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Developing Organ Offer and Acceptance Measures: When 'Good' Organs Are Turned Down

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Turndowns of offers of deceased donor kidneys for transplantation can contribute to inefficiencies in the organ distribution system and inequality in access to donated organs. Match run data were obtained for 4967 'good' kidneys placed and transplanted in 2005 after fewer than 50 offers. These kidneys were not recovered from donation after cardiac death or expanded criteria donors, or from donors with a history of substance abuse. On average, these good kidneys were not accepted until after seven offers to candidates and after offers to 2.4 programs. Models for the likelihood of acceptance found several donor and candidate characteristics to be significantly related to acceptance rates ($p < 0.05$). After accounting for these variables, there remained 2- to 3-fold differences among transplant programs in acceptance rates. These models could be used to identify kidney transplant centers with exceptional acceptance practices. Several strategies might be employed to increase acceptance rates for good organs.

Key words: Acceptance rates, graft survival, kidney transplantation, methodology, OPTN, organ offers, SRTR

Background

Much of the literature concerning the processes by which kidneys and other solid organs are distributed for transplantation in the United States has focused on allocation policies that determine the order in which offers are made to candidates on the waiting list. Perhaps too little attention has been paid to assessing whether those offers are accepted in an efficient manner that best serves the needs of the wait-listed population. Transplant programs receive numerous offers of organs for candidates on their center's waiting list. Most of these offers are turned down. Low acceptance rates of organ offers leads to inefficiency, longer ischemia time, unequal access to donated kidneys and perhaps to higher rates of discarded organs.

A variety of causes for low acceptance rates have been postulated, including expectations of poor posttransplant outcomes based upon perceived donor quality and anticipated interactions between donor and recipient characteristics such as age, size, viral serology and tissue type. In order to distinguish between turndown reasons that led to good or bad outcomes, Cadillo-Chavez et al. (1) reported single-center results for 101 kidneys that were refused locally but subsequently transplanted outside the recovering donor service area, and categorized turndown rates as due to donor quality, donor social history, donor age, donor size/weight, positive serological test results, organ preservation time, organ anatomical damage, elevated creatinine, abnormal urinalysis, abnormal biopsy and decreased urine output. Edwards et al. (2) found, among 3444 biopsied kidneys, that glomerulosclerosis alone did not increase the risk of 1-year posttransplant graft failure. However, among organs with 20% or more glomerulosclerosis, a creatinine clearance less than or equal to 80 mL/min was associated with a 4% decrease in graft survival. Based on national data for 1994–1999 from the United States Renal Data System, Kasiske et al. (3) reported that kidneys from smaller donors had worse outcomes than kidneys from larger donors among medium and large recipients, and suggested that centers may be turning down kidney offers due to donor-recipient size mismatch. In contrast, Lee et al. (4) reported good outcomes for a series of 31 kidneys that had been previously turned down by all other local programs, and Sonnenday et al. (5) described the successful transplantation of 11 kidneys that had been turned down based on poor pulsatile perfusion parameters.

Although the effects of donor and recipient characteristics on kidney graft survival have been documented (6), the relationship of these characteristics and center-specific practices on organ acceptance rates is not well understood. We hypothesized that variation in acceptance rates, beyond that which can be explained by recipient and

donor characteristics, exists among transplant programs, and that metrics could be developed to quantify these behaviors.

The Organ Procurement and Transplantation Network (OPTN), which administers the U.S. organ allocation system, collects information about the reasons for organ turndowns. Data on reasons for each turndown are taken from the 'match run'—the computerized ranking of candidates based on candidate waiting time, donor-recipient compatibility and other criteria that is generated by the OPTN each time a deceased donor kidney becomes available—and designated with one of 34 category codes. In this investigation, we analyze US kidney waiting list and match run data from 2005 to address several related questions: What donor and candidate characteristics are associated with organ acceptance? Are there differences among transplant program practice patterns in the acceptance of organs? Do different rates of organ acceptance lead to different rates of access to transplantation or to different posttransplant outcomes among programs?

