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Disparity in Access to Kidney Allograft Offers Among Transplant Candidates with Human Immunodeficiency Virus

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Abstract

Background: Despite a survival benefit from transplantation and acceptable outcomes, patients with human immunodeficiency virus (HIV+) face barriers to kidney transplantation. Little is known about the acceptance or decline of organ offers on their behalf because wait-list registry data do not include HIV serostatus.

Methods: We performed a retrospective cohort study using match-run data from the Organ Procurement and Transplantation Network, including every kidney offer from May 1, 2007 to July 3, 2013. HIV and hepatitis C virus (HCV) serostatus were obtained by merging the match-run with clinical data from a large dialysis provider. We used Cox proportional hazards modeling to evaluate differences in time to the first organ offer and to transplantation. 35,646 uninfected, 2,213 HCV+, 418 HIV+, and 71 HIV+/HCV+ candidates received organ offers during the study period.

Results: Compared to uninfected candidates, HIV+ candidates had a significantly lower likelihood of receiving a first offer (adjusted hazard ratio [aHR] 0.88, 95% confidence interval [CI] 0.79–0.99) and undergoing transplantation (aHR 0.82, 95% CI 0.68–0.98) after receiving a first offer; HCV+ candidates had a similar likelihood of receiving a first offer (aHR 0.98, 95% CI 0.92–1.03) and greater likelihood of transplantation after receiving a first offer (aHR 1.23, 95% CI 1.12–1.36).

Conclusions: HIV+ candidates had a significantly longer wait until their first organ offer and to transplantation. Efforts to increase their access to transplantation are needed.

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CONFLICTS OF INTERESTS

The authors of this manuscript have no conflicts of interest to disclose.

Keywords

Kidney transplantation; organ allocation; human immunodeficiency virus; hepatitis C virus

INTRODUCTION

Kidney transplantation remains the ideal therapy for end-stage renal disease (ESRD), even in high risk subgroups such as the elderly¹, people with diabetes², and people living HIV.³ Acceptable post-transplant outcomes for HIV+ recipients have been demonstrated in both prospective multicenter studies⁴ and transplant registry analyses.^{5,6} However, despite the fact that rates of ESRD are disproportionately higher among individuals with HIV than in the general population⁷, they face difficulties in accessing transplantation. One study demonstrated that only 30% of HIV+ candidates referred for transplantation at a single center were ultimately listed, compared to 73% of their HIV negative (HIV-) contemporaries.⁸ A more recent analysis reported improved rates of listing (70%) but 22.6% of candidates were unable to complete all of the testing required for listing and 50% of those ultimately listed for transplant experienced delays in navigating the evaluation process.⁹ Unfortunately, wait-listing alone does not guarantee transplant access for HIV+ patients. A recent analysis of wait-list outcomes among HIV+ transplant candidates demonstrated that they were 13% less likely to receive a deceased donor kidney transplant, compared to HIV- candidates.¹⁰ This disparate access to transplantation is particularly concerning given that HIV+ transplant candidates are predominantly young and African American.¹⁰ The reasons for this disparity are unknown.

Transplantation is a highly regulated field, with patient and allograft outcomes reported publicly¹¹ and these ratings are used to make decisions regarding insurance reimbursements as well as the ability to operate a transplant program.¹² Regulatory oversight is important for ensuring high quality care but can have unintended consequences, namely restricting access to transplantation for candidates deemed to be high risk or encouraging the discard of donor organs likely to have poor function. The impact of transplant center performance evaluations on transplant volumes and candidate selection has been clearly demonstrated; centers that have been rated as “low performing” are more likely to delist candidates^{13,14} and less likely to utilize lower-quality organs.¹⁵ We hypothesized that organs are more likely to be declined on behalf of HIV+ candidates, resulting in a lower transplant rate.

In order to examine whether organ refusals negatively impact access to transplantation for HIV+ candidates on the waitlist, we performed a novel data linkage between OPTN match-run data and a detailed dataset from a national dialysis provider for ascertainment of HIV and HCV serostatus at the time of waitlisting. We compared time to first organ offer and the total number of organ offers made to HIV+ or HIV/HCV co-infected candidates to those received by patients with HCV infection (HCV+, another high risk group) and HIV-/HCV- patients. Due to the fact that HIV and HCV information is not reported among waitlisted patients in the transplant registry, we used this unique linked dataset to generate novel insights into patterns of organ acceptance and transplantation according to the viral serostatus of waitlisted patients.

