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BRIEF COMMUNICATION

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Early graft losses in paired kidney exchange: Experience from 10 years of the National Kidney Registry

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Cooperative kidney paired donation (KPD) networks account for an increasing proportion of all living donor kidney transplants in the United States. There are sparse data on the rate of primary nonfunction (PNF) losses and their consequences within KPD networks. We studied National Kidney Registry (NKR) transplants (February 14, 2009 to December 31, 2017) and quantified PNF, graft loss within 30 days of transplantation, and graft losses in the first-year posttransplant and assessed potential risk factors. Of 2364 transplants, there were 38 grafts (1.6%) lost within the first year, 13 (0.5%) with PNF. When compared to functioning grafts, there were no clinically significant differences in blood type compatibility, degree of HLA mismatch, number of veins/arteries, cold ischemia, and travel times. Of 13 PNF cases, 2 were due to early venous thrombosis, 2 to arterial thrombosis, and 2 to failure of desensitization and development of antibody-mediated rejection (AMR). Given the low rate of PNF, the NKR created a policy to allocate chain-end kidneys to recipients with PNF following event review and attributable to surgical issues of donor nephrectomy. It is expected that demonstration of low incidence of poor early graft outcomes and the presence of a "safety net" would further encourage program participation in national KPD.

KEYWORDS
clinical research/practice, donors and donation: living, graft survival, kidney transplantation/nephrology, kidney transplantation: living donor, primary nonfunction

1 | INTRODUCTION

Kidney paired donation (KPD) has seen consistent growth over the last 2 decades.[1] Although some single-center systems have seen modest growth,[2,3] regional and national systems currently account for the majority of KPD transplants in the United States.[4,5] These cooperative networks require a great deal of trust between different teams of surgeons, nephrologists, nurses, donor advocates, social workers, and living donor coordinators responsible for the preoperative evaluation of donors, as well as kidney quality resulting from the performance of the donor nephrectomy. Although deceased donor kidneys are routinely procured by remote centers, living donor organs are produced by a program's own surgeons; this was especially true prior to the establishment of large KPD systems.[6] Programs depend upon cooperation between transplant centers and teams, and necessitate trust in the quality of donor procurements at other centers. As evidenced in a recent debate at the 2019 ASTS Winter Symposium titled, "Trust or Fly: We Need to Procure Organ for Each

Abbreviations: DGF, delayed graft function; KPD, kidney paired donation; KT, kidney transplant(ation); LDKT, living donor kidney transplant(ation); NKR, National Kidney Registry; OPTN, Organ Procurement and Transplantation Network; PNF, primary nonfunction (loss within 30 days of transplant); PRA, panel reactive antibody test; SRTR, Scientific Registry of Transplant Recipients.

Other," there is still a tendency for many centers to only want to rely on their own surgeons.

Participation in national exchange programs challenges this preference. Medium- and long-term graft survival for these transplants are high, which is expected of living donor kidney transplantation (LDKT) even in the context of longer KPD cold ischemic times.[4,7,8] However, scarce data exist on primary nonfunction (PNF, or loss within 30 days of transplant), other early graft failures, and surgical complications that may continue to cause a reluctance by many transplant centers to enter larger multicenter, diverse geographical KPD systems.

The National Kidney Registry (NKR) is a KPD network that facilitates live donor transplants between 85 participating centers.[5,9,10] The NKR's core functions include outlining protocols for evaluating patients, creating matches to maximize the number of transplants according to established computerized algorithms, arranging transport between centers, and organizing the collection of follow-up data. The participating transplant centers complete all transplants in concordance with United Network for Organ Sharing and center-specific protocols. The ultimate goal is increasing the number of transplants for incompatible or difficult to match pairs. The number of transplants facilitated by the NKR has grown annually since its inception in 2008.[11] As the NKR evolved, it became apparent that kidneys, rather than donors, would travel from one center to another. In the beginning, there was great trepidation about the negative impact of longer cold ischemic times imposed by shipping, especially for highly sensitized and retransplanted patients.[6,12-14] However, reports that demonstrated a slight increase in delayed graft function (DGF) but no impact on graft or patient survival encouraged wider sharing and allowed for cold ischemia times that exceed 20 hours.[7,8] These reports focus on long-term outcomes, but little has been reported on the occurrences of graft failures within days or months of transplantation.

