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Authors

Werbel, William

Bae, Sunjae

Yu, Sile

et al.

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Early steroid withdrawal in HIV-infected kidney transplant recipients: Utilization and outcomes

William A. Werbel[1], **Sunjae Bae**[2], **Sile Yu**[3], **Fawaz Al Ammary**[1], **Dorry L. Segev**[2,3,4], **Christine M. Durand**[1,5]

[1]Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland
[2]Department of Epidemiology, Johns Hopkins School of Public Health, Baltimore, Maryland
[3]Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland
[4]Scientific Registry of Transplant Recipients, Minneapolis, Minnesota [5]Department of Oncology, Johns Hopkins University School of Medicine, Baltimore, Maryland

Abstract

Kidney transplant (KT) outcomes for HIV-infected (HIV+) persons are excellent, yet acute rejection (AR) is common and optimal immunosuppressive regimens remain unclear. Early steroid withdrawal (ESW) is associated with acute rejection (AR) in other populations, but its utilization and impact are unknown in HIV+ KT. Using SRTR, we identified 1225 HIV+ KT recipients between 1/1/2000-12/31/2017 without AR, graft failure, or mortality during KT admission, and compared those with ESW versus steroid continuation (SC). We quantified associations between ESW and AR using multivariable logistic regression and interval-censored survival analysis, as well as with graft failure and mortality using Cox regression, adjusting for donor, recipient, and immunologic factors. ESW utilization was 20.4%, with more zero HLA mismatch (8% vs 4%), living donors (26% vs 20%), and lymphodepleting induction (64% vs 46%) compared to the SC group. ESW utilization varied widely across 129 centers, with less use at high versus moderate volume centers (6% vs 21%, p<0.001). AR was more common with ESW by one year (18.4% vs 12.3%; aOR: $_{1.08}1.61_{2.41}$, p=0.04) and over the study period (aHR: $_{1.02}1.39_{1.90}$, p=0.03), without difference in death-censored graft failure (aHR $_{0.60}0.91_{1.36}$, p=0.33) or mortality (aHR: $_{0.75}1.15_{1.77}$, p=0.45). To reduce AR after HIV+ KT, tailoring of ESW utilization is reasonable.

INTRODUCTION

Patient and graft survival among HIV+ kidney transplant (KT) recipients is excellent (1), and focus has shifted toward reducing post-transplant morbidity. An important opportunity to improve care is through mitigation of acute rejection (AR), as HIV+ KT recipients

Correspondence William A. Werbel, wwerbel1@jhmi.edu.

DATA AVAILIBILITY STATEMENT

The data supporting the findings of this study are available from the SRTR by permission. Restrictions apply to the availability of these data, which were accessed under license for this study.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

experience 2-3-fold higher rates than in the general KT population (2) for uncertain reasons. One modifiable risk factor for AR is optimization of maintenance immunosuppression. Current guidelines have not established ideal strategies for HIV+ KT recipients (3) and practices may vary among centers.

Early steroid withdrawal (ESW) is an approach utilized in 30% of all KTs to limit corticosteroid exposure, and is an attractive strategy to reduce associated cardiometabolic and infectious complications in at-risk patients (4). Several early trials in select populations such as living donor recipients and recipients of lymphodepleting antibody induction did not find significant increases in serious AR or graft failure with ESW (5, 6). In contrast, ESW use in immunologically higher risk populations such as black recipients not receiving lymphodepleting induction (7), and those with delayed graft function (8), showed associations with increased AR and graft failure. Systematic reviews and meta-analyses studying the total KT population have indicated 1.56–1.77-fold increased risk of AR with ESW (9, 10), while noting decreased burden of cardiovascular disease and death with a functioning graft (11). In HIV+ KT recipients, ESW data are limited to two small, single-center retrospective series that observed one-year AR rates ranging from 9% in one study of 11 patients (12) to 54% in another study of 13 patients (13); as such, national data are critical.

The objectives of our study were to use national registry data to (i) describe ESW utilization in HIV+ KT recipients over time and across transplant centers and (ii) compare characteristics and outcomes between HIV+ KT recipients undergoing ESW versus those treated with steroid continuation (SC), with a focus on AR.

METHODS

Data source

This study used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes data on all donor, wait-listed candidates, and transplant recipients in the US, submitted by the members of the Organ Procurement and Transplantation Network (OPTN). The Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors. 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.

Study population

We identified 1437 HIV+ KT recipients aged≥18, undergoing transplantation between January 1, 2000 and December 31, 2017. We excluded recipients with incomplete immunosuppressive exposure and outcome data (n=135), rejection, graft failure, or death, or length of stay >90 days during index transplant hospitalization (n=132), or with prior KT or multiorgan transplant (n=37) (n=212 total excluded, Figure 1), for a study population of n=1225. We defined the early steroid withdrawal (ESW) group as those discharged from index transplant hospitalization without a corticosteroid maintenance drug, and the steroid

continuation (SC) group as those discharged on any corticosteroid medication. Demographics and immunologic factors were compared between ESW and SC groups via Fisher's exact and chi-square testing as appropriate for categorial variables, and via Student's t-test and Wilcoxon rank-sum testing for continuous variables.

National and center-level ESW utilization

ESW utilization (proportion of HIV+ KT recipients undergoing ESW) was presented by calendar year, starting in 2004 when >20 HIV+ KTs were performed, through 2017. Individual center-level ESW utilization during the study period was calculated and displayed for those centers performing 20–40 HIV+ KTs ("moderate volume centers") and those performing >40 HIV+ KTs ("high volume centers"). Median ESW utilization between groups was compared via Wilcoxon rank-sum testing.

Outcome definitions

The primary outcome was acute rejection (AR), defined as first event recorded during follow up, irrespective of need for biopsy or treatment, comparing ESW and SC groups. Secondary outcomes included (i) recipient mortality and (ii) death-censored graft failure (DCGF), defined as graft failure, retransplantation, or resumption of maintenance dialysis prior to recipient death. All outcomes were compared using Fisher's exact and chi-square testing as appropriate, while change in AR incidence over time was assessed using non-parametric test of trend (extension of Wilcoxon rank-sum testing).

