Kidney donation and transplantation in Eurotransplant 2006-2007: minimizing discard rates by using a rescue allocation policy

Context—All organ exchange organizations are challenged to maximize the utilization rate of all donors.
Objective—To investigate the benefit of a rescue allocation policy and to study the impact of donor factors on the risk of kidney discard.
Design and Setting—All 4057 donors with kidneys offered for allocation to Eurotransplant between 2006 and 2007 were included. Allocation was patient-oriented, based on a point-score system including recipient and donor factors. If an organ offer was rejected 5 times for medical reasons, allocation was switched to rescue allocation (ie, the organ was then offered in a center-oriented way). A logistic regression model was built to test whether donor factors were predictors of rescue allocation or kidney discard.
Results—Rescue allocation was used for 665 donors (16.4%); within this group, transplant rate was 54.3%, resulting in a donor discard rate of 304 donors (7.5% of total study group). The multivariate model showed that rescue allocation was used significantly more for kidneys from child donors and donors with a high creatinine level. Moreover, testing positive for hepatitis B surface antigen or antibody to hepatitis C virus was associated with an increased probability of rescue allocation. Kidney discard was significantly associated with donation after cardiac death, donor age, serum creatinine level, history of diabetes, and history of hepatitis.
Conclusions—Rescue allocation is effective in lowering donor discard rates. Even with rescue allocation, several donor factors were significantly associated with a higher discard rate. Use of liberal donor criteria and a rescue allocation policy can reduce kidney discards and thus shorten the waiting list for kidney transplantation.

(*Progress in Transplantation.* 2009;19:365-370)

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Despite the increase in the number of organ donors in recent years, a large gap remains between the number of patients on the waiting list and the number of kidney transplants performed.[1] This disparity stimulates a responsibility in the transplant community to maximize the use of organs procured from deceased donors.

Decreases in donor organ damage, improvements in posttransplant organ function, and the reassuring experiences of other centers with the use of expanded-criteria donors have allowed a broadening of the strict criteria for donor selection. Donors with adverse medical characteristics once thought to be a contraindications for donation are therefore being used more and more often.[2]

This worsening of the donor profile further increases the pressure on organ exchange organizations to minimize their organ discard rates. What are the donor factors that lead to discard of a donor kidney? If this information is known beforehand, a potential difficult-to-allocate donor can be anticipated and a rescue allocation process can be started earlier in the process.

Most importantly, early identification of factors that jeopardize kidney transplantability should not lead to cancellation of the donation and allocation process, but on the contrary should lead to the recognition that those donated organs will most probably be allocated via the rescue allocation scheme.

The aim of this study was to provide an in-depth analysis of all potential kidney donors by studying 2 performance measures of this offering process: the rescue allocation rate and the ultimate discard rate. If the performance of the allocation process is better understood, weaknesses in this process can be better addressed and will then lead to further improvement in the utilization of all reported donated kidneys.

Methods

All deceased donors who offered at least 1 kidney for allocation to the Eurotransplant office in the period from January 1, 2006, to December 31, 2007, were studied. Eurotransplant is responsible for the mediation and allocation of organ donation procedures in Austria, Belgium, Croatia, Germany, Luxemburg, the Netherlands, and Slovenia (www.eurotransplant.org). Donors from outside the Eurotransplant area were excluded from the analysis.

The Eurotransplant kidney allocation scheme is based on the following factors: ABO blood group, urgency (transplantable, immunized, highly immunized) of the recipient, percentage of panel reactive antibodies (PRA), distance between donor and recipient center, waiting time, age, human leukocyte antigen (HLA) match, and country balance within Eurotransplant.[3] If a donor kidney has been rejected 5 times for medical reasons related to the donor, or if the donor's condition becomes unstable, allocation can be switched to a so-called rescue allocation. The major feature of this rescue allocation policy is that the offers are no longer made to individual patients but to the whole center, where any listed recipient can then be selected from the local waiting list. The aim of rescue allocation is to reduce the risk of losing organs in the allocation process and to allow for a transparent alternative scheme.