When an early graft failure occurs, the recipient is left both without a functioning kidney and perhaps their only donor having already undergone a donor nephrectomy. Following PNF, KPD pairs may be left questioning their decisions around donation, particularly if they were a compatible pair that voluntarily entered the exchange. Without additional potential donors, the recipient may be limited to retransplantation on the deceased donor list. Trust in living donor transplantation and KPD may erode between the recipient, the family, and the transplant center, as well as the other participating KPD centers.[6] The aim of this study was to focus on quantifying the risk of early graft loss and to identify potential risk factors within the NKR system, including, and especially, surgical complications during the donor nephrectomy.

2 | MATERIALS AND METHODS

2.1 | The National Kidney Registry

Data were collected from the NKR registry, which receives regular updates from participating transplant centers. The clinical and research activities of this study are consistent with the Declaration of Helsinki and Declaration of Istanbul. Using the NKR registry, we identified 2454 LDKTs facilitated by the NKR between February 2008 and December 2017 with complete 1-year follow-up.

2.2 | National Registry

In addition to NKR registry data, this study also used data from the Scientific Registry of Transplant Recipients (SRTR) external release made available in March 2019. The SRTR data system includes data on all donors, waitlist candidates, and transplant recipients in the United States, submitted by members of the Organ Procurement and Transplantation Network (OPTN), and has been described previously.[15] The Health Resources and Services Administration, US Department of Health and Human Services, provides oversight to the activities of the OPTN and SRTR contractors. All recipients were followed for posttransplant outcomes through December 31, 2018. We include 49 864 non-KPD LDKT recipients as controls.

2.3 | Data linkage

Data on KPD transplants facilitated by the NKR were linked to the SRTR using unique, encrypted, person-level identifiers; they were cross-validated using redundantly captured characteristics (transplant center, transplant date, donor blood type, donor sex, recipient blood type, and recipient sex). As a result of linkage and cross-validation, 2364 LDKTs (96%) facilitated by the NKR were included in the study population. Those that did not cross-validate were transplanted more recently and, thus, failed to link due to reporting lag between transplant centers, SRTR, and NKR.

2.4 | Statistical analysis

The members of the study population were followed for a minimum of 1-year posttransplant (ie, earliest transplant date was 1 year before administrative censoring). We estimate the risk of death-censored graft failure defined as the earliest resumption of maintenance dialysis, relisting for kidney transplant, or retransplantation. Graft failure was assessed by transplant center report to the OPTN supplemented by Centers for Medicare & Medicaid Services Form 2728. Potential risk factors (delayed graft function, preemptive transplant, donor sex, donor race, donor anatomy, cold ischemia time >8 hours, blood type, and HLA mismatch) were evaluated using multivariable linear risk regression to estimate risk differences (RDs) and 95% confidence intervals. Regression models used inverse probability of treatment weights to account for recipient factors (age, sex, African American, BMI, college education, public insurance, history of previous transplant, and panel reactive antibody test [PRA] >80). We conducted 15 independent tests, resulting in a Bonferroni-corrected

critical *P*-value of .003. All analyses were performed using Stata 15/MP for Linux.

3 | RESULTS

3.1 | Study population

During the study period, the risk of PNF was 0.5% (n = 13), and the 1-year graft failure risk was 1.6% (n = 38) (Figure 1). The risk of graft failure was not constant throughout the first year. There were 7 failures within 1 week, but only one additional failure between 8 and 14 days posttransplant. A similar trend was seen among SRTR controls. Among the 13 recipients who experienced PNF, 46% were female, 8% were African American, the median age was 55 years, and 31% had PRA >80%. Compared to those with immediate function, PNF recipients did not have clinically significant differences in recipient, donor, and transplant characteristics (Table 1). Inferences were similar comparing those with a graft loss ≤180 days to those without a graft loss ≤180 days (Table S1) and comparing those with a graft loss within a year to those without a graft loss (Table S2). After adjustment for recipient characteristics, delayed graft function (risk difference [RD] = 0.074, 95% confidence interval [CI] 0.009-0.139) and donor female sex (RD = 0.006, 95% CI 0.001-0.011) were associated with a higher risk of early graft failure; these results were not statistically significant after correction for multiple comparisons (Table 2).