Multivariable model

Analyses tested for associations of the primary exposure, ESW, with the primary outcome (AR) and secondary outcomes (recipient mortality, DCGF), adjusting for possible confounders including: donor factors (age, living donation), recipient factors (age, black race, hepatitis C [HCV] antibody status), immunologic factors (calculated panel reactive antibody [cPRA] at KT, human leukocyte antigen [HLA] zero mismatch on A, B, and DR loci, anti-thymocyte globulin [ATG] induction, delayed graft function [DGF]), and transplant era (2000–2007 [reference], pre-HIV integrase strand transfer inhibitor [INSTI] era; 2008–2013, INSTI era; and 2014–2017, INSTI + HCV direct-acting antivirals [DAA] era). Recipients missing covariable data (n=53) were excluded from the final model (Figure 1).

Logistic regression

Multivariable logistic regression was used to assess for associations of ESW with AR by one year (i.e. reported on 3, 6, or 12-month follow-up forms, within 365 days of KT), using the above model. Additional analyses included evaluation for effect measure modification, i.e. whether the effect of ESW on AR varied by level of other key factors, via interaction terms and likelihood ratio testing of nested models informed by Akaike information criteria. This included interactions between ESW and ATG induction, recipient black race, transplant era, and living donation. Additionally, we performed subgroup analyses to assess adjusted odds ratios (aORs) for populations of interest, restricting upon recipients coadministered mycophenolate derivatives plus tacrolimus (n=1022) as well as those undergoing KT during

the INSTI and INSTI+DAA eras (n=1099). As a sensitivity analysis, we explored the impact of transplant center volume during the study period by addition of a factor variable for low (<20 HIV+ KTs), moderate (20–40 HIV+ KTs), or high (>40 HIV+ KTs) volume centers. Finally, we explored inverse probability of treatment weighting (IPTW; a form of propensity analysis) to balance observed and unobserved confounding and assess for changes in the association between ESW and AR. Covariable balance was assessed to ensure standardized differences <0.1, and density of the predicted probabilities assessed to ensure no violation of the overlap assumption.

Survival analyses

For AR, an interval-censoring approach was used (14) because OPTN does not capture the precise date of rejection events after KT, instead recording the dates of serial patient follow-up form submissions containing updated outcome information. This permits definition of an interval between the last follow-up form reporting no rejection (“left time”), and the first follow-up form to report a rejection event (“right time”), during which a rejection event has occurred. A Weibull parametric proportional hazards model was selected to estimate the hazard of AR over time, with fit confirmed by plotting Cox-Snell residuals versus the estimated cumulative hazard function. The hazard ratio (HR) for ESW was calculated adjusting for identical donor, recipient, and immunologic variables as in the logistic regression model. The impact of transplant center volume during the study period was also explored.

For mortality and death-censored graft failure (DCGF) between ESW and SC groups, Cox proportional hazards regression was used to calculate the aHR for ESW, adjusting for identical factors as in the logistic regression and interval-censoring survival analysis models. Unadjusted survival curves, the complements of DCGF and mortality, were plotted using the Kaplan-Meier method and functions were compared using log-rank testing. The proportional hazards assumption was examined via log-log plot of survival curves over time. We explored center-level effects in each Cox model by performing a sensitivity analysis accounting for random effects common to individuals at each center (a shared frailty model).

Statistical analyses

All analyses were performed using Stata/SE 15.1 for Mac (College Station, Texas). Confidence intervals for aORs were presented per the method of Louis and Zeger (15). Significance level for all tests was set at a two-sided alpha <0.05.

RESULTS

Population characteristics

Among 1225 HIV+ KTs, 1099 (90%) occurred following the advent of HIV INSTIs (2008–2017), and 661 (54%) in the INSTI + HCV DAA era (2014–2017) (Figure 2). There was a sharp increase in transplant volume beginning in 2015, with an average of 180 HIV+ KTs performed per year from 2015–2017 (n=542, 44% of total). ESW was utilized in 250 patients (20.4%) during the study period. ESW utilization ranged from 10–26% per year

from 2004–2017, and remained fairly stable from 2008–2017 (median 20%, IQR 19–23), without a clear temporal trend.

Donor and recipient characteristics were largely similar between ESW and SC groups (Table 1). There were more living donors in the ESW group (26% vs 20%, p=0.03) and shorter median cold ischemia time (12.2 vs 14.3 hours, p=0.02), though median KDPI was nearly identical (44 vs 44, p=0.7). Notable recipient characteristics included high proportion of black patients (70% vs 76%, p=0.27), with low proportion of diabetes (19% vs 16%, p=0.29) and HCV coinfection (18% vs 19%, p=0.8). Etiology of end-stage renal disease (ESRD) was similar between groups, with two-thirds requiring KT for either HIV-associated nephropathy or hypertension. Immunologic characteristics were also similar, including cPRA>30% (20 vs 17% p=0.44), although zero HLA mismatch was more common in the ESW group (8% vs 4%, p=0.02). Notably, lymphodepleting induction was used more often in the ESW group (64% vs 46%, p<0.001), with less use of anti-IL2 receptor blockade (32% vs 48%, p<0.001). Both groups were frequently coadministered mycophenolate and tacrolimus (87% vs 86%, p=0.82).

Center-level ESW utilization

During the study period, 129 centers performed at least one HIV+ KT (median n=23 KTs per center, IQR 10–48). Among moderate volume centers, there was wide variation in ESW utilization (median 21%, IQR 5–74%) (Figure 3). ESW utilization was lower, and more consistent, at the six highest volume centers (median 6%, IQR 2–14%; p<0.001 versus moderate volume centers). When contrasting patient composition at moderate versus high volume centers, however, there were many similarities: 78% vs 80% black recipients (p=0.52), 19% vs 23% living donors (p=0.21), 44% vs 41% ATG induction (p=0.32), and 17% vs 15% diabetic recipients (p=0.49). Otherwise, although cPRA profiles were very similar (data not shown), there was somewhat more zero HLA mismatch (7% vs 4%, p=0.054) and more DGF (35% vs 25%, p<0.01) among recipients at moderate volume centers versus at high volume centers.

Association of ESW with AR

The cumulative incidence of AR by 1 year was 18.4% in the ESW group (46 events) versus 12.3% in the SC group (120 events), a 1.5-fold increase in the ESW group (p=0.04). AR seemed to decrease across transplant eras (15.9% pre-INSTI, 15.1% INSTI, 12.1% INSTI + DAA), yet the trend did not reach statistical significance (p trend=0.12). When stratifying by steroid maintenance strategy, there remained no significant decrease in AR among the ESW group across transplant eras (16.0%, 19.6%, 18.1%, p trend>0.9), albeit a stronger pattern of decrease in the SC group (15.8%, 13.9%, 10.6%, p trend=0.069).

