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ORIGINAL ARTICLE

The association between loss of Medicare, immunosuppressive medication use, and kidney transplant outcomes

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Kidney transplant recipients aged <65 years qualify for Medicare coverage, but coverage ends 3 years posttransplant. We determined the association between timing of Medicare loss and immunosuppressive medication fills and kidney allograft loss. Using data from the Scientific Registry of Transplant Recipients (SRTR), US Renal Data System, and Symphony pharmacy fill database, we analyzed 78 861 Medicare-covered, kidney-alone recipients aged <65 years, and assessed the timing of Medicare loss posttransplant: early (<3 years), on-time (at 3 years), or late (>3 years). Immunosuppressant use was measured as medication possession ratio (MPR). Allograft loss was assessed using SRTR data. MPR was lower for recipients with early or late Medicare loss compared with no coverage loss for all immunosuppressive medication types. For calcineurin inhibitors, early Medicare loss was associated with a 53% to 86% lower MPR. On-time Medicare loss was not associated with a lower MPR. When recipients were matched by age, posttransplant timing of Medicare loss, and donor risk, the hazard of allograft loss was 990% to 1630% higher after early Medicare loss, and 140% to 740% higher after late Medicare loss, with no difference in the hazard for on-time Medicare loss. Ensuring ongoing Medicare access before and after 3 years posttransplant could affect graft survival.

KEYWORDS
clinical research/practice, insurance - public, kidney transplantation/nephrology, Scientific Registry for Transplant Recipients (SRTR)

1 | INTRODUCTION

Kidney transplant confers profound survival, quality of life, and cost benefits over dialysis for treatment of end-stage kidney disease (ESKD).[1-7] In the US, patients with ESKD qualify for Medicare coverage for dialysis or kidney transplant regardless of age, and ESKD patients account for approximately 7% of the annual Medicare spending despite comprising <1% of the total Medicare population.[8]

Abbreviations: ACA, Affordable Care Act; CI, confidence interval; CNI, calcineurin inhibitor; ESKD, end-stage kidney disease; GEE, generalized estimating equation; HR, hazard ratio; MPR, medication possession ratio; OPTN, Organ Procurement and Transplantation Network; SRTR, Scientific Registry of Transplant Recipients; USRDS, United States Renal Data System.

Medicare coverage for kidney transplant immunosuppressive medications ends 3 years posttransplant for patients aged younger than 65 years and not disabled. This policy is predicated on the assumption that transplant recipients are able to work and obtain private insurance, or, if unable to work, qualify for Medicare through disability coverage. Mortality rates are higher for patients who start dialysis after graft failure than for age-matched patients who never undergo transplant.[9] Therefore, preventing kidney allograft rejection by ensuring access to immunosuppressive medications confers benefits to both patients and payers.[10-12]

Previous analyses have found that risk of graft failure is higher for transplant recipients with Medicare at the time of transplant than for recipients with private insurance, and that the higher risk of graft

failure is even more pronounced after 3 years posttransplant.[12] These data raise concerns that the scheduled loss of Medicare coverage at 3 years for patients aged younger than 65 years or not disabled results in loss of access to immunosuppressive medications, causing unnecessary graft failure. However, Page et al analyzed the effect on racial disparities of extending Medicare coverage for immunosuppressive medications from 3 years to lifetime for recipients aged 65 years or older or disabled who underwent transplant after January 1, 1997.[13] They found no effect of lifetime immunosuppressive medication payments on racial disparities in those outcomes. Another analysis found that implementation of the 3-year Medicare policy was associated with decreased access to the waiting list for younger, non-disabled patients with ESKD, particularly those in lower income groups. This finding suggests that transplant centers' concern about the negative impact of immunosuppression coverage ending at 3 years may affect decisions about listing.[14]

In addition, Medicare coverage can be lost early (before 3 years posttransplant) due to nonpayment of premiums, on-time (at 3 years posttransplant), or late (after 3 years posttransplant) due to transition to private insurance, nonpayment of premiums, or loss of disability status.[15] Therefore, the timing and reason for losing Medicare coverage may affect outcomes. Specifically, risk of graft failure may be higher for recipients who lose Medicare early or late than for those who lose Medicare on time due to higher likelihood of becoming uninsured and thus reducing immunosuppressant fills. We first determined the risk factors for early, on-time, or late posttransplant Medicare loss, then evaluated the association between the timing of Medicare loss and immunosuppressive medication use and allograft failure.