This study focuses upon the limited goal of answering these questions for 'good' donor kidneys. The data available for each donor organ are generated by a match run that lists every wait-listed kidney transplant candidate, ranked according to allocation policy, through the candidate who accepted the organ. A naïve interpretation of the match run data would count every candidate listed before the one who accepted the organ as a turned-down offer. During 2005, using this 'naïve definition', the average number of such offers required to place a kidney was 112. However, 75% of the kidneys allocated during 2005 were placed within 22 offers. This observation suggests that a small proportion of organs require many offers before they are accepted. These data also imply that not all of the 'naïve interpretation' offers should be counted as actual offers.

Anecdotal sources suggested that there are two ways to analyze the decision process to accept or reject an organ offer. An organ might be deemed acceptable or unacceptable for all candidates listed at a transplant center based on the characteristics of the organ, or it might be considered on an offer-by-offer basis for each eligible candidate at a program (by position on the match run), based on the characteristics of each donor and candidate pair. These two approaches require separate analyses with different denominators. Since there can be multiple offers for the same organ, an organ-based analysis uses the count of organs as a denominator to compute the fraction of organs accepted per center, while an offer-based analysis uses the number of offers made to compute the fraction of offers that were accepted. It was hypothesized that analyses based on both perspectives would yield similar results about the likelihood of a transplant center accepting an organ.

Methods

These analyses were limited to good organs—kidneys that in general would be accepted on behalf of a wide range of candidates by a large fraction of programs, as summarized in Table 1. The initial sample included 9018 deceased donor kidneys that were transplanted in 2005. Based on donor characteristics, 1975 kidneys from donors who donated after cardiac death or who met the OPTN expanded criteria donor (ECD) definition (6) were excluded. From the remaining sample, 1496 kidneys that were likely to be from atypical donors were excluded. This included organs from donors with a substance abuse history, organs placed through directed donation, organs from military donors and organs that had ever been refused due to donor medical urgency. In addition, some categories of offers for kidneys that were included in the final sample for this study were excluded from analysis. Excluded offers had codes indicating that the offer was not actually made to the transplant center for reasons such as positive cross-match, time limit for offers exceeded and minimum acceptance criteria not met. Offers occurring after the first expedited offer were also excluded. Even after excluding these classes of organs and offers, the presence of a few kidneys with a large number of offers before placement continued to skew the distribution of the number of offers. Among the remaining 5547 kidneys, 50% were accepted on or before the fourth offer but, on average, there were 43 candidates listed before the candidate for whom the allocated kidney was accepted. To address the concern that kidneys that were turned down for more than 50 patients might have undocumented defects that were not captured in the OPTN/SRTR database, such kidneys were excluded from the count of good organs; consequently, 580 kidneys with more than 50 turndowns (after making the exclusions of offers, as described above) were excluded. The final sample included 4967 kidneys transplanted in 2005 that did not meet any of the exclusions listed above and were accepted and transplanted within 50 offers.

Although all of the kidneys in the study population were eventually transplanted, most were turned down several times before being accepted. Two logistic regression models were developed to calculate the acceptance rate of these organs: one for the probability of accepting an organ and one for accepting an offer. In the organ-based analysis, each organ was counted once for each program that it was offered to, regardless of how many candidates at that transplant center received an offer for that organ. In this organ-based analysis, the organ was turned down by a series of programs until it was accepted. In the offer-based analysis, each organ was counted each time it was offered to a different candidate until it was accepted. Consider an example for an organ turned down by three candidates at facility A and by four candidates at facility B before being accepted on offer number eight by a candidate at facility B. In the organ-based analysis, this organ was turned down once by facility A and was accepted by facility B. In the

Table 1: Number of offers per organ for deceased donor kidney transplants, 2005

Number of organs and offers meeting criteria[1]	Number of kidneys	Offers per kidney	
		Mean	Median
All transplanted	9018	112	5
SCD kidneys only	7043	99	5
Other exclusions applied (see 'Methods' section)	5547	43	4
Final sample: accepted within 50 offers	4967	7	3

[1]Each row is a subset of the row above it. Excludes simultaneous kidney-pancreas transplants. Source: SRTR Analysis, August 2006.

offer-based analysis, this organ was turned down seven times and was accepted once. Facility A is credited with one turndown in the organ-based analysis and three turndowns in the offer-based analysis. Facility B is credited with one acceptance in the organ-based analysis and four turndowns and one acceptance in the offer-based analysis.