After adjustment for donor, recipient, and immunologic factors, ESW was associated with 1.61-fold higher odds of AR (aOR) by one year ($_{1.08}1.61_{2.41}$, p=0.02). The association between ESW and AR at one year did not vary by recipient race (p interaction>0.9), donor type (p interaction>0.9), induction (p interaction=0.14), or transplant era (p interaction=0.21).

When restricting to HIV+ KT recipients receiving mycophenolate and tacrolimus maintenance (n=1022), the point estimate for odds of one-year AR with ESW did not appreciably change (aOR $_{1.03}1.60_{2.49,}$ p=0.04). Restricting to the INSTI and INSTI + DAA eras (post 2007, N=1064), the ESW aOR remained statistically significant (aOR $_{1.16}1.75_{2.67}$, p<0.01). When adjusting for center volume, ESW aOR was $_{1.14}1.72_{2.60,}$ p=0.01; center volume itself was not significantly associated with AR (data not shown). Similarly, using IPTW, the average treatment effect of ESW was similar with aOR $_{1.08}1.49_{2.05}$, p=0.02.

In interval-censored survival analysis, unadjusted estimated AR survival curves separately quickly after KT in favor of SC (Figure 4). AR was more common at one, three, and five years in the ESW vs the SC group (15.6%, 23.6%, 28.3% versus 12.6%, 19.2%, 23.2%; crude HR $_{0.93}1.26_{1.71}$, p=0.12). This pattern was more prominent in adjusted analysis, where ESW was associated with a 1.39-fold higher hazard of AR (aHR $_{1.02}1.39_{1.90}$, p=0.03; Table 2, Supplemental Figure 1). In multiple secondary analyses, the aHR for ESW was largely unchanged: restricting to INSTI and INSTI+DAA eras (aHR $_{1.08}1.49_{2.06}$), restricting to tacrolimus plus MMF maintenance (aHR $_{1.03}1.46_{2.07}$), and assessing for center effects by center volume category (aHR $_{1.04}1.43_{1.96}$).

Graft Failure and Recipient Mortality

Death-censored graft failure (DCGF) did not significantly differ between ESW and SC groups at one, three, or five years (2.2%, 7.6%, 13.3% versus 2.8%, 7.7%, 13.8%), log-rank p=0.31 (Figure 5a). There was no significant association between ESW and graft failure, aHR $_{0.60}0.91_{1.36}$ (p=0.33). Similarly, recipient mortality did not differ between ESW and SC groups at one, three, or five years (1.7%, 7.2%, 10.7% versus 1.9%, 5.2%, 8.0%), log-rank p=0.19 (Figure 5b). There was no significant association between ESW and mortality, aHR $_{0.75}1.15_{1.77}$ (p=0.45). When accounting for center-level effects, the point estimates for DCGF (aHR $_{0.59}0.91_{1.36}$) and patient survival (aHR $_{0.75}1.15_{1.77}$) were essentially identical.

DISCUSSION

In this national study, we found that 20.4% of HIV+ KT recipients were treated with ESW. ESW utilization varied widely across US centers, but was consistently lower at centers with a higher volume of HIV+ KT. AR was more common in those undergoing ESW (18.4%) than those undergoing SC (12.3%) by 1 year post KT, with a 39% higher estimated hazard after adjustment for donor, recipient, and immunologic factors. DCGF and mortality were similar between groups at one, three, and five years post KT.

Our finding of 20% ESW utilization in HIV+ KT recipients is lower than utilization in the general KT population (4). In keeping with KDIGO recommendations (16), this difference may be due more immunologically high-risk characteristics in HIV+ KT versus HIV- KT, such as higher proportion of black recipients (75% vs 27%) and less use of lymphodepleting induction therapy (50% vs 65%). Otherwise, there was lower prevalence of diabetes in the HIV+ KT population (17% vs 37%), which may further influence risk-benefit calculus regarding ESW.

There is significant center-level variability in ESW utilization, particularly among moderate-volume HIV+ KT centers, while this approach was 3.4-fold less common at the six highest volume centers (median 21% vs 6%, p<0.001). Although some variability may be related to differences in patient factors among centers, many important characteristics appear similar across both moderate and high-volume centers (e.g. recipient black race, living donation, cPRA, ATG induction). Therefore, some of this observed variability is likely related to local provider preference, further emphasizing the need for evidence-based guidelines to inform immunosuppressive selection in this unique population.

Our finding of 13.6% AR at one year was consistent with prior registry studies of HIV+ KT (17, 18) and supports the paradigm that AR remains a significant issue in this population. Reasons for elevated AR risk in HIV+ KT recipients are not fully elucidated, but include: drug interactions with HIV protease inhibitors and calcineurin inhibitors (18) most common in the pre-INSTI era, reluctance to use lymphodepleting induction therapy (19), HCV coinfection (20), as well as immune dysregulation and possible HIV infection of the graft itself (21). Optimizing immunosuppressive regimens remains a priority in order to reduce AR, subsequent immunosuppressive intensification, and associated opportunistic infections (22). Our study suggests a potential contribution of ESW in worsening AR risk.

It is notable that the subgroup with the lowest AR rate (10.6%) was the SC group undergoing KT during the most recent transplant era (when HIV INSTIs and HCV DAAs were available), a rate similar to that reported for HIV- KT recipients per OPTN (4). This may indicate a potential added approach toward normalizing AR rates among HIV+ KT recipients in the modern era and reducing associated complications.

There are several limitations of this work. Regarding ESW exposure, we defined this as discharge without corticosteroid, assuming it was a deliberate management strategy and defining an “intention-to-treat” population. We were not, however, able to confirm decision-making for medication selection including whether this was made in response to events occurring during index hospitalization (e.g. uncontrolled hyperglycemia, infection, wound-healing concerns) than may predispose to downstream sequela. That said, median length of stay for the analytic cohort was 5 days (IQR 4–7), consistent with the recommended timing for ESW per KDIGO (16) and employed in prior clinical trials (≤ 7 days) (6). Regardless, we were most interested in the primary outcome of incident AR following decision to pursue ESW, irrespective of rationale. Underlying basis for reinstitution of corticosteroids (e.g. incident AR, resolution of preceding infection, improvement in glucose control, etc) was not available and thus limits conclusions.