2 | METHODS

2.1 | Source of data

This study used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes listing and outcome data for all donors, waitlisted candidates, and transplant recipients in the United States, submitted by the members of the Organ Procurement and Transplantation Network (OPTN), and has been described elsewhere.[16] The Health Resources and Services Administration, US Department of Health and Human Services, provides oversight of the activities of the OPTN and SRTR contractors. Medicare coverage (Part A, Part B, Parts A and B, health maintenance organization [HMO]), or lack thereof, was assessed at the time of transplant, based on the Unites States Renal Data System (USRDS) database.[8] Pharmacy fill data were obtained from the Symphony pharmacy fills database (https://symphonyhealth.prahs.com). Analyses were performed in SAS 9.4 (SAS Institute, Cary, NC) and R 3.3.2 (R Core Team [2015]. R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria, https://www.R-project.org/).

2.2 | Analytic cohorts

The analytic cohorts are described in Figure 1. The main cohort included 78 861 Medicare-covered kidney-alone recipients, aged younger than 65 years, who underwent transplant between January 1, 2008, and December 31, 2014. Medicare coverage (Part A, Part B, Parts A and B, HMO), or lack thereof, was assessed at the time of transplant, based on the USRDS database. To evaluate immunosuppressant use, the Medicare-covered subset was merged with the Symphony pharmacy claims database, an integrated data source incorporating dispensed prescriptions.

2.3 | Variables

Recipients with Medicare Parts A, B, A and B, or HMO coverage on the date of transplant were considered to be receiving Medicare. Medicare loss timing was defined as early (before 3 years posttransplant), on-time (36-38 months posttransplant), or late (after 38 months posttransplant). Demographic characteristics included age, race, sex, primary diagnosis, diabetes status, years on dialysis,

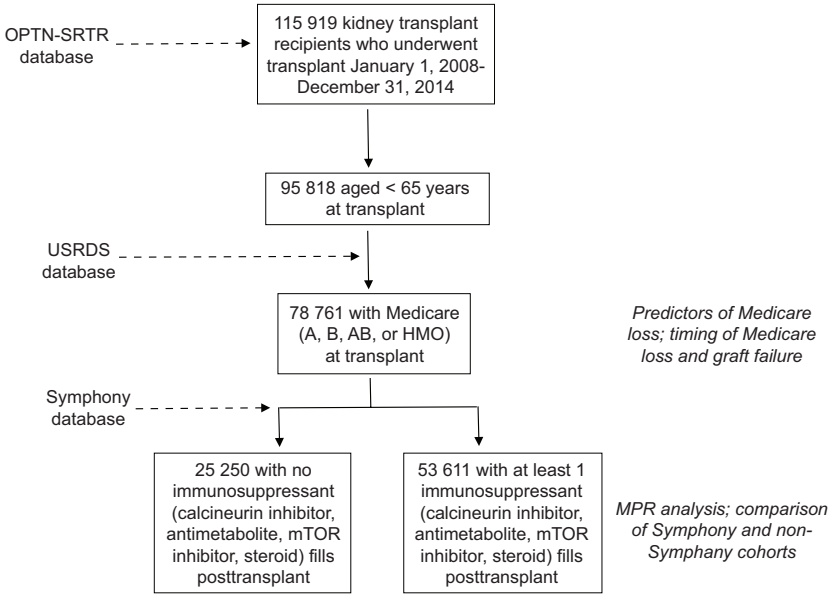


FIGURE 1 Description of the analytic cohort

median household income by zip code, and education. Donor predictors of graft loss in multivariable analyses included living versus deceased donor, donor age, race, height, weight, hypertension status, diabetes status, and serum creatinine. Immunosuppressive medication use was evaluated as a medication possession ratio (MPR), defined as the sum of days supplied divided by the days at risk for filling.[17,18] For example, an MPR of 0.5 corresponds to 15 days supplied out of 30 days in a month. All-cause graft loss was assessed via the SRTR database as the earliest of reported OPTN graft failure, return to dialysis, retransplant, or death; this outcome was confirmed using USRDS data.