The organ-based acceptance model used donor characteristics as predictors of the likelihood of acceptance. The offer-based acceptance model used both donor and candidate factors as predictors. Table 3 lists all donor and candidate factors that were included in the final models. Several donor factors were statistically significant, including terminal serum creatinine, cause of death, hypertension (offer model only), age, race, height, hepatitis B and C status, allocation level (local vs. regional or national) and type O blood (organ model only). Candidate factors included age, gender, race, height, diagnosis and the number of human leukocyte antigen (HLA) mismatches. A categorical variable for size of the waiting list at the candidate's listing center was also included in the organ-based analysis. The log odds for acceptance, based on the coefficients for the donor characteristics in each of these two models, was computed separately in both the organ and offer models as an index of acceptability (IA) for each organ. The correlation between the organ and offer model IA's was then calculated to determine if the two models yielded similar measures of 'acceptability' for the study organs.

The adjusted odds ratio (AOR) for acceptance was estimated for each program by including an indicator for that program in the models, along with the predictors and coefficients estimated in the models described previously. Models were fit once for each center in order to estimate the log odds ratio for acceptance at that center compared to all other centers, and adjusted for what would be expected based on the characteristics of organs offered and the case-mix of candidates who received offers at each program. In addition, a random effects model was used to estimate the variation in acceptance rates among facilities, after adjusting for the donor and candidate characteristics listed above.

The resulting AOR for each center summarized the level to which a program accepts more or fewer organs than would be expected, given the characteristics of the organs offered to that program (and, in the offer-model, the program's candidate case-mix). We also analyzed the transplantation rate and standardized mortality ratio for each kidney transplant center, as reported in the SRTR's 2005 center-specific reports (7). The rate of transplantation (per person year on the list) is a measure of access to transplantation. The standardized mortality ratio compares post-transplant recipient mortality to expected mortality at each center. These two measures (transplantation rate and standardized mortality ratio) were correlated with the AOR for offer and organ acceptance based on data for each of 244 transplant programs.

Results

Table 1 reports the number of mean and median offer numbers for deceased donor kidneys transplanted in 2005 after several exclusions were imposed. The next to the bottom row of this table shows that, even after excluding potentially poor kidneys based on reported data, there were some organs with exceptionally long match runs. Among those with match runs longer than 50, the average number of candidates listed before acceptance was 374. The 4967 kidneys from the final sample were placed after a median of three and a mean of seven offers. The turndown codes used prior to acceptance for these kidneys are reported in Table 2. Candidate condition was the most commonly reported reason for turndown. Notably, however, the second most common reason for turndown of these apparently good, non-ECD kidneys was 'donor age or quality' (reported 18.9% of the time).

Table 3 reports the odds ratio for acceptance of offers (column 2) and organs (column 3) for the candidate and donor characteristics listed in column 1. Odds ratios greater than 1.0 correspond to higher acceptance rates, while odds ratios less than 1.0 correspond to lower acceptance rates. In both models, organs from donors who were taller and between the ages of 10 and 35 were more likely to be accepted ($p < 0.05$). Organs from donors who were either Hispanic/Latino, had higher terminal serum creatinine, or had positive serologies for hepatitis B or C were less likely to be accepted ($p < 0.05$). Candidates who were African American, had a diagnosis from the category of congenital, rare familial or metabolic disorders, or with HLA mismatches were less likely to have offers accepted on their behalf ($p < 0.05$). Those candidates who were male, between the ages of 10 and 18, or having a diagnosis of hypertensive nephrosclerosis or polycystic kidneys were more likely to have offers accepted on their behalf ($p < 0.01$). Locally transplanted organs were more likely to be accepted ($p < 0.01$).