We compared those with PNF with those who had a graft failure between 31 days and 1 year posttransplant (Table 3) to understand if there were any differences between PNF and other early graft losses. Compared to those graft losses between 31 days and 1 year posttransplant, recipients with PNF were more likely to have female donors and have fewer HLA A, B, and DR mismatches. These relationships were not replicated in the SRTR control population. There were no other clinically significant differences between recipients with PNF and other recipients with early graft failures.

3.2 | Description of early graft losses

Reasons for PNF were ascertained after chart review (Table 4). Two recipients had undergone intensive desensitization protocols in preparation for receiving their kidney. One of those requiring desensitization was a pediatric recipient (age 7) undergoing retransplant. Both desensitization cases had minimal kidney function, and despite aggressive treatment for antibody-mediated rejection, both experienced early failure.

In 2 other failures, complex anatomy appeared to play a role. In 1 case, two veins were anastomosed with difficulty at the time of transplantation, and the patient experienced an irreversible venous thrombosis, despite a return to the operating room and thrombectomy. At another site, the donor kidney had 3 arteries and a single vein. Following poor initial function, an ultrasound on postoperative day 1 showed minimal flow to the kidney. The patient returned to the operating room, and 2 of the 3 arteries were reanastomosed. However, the kidney never recovered function.

In 5 cases with standard anatomy (single renal artery and vein), and 1 case with 2 renal arteries, the kidneys were declared as PNF without a clear reason for the failure elucidated.

The remaining 3 early graft losses (3/2676 or 0.11%) were felt to be directly attributable to a donor procurement injury. The first, in 2015, was a left kidney with a single artery and vein. When the kidney was received by the recipient center, brown-colored tissue around the vessels in the hilum appeared to be electrocautery burns. A technical issue was suspected during the procurement leading to arterial spasm and warm ischemia of the organ. The kidney had no postoperative function and loss of diastolic flow on ultrasound. The recipient was brought back to the operating room for 2 reexplorations, with a transplant nephrectomy performed on the

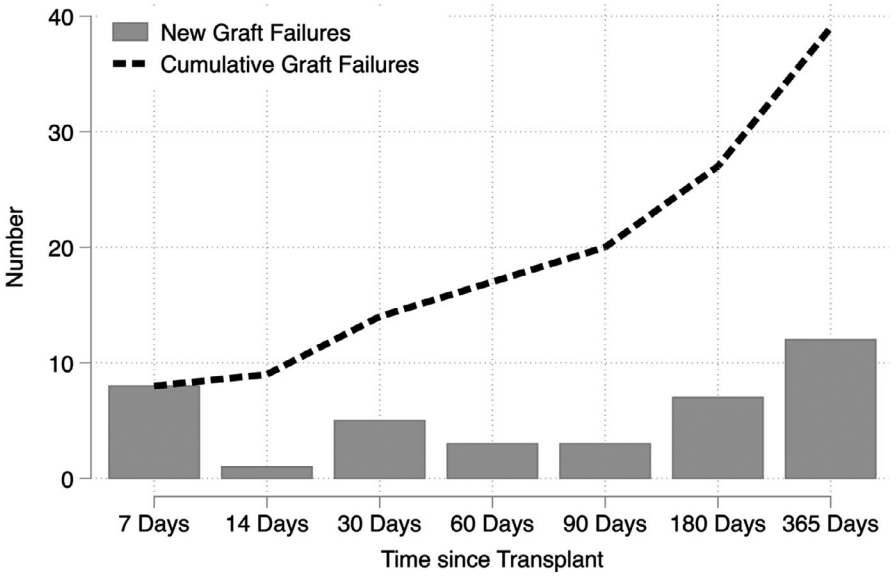

FIGURE 1 Cumulative number of early graft failures in the National Kidney Registry (2008-2017). Of the 2364 NKR-facilitated living donor transplant recipients, 38 experienced graft failure within 1 year. There were 7 who experienced primary nonfunction (PNF) within 7 d of transplant of a total 13 PNF cases. Half (19 of 38) the early graft failures occurred between 3 and 12 mo posttransplant