Kidney donors were classified according to their final stage in the offering process. Three classes were identified: (1) regularly allocated donor: both kidneys of the donor were successfully allocated and transplanted via the regular allocation process, (2) rescue allocated donor: one or both kidneys were allocated and transplanted via the rescue allocation scheme, and (3) discarded donor: none of the kidneys were used for transplantation.

The following donor characteristics were described for the 3 study groups: age, sex, ABO blood group, body mass index (calculated as weight in kilograms divided by height in meters squared), serum creatinine level at time of offer, cause of death, expanded-criteria donor,[4] donation after cardiac death, viral serology, and the medical history of the donor, including preexisting conditions such as diabetes and hypertension. For each level of these donor characteristics, the proportion of rescue allocated donors and the proportion of discarded kidney donors were calculated.

A multivariate logistic regression model was constructed to test which donor factors were predictors of a successful rescue allocation, and all previously listed donor factors were entered into the model. In a second logistic regression model, associations between ultimate discard of the donor organ and the donor characteristics were tested.

Results

A total of 4057 consecutive deceased donors from whom at least 1 kidney was offered for transplantation were included in the study. The kidneys were derived from a donor population with a mean age of 49.7 years and a mean body mass index of 25.7; 54.6 % of the donors were male and 92.8 % were heart-beating donors. Cerebrovascular accident as cause of death was most common (Table 1).

For 665 donors (16.4%), the regular allocation did not result in donor acceptance but led to a switch in the allocation procedure to a rescue allocation. Within this rescue allocation group, 361 donors (54.3%) could ultimately be used for transplantation. From the remaining 304 donors, both kidneys were discarded, yielding a final donor discard rate of 7.5%.

The proportion of transplants performed via the rescue allocation scheme stratified by donor characteristics are provided in Table 1. As an example of how to interpret this table, we highlight donors under the age of 10. Of all donors less than 10 years of age, 34 donors (59.6%) were allocated through the regular allocation procedure; the remaining 23 donors (40.4%) of the donors went into the rescue allocation procedure. Of this rescue allocated group, 65.2% were successfully transplanted, hence the final donor discard rate of the total subgroup was 14%.

Results from the multivariate model showed that donors less than 10 years of age and donors with a high terminal serum creatinine level (≥1.5 mg/dL; multiply by 88.4 to convert to micromoles per liter) were significantly more likely to have organs allocated by the rescue allocation system (odds ratio [OR] 6.6, 95 % confidence interval [CI] 2.81-15.54, $P < .001$ and OR 3.2, 95 % CI 2.38-4.33, $P < .001$, respectively; Table 2). Moreover, a positive viral serology (hepatitis B surface antigen, OR 14.8, $P < .001$, antibodies to hepatitis C virus, OR 28.2, $P < .001$) led to an increased probability of being successfully transplanted by the rescue allocation system. Other donor factors, including cause of death, a history of diabetes or hypertension, and a positive result for antibodies to anti-hepatitis B core antigen, did not affect the kidney allocation policy (Table 2).

Table 2 also shows the results of the multivariate model for donor discard. Donation after cardiac death, high donor age, elevated serum level of creatinine, a history of diabetes, the presence of antibodies to

Table 1 Clinical characteristics of all 4057 donors offering a kidney and numbers of donors whose kidneys were rescue allocated or discarded as a proportion of the whole study group