The two measures of 'acceptability' of an organ based on these models correlated significantly. The correlation between the acceptability for each organ, as measured separately by the IA values from the offer and organ acceptance models, was $r = 0.82$, $p < 0.001$. Furthermore, as

Table 2: Turndown reasons before acceptance for 4967 kidneys in study population

Refusal code	Frequency	Percentage
Patient ill, unavailable, refused or temporarily unsuitable	7805	22.0%
Donor age or quality	6696	18.9%
High PRA	4167	11.8%
No serum	2260	6.4%
Donor size/weight	1762	5.0%
Number of HLA mismatches unacceptable	1665	4.7%
Other specify	1375	3.9%
Unacceptable antigens	1244	3.5%
Organ anatomical damage or defect	641	1.8%
Positive serological tests	636	1.8%
Organ preservation	528	1.5%
Surgeon unavailable	472	1.3%
Organ-specific donor issue	381	1.1%
Operational-transplant center	249	0.7%
Heavy workload	249	0.7%
Donor social history	208	0.6%
Exceeded 1-h response time	64	0.2%
Patient condition improved, transplant not needed	43	0.1%
Donor ABO	2	<0.1%

Source: SRTR Analysis, August 2006.

Table 3: Factors predicting organ and offer acceptance: odds ratios and 95% confidence limits

Donor factors	Offer model	Organ model
Age		
<2	0.86 (0.52–1.42)	0.72 (0.42–1.42)
2–10	0.92 (0.71–1.19)	1.05 (0.79–1.19)
10–18	1.26 (1.12–1.42)	1.32 (1.15–1.42)
18–35	1.23 (1.13–1.33)	1.17 (1.06–1.33)
35–40	(Ref.)	(Ref.)
>50	0.89 (0.81–0.98)	0.91 (0.81–0.98)
Race		
African American	0.98 (0.89–1.08)	0.9 (0.8–1.08)
Hispanic/Latino	0.79 (0.72–0.87)	0.89 (0.8–0.87)
Other non-Caucasian	1.01 (0.84–1.2)	1.02 (0.82–1.2)
Caucasian	(Ref.)	(Ref.)
Cause of Death		
Anoxia	0.88 (0.8–0.98)	0.87 (0.77–0.98)
Stroke	0.98 (0.91–1.07)	1.03 (0.93–1.07)
CNS	0.71 (0.51–1)	0.84 (0.56–1)
Other	0.94 (0.78–1.14)	1.12 (0.89–1.14)
Head trauma	(Ref.)	(Ref.)
Height (cm)	1.08 (1.04–1.12)	1.05 (1.01–1.12)
HBV/HCV+	0.77 (0.66–0.89)	0.65 (0.55–0.89)
Male	0.95 (0.88–1.03)	0.98 (0.9–1.03)
Type O blood	1.05 (0.99–1.12)	1.22 (1.13–1.12)
Local vs. shared	1.61 (1.47–1.77)	1.45 (1.34–1.77)
Serum creatinine	0.85 (0.8–0.9)	0.89 (0.83–0.9)
History of hypertension	1.11 (1.02–1.22)	1.1 (0.99–1.22)
Candidate factors		
Age		
<2	0.81 (0.35–1.84)	
2–10	1.06 (0.79–1.43)	
10–18	1.3 (1.1–1.54)	
18–35	1.04 (0.94–1.15)	
35–50	(Ref.)	
50–65	1.01 (0.93–1.09)	
>65	0.94 (0.85–1.05)	
Race		
African American	0.85 (0.78–0.92)	
Hispanic/Latino	0.9 (0.82–1)	
Other non-Caucasian	1.31 (1.15–1.49)	
Caucasian	(Ref.)	
Diagnosis		
Congenital, rare familial and metabolic disorders	0.73 (0.59–0.89)	
Diabetes	1.05 (0.95–1.16)	
Hypertensive nephrosclerosis	1.18 (1.07–1.31)	
Missing	0.45 (0.35–0.56)	
Neoplasms	1.19 (0.63–2.24)	
Other	1.21 (1.09–1.35)	
Polycystic kidneys	1.29 (1.13–1.47)	
Renovascular and other vascular diseases	1.03 (0.88–1.2)	
Tubular and interstitial diseases	0.88 (0.75–1.03)	
Glomerular diseases	(Ref.)	
Height (cm)	1 (1–1.01)	
Male	1.25 (1.16–1.34)	
Joint factors		
HLA Mismatches		
0 (Ref.)		
1	0.49 (0.34–0.69)	
2	0.4 (0.33–0.49)	
3	0.27 (0.24–0.31)	
4	0.22 (0.2–0.25)	
5	0.18 (0.16–0.2)	
6	0.12 (0.1–0.14)	

Source: SRTR Analysis, August 2006.

described in the 'Methods' section, although the organ- and offer-level analyses employ different denominators and produce separate measures of the expected counts of accepted organs at each program, the correlation across centers of the expected number of organs accepted, based on both analyses, was $r = 0.71$, $p < 0.01$, for 244 kidney transplant programs.