It is also possible that not all rejection episodes were captured in the SRTR (23). The observed AR rate of 13.6% by one year in this study is lower than that reported in some clinical trials of HIV+ KT (2). Several of these series, however, predate the eras of HIV INSTIs and HCV DAAs and may be less representative of HIV+ KT in the modern age. Regardless, we do not suspect differential reporting of rejection in the SRTR based upon corticosteroid exposure, so bias in our particular inferences is unlikely. Additionally, as in most registry analyses, factors such as medication adherence, calcineurin inhibitor trough levels, preformed donor specific antibodies, and Banff classification of rejection were not

available. Otherwise, details on HIV control and biology e.g. longitudinal viral loads and CD4 T-cell counts were unavailable in the SRTR, which could impact post-KT outcomes. That said, HIV+ KT recipients are a highly select group with median CD4 T-cell counts typically >400 cells/uL along with durable viral suppression before transplant (1). In fact, lymphodepleting induction, recorded in SRTR, is likely a major arbiter of CD4 lymphopenia after transplant (24), while viral breakthrough is uncommon and typically low level (25).

Overall, this is the largest study of US HIV+ KT recipients to date, detailing important clinical characteristics and outcomes with key emphasis on the modern antiviral era. Additionally, it is the first dedicated study to explore associations of steroid maintenance strategy with AR following HIV+ KT, which is an important step toward development of evidence-based optimization strategies for post-transplant immunosuppression. Future investigations should focus on steroid-associated side effects post HIV+ KT to more fully inform the risk/benefit calculus for ESW in this complex and expanding patient population that may be at elevated risk (26–28).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DISCLOSURE

The authors of this manuscript have conflicts of interest to disclose as described by the *American Journal of Transplantation*. DLS receives speaking fees, consulting fees, and honoraria from Sanofi, Novartis, Veloxis, Mallinckrodt, and CSL Behring. CMD serves on a grant review committee for Gilead Sciences and receives research grants from Gilead Sciences, Abbvie, and GlaxoSmithKline. The other authors have no conflicts of interest to disclose.

Abbreviations:

aOR	adjusted odds ratio
aHR	adjusted hazard ratio
AR	acute rejection
ATG	anti-thymocyte globulin
cPRA	calculated panel reactive antibody
DAA	direct-acting antiviral

DCD	donation after circulatory death
DGF	delayed graft function
ESRD	end-stage renal disease
ESW	early steroid withdrawal
FSGS	focal segmental glomerulosclerosis
HCV	hepatitis C virus
HIV+	Human Immunodeficiency Virus-infected
HLA	human leukocyte antigen
INSTI	integrase strand transfer inhibitor
IL2R	interleukin 2 receptor
KDIGO	Kidney Disease Improving Global Outcomes
KDPI	kidney donor profile index
KT	kidney transplant
OPTN	Organ Procurement and Transplantation Network
SC	steroid continuation
SRTR	Scientific Registry of Transplant Recipients

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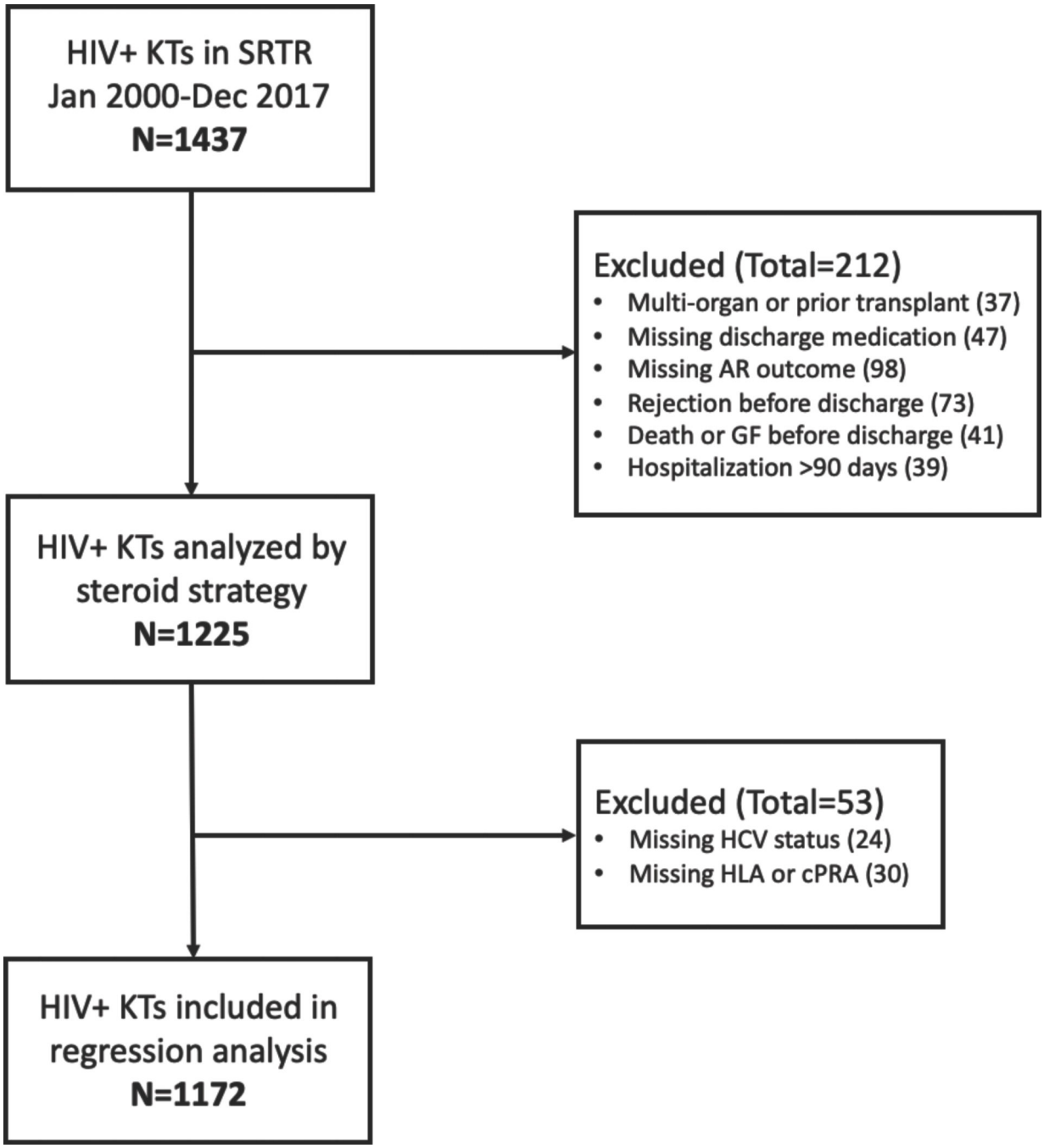


Figure 1:
Study flow diagram.