TABLE 1 Characteristics of 2364 living donor kidney transplants (KT) facilitated by the National Kidney Registry (NKR) and SRTR controls 2008-2017 by graft loss ≤30 d posttransplant

N	NKR No loss ≤30 d 2351 (99.5%)	NKR DCGF ≤30 d 13 (0.5%)	SRTR control[b] no loss ≤30 d 49 463 (99.2%)	SRTR control DCGF ≤30 d 401 (0.8%)
Recipient characteristics[a]				
Female	46	46	37	47
African American	18	8	13	16
Age (years)	51 (39-60)	55 (37-60)	49 (36-59)	46 (34-56)
Preemptive transplant	25	23	36	39.7
Years on dialysis	1 (0-3)	2 (0-4)	1 (0-2)	0.4 (0-1)
BMI (kg/m^2)	27 (23-31)	28 (25-33)	27 (24-31)	28 (24-33)
College educated	65	82	60	61
Public insurance	50	62	42	42
Diabetes	19	8	21	16
Hypertension	16	15	16	15
HIV	1	0	0.5	0.5
Previous transplant	25	31	11	12
PRA >80 at transplant	21	31	3	5
Antibody depleting induction	66	58	61	69
Antibody nondepleting induction	30	42	30	30
eGFR pre-transplant (mL/min/1.73 m^2)	8 (6-12)	8 (5-16)	9 (6-13)	10 (6-14)
Delayed graft function	5	62	3	57
Donor characteristics				
Female	62	85	62	65
African American	10	8	11	15
Age (years)	45 (35-53)	42 (37-57)	42 (33-51)	42 (33-52)
BMI (kg/m^2)	26 (23-29)	25 (23-29)	26.7 (23.8-29.7)	27 (24-30)
eGFR (mL/min/1.7 m^2)	98 (86-109)	94 (79-101)	100 (87-112)	100 (88-112)
Blood type A	30	46	24	25
Blood type A1	7	0	2	2
Blood type A2	2	8	0.5	1
Blood type AB	4	0	0.8	1
Blood type B	17	23	7	10
Blood type O	39	23	66	62
1 Renal vein	83	92	ND[c]	ND
2 Renal veins	4	8	ND	ND
1 Renal artery	68	77	ND	ND
2 Renal arteries	18	23	ND	ND
Transplant characteristics				
ABO incompatible	2	0	1	5
Zero HLA mismatch	1	8	8	7
1 HLA mismatch	2	0	5	6
2 HLA mismatch	6	8	16	20
3 HLA mismatch	16	31	27	24

(Continues)

second occasion. Pathology did not show any evidence of rejection, but an inflammatory response most likely secondary to ischemic injury.

The second case, in 2017, was also a left kidney. Preoperatively, the patient was reported to have a single renal artery and vein. During procurement, however, the recovering surgeon discovered

TABLE 1 (Continued)

N	NKR No loss ≤30 d 2351 (99.5%)	NKR DCGF ≤30 d 13 (0.5%)	SRTR control[b] no loss ≤30 d 49 463 (99.2%)	SRTR control DCGF ≤30 d 401 (0.8%)
4 HLA mismatch	26	39	15	17
5 HLA mismatch	33	8	18	19
6 HLA mismatch	15	8	10	7
Cold ischemia time (hours)	9 (6-12)	9 (6-12)	1 (0.7-2)	1 (0.8-2)

KPD, kidney paired donation; PRA, panel reactive antibody test; SRTR, Scientific Registry of Transplant Recipients.

[a]Characteristics are presented as percentages for binary variables and median (25 to 75 percentile) for continuous variables.

[b]SRTR controls are non-KPD (NKR or another system) living donor kidney transplant recipients.

[c]Not determined because information not available in SRTR.

a second artery and contacted the recipient center to report this finding. However, on the recipient center back table, 3 arteries were identified. An upper pole artery was very small, and therefore, sacrificed. After reperfusion, the kidney initially looked well perfused, but within minutes, it appeared globally ischemic with poor Doppler signals in the renal parenchyma, but strong signals in the main renal artery and at the anastomoses. Despite multiple efforts by the recipient center to correct the situation, the kidney thrombosed, and a transplant nephrectomy was performed. It was felt that the arteries had been damaged during procurement, since the donor surgeon was unaware that multiple arteries existed.