PATIENTS AND METHODS

Data Sources

This study used data from the Organ Procurement and Transplantation Network (OPTN). The OPTN database includes data on all donor, wait-listed candidates, and transplant recipients in the US, submitted by the members of the OPTN Network. The Health Resources and Services Administration, US Department of Health and Human Services provides oversight to the activities of the OPTN contractor. The study also incorporated OPTN match-run dataset, which include data on organ acceptance and turn-down for all procured deceased donor kidneys that resulted in a successful transplant between May 1, 2007 and July 3, 2013. The study was approved by the Institutional Review Board at the University of Pennsylvania.

As HIV and HCV serostatus are not collected by the OPTN at the time of waitlist registration, serostatus information was obtained by merging the OPTN match-run data with contemporary clinical data from a large dialysis provider (DaVita) with >2800 dialysis facilities in 47 states.

Subjects

Kidney transplant candidates were included if they were waitlisted between May 1, 2007 to July 3, 2013 (dates of the available match run data), were ≥ 18 years of age and had viral serostatus information available from the dialysis provider. Please see the *Supplemental Methods* for additional details regarding cohort selection.

Primary exposure

The primary exposures were HIV and HCV serostatus. HCV and HIV serostatus were obtained from dialysis provider data. HCV serostatus was determined by routine dialysis unit screening with HCV antibody testing. Results were reported as “positive,” “negative” or “indeterminate”; only individuals with a positive or negative result were included. HIV status was determined using International Classification of Diseases-9 (ICD-9) codes indicative of HIV infection (042.0, V08, 079.53 and 795.71)¹⁶ and/or by a home medication list including HIV-specific antiretroviral medications (ART).¹⁷ Patients prescribed emtricitabine, lamivudine or tenofovir without additional ART were not included in the HIV + group as these medications can be used to treat Hepatitis B virus (HBV) infection.

Outcomes and Covariates

For the multivariable analyses, the primary outcomes were time to first deceased donor organ offer and to transplantation from the time of the first deceased donor organ offer. The index date for the time to first organ offer was the date of waitlisting. The index date for the time to transplantation was the date of the first organ offer (restricted to patients who received at least one offer). Patients were censored for achieving the primary outcome, living donor transplantation, death, removal from the waitlist, or the end of the follow up period (June 5, 2015). Please see *Supplemental Methods* for a detailed description of covariates.

Statistical Analyses

Statistical analyses were performed with STATA version 15.0 (Statacorp LP, College Station, TX). Multivariable Cox proportional hazards models were used to evaluate time to development of each of the outcomes. For the time to first offer and time from first offer to transplantation analyses, we performed sensitivity analyses in which we restricted the cohort to only patients who were always active on the waitlist, as well as analyses in which HCV positive donor offers were censored. For the outcome of time to transplantation from the first offer, we also performed analyses where death was treated as a competing risk for transplantation, and where we censored for live donor kidney transplantation. Please see *Supplemental Methods* for additional details regarding the statistical analyses.

RESULTS

Candidate Characteristics

We identified 35,646 HIV−/HCV− (reference), 221 HCV+, 418 HIV+ and 71 HIV+/HCV+ transplant candidates who received organ offers during the study period; there were notable clinical differences between the groups (Figure 1, Table 1). HIV+ and HIV+/HCV+ candidates were significantly younger (median age HIV+ 46 years; HIV+/HCV+ 50 years) than reference candidates (HIV−/HCV− median age 53 years, $p<0.001$). They were more likely to be African American (HIV+ 69% and HIV+/HCV+ 82%) than HCV+ or reference candidates (HCV+ 54% and HIV−/HCV− 33%, $p<0.001$). The majority of listed patients overall were male.

Compared to uninfected reference or HCV+ candidates, HIV+ candidates were less likely to have diabetes as the etiology of renal disease (<15%) or as a comorbidity (~20%), and their dialysis exposure at time of wait-listing was more than twice as long. HIV+, HCV+ or HIV+/HCV+ candidates were all less likely to be continually active on the transplant waiting list ($p<0.001$) compared to HIV− candidates. HIV+ and HIV+/HCV+ candidates were listed at a total of 92 centers; compared to HIV− or HCV+ candidates, HIV+ and HIV+/HCV+ candidates were more likely to be listed at a transplant center that had participated in the NIH trial of solid organ transplantation in HIV, at a center also performing liver transplants or at a center in the top 25th percentile of high kidney donor profile index (KDPI) kidney usage.