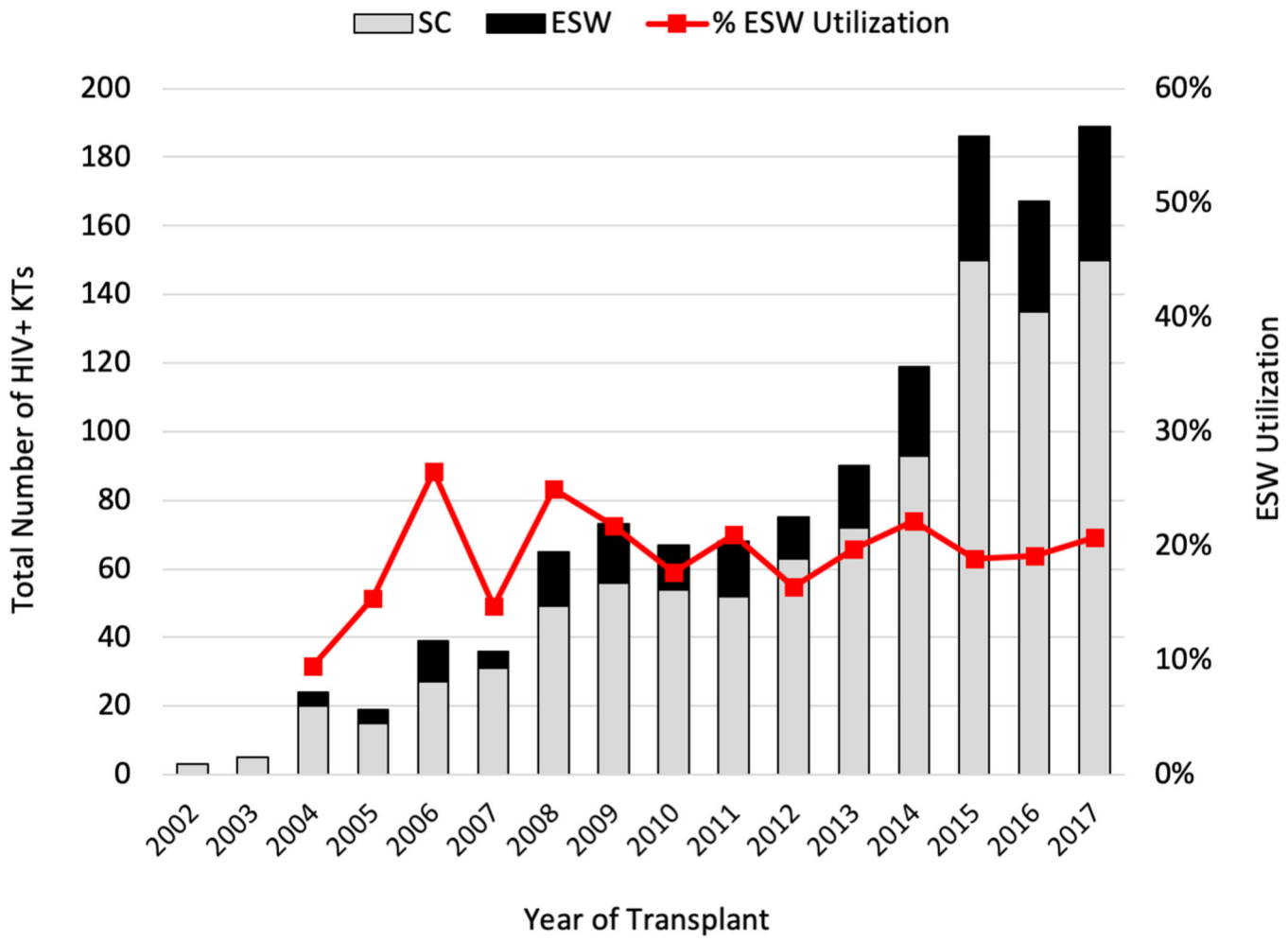


Figure 2: ESW utilization among HIV+ KT recipients.

Dark bars denote the number of HIV+ KT recipients undergoing ESW each year in the study population (N=1225). Percent yearly ESW utilization, displayed by the red line, was approximately stable from 2004–2017 (median 20.3% KTs).