The third case was reported to the NKR as a loss due to a procurement injury, but details of the case were not available.

4 | DISCUSSION

Overall, PNF and early kidney graft losses in transplants facilitated by the NKR are rare. PNF accounted for 0.5% (N = 13) of the 2351 KPD transplants during our time of study. Losses to 1 year remained very low, with 0.8% at 3 months, 1.1% at 6 months, and 1.6% at 1 year. In comparison, SRTR data for all recipients undergoing a primary LDKT between 1991 and 2014 show a 1-year unadjusted allograft survival rate is of 97.2%, which is slightly inferior to our reported results.[16] A Canadian KPD system reported 5 early graft failures after 240 transplants, with 3 due to PNF or technical errors (3/240 = 1%).[17] In an Australian KPD report, there was 1 early graft failure after 100 transplants.[18] Although concerns regarding another center procuring a live donor kidney for transplant and increased transit times persist, only 3 (0.11%) of the PNF cases were thought to be caused by donor organ injury. These data confirm a very low level of PNF and early graft loss among NKR Centers, and fully support wide participation in KPD, especially those with a cadre of highly sensitized patients.

There were no clinically significant differences in donor, recipient, or transplant characteristics between patients with lost grafts compared to those with good function. It is worth noting that there were no differences in cold ischemia or transit time between the 2 groups. There were no unifying characteristics underlying these early graft losses, including use of right kidneys, complex vascular anatomy, or travel between centers. Due to the infrequent occurrence and lack of common etiology for these early graft losses, we were unable to offer a comprehensive preventive strategy or suggest a change in clinical practice to ameliorate this issue in the future.

One PNF case described previously involved a kidney where the anatomy found intraoperatively differed from the preoperative report. Under NKR guidelines, all centers must obtain either a CT scan or an MRI of all potential donors. In rare instances, whether involved in an exchange or not, a vascular structure will be missed in the initial reading. This emphasizes the importance and duty of the recipient center to review all imaging when initially accepting an organ. In the past, and at the time of this loss, only readings were available online to centers, and actual films had to be requested. However, the NKR

TABLE 2 Risk factors for early graft loss (within 30 d) in the National Kidney Registry

Risk factor	RD 95% CI	*P*[a]
Delayed graft function	0.0742 (0.0093-0.1391)	.02
Preemptive transplant	0.0013 (−0.0060 to 0.0086)	.7
Donor female	0.0061 (0.0010-0.0113)	.02
Donor African-American	0.0005 (−0.0108 to 0.0117)	.9
1 Renal vein	−0.0048 (−0.0250 to 0.0153)	.6
2 Renal veins	0.0137 (−0.0241 to 0.0515)	.5
1 Renal artery	−0.0016 (−0.0100 to 0.0068)	.7
2 Renal arteries	0.0033 (−0.0071 to 0.0136)	.5
CIT >8 h	0.0034 (−0.0021 to 0.0089)	.2
Blood type A vs. O	0.0028 (−0.0046 to 0.0101)	.5
Blood type A1 vs. O	ND[b]	ND
Blood type A2 vs. O	0.0343 (−0.0407 to 0.1094)	.4
Blood type AB vs. O	ND	ND
Blood type B vs. O	0.0033 (−0.0055 to 0.0120)	.5
HLA mismatches>=3	−0.0056 (−0.0200 to 0.0087)	.4

RD, risk difference.

[a]The Bonferroni-corrected critical *P*-value for 15 tests is .003.

[b]Not determined because there were no early graft failure with this risk factor.