Donor Characteristics

During the study period, there were a total of 327,054 kidney organ offers among candidates and donors who met inclusion criteria. The median KDPI of all the offers was 57% (interquartile range [IQR] 33–79%) and 8,060 kidneys were accepted for transplantation. When stratified by candidate serostatus, the median KDPI of all offers made during the time period did not differ clinically (Table 2); the median KDPI of accepted offers, while lower in the HIV+ and HIV+/HCV+ groups, did not achieve statistical significance ($p=0.412$). Public health service (PHS) increased risk donors were significantly more likely to be offered to (19%) and accepted by (43%) HIV+/HCV+ candidates ($p<0.001$). Similarly, high acceptance rates of HCV+ donor kidneys were noted among HCV+ (21%) and HIV+/HCV+ (36%) candidates. HIV−/HCV− candidates were significantly more likely to ultimately

accept a live donor kidney (18%) compared to HCV+ (7%), HIV+ (12%), and HIV+/HCV+ (3%) candidates ($p<0.001$).

Organ Offer Characteristics

Among those individuals who received organ offers, the median number of offers a candidate received differed across serostatus groups (Table 2). Reference candidates received the most offers (median 5, interquartile range [IQR] 2–10), followed by HCV+ (median 4, IQR 2–10) and HIV+ candidates (median 4, IQR 2–11), with HIV+/HCV+ candidates receiving the fewest offers (median 3, IQR 2–8; $p<0.001$). There was no difference in the rate of offers per year by serostatus for the overall group ($p=0.147$), although there were significantly fewer offers per year among always-active HIV+ candidates compared to the other groups (median 2.5, IQR 1.2–5.1 among HIV+; compared to median 2.8, IQR 1.5–5.2 among HIV–/HCV–; median 3.4, IQR 1.6–7.4 among HCV+; and 5.0, IQR 2.3–7.1 among HIV+/HCV+, of whom there were only 18 always-active candidates; $p<0.001$).

Compared to all other groups, HIV+ candidates were more likely to have offers accepted later in the match run sequence (median position 7 versus 4; $p=0.006$). Among incident patients, HCV+ candidates did not have a clinically significant difference in the median time to their first organ offer (110 days, IQR 37–270) compared to HIV–/HCV– candidates (117 days, IQR 43–367), but their median time from first organ offer to transplantation was shorter (HCV+ 308 days, IQR 52–779 vs HIV–/HCV– 496 days, IQR 148–951). While both HIV+ and HIV+/HCV+ candidates faced longer waits to their first organ offer (139 days and 175 days, respectively), HIV+/HCV+ candidates had the shortest time from first organ offer to transplantation (255 days, IQR 40–631) and HIV+ candidates waited the longest overall (719 days, IQR 267–1135). When HCV+ organ offers were excluded, the advantages for HCV+ and HIV/HCV+ candidates were diminished.

Cox Proportional Hazards Models

In multivariable models (Figure 2, Table S1) that were adjusted for candidate age, race, diabetes status, time on dialysis, PRA, and KDPI, and clustered by transplant center, HIV+ (aHR 0.88, 95% CI 0.79–0.99) and HIV+/HCV+ (aHR 0.71, 95% CI 0.54–0.94) candidates were significantly less likely to receive an offer compared to HIV–/HCV– patients. HCV+ candidates had a similar likelihood of receiving an offer compared to reference patients (aHR 0.98, 95% CI 0.92–1.03). Similar results were generated by models that accounted for blood group. However, in subgroup analyses restricting to always active patients, HCV+ candidates were more likely to receive an offer (aHR 1.20, 95% CI 1.06–1.35) compared to HIV–/HCV– patients, whereas HIV+ candidates remained less likely to receive a first offer (aHR 0.80, 95% CI 0.67–0.96). After restricting to always active patients and censoring for HCV+ donor offers, HCV+ candidates were still more likely to receive an organ offer compared to HIV–/HCV– candidates (aHR 1.16, 95% CI 1.03–1.31), and HIV+ candidates continued to have a lower likelihood of receiving an organ offer (aHR 0.81, 95% CI 0.67–0.97). There was inadequate statistical power to assess for an association between HIV+/HCV+ serostatus and time to the first offer in both subgroup analyses.