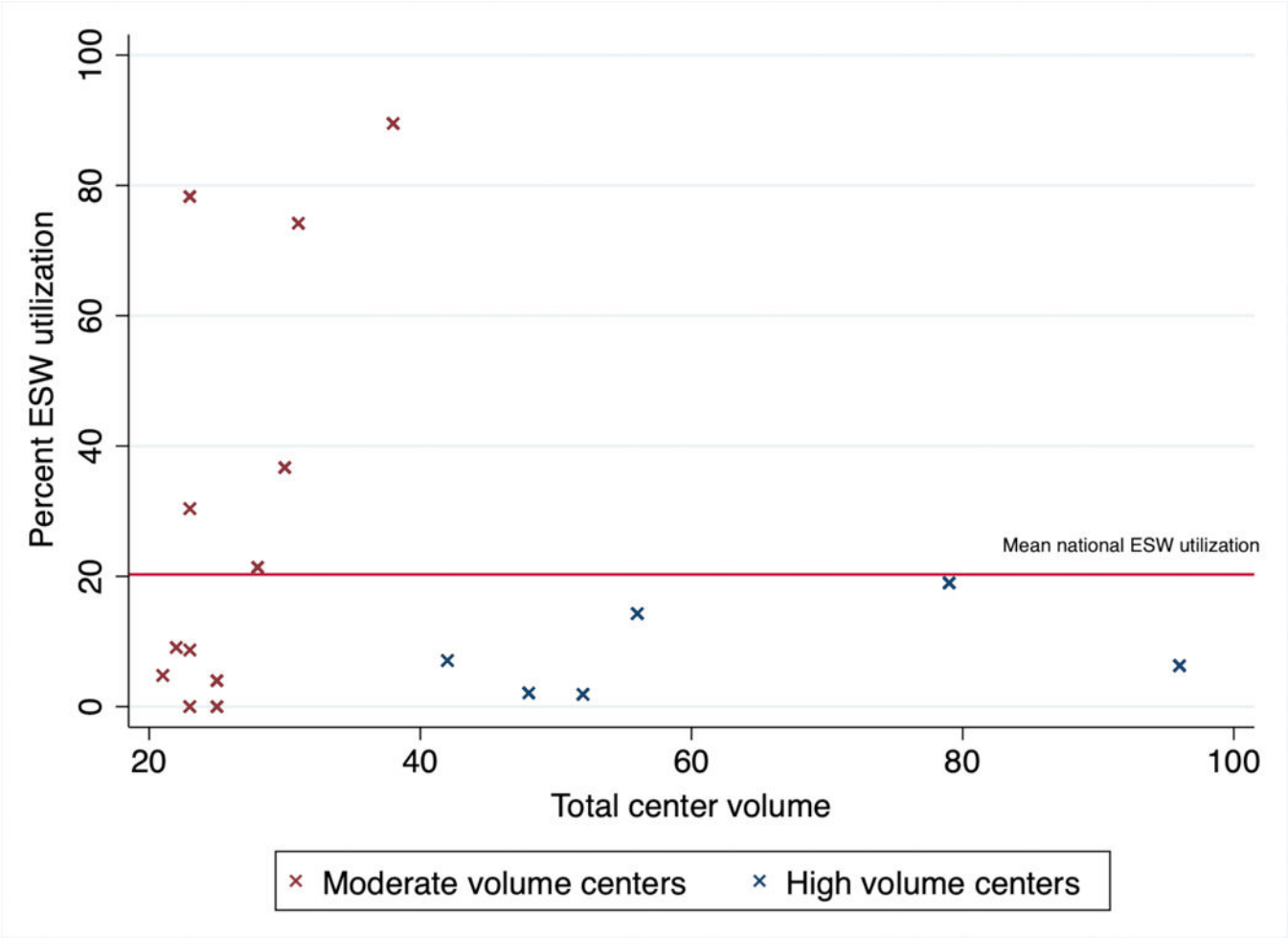


Figure 3: ESW utilization across transplant centers.

Each "x" represents centers performing ≥20 HIV+ KTs during the study period (n=18), with the y axis denoting the percent ESW utilization at each center. The red line denotes overall national ESW utilization (20.4%). Among moderate volume centers (20–40 KTs), ESW utilization varied greatly (median 21%, IQR 5–74%). Among high volume centers (>40 KTs), there was more uniformity in practice and less ESW utilization (median 6%, range 2–14).