Table 4 summarizes the offer and organ acceptance rates among kidney transplant programs. In 2005, 14% of all offers for good organs were accepted (i.e. organs were accepted after 7.1 [=1/0.14] offers on average). However, 25% of programs accepted less than 11% of the offers made to them and 25% of programs accepted more than 29% of the offers made to them. Similarly, programs accepted 41% of the good kidneys that they were offered (i.e. the good kidneys were accepted after being offered to 2.4 [=1/0.41] programs on average) while 25% of programs accepted less than 29% of the organs offered to them and 25% of the programs accepted more than 55% of organs offered to them. Some of this variation might be due to differences in donor quality and candidate characteristics. The AORs (which account for such differences) varied 3-fold from 0.76 to 2.35 for offer acceptance and from 0.62 to 1.89 for organ acceptance, for the 50% of the facilities in the middle of the odds ratio ranges.

After adjusting for the expected variation based on donor and candidate characteristics, the log-AOR had an estimated standard deviation of 0.72 above and below the national average, based on an offer-based analysis with a random effect for facility. That is, some facilities had acceptance rates at least 72% higher or lower than the national average acceptance rate.

Figures 1 and 2 plot the observed versus expected number of offers (adjusted for candidate and donor factors) and organs (adjusted for donor factors) that were accepted in 2005. Among the 244 kidney programs shown in Figure 1, the observed/expected ratio of offers accepted was greater than 1.5 at the 99 centers (41%) above the upper dotted line and was less than 0.67 at the 30 centers (12%) below the lower dotted line. As demonstrated in Figure 2, the observed/expected ratio of organs accepted was greater than 1.5 at 82 centers (34%) and less than 0.67 at 46 centers (19%).

Table 5 reports the Spearman correlation coefficients (*r*-values) of the AOR for offer and organ acceptance at each program with the transplant rates and posttransplant mortality rates at each facility (7). The transplant rate was significantly ($p < 0.05$) and positively correlated with both offer and organ acceptance rates. In contrast, posttransplant mortality was not significantly correlated with either measure of acceptance rate ($p > 0.10$).

Table 4: Measures of the likelihood of acceptance: variation among transplant centers

		Transplant centers	
	United States	25th Percentile	75th Percentile
Offer acceptance rates			
Fraction accepted	14%	11%	29%
Adjusted odds ratio	1	0.76	2.35
Kidney acceptance rates			
Fraction accepted	41%	29%	55%
Adjusted odds ratio	1	0.62	1.89

N = 244 transplant centers. Source: SRTR analysis, August 2006.

Discussion

Even after excluding 38% of donated kidneys from the analysis because of adverse donor characteristics, some organs were identified that were not accepted until far down the match run (Table 1). While there may be good reasons that many candidates were skipped over for these organs, those reasons were not easily determined from the data elements available for analysis from the OPTN/SRTR database. In order to restrict this study to good kidneys, we additionally limited the analyses to those organs that were accepted within 50 offers on the match run, thus excluding a total of 45% of donated kidneys.

Several donor and candidate characteristics were significantly related to the likelihood of acceptance among these good kidneys (Table 3). Donor characteristics of age, creatinine and cause of death were identified as predictors of lower acceptance rates for kidneys, plausibly because these characteristics are also associated with poor posttransplant outcomes (6). Several candidate characteristics, including female gender, race, height and diagnosis of congenital, rare familial and metabolic disorders, were also identified as predictors of lower acceptance rates. In addition, organs were less likely to be accepted when offered to candidates outside of the local donation service area.