	No. (%) of donors[a]			
Donor characteristic	Total (N = 4057)	Who had kidneys transplanted via regular allocation (n = 3392)	Who had kidneys transplanted via rescue allocation (n = 361)	Donors discarded (n = 304)
Type of donor				
Heart beating	3765 (92.8)	3163 (84.0)	333 (8.8)	269 (7.2)
Non–heart beating	292 (7.2)	229 (78.4)	28 (9.6)	35 (12.0)
Expanded-criteria donor				
Yes	1587 (39.1)	1240 (78.1)	161 (10.1)	186 (11.8)
No	2470 (60.9)	2152 (87.1)	200 (8.1)	118 (4.8)
Age,[b] y				
<10	57 (1.4)	34 (59.6)	15 (26.3)	8 (14.1)
10-39	920 (22.7)	806 (87.6)	81 (8.8)	33 (3.6)
40-49	864 (21.3)	760 (88.0)	67 (7.8)	37 (4.2)
50-59	967 (23.8)	832 (86.0)	68 (7.0)	67 (7.0)
60-64	389 (9.6)	313 (80.5)	41 (10.5)	35 (9.0)
≥65	860 (21.2)	647 (75.2)	89 (10.3)	124 (14.5)
Sex				
Male	2215 (54.6)	1826 (82.4)	198 (8.9)	191 (8.7)
Female	1842 (45.4)	1566 (85.0)	163 (8.8)	113 (6.2)
ABO blood group				
A	1777 (43.8)	1490 (83.8)	150 (8.4)	137 (7.8)
AB	221 (5.5)	174 (78.7)	26 (11.8)	21 (9.5)
B	428 (10.5)	350 (81.8)	48 (11.2)	30 (7.0)
O	1631 (40.2)	1378 (84.5)	137 (8.4)	116 (7.1)
Body mass index[c]				
<20	207 (5.1)	169 (81.6)	24 (11.6)	14 (6.8)
20-24	1871 (46.1)	1599 (85.5)	156 (8.3)	116 (6.2)
25-29	1450 (35.7)	1201 (82.8)	127 (8.8)	122 (8.4)
≥30	529 (13.0)	423 (80.0)	54 (10.2)	52 (9.8)
Cause of death				
Cerebrovascular accident	2607 (64.3)	2173 (83.4)	223 (8.6)	211 (8.0)
Traumatic	982 (24.2)	856 (87.2)	74 (7.5)	52 (5.3)
Other	468 (11.5)	363 (77.6)	64 (13.7)	41 (8.7)
Creatinine level,[d] mg/dL				
<1.5	3612 (89.0)	3111 (86.1)	281 (7.8)	220 (6.1)
≥1.5	445 (11.0)	281 (63.1)	80 (18.0)	84 (18.9)
Hypertension				
Yes	1150 (28.3)	929 (80.8)	110 (9.6)	111 (9.6)
No	2907 (71.7)	2463 (84.7)	251 (8.6)	193 (6.6)
Diabetes				
Yes	262 (6.5)	192 (73.3)	29 (11.1)	41 (15.6)
No	3795 (93.5)	3200 (84.3)	332 (8.7)	263 (7.0)
Viral serology positive				
Hepatitis B surface antigen	18 (0.4)	4 (22.2)	8 (44.4)	6 (33.3)
Anti-hepatitis C virus	70 (1.7)	17 (24.3)	19 (27.1)	34 (48.6)
Anti-hepatitis B core antigen	215 (5.3)	157 (73.0)	29 (13.5)	29 (13.5)

[a] Percentages in second column are based on total of 4057 donors. Percentages in third through fifth column are based on the number in the total column for that characteristic.
[b] Mean (SD) age for all 4057 donors was 49.7 (17.1) years.
[c] Body mass index is calculated as the weight in kilograms divided by height in meters squared. Mean (SD) body mass index for all 4057 donors was 25.7 (4.6).
[d] Mean (SD) creatinine level for all 4057 donors was 1.01 (0.67) mg/dL. Multiply by 88.4 to convert to micromoles per liter.

hepatitis C virus and a positive result for hepatitis B core antigen were strongly associated with donor discard after covariates were controlled for. The adjusted ORs for donors aged 65 years and older and for donors younger than 10 years were 7.52 and 7.26, respectively ($P < .001$). Donors after cardiac death were