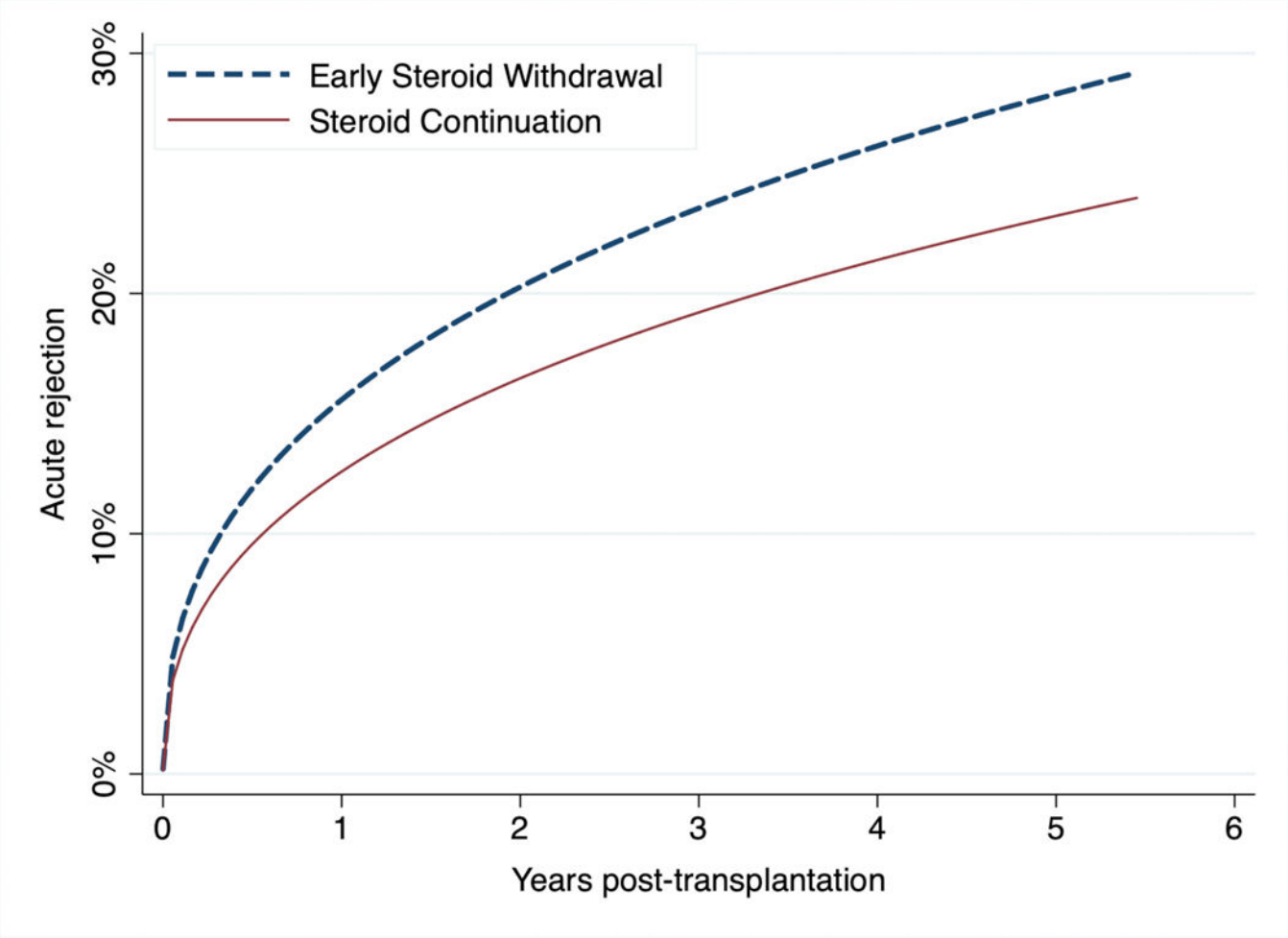
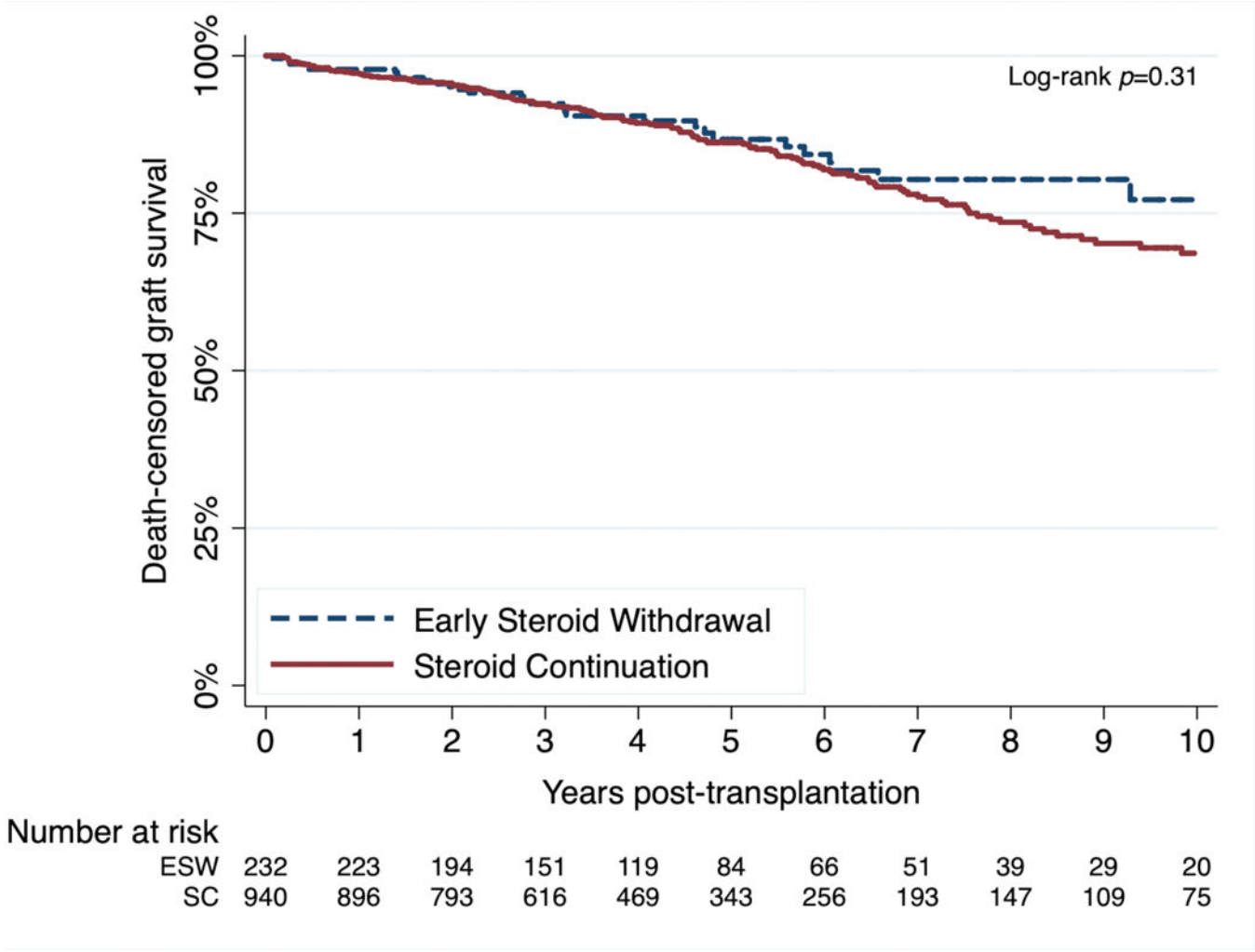


Figure 4: Unadjusted interval-censored survival curves for AR in ESW vs SC groups.
Dashed lines represent the ESW group and solid lines represent the SC group.