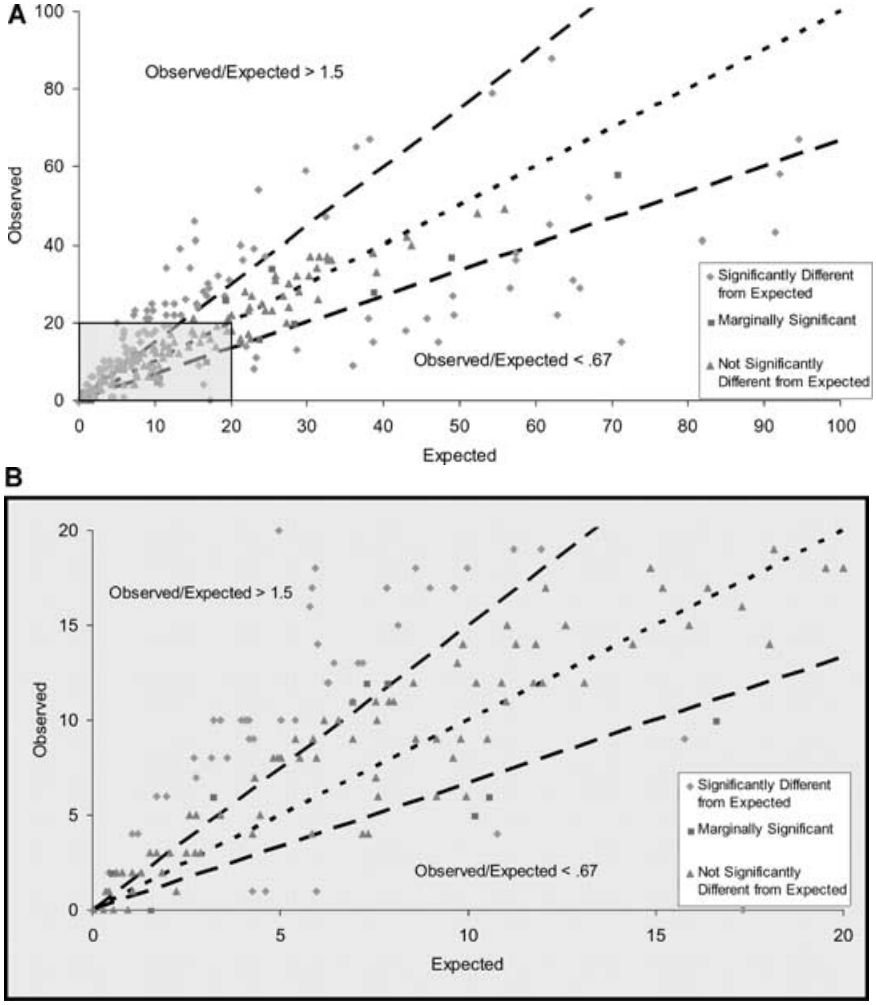
Even among good organs, as defined by the exclusions in Table 1, the likelihood of acceptance varied greatly, depending upon donor and candidate characteristics. Thus, when comparing acceptance rates among programs, it is important to adjust the expected acceptance rates for the donor and candidate case-mix.

The correlation between the odds of organ and offer acceptance (IA) from the two models based on donor

Table 5: Spearman correlation coefficients between acceptance rates and waiting list mortality and transplant rates

Variable	Adjusted offer acceptance rate	Adjusted organ acceptance rate
Adjusted transplant rate	0.33*	0.38*
Adjusted posttransplant mortality rate	−0.03	−0.01

*$p < 0.001$. Source: SRTR analysis, August 2006.



Source: SRTR Analysis, August 2006.