2.4 | Predictors for timing of Medicare loss

To avoid unequal recipient follow-up times, piecewise exponential survival models estimated the association of demographic characteristics with timing of Medicare loss. The baseline hazard was separated into early (<36 months), on-time (36-38 months), and late (>38 months) Medicare loss. Demographic characteristics were interacted with time period (early, on-time, late) to identify potential differential effects across time periods. Only recipients receiving Medicare at transplant were included, and follow-up was censored at the earliest of graft failure, age 65 years, or January 1, 2015. We used a complete case analysis to ensure that the interpretation was conditional on observed data.

2.5 | Association between Medicare loss and immunosuppressive medication prescription filling

Monthly MPR for each immunosuppressant class (calcineurin inhibitors [CNIs], antimetabolites, mechanistic target of rapamycin [mTOR] inhibitors, and steroids) was the primary outcome, and Medicare status (whether Medicare had been lost before the current month) was determined monthly, from the first month up to 48 months posttransplant. Follow-up began after a recipient's first fill in the Symphony database and was censored at the earliest of graft failure, age 65 years, or January 1, 2015. Since the effect of Medicare loss may depend on the timing, we allowed the effect to vary by the timing of initial Medicare loss. For example, we separately estimated the association after losing Medicare 1 to 6 months posttransplant, 7 to 12 months posttransplant, etc. Generalized estimating equations (GEE) with a log link and an independent working correlation structure accounted for repeated measurements from recipients, and confidence intervals (CIs) were estimated with robust standard errors.[19] The GEEs adjusted for several recipient characteristics (age, race, sex, primary diagnosis, education level, years of ESKD, median household income by zip code) and donor characteristics (living versus deceased, diabetic versus non-diabetic, age). B-splines adjusted for the potentially nonlinear trajectory of MPR for months after transplant. Separate models were estimated for CNIs, antimetabolites, steroids, and mTOR inhibitor classes. Multiple imputation (10 iterations) accounted for missing data, and included recipient and donor characteristics, month of first Symphony fill, and average MPR over the first 6 months in the symphony database before censoring.[20]

2.6 | Association between timing of Medicare loss and graft failure

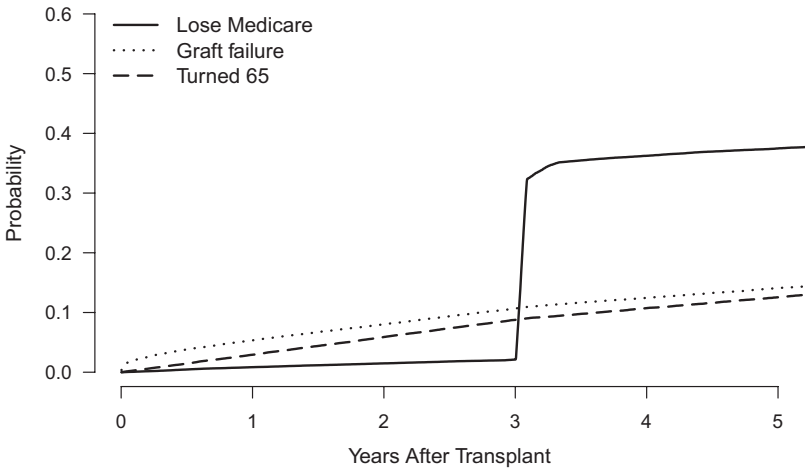
A matching analysis estimated the association between Medicare loss and graft failure dependent on the timing of Medicare loss. Specifically, recipients who lost Medicare (ie, cases) were matched with recipients receiving Medicare at transplant who had not lost Medicare and whose grafts functioned at the time the case lost Medicare; recipients were also matched based on donor type (living versus deceased) and age group at transplant. For each recipient who lost Medicare, controls were randomly selected without replacement from recipients who satisfied the matching criteria. However, a recipient could be selected as a control for multiple recipients who lost Medicare. The number of controls was the lowest of four or the number of recipients who satisfied the matching criteria. After matching, a Cox proportional hazards model estimated the association between Medicare loss and graft failure with the association depending on when each case lost Medicare. Specifically, cases and controls were left truncated at the time the case lost Medicare and, if the graft was still functioning, censored at age 65 years or January 1, 2015. The model was stratified by recipients who lost Medicare and their matched controls, and robust standard errors accounted for using the same control for multiple recipients who lost Medicare. The model adjusted for the donor characteristics outlined above. Penalized splines estimated the effect of donor age, height, weight, and serum creatinine. Multiple imputations (10 iterations) accounted for missing data, and included the recipient and donor characteristics, the natural-log of follow-up time, and the graft failure indicator.