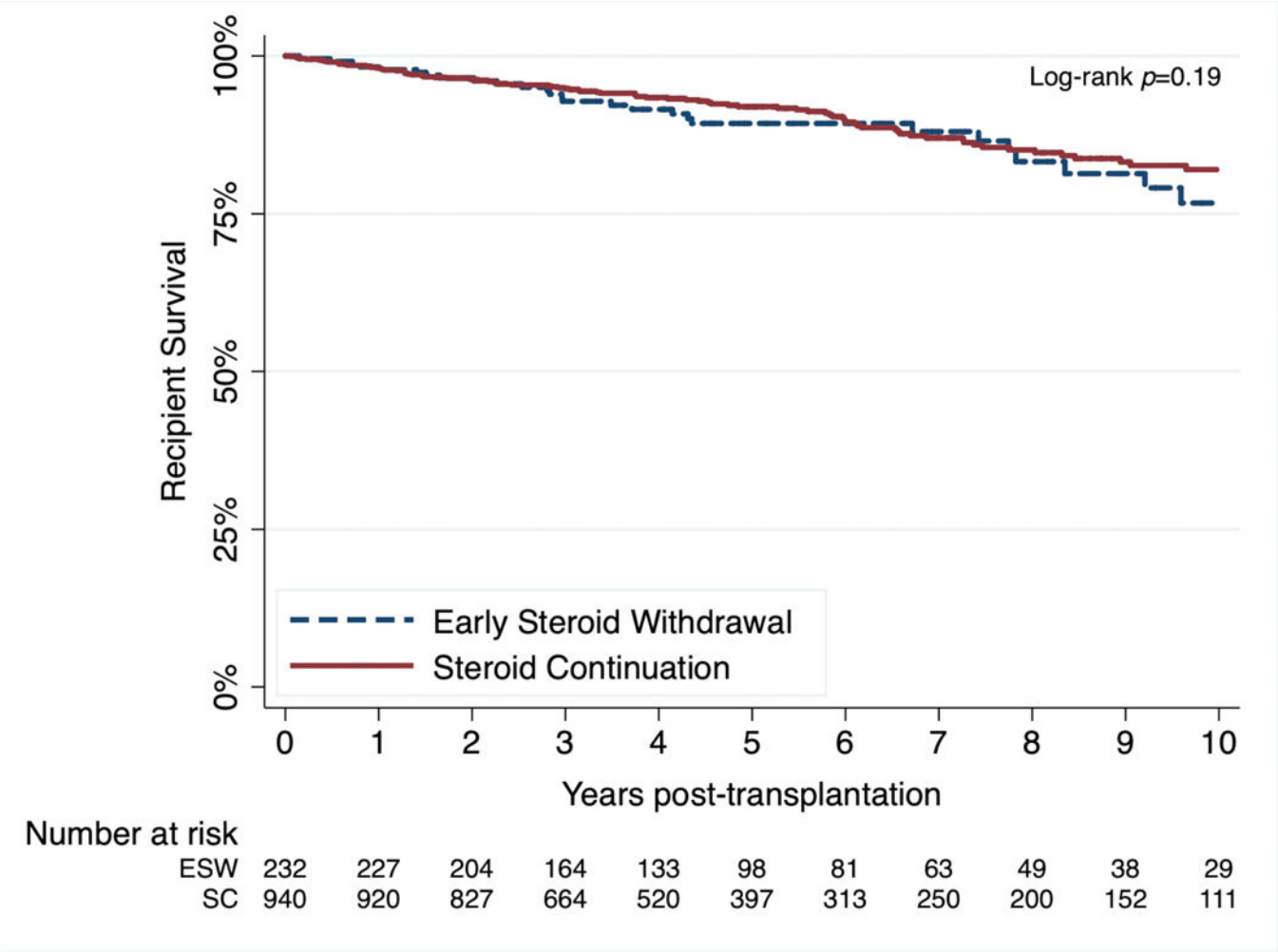


Figure 5: Unadjusted Kaplan-Meier survival curves for (a) graft survival, censored for death and (b) recipient survival.

Dashed lines represent the ESW group and solid lines represent the SC group.

Table 1:

Demographic and immunologic characteristics of donors and recipients, by steroid maintenance strategy.

Values are presented as percent (%) for categorical variables and median, interquartile range [med (IQR)] for continuous variables.

Recipient Factor	ESW (N=250)	SC (N=975)	Total (N=1225)	*p* value
Age, med (IQR)	50 (42, 56)	49 (42, 55)	49 (42, 55)	0.43
Male, %	78	76	76	0.60
Black, %	70	76	75	0.27
HCV Antibody +, %[a]	18	19	19	0.8
Diabetes, %	19	16	17	0.29
BMI ≥ 30, %[a]	20	22	22	0.42
Etiology of ESRD, %				0.15
HIV Nephropathy	30	35	35	
Hypertension	35	33	33	
Diabetes	16	12	13	
Other FSGS	5	6	5	
Glomerulonephritis	5	7	7	
Other	8	7	7	
cPRA, %[a]				0.44
0%	64	65	64	
0.01–29.9%	17	18	18	
30–80%	17	13	14	
>80%	3	4	4	
HLA Mismatch, med (IQR)[a]	5 (4, 5)	5 (4, 5)	5 (4, 5)	0.58
DGF, %	27	28	28	0.8
Induction, %				
Lymphodepletion	64	46	50	<0.001
ATG	53	43	45	<0.01
Alemtuzumab	8	2	3	<0.001
Anti-IL2R	32	48	45	<0.001
Maintenance, %				
Tacrolimus	89	89	89	0.79
Mycophenolate	95	95	95	0.69

Recipient Factor **Donor Factor**	**ESW (N=250)** **ESW**	**SC (N=975)** **SC**	**Total (N=1225)** **Total**	***p* value** ***p* value**
Age, med (IQR)	38 (26, 51)	38 (26, 48)	38 (26, 49)	0.52
Male, %	54	59	58	0.11
Black, %	26	24	24	0.88
KDPI, med (IQR)	44 (25, 67)	44 (27, 64)	44 (27, 64)	0.70
Living Donor, %	26	20	21	0.03
Cold Ischemia Time, med (IQR)[a]	12 (6, 20)	14 (8, 22)	14 (8, 22)	0.02
DCD, %	15	14	14	0.64

[a]**Missing data**: recipient HCV status (31), BMI (44), HLA mismatch on A, B, DR loci (6), cPRA (25), cold ischemia time (38)

Abbreviations: ATG=anti-thymocyte globulin, BMI=body mass index, cPRA=calculated panel reactive antibody, DCD=donation after circulatory death, DGF=delayed graft function, ESRD=end-stage renal disease, ESW=early steroid withdrawal, FSGS=focal segmental glomerulosclerosis, HCV=hepatitis C virus, HIV=human immunodeficiency virus, HLA=human leukocyte antigen, IL2R=interleukin-2 receptor, KDPI=kidney donor profile index (deceased donors), SC=steroid continuation

Table 2:
Association of ESW with post-KT outcomes.

Point estimates are flanked by subscripts indicating lower and upper bounds of the 95% confidence interval.

Outcome	Number of Events[a] ESW vs SC		Crude ESW HR (95% CI)	*p* value	Adjusted ESW HR[b] (95% CI)	*p* value
Acute rejection	54	177	$_{0.93}1.26_{1.71}$	0.14	$_{1.02}1.39_{1.90}$	0.03
Death-censored graft failure	29	143	$_{0.55}0.81_{1.21}$	0.31	$_{0.60}0.91_{1.36}$	0.33
Recipient mortality	30	92	$_{0.87}1.31_{1.98}$	0.20	$_{0.75}1.15_{1.77}$	0.45

[a] N=1172 HIV+ KT recipients (232 ESW, 940 SC) included in survival analyses.

[b] Multivariable models adjusted for donor age, living donation, recipient age, recipient black race, recipient HCV antibody status, calculated panel reactive antibody at KT, human leukocyte antigen zero mismatch on A, B, DR loci, anti-thymocyte globulin induction, delayed graft function, and transplant era (2000–2007, pre-HIV integrase strand transfer inhibitor [INSTI] era; 2008–2013, INSTI era; 2014–2017, INSTI + HCV direct-acting antivirals [DAA] era).