In multivariable models constructed for the outcome of time to kidney transplantation from the first offer (Figure 3, Table S2), HCV was associated with a higher probability of transplantation (aHR 1.23, 95% CI 1.12–1.36) whereas HIV was associated with an 18% lower rate of transplantation (aHR 0.82, 95% CI 0.68–0.98). Again, due to the relatively small size of the HIV+/HCV+ group, we were unable to detect a statistically significant difference in their transplantation rate. In subgroup analyses, HCV+ candidates had a higher rate of transplantation (aHR 1.24, 95% CI 1.06–1.45 after restricting to always-active patients and censoring offers from HCV+ donors); HIV+ candidates still had a lower rate of transplantation (0.75, 95% CI 0.58–0.99). In models that accounted for death as a competing risk (Figure S1, Table S3), there was no significant difference in time to transplantation by serostatus. In models that censored for live donor kidney transplantation (Figure S2, Table S4), HCV+ candidates continued to have a higher rate of transplantation, but there was no significant difference for HIV+ candidates or HIV+/HCV+ candidates.

DISCUSSION

Here we present the first analysis of OPTN match-run data assessing differences in organ offers on the basis of HCV and HIV serostatus. We found that while the quality of the organs accepted for transplantation across serostatus groups, as measured by KDPI, was similar, patients with HIV or HIV/HCV co-infection received fewer organ offers overall and later in the match run sequence. This translated into a 12% lower likelihood of receiving a first organ offer for HIV+ candidates, and 18% lower likelihood of transplantation after the first offer for HIV+ recipients in the adjusted analyses.

HIV+ candidates face numerous barriers to transplantation. They are subject to a more intensive evaluation process that often prolongs their time to waitlisting.⁹ Not all transplant centers will accept them as candidates, although the number of transplants performed in HIV+ recipients at centers that did not participate in the original NIH multi-center trial has grown.¹⁸ There may be barriers at the provider level as well. The physicians accepting organ offers are the “gate-keepers” of transplantation and not much is known about contemporary physician attitudes towards transplantation for individuals with HIV. One older survey of transplant centers conducted in 1997 indicated that 88% of centers would not offer transplantation to HIV+ candidates,¹⁹ citing concerns of accelerated progression to AIDS, the potential for unacceptable complication rates and anticipation of limited recipient survival; these concerns have all been shown to be invalid.^{4,5,17} A more recent survey of transplant surgeons published in 2005 demonstrated lingering biases on the part of providers²⁰; only one-third of respondents indicated a willingness to transplant HIV+ candidates, compared to potential recipients with HBV or HCV. A contemporary assessment of physician attitudes towards transplantation for individuals with HIV would be helpful to assess the impact, if any, of provider biases in their access to transplantation.

When HIV+ candidates were compared to another “high risk” group, HCV+ candidates, we still observed significant differences in access to organ offers. When we excluded offers from HCV+ donors there was still a shorter time to first offer for these patients, but the magnitude of their advantage was diminished, indicating that not all of their wait-time brevity comes from access to HCV+ organs. This is consistent with the survey results

reported by Halpern et al. where HCV+ candidates were viewed as “more appropriate” for transplantation than those with HIV.²⁰ As our study was conducted with data from the pre-direct acting antiviral (DAA) era, we would expect these differences to be magnified, with HCV+ candidates having better access now that there are effective therapies for HCV that can be safely used in the post-transplant setting; HIV/HCV co-infected candidates might also be perceived as lower risk now that their HCV is curable and have improved access. This remains to be proven.

It is not surprising that the majority of organs offered to HIV+ and HIV/HCV+ candidates met PHS increased risk criteria, however the similarity in KDPI among accepted offers was unexpected, particularly given that HIV+ and HIV/HCV+ candidates were younger and less likely to have diabetes. Organ quality has been shown to have a significant impact on outcomes for HIV+ kidney^{21,22} and liver^{23,24} recipients, calling into question this practice, and suggesting that accepting physicians should balance access to transplantation for HIV+ candidates while being cognizant of their need for good quality organs.

Our study has a number of strengths. It is the first of its kind to examine the impact of serostatus on organ acceptance or refusals due to a novel linkage with dialysis data that enabled us to identify HIV+ patients on the waiting list. These data provide important insights that help explain in part the observed disparity in deceased donor transplantation rates for HIV+ patients. Our models were clustered on transplant center to account for center-level practice differences.