A sensitivity analysis used a piecewise exponential model with two time-scales to estimate the association between Medicare loss and graft failure and the effect of losing Medicare early, on time, or late on the hazard of graft failure (see Figure S1).

3 | RESULTS

3.1 | Timing of Medicare loss

Of patients receiving Medicare at the time of transplant, 2.4% lost Medicare early, 39.2% on time, and 7.7% late (Figure 2). Characteristics of the cohort are shown in Table 1, stratified by presence or absence of medication fills in the pharmacy claims database. Table 2 shows the association between demographic characteristics and timing of Medicare loss. Recipients who lost Medicare ontime or late were younger, more likely to be white, with higher median zip code income and less dialysis time. Risk of losing Medicare early was higher for African Americans than for whites (hazard ratio [HR] 1.4; 95% CI 1.3-1.6), and for recipients aged 18 to 34 years at transplant than for recipients aged 35 to 49 years (HR 1.2; 95% CI 1.0-1.4). A positive graded association was noted with median household



Still on Medicare	78861	61902	48284	36097	13961	8231
Lost Medicare	0	623	1022	1350	16734	17093
Graft Failure	275	4027	5711	7079	7794	8266
Turned 65	0	2150	4007	5489	6279	6796

FIGURE 2 Cumulative incidences of potential outcomes after transplant. Only a recipient's first event was included in the curves. The cohort included kidney-alone recipients on Medicare at transplant, aged younger than 65 years at transplant, who underwent transplant between January 1, 2008, and December 31, 2014

income and on-time Medicare loss, such that higher median household income was associated with higher risk of on-time Medicare loss.

3.2 | Medicare loss and immunosuppressive medication use

Of the Medicare cohort, 53 611 (68.0%) had at least one fill for an immunosuppressant medication in the Symphony database posttransplant. Recipients in the pharmacy claims database were younger, more likely to be white, with higher median household income by zip code and less dialysis time, and were more likely to have undergone a living donor kidney transplant (Table 1). Early or late Medicare loss was associated with lower subsequent MPR for all immunosuppressive medication types compared with no loss of coverage (Figure 3, data shown for CNI and antimetabolites only). For example, early Medicare loss was associated with 53% to 86% lower MPR for CNIs compared with no Medicare loss. Late Medicare loss was associated with 19% lower MPR for CNI fills compared with no Medicare loss. Conversely, on-time Medicare loss was associated with a slightly higher CNI-specific MPR (12%). Results were similar for antimetabolite-specific MPRs (early loss, 55% to 87% lower; late loss, 23% lower; on-time loss 11% higher).

3.3 | Timing of Medicare loss and graft failure

The association between Medicare loss and graft failure was modified by the timing of Medicare loss (Table 3). Early Medicare loss was associated with a 10.9-17.3-times higher hazard of graft failure than no Medicare loss. Late Medicare loss had an attenuated association with a higher hazard of graft failure, 2.4-8.4 times higher. Conversely, the hazard of graft failures was similar for recipients who lost Medicare at 3 years and those still on Medicare at 3 years. This result was consistent in a dual time scale sensitivity analysis using Medicare recipients in the first 6 months posttransplant as the reference group and adjusting for multiple donor and recipient factors (Figure S1).

4 | DISCUSSION

We found that the association between Medicare loss and immunosuppressive medication use and graft failure differed by the timing of Medicare loss relative to transplant. Specifically, the risk of graft failure and reduction in immunosuppressive medication fills was markedly higher with early Medicare loss. The adverse association of late Medicare loss was less striking but still notable. Conversely, risk was not increased for recipients who lost Medicare on time compared with those who remained on Medicare. In addition, recipients who lost Medicare early or late differed from those who lost Medicare on time; African American race, younger age, and lower median zip code income increased risk for early or late Medicare loss.