TABLE 3 Characteristics of 38 living donor kidney transplants (KTs) facilitated by the National Kidney Registry (NKR) and SRTR controls 2008-2017 with early graft failure by graft loss ≤30 d posttransplant

N	NKR 30 < DCGF ≤ 365 d 25 (65.8%)	NKR DCGF ≤ 30 d 13 (34.2%)	SRTR control[b] 30 < DCGF ≤ 365 d 401 (48.5%)	SRTR control DCGF ≤ 30 d 425 (51.5%)
Recipient characteristics[a]				
Female	56	46.2	47	41
African American	20	7.7	16.2	18
Age (years)	42.0 (26.0-48.0)	55.0 (37.0-60.0)	46 (34-56)	47 (32-60)
Preemptive transplant	28	23.1	40	21
Years on dialysis	1.7 (0.0-2.7)	1.5 (0.0-4.1)	0.4 (0.0-1)	1.2 (0.3-2)
BMI (kg/m^2)	26.9 (22.8-29.8)	27.8 (25.4-32.6)	28 (24-33)	27 (23-32)
College educated	47.8	81.8	61	58
Public insurance	40	61.5	42	50
Diabetes	20	7.7	16	17
Hypertension	16	15.4	15	16
HIV	4.3	0	0.5	0.5
Previous transplant	32	30.8	12	14
PRA >80 at Transplant	8	30.8	5	7
Antibody depleting induction	68	58.3	69	67
Antibody nondepleting induction	20	41.7	30	27
eGFR pretransplant (mL/min/1.7 m^2)	7.9 (6.2-13.9)	7.8 (5.0-15.9)	10 (6-14)	8 (6-11)
Delayed graft function	20	61.5	57	16
Donor characteristics				
Female	48	84.6	65	66
African American	12	7.7	15	15
Age (years)	47.0 (34.0-53.0)	42.0 (37.0-57.0)	42 (33-52)	45 (35-54)
BMI (kg/m^2)	25.7 (25.0-28.8)	25.4 (22.9-28.5)	27 (24-30)	26.6 (24-29)
eGFR (mL/min/1.7 m^2)	98.5 (85.9-107.6)	94.2 (79.4-100.6)	100 (88-112)	97 (86-107)
Blood type A	32	46.2	25	26
Blood type A1	12	0	2	2
Blood type A2	0	7.7	1	0.2
Blood type AB	16	0	1	0.7
Blood type B	20	23.1	10	6
Blood type O	20	23.1	62	65
1 Renal vein	72	92.3	—[c]	—
2 Renal veins	8	7.7	—	—
1 Renal artery	52	76.9	—	—
2 Renal arteries	28	23.1	—	—
Transplant characteristics				
ABO incompatible	8	0	5	3
Zero HLA mismatch	0	7.7	7	5
1 HLA mismatch	4	0	6	5
2 HLA mismatch	12	7.7	20	12
3 HLA mismatch	8	30.8	24	29

(Continues)

has now made vast improvements to the system and all radiology studies are uploaded and available to any reviewing center. With this change, small findings that may have been inadvertently missed by a radiologist and could possibly lead to surgical mishaps in the operating room, will hopefully be picked up by the donor or recipient center involved with the case.

TABLE 3 (Continued)

N	NKR 30 < DCGF ≤ 365 d 25 (65.8%)	NKR DCGF ≤ 30 d 13 (34.2%)	SRTR control[b] 30 < DCGF ≤ 365 d 401 (48.5%)	SRTR control DCGF ≤ 30 d 425 (51.5%)
4 HLA mismatch	20	38.5	17	17
5 HLA mismatch	48	7.7	19	18
6 HLA mismatch	8	7.7	7	13
Cold ischemia time (hours)	8.9 (8.0-13.6)	8.6 (5.8-12.3)	1 (0.8-2)	1 (0.6-2)

KPD, kidney paired donation; PRA, panel reactive antibody test; SRTR, Scientific Registry of Transplant Recipients.

[a]Characteristics are presented as percentages for binary variables and median (25 percentile to 75 percentile) for continuous variables.

[b]SRTR controls are non-KPD (NKR or another system) living donor kidney transplant recipients

[c]Information not available in SRTR.