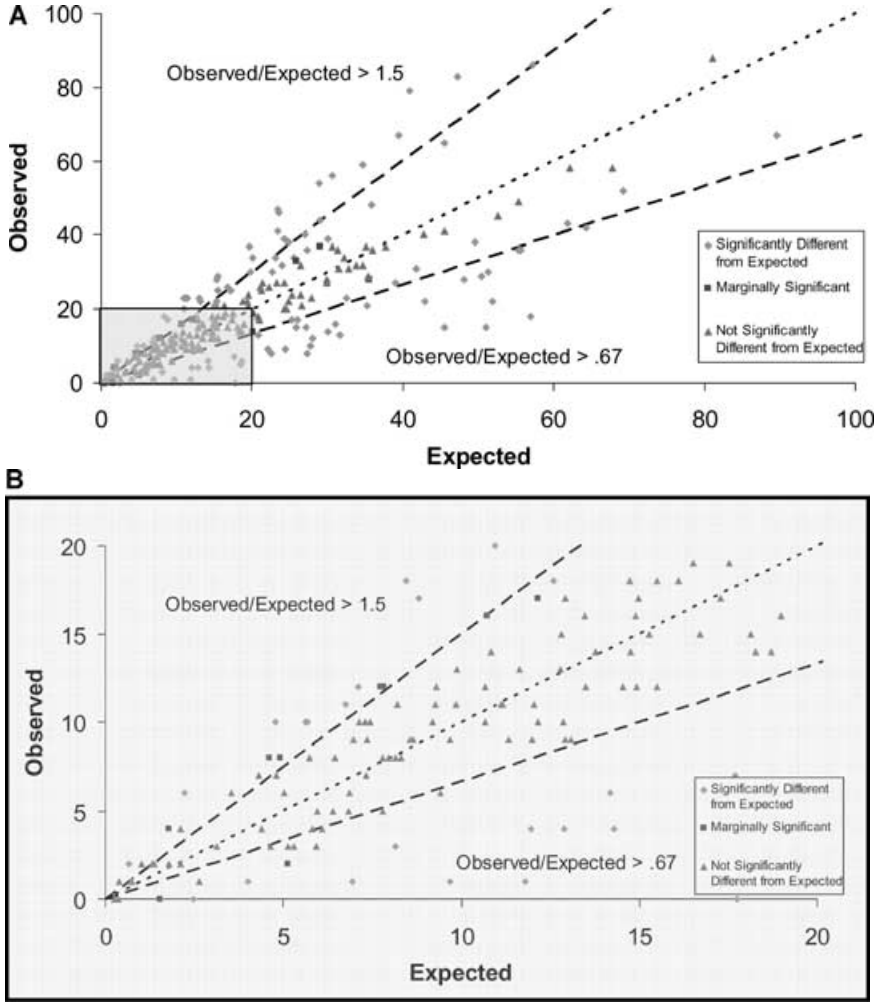
Figure 1: (A) Observed Versus Expected Accepted Kidney Offers (All). (B) Observed Versus Expected Accepted Kidney Offers (Magnified Inset).

measures was $r = 0.82$. This correlation suggests good agreement between these two measures of organ acceptability, even though they are conceptually different, were derived from different analyses, and used different denominators. When these probabilities were aggregated to the facility level, a correlation was observed for the expected numbers of acceptances computed from the two models ($r = 0.71$) (Figure 3). Despite the good agreement of the number of acceptances expected at the facility level from these two models, it may be desirable, when screening to identify centers with low acceptance rates, to flag only those centers that have low acceptance rates relative to both expected calculations.

There was a positive relationship between higher acceptance rates and higher transplant rates; that is, facilities with higher acceptance rates had higher rates of transplantation among the patients on their waiting list. However, no relationship was found between acceptance rates and post-transplant patient survival (Table 5), suggesting, given existing practice patterns, that high acceptance rates can be achieved without necessarily decreasing the quality of post-transplant outcomes. This outcome might be different if offers were 'indiscriminately' accepted.

After accounting for the number of organs or offers that would be expected at each program, there were significant and substantial differences among programs in acceptance rates (Table 4). The causes for such differences—including size of OPO, size of OPO and transplant center waiting list (added to offer-based analyses), competition within an OPO, and transplant center practices—remain to be investigated.

This study identified several predictors of acceptance rates and substantial variation in acceptance rates, even



Source: SRTR Analysis, August 2006.

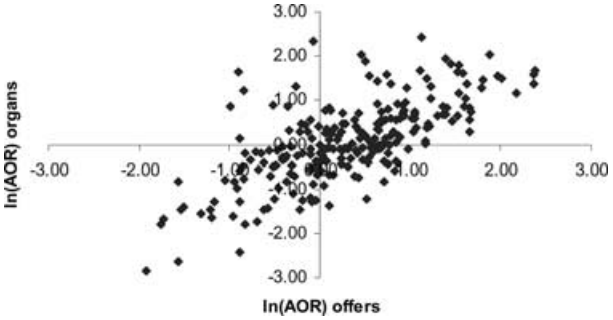
Figure 2: (A) Observed Versus Expected Accepted Kidney (All). (B) Observed Versus Expected Accepted Kidney (Magnified Inset).