There are limitations to our study. We had insufficient power to comment extensively upon HIV+/HCV+ candidates due to the small number of patients in the co-infected group. We were limited by use of HCV antibody testing to identify patients with HCV (or HIV/HCV) infection and no viral load data were available. Therefore, we cannot identify patients who have spontaneously cleared their HCV infection or been treated successfully with interferon. However, given that interferon is not very effective at curing HCV (summary sustained viral response rate 33%²⁵) and our cohort ended in 2013 when there were no approved DAAs for use in patients with chronic kidney disease or ESRD, the number of treated patients is likely to be small. Dependence on ICD-9 codes and ART to identify individuals with HIV may have resulted in misclassification bias, causing us to misclassify some patients as HIV– who were actually HIV+ but not on ART, and biasing the results toward the null; this may explain why we did not see a significant difference in time to transplantation among HIV+ patients in the subgroup analyses. Additionally, we did not have access to HIV viral load or CD4 count data, but analyses that were restricted to always active patients yielded similar findings. We were unable to assess unmeasured confounders about the donors, including pump characteristics, anatomical abnormalities, infections, and specific reason for organ turn-down. The study period was prior to the implementation of the new Kidney Allocation System (KAS), which may limit its generalizability to more current turn-down behaviors²⁶. Additionally, KAS has provided greater organ access for transplant candidates with long dialysis vintage as well as ethnic/racial minorities²⁶; it is possible that KAS may have narrowed the observed disparity in transplant access for patients with HIV or HIV/HCV co-infection, who are more likely to have longer dialysis vintage and identify as African American; with our current dataset we are unable to assess this. Our study period was also

prior to the implementation of the HIV Organ Policy Equity (HOPE) Act in 2015 and we cannot assess the impact of the HOPE Act on organ acceptance practices for patients with HIV; however, despite aspirations that the HOPE Act would improve access to transplantation for individuals with HIV, only 12 true HIV+ deceased kidney donors have been utilized to date²⁷, far fewer than was originally projected. Similarly, we are unable to directly assess the impact of DAAs on organ acceptance rates for patients with HIV/HCV co-infection; while one could hypothesize that DAAs should have a beneficial effect, in fact implementation of HCV treatment in the kidney transplant population has been slow²⁸, therefore a difference in organ acceptance practices may not yet be apparent.

Patients with HIV still encounter barriers to transplantation, even after being placed on the transplant waiting list. Further study to elucidate the reasons why they are not offered organs while actively listed will be an important step towards improving access to transplantation in this vulnerable population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Cohort selection for evaluation of organ offers and transplantation by HIV and HCV serostatuses

Figure 2. Cox proportional hazards models for time to first organ offer

The figure demonstrates hazard ratios and 95% confidence intervals relative to the reference group (uninfected patients). All adjusted analyses are adjusted for candidate age, race, diabetes status, dialysis vintage, maximum panel reactive antibody, and kidney donor profile index; all analyses use robust sandwich estimation to address dependence between observations within any given listing center.

Figure 3. Cox proportional hazards models for time to transplantation

The figure demonstrates hazard ratios and 95% confidence intervals relative to the reference group (uninfected patients). All adjusted analyses are adjusted for candidate age, race, diabetes status, dialysis vintage, maximum panel reactive antibody, and kidney donor profile index; all analyses use robust sandwich estimation to address dependence between observations within any given listing center.

Table 1.

Candidate Characteristics by Serostatus Among Candidates Who Received at Least One Offer

