cardiol*. 2014;174:877–878.
6. Groves EM, Khoshchehreh M, Le C, Malik S. Effects of weekend admission on the outcomes and management of ruptured aortic aneurysms. *J Vasc Surg*. 2014;60:318–324.
7. Dube GK, Pastan SO, Patzer RE, Mohan S. Does transplant on the weekend affect outcomes after kidney transplant? A UNOS analysis. *Am J Transplant*. 2014;14(suppl 3):599.
8. Orman ES, Hayashi PH, Dellon ES, et al. Impact of nighttime and weekend liver transplants on graft and patient outcomes. *Liver Transpl*. 2012;18:558–565.
9. Tanriover B, Mohan S, Cohen DJ, et al. Kidneys at higher risk of discard: expanding the role of dual kidney transplantation. *Am J Transplant*. 2014;14:404–415.
10. Mohan S, Tanriover B, Ali N, et al. Availability, utilization and outcomes of deceased diabetic donor kidneys; analysis based on the UNOS registry. *Am J Transplant*. 2012;12:2098–2105.
11. Kasiske BL, Stewart DE, Bista BR, et al. The role of procurement biopsies in acceptance decisions for kidneys retrieved for transplant. *Clin J Am Soc Nephrol*. 2014;9:562–571.
12. Azancot MA, Moreso F, Salcedo M, et al. The reproducibility and predictive value on outcome of renal biopsies from expanded criteria donors. *Kidney Int*. 2014;85:1161–1168.
13. Shapiro R, Halloran PF, Delmonico FL, Bromberg JS. The "two, one, zero" decision: what to do with suboptimal deceased donor kidneys. *Am J Transplant*. 2010;10:1959–1960.
14. Matas AJ, Smith JM, Skeans MA, et al. OPTN/SRTR 2011 Annual Data Report: kidney. *Am J Transplant*. 2013;13(suppl 1):11–46.
15. The Organ Procurement and Transplantation Network, United Network for Organ Sharing. A guide to calculating and interpreting the Kidney Donor Profile Index (KDPI). May 14, 2014. Available at: https://optn.transplant.hrsa.gov/contentdocuments/guide_to_calculating_interpreting_kdpi.pdf, accessed December 1, 2015.
16. Massie AB, Luo X, Lonze BE, et al. Early changes in kidney distribution under the new allocation system [e-pub ahead of print]. *J Am Soc Nephrol*. pii: ASN.2015080934, accessed January 10, 2016.
17. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61:344–349.
18. Rao PS, Schaubel DE, Guidinger MK, et al. A comprehensive risk quantification score for deceased donor kidneys: the kidney donor risk index. *Transplantation*. 2009;88:231–236.
19. Callaghan CJ, Harper SJ, Saeb-Parsy K, et al. The discard of deceased donor kidneys in the UK. *Clin Transplant*. 2014;28:345–353.
20. Pine J, Goldsmith P, Ridgway D, et al. Validation of the Kidney Donor Risk Index (KDRI) score in a UK single centre DCD cohort. *Transplantation*. 2010;90:196.
21. Watson CJ, Johnson RJ, Birch R, et al. A simplified donor risk index for predicting outcome after deceased donor kidney transplantation. *Transplantation*. 2012;93:314–318.
22. Bendel RB, Afifi AA. Comparison of stopping rules in forward "stepwise" regression. *J Am Stat Assoc*. 1977;72:46–53.
23. Mickey RM, Greenland S. The impact of confounder selection criteria on effect estimation. *Am J Epidemiol*. 1989;129:125–137.
24. Mohan S, Foley KF, Chiles MC, et al. Discard of deceased donor kidneys in the United States: the weekend. *J Am Soc Nephrol*. 2015;26:918A.