among good organs. Despite adjustment for these predictors, there remains measurable and meaningful variability among programs in their acceptance rates of organs and offers. Even though this analysis was limited to donor kidneys that were ultimately transplanted to a candidate who was high on the match run, offers to donor and recipient pairs with positive cross-matches were excluded from both metrics, and statistical adjustments were made to account for differences in quality even among these good organs, this variation among programs is unexplained. Future analyses could improve the predictive accuracy of the acceptance models by considering additional donor and candidate characteristics and interactions—such as an indicator of adult donor-pediatric recipient, or by including waiting list size in the offer-based analysis.

Based on these two models, a variety of criteria could be used to identify programs with lower than expected acceptance rates. For example, among the 244 kidney centers, there were 20 that satisfied for both the organ and the offer models all the following criteria simultaneously:

1. Observed/Expected $<2/3$,
2. Observed $<$ Expected—3,
3. Observed $<$ Expected with significance $p < 0.05$ (one-sided)

The results of these analyses could be used by several stakeholders in the transplant community. Individual transplant programs could compare their organ acceptance practices to those of their peers. When selecting a transplant center, patients could use this information to improve their chances of receiving a kidney transplant by choosing a more aggressive center. These results could also help regulators identify programs that are underperforming or unofficially inactive. Such information could even serve as an



Correlation (Spearman r = +0.71. Source: SRTR Analysis, August 2006.

Figure 3: Kidney Adjusted Odds Ratios at 244 Transplant Programs: Organ vs. Offer Acceptance Models (Log Scale).

'early warning' mechanism before more official action is needed.

Importantly, these metrics paired with other measures of transplant center performance could be used to help identify efficient centers with high acceptance rates and good waiting list and post-transplant outcomes. The 'best practices' of these centers could be identified and disseminated to less functional centers, and overall system performance could be improved. Additional studies of outcomes among organs that have been previously turned down, such as those reported by Cadillo-Chavez et al. (1), may help to distinguish among turndown causes that lead to good and bad outcomes.

In addition, the results reported here might give direction when attempting to understand the mechanisms that lead to low acceptance rates of good organs at particular centers. Centers that dictate very cautious matching of donor and recipient pairs or with other very conservative organ acceptance criteria might be more likely to have low acceptance rates. Similarly, centers whose protocols do not adequately prepare their candidates for transplantation, or centers with inadequate resources to perform transplantation when organs become available, might be more likely to turn down usable kidneys for transplantation.

These proposed metrics are distinct from other measures of waiting list outcomes in that they do not reflect organ availability, but rather attempt to identify and quantify center-specific differences in the utilization of available organs. Within the limits imposed by organ availability, centers with high acceptance rates and good outcomes provide 'optimal' opportunities for their wait-listed patients, while those with low acceptance rates and poor outcomes impart diminished opportunities.

Conclusions

Low acceptance rates contribute to allocation inefficiency and inequity in access to transplantation; they may also contribute to the discard of organs and longer ischemia time. Here we propose two metrics that could be employed to compare organ and offer acceptance practices among transplant programs. These two measures are distinct in that the organ-based analysis uses the count of organs as a denominator to compute the fraction of organs accepted per center, while the offer-based analysis uses the number of offers made to compute the fraction of offers that the center accepted. Despite the use of distinct endpoints, these metrics of acceptance are highly correlated, both at the organ level ($r = 0.83$ and when aggregated to the program level ($r = 0.71$). This study found no evidence of a relationship between acceptance rates and adjusted post-transplant patient survival. The measures described in this article might prove useful for identifying centers with exceptional acceptance rates. Those centers with low acceptance rates could be afforded the opportunity to compare their performances to those of their peers and potentially to improve their performance. The practices at programs with high acceptance rates might serve as helpful models for the wider transplant community.

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This study was approved by HRSA's SRTR project officer. HRSA has determined that this study satisfies the criteria for the IRB exemption described in the 'Public Benefit and Service Program' provisions of 45 CFR 46.101(b)(5) and HRSA Circular 03.

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