The NKR has developed an organizational algorithm for reviewing and managing issues that come up through the exchange process. The surgical board is made up of 6 surgeons, who either sit on the medical board or act as primary surgeons in high-volume programs. When a surgical problem is reported, the board requests a description of the problem, photographs, and a timeline of events from both the donor and recipient teams. A conference call is then held, with both parties to discuss their experience, concerns, and provide an opportunity for any questions to be raised. This process is also repeated with the donor and recipient centers individually. The surgical board then decides whether there is sufficient evidence that the graft loss was due to some issue with the donor nephrectomy. Given the low number of early graft losses demonstrated to be secondary to donor surgical issues, the NKR Medical Board has developed a policy that ensures centers that the affected recipients will be offered another compatible kidney following availability. The NKR Medical Board has established an "End-Chain Policy," which ends chains according to a priority list that includes "patients transplanted within the NKR who experience graft failure within 90 days of the transplant that was a result of an impaired kidney delivered to the recipient center." This is contingent on immediate reporting of any issue to the NKR, including pictures of the kidney within 8 hours of kidney receipt, and presentation of the case to the NKR Surgical Committee and Medical Board. Simulations have been completed to calculate the ability of the NKR to provide allografts for these early graft losses. Given the low rate attributable to donor surgical injury, the program may reasonably expect to maintain this allocation policy as long as the PNF rates remain low.

TABLE 4 Cause of primary nonfunction in NKR transplants

Cause	Incidence (n = 13)
Standard anatomy (1-2 renal arteries, 1 renal vein), unclear cause of failure	6
Possible donor surgical injury	3
Desensitization failure/unsuccessful treatment of AMR	2
Complex anatomy (≥2 veins, ≥3 arteries), postoperative thrombosis	2

AMR, antibody-mediated rejection; NKR, National Kidney Registry.

A graft loss is tragic for any live donor transplant but can be devastating if the recipient of a compatible pair experiences PNF while participating in KPD. Compatible pairs are those that could have been a direct donation between donor and recipient but have opted to join an exchange program. They do this for a variety of reasons, including an attempt to be matched with a younger donor, one with a more advantageous HLA profile, or to simply as a truly altrustic effort to unlock additional transplants for those without compatible options. Compatible pairs represent a rapidly expanding segment of the NKR. Past studies by Gentry et al have shown that in a national program, participation of compatible pairs can increase the match rate from 37.4% to 75.4%.[8] Because participating centers are encouraged to educate and enroll compatible pairs in the NKR, this group in particular heralded the need for retransplant priority in the event of an early graft loss. If recipients, regardless of compatibility, can be assured that they will be prioritized for re-allocation should an initial transplant fail secondary to donor procurement injury, this should settle some fears of participation.

The incidence of PNF and early graft loss was low in the paired exchange transplants facilitated by the NKR. In addition to the very low rate, recipients are now prioritized for retransplant if the kidney is lost within the first 90 days, when due to technical problems with the donor or other extenuating circumstances deemed attributable to logistics. There have been 5 recipients who have been retransplanted from this policy so far, and all have functioning grafts. This policy assumes that the recipient affected by early graft loss remains an active transplant candidate. This report and new policy enacted by the NKR should provide centers and patients further reassurance and encouragement when participating in a kidney exchange program.

DISCLAIMER

The analyses described here are the responsibility of the authors alone and do 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

(MMRF) as the contractor for the Scientific Registry of Transplant Recipients (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.

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DISCLOSURE

The authors of this manuscript have conflicts of interest to disclose as described by the *American Journal of Transplantation*. All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Mr Thomas and Dr Segev reported institutional grant support from the National Institutes of Health. Dr Segev also report institutional grant support from the Doris Duke Charitable Foundation and National Kidney Registry. Mr Ronin is a full-time, paid employee of the National Kidney Registry. The other authors have no conflicts of interest to disclose.

AUTHOR CONTRIBUTIONS

Dr Jennifer Verbesey had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Verbesey, Thomas, Flechner, Cooper. Acquisition of data: Verbesey, Thomas, Flechner, Segev. Analysis and interpretation of data: Verbesey, Thomas, Flechner, Cooper. Drafting of the manuscript: Verbesey, Thomas, Waterman, Flechner, Cooper. Critical revision of the manuscript for important intellectual content: Verbesey, Thomas, Ronin, Waterman, Segev, Flechner, Cooper. Obtained funding: Segev. Administrative, technical, and material support: Ronin, Waterman. Study supervision: Cooper.

DATA AVAILABILITY STATEMENT

The analyses described here are the responsibility of the authors alone and do 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 (MMRF) as the contractor for the Scientific Registry of Transplant Recipients (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.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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