	HIV-/HCV- Candidate N=35,646	HCV+ Candidate N=3,313	HIV+ Candidate N=418	HIV+/HCV+ Candidate N=71	P-value
Candidate Characteristics					
Median age, years (IQR)	53 (42–61)	54 (48–59)	46 (38–53)	50 (46–57)	<0.001
Male gender (%)	21,955 (62%)	1,561 (71%)	319 (76%)	54 (76%)	<0.001
African American race (%)	11,922 (33%)	1,189 (54%)	290 (69%)	58 (82%)	<0.001
Dialysis vintage at waitlisting, days (IQR)	304 (84–671)	426 (141–973)	718 (260–1569)	842 (245–1743)	<0.001
Median panel reactive antibody, % (IQR)	0 (0–29)	0 (0–51)	0 (0–27)	2 (0–30)	<0.001
Maximum panel reactive antibody 80% (%)	4,467 (13%)	379 (17%)	32 (8%)	5 (7%)	<0.001
Cause of end stage kidney disease (%)					<0.001
Diabetes	12,242 (34%)	679 (31%)	61 (15%)	7 (10%)	
Hypertension	8,860 (25%)	708 (32%)	118 (29%)	22 (31%)	
Glomerular disease	4,299 (12%)	180 (8%)	55 (13%)	6 (9%)	
Cystic disease	2,240 (6%)	64 (3%)	9 (2%)	0 (0%)	
Other or missing	8,005 (23%)	582 (26%)	175 (41%)	36 (50%)	
History of diabetes (%)	15,765 (44%)	996 (45%)	95 (23%)	14 (20%)	<0.001
Insurance type (%)					<0.001
Private	15,024 (42%)	693 (31%)	140 (33%)	14 (20%)	
Public	20,428 (57%)	1,505 (68%)	275 (66%)	56 (79%)	
Self or donation	85 (1%)	5 (1%)	0 (0%)	0 (0%)	
Functional status (%)					<0.001
No Assistance	24,654 (69%)	1,289 (63%)	284 (68%)	44 (62%)	
Some Assistance	7,538 (21%)	529 (24%)	94 (22%)	23 (32%)	
Total Assistance	259 (1%)	41 (2%)	3 (1%)	0 (0%)	
Unknown	2,195 (9%)	254 (11%)	37 (9%)	4 (6%)	
Region (%)					<0.001
1	1,327 (4%)	76 (3%)	19 (5%)	5 (7%)	
2	4,958 (14%)	409 (18%)	86 (21%)	21 (30%)	
3	5,033 (14%)	281 (13%)	85 (20%)	13 (18%)	
4	3,324 (9%)	229 (10%)	23 (6%)	1 (1%)	
5	8,538 (24%)	538 (24%)	82 (20%)	15 (21%)	
6	548 (2%)	24 (1%)	29 (7%)	2 (3%)	
7	2,210 (6%)	119 (5%)	29 (7%)	2 (3%)	
8	2,391 (7%)	109 (5%)	7 (2%)	0 (0%)	
9	1,722 (5%)	117 (5%)	37 (9%)	6 (9%)	
10	2,684 (7%)	149 (7%)	19 (5%)	3 (4%)	
11	2,911 (8%)	162 (7%)	28 (7%)	5 (7%)	
First listed as active on the waitlist (%)	29,260 (82%)	1,805 (82%)	323 (77%)	57 (80%)	0.074

	HIV-/HCV- Candidate N=35,646	HCV+ Candidate N=3,313	HIV+ Candidate N=418	HIV+/HCV+ Candidate N=71	P-value
Always active on the waitlist (%)	13,331 (37%)	667 (30%)	132 (32%)	18 (25%)	<0.001

Abbreviations: HIV = human immunodeficiency virus, HCV = hepatitis C virus; IQR = interquartile range

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Table 2.