Table 2 Donor factors predictive of the probability of rescue allocation and the probability of discarding a kidney from a deceased donor

	Kidney allocation (rescue vs regular)		Kidney discarded vs kidney transplanted	
Donor characteristic	Adjusted odds ratio (95% confidence interval)	*P*	Adjusted odds ratio (95% confidence interval)	*P*
Type of donor		.30		<.001
Heart beating	1		1	
Non–heart beating	1.26 (0.81-1.96)		2.35 (1.53-3.62)	
Expanded-criteria donor		.45		.74
Yes	1.25 (0.70-2.21)		1.11 (0.61-2.00)	
No	1		1	
Age, y		<.001		<.001
<10	6.61 (2.81-15.54)		7.26 (2.40-21.94)	
10-39.9	1		1	
40-49.9	0.92 (0.62-1.37)		1.38 (0.81-2.38)	
50-59.9	0.81 (0.51-1.27)		2.67 (1.56-4.59)	
60-64.9	1.30 (0.65-2.59)		4.32 (1.98-9.42)	
≥65	1.34 (0.70-2.55)		7.52 (3.65-15.46)	
Sex		.55		.05
Male	1		1	
Female	1.08 (0.85-1.36)		0.77 (0.59-1.00)	
ABO blood group		.13		.55
A	1.00 (0.78-1.29)		0.88 (0.67-1.16)	
AB	1.51 (0.95-2.40)		0.75 (0.45-1.26)	
B	1.35 (0.94-1.94)		1.08 (0.69-1.68)	
O	1		1	
Body mass index[a]		.77		.97
<20	0.74 (0.38-1.41)		1.08 (0.47-2.48)	
20-24	1		1	
25-29	0.95 (0.73-1.23)		1.03 (0.77-1.38)	
≥30	1.04 (0.72-1.49)		0.95 (0.65-1.39)	
Cause of death		.07		.18
Cerebrovascular accident	1.57 (1.06-2.34)		1.59 (0.97-2.60)	
Traumatic	1		1	
Other	1.09 (0.77-1.52)		1.12 (0.78-1.62)	
Creatinine level, mg/dL		<.001		<.001
<1.5	1		1	
≥1.5	3.21 (2.38-4.33)		3.85 (2.83-5.24)	
Hypertension		.64		.69
Yes	1.07 (0.80-1.44)		1.06 (0.78-1.44)	
No	1		1	
Diabetes		.34		.02
Yes	1.24 (0.80-1.93)		1.58 (1.06-2.36)	
No	1		1	
Viral serology positive				
Hepatitis B surface antigen	14.79 (7.36-29.8)	<.001	10.47 (3.41-32.2)	<.001
Anti-hepatitis C virus	28.16 (7.87-100.7)	<.001	23.26 (13.4-40.5)	<.001
Anti-hepatitis B core antigen	1.34 (0.83-2.15)	.23	1.16 (0.71-1.89)	.55

SI conversion factor: To convert creatinine to micromoles per liter, multiply by 88.4.
[a] Calculated as the weight in kilograms divided by height in meters squared.

significantly more likely to be discarded than were heart-beating donors (OR 2.35, $P<.001$); the factor last serum creatinine value of 1.5 mg/dL or greater yielded an OR of 3.85 ($P<.001$), the previous history of diabetes was significantly associated with donor discard (OR 1.58 , $P=.02$), as were the following 2 factors: the presence of antibodies to hepatitis C virus (OR 23.26, $P<.001$) and a positive result for hepatitis B surface antigen (OR 10.47, $P<.001$). Other donor factors, including cause of death, a history of hypertension, and a positive result for hepatitis B core antibodies, did not affect the risk of kidney discard (Table 2).