Donor and Center Characteristics by Candidate Serostatus

	HIV-/HCV- Candidate N=35,646	HCV+ Candidate N=3,313	HIV+ Candidate N=418	HIV+/HCV+ Candidate N=71	P-value
Donor Characteristics					
Median KDPI of all offers, % (IQR)	57 (33–78)	58 (33–79)	58 (34–81)	58 (35–83)	0.002
Median KPDI, accepted kidneys, % (IQR)	47 (24–71)	50 (25–74)	43 (29–69)	37 (32–61)	0.412
High KDPI (>85%) donor offers (%)	49,553 (17%)	3,025 (18%)	646 (19%)	121 (22%)	<0.001
High KDPI (>85%) donor, accepted kidneys (%)	763 (11%)	72 (15%)	7 (9%)	1 (7%)	0.059
Public health service increased risk offers (%)	43,697 (14%)	2,684 (15%)	477 (14%)	107 (19%)	<0.001
Public health service increased risk, accepted kidneys (%)	603 (8%)	56 (11%)	11 (14%)	6 (43%)	<0.001
Hepatitis C virus antibody positive offers (%)	1,102 (<1%)	891 (5%)	3 (<1%)	35 (6%)	<0.001
Hepatitis C virus antibody positive, accepted kidneys (%)	2 (<1%)	110 (21%)	0 (0%)	5 (36%)	<0.001
Deceased after cardiac death offers (%)	52,888 (17%)	2,724 (15%)	584 (17%)	122 (21%)	<0.001
Deceased after cardiac death, accepted kidneys (%)	1,117 (15%)	67 (13%)	9 (12%)	1 (7%)	0.398
Pumped offers (%)	156,568 (52%)	8,907 (51%)	1,907 (55%)	296 (52%)	<0.001
Pumped, accepted kidneys (%)	3,145 (43%)	188 (37%)	33 (42%)	1 (7%)	0.002
Live donor kidney transplanted (%)	2,474 (18%)	65 (7%)	18 (12%)	1 (3%)	<0.001
Listing Center Characteristics					
NIH HIV trial transplant center	7,279 (20%)	523 (24%)	213 (51%)	43 (61%)	<0.001
Liver transplant program at the same center	26,981 (76%)	1,728 (78%)	364 (87%)	61 (86%)	<0.001
Aggressive transplant center (top 25th percentile of centers accepting high-KDPI kidneys)	9,963 (28%)	698 (31%)	192 (45%)	35 (49%)	<0.001
Median center waitlist time, years (IQR)	3.4 (2.8–4.7)	3.5 (2.9–4.8)	3.3 (3.1–4.7)	3.6 (3.2–5.3)	<0.001

Abbreviations: HIV = human immunodeficiency virus, HCV = hepatitis C virus; KDPI = kidney donor profile index; IQR = interquartile range; NIH = National Institutes of Health

Table 3.

Organ Offer Characteristics by Candidate Serostatus Among Candidates Who Received at Least One Offer

	HIV-/HCV- Candidate N=35,646	HCV+ Candidate N=3,313	HIV+ Candidate N=418	HIV+/HCV+ Candidate N=71	P-value
Median number of offers (IQR)	5 (2–10)	4 (2–10)	4 (2–11)	3 (2–8)	<0.001
Median offers per year (IQR)	2.1 (1.1–4.1)	2.1 (0.9–4.5)	1.8 (1.0–4.1)	2.3 (0.8–5.1)	0.147
Median number of offers among always active candidates (IQR)	4 (2–10)	4 (2–9)	4 (2–10)	3 (2–6)	0.002
Median offers per year among always active candidates (IQR)	2.8 (1.5–5.2)	3.4 (1.6–7.4)	2.5 (1.2–5.1)	5.0 (2.3–7.1)	<0.001
Transplanted during the study period, n (%)	4,300 (16%)	312 (21%)	41 (13%)	6 (11%)	<0.001
Median match-run sequence of accepted offers (IQR)	4 (2–11)	4 (2–10)	7 (3–16)	4 (2–10)	0.006
Median time to first offer from waitlisting, days (IQR)	117 (43–267)	110 (37–270)	139 (51–325)	175 (47–352)	0.045
Median time to first offer among always active candidates (IQR)	127 (43–341)	105 (34–357)	141 (43–377)	165 (9–352)	0.194
Median time to first offer among always active candidates, excluding hepatitis C antibody positive donors (IQR)	125 (43–336)	110 (35–365)	139 (42–375)	178 (9–373)	0.801
Median time to transplant during follow up, days (IQR)	921 (502–1438)	760 (289–1343)	1180 (561–1508)	1041 (223–2550)	<0.001
Median time to transplant among always active candidates (IQR)	727 (338–1175)	394 (97–899)	1024 (229–1204)	201 (49–625)	<0.001
Median time to transplant, excluding hepatitis C antibody positive donors (IQR)	921 (502–1438)	908 (463–1499)	1180 (561–1508)	2260 (677–2811)	0.029
Median time to transplant from first offer, days (IQR)	496 (148–951)	308 (52–779)	719 (267–1135)	255 (40–631)	<0.001
Median time to transplant from first offer among always active candidates (IQR)	395 (121–794)	222 (36–586)	675 (148–1107)	147 (34–407)	<0.001
Median time to transplant from waitlisting, days (IQR)	1294 (843–1879)	1223 (776–1863)	1482 (1187–2153)	1339 (678–2261)	<0.001

Abbreviations: HIV = human immunodeficiency virus, HCV = hepatitis C virus; IQR = interquartile range