Discussion

Driven by the discrepancy between organ need and organ supply, clinicians have to consider the use of kidneys from nonideal donors. In addition to this adapted attitude, the profiles of the available donors have changed: the proportion of donors that died from a cerebrovascular accident has increased from 58% to 75% since the late 1990s, and the proportion of donors after cardiac death of the entire Eurotransplant donor pool has increased from 2.6% to 7.2%.[1] Therefore, donor factors considered to affect kidney acceptability have changed with time.

This study was aimed at critically assessing the outcome of the allocation of all offered kidneys and at identifying donor factors that lead to kidney discard in this new framework of changed donor profiles. In addition the 2 allocation procedures—regular and rescue allocation—were described in order to better highlight the characteristics of a so-called difficult-to-allocate donor and to improve the computer-driven algorithm of kidney allocation.

In this 2-year study period, 4057 kidney donors were offered to Eurotransplant. Rescue allocation was used for 665 donors (16.4 %); within this allocation procedure, 361 donors (54.3 %) could be used for transplantation. Hence 304 (7.5%) of all kidney donors were ultimately not used for transplantation. Furthermore, donors that went through the rescue allocation system and the discarded donors were more likely to have a positive result on serologic tests for hepatitis B surface antigen and anti-hepatitis C virus, very young age (<10 years), and a high creatinine level (≥1.5 mg/dL). Additionally, donation after cardiac death and donors with a history of diabetes mellitus were associated with a significant increase in the probability of kidney discard.

Consistent with our findings, Wolfe et al[5] reported that increased donor age, a positive result on viral serology, and increased serum level of creatinine were significantly related to the likelihood of kidney rejection among transplant centers. In the latter study, the population was restricted to good donor kidneys—defined as "a kidney that in general would be accepted on behalf of a wide range of candidates by a large fraction of programs." Despite this restriction, the authors still could detect donor factors that are associated with kidney acceptance.

In the United States, the proportion of kidneys that were finally not used for transplantation had gradually increased to 22% in 2006.[2] This high proportion of discarded kidneys makes it even more important to understand why centers decline kidney offers and whether the statement that too many organs are discarded is valid.[6,7]

For years, Eurotransplant has had a backup system in place for those organs that cannot be allocated via regular allocation. If a kidney donor is of such marginal quality that 5 different clinicians decline the offer—and thus judge this donor to be an expanded-criteria donor—the kidneys are not withdrawn from the offering process, but continue to be offered via the rescue allocation scheme. In our study, more than half (54.3%) of these expanded-criteria donors could ultimately be used for transplantation; therefore our study shows that the rescue allocation policy is an effective way to achieve a lower discard rate.

In addition to the just-mentioned rescue allocation system, Eurotransplant has another system in place that allows a smooth allocation of organs from expanded-criteria donors. Transplant physicians can denote for any particular patient if organs from donors with one of the following conditions: positive for hepatitis B surface antigen, presence of anti-hepatitis C virus antibodies, cytomegalovirus immunoglobulin G, previous history of malignant tumor, sepsis, drug abuse, meningitis, should not be offered to any of their patients. This whole system of choosing a patient-specific donor profile has 2 major benefits: with this directional allocation, expanded-criteria donor organs can be allocated to patients who will benefit from them, and the allocation process is not hampered by too many offers that will be declined because the organ is not suitable. Thus no allocation time is lost, and the risk of losing an organ is reduced.

The rescue allocation policy plays a pivotal role in reducing the loss of kidneys; however, even with a rescue allocation scheme in place, not every reported kidney can be used as an allograft. The donor profile of those kidneys that go via the rescue allocation scheme almost reflects the type of expanded-criteria donor described by Metzger et al[4] (hypertension and cause of death were not risk factors in the Eurotransplant data), therefore a rescue allocated donor can be seen as a surrogate marker for an expanded-criteria donor.

Finally, further research is required to determine whether changing acceptability criteria for selecting kidneys may have an influence on the posttransplant outcome. If the results are encouraging, liberal criteria might be used to provide transplants for most patients needing a kidney transplant.

Financial Disclosures

None reported.

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