These findings provide critical new information to help evaluate the effect of Medicare coverage on transplant recipient outcomes and costs, and have important implications for consideration of future policy. Allograft outcomes improved significantly following the extension of Medicare coverage from 1 to 3 years posttransplant between 1993 and 1995,[21] suggesting that extension of Medicare coverage helped in maintaining access to critical immunosuppressive medications. In 2000, the Beneficiary Improvement and Protection Act extended Medicare coverage to patients who qualified for disability. This policy provided Medicare access to some transplant recipients who could not obtain or afford private insurance through

TABLE 1 Comparison of recipients with Medicare at transplant by immunosuppressant fills in Symphony database

	Immunosuppressant fills in pharmacy claims database			
	Yes		No	
	n	%	n	%
Age, y				
<18	2298	4.3	753	3.0
18-34	8086	15.1	3371	13.4
35-49	17 588	32.8	7500	29.7
50-65	25 639	47.8	13 626	54.0
Race				
White	36 916	68.9	16 587	65.7
Black	7367	13.7	3833	15.2
Hispanic	7399	13.8	3839	15.2
Asian	1491	2.8	765	3.0
Other	438	0.8	226	0.9
Dialysis duration, y				
0	6569	12.3	1898	7.5
<1	7609	14.2	2728	10.8
1-<3	13 317	24.8	5892	23.3
3-<5	9928	18.5	5217	20.7
5-<10	9629	18.0	5894	23.3
>10	6559	12.2	3621	14.3
Diabetes type				
None	37 568	70.1	16 440	65.1
Type 1	3119	5.8	1497	5.9
Type 2	11 752	21.9	6780	26.9
Other	720	1.3	368	1.5
Unknown	452	0.8	165	0.7
Donor type				
Deceased donor	33 981	63.4	18 461	73.1
Living donor	19 630	36.6	6789	26.9
Median income by zip code, $				
<35k	7758	14.5	4343	17.2
35-<45k	11 404	21.3	5603	22.2
45-<55k	11 008	20.5	5030	19.9
55-<70k	10 870	20.3	4768	18.9
Unknown	1031	1.9	571	2.3
Total	53 611	100	25 250	100

The cohort included kidney-alone recipients on Medicare at transplant, aged younger than 65 years at transplant, who underwent transplant between January 1, 2008, and December 31, 2014.

employment or the individual market, while ending coverage at 3 years for recipients who could presumably find employment and obtain private insurance. Subsequent cost-effectiveness analyses based on data before 2000 found that the allograft survival benefits, and therefore the Medicare cost savings, that would result from lifetime Medicare coverage for all transplant recipients would be substantial.[22]

More contemporary analyses have demonstrated that the cost of immunosuppressive medications remains a significant burden on patients, and that cost-related nonadherence is a significant source of both graft loss and patient death.[23,24] In 2012, Gill et al found that rates of graft loss were overall higher for recipients with Medicare coverage than for those with private insurance, and this risk increased after 3 years,[12] consistent with the hypothesis that payment and affordability influence adherence to immunosuppressive medication use.

Three parts of our analysis highlight important and perhaps underappreciated issues related to Medicare coverage of immunosuppressive medications. First, the availability of private insurance may have increased due to the Affordable Care Act (ACA), which provided premium subsidies, expanded Medicaid in some states, and eliminated preexisting conditions as an exclusion to private medical insurance access. By expanding access to health insurance, the ACA may have attenuated the impact of Medicare's 3-year policy on graft loss. Second, we included recipients who were receiving disability benefits at the time of transplant, possibly attenuating the effect of Medicare's 3-year policy on the hazard of graft loss. This has important policy implications, as extending the 3-year policy may have less effect on graft failure since more than 50% of the recipients aged younger than 65 years continued to receive Medicare after 3 years, presumably due to disability status. Finally, we allowed the association between Medicare loss and immunosuppressive medication fills and graft loss to depend on time after transplant. In both cases, we found that averaging recipients who lost Medicare early and late with all recipients who lost Medicare underestimates both the risk of graft loss and the reduction in immunosuppressive medication access for recipients who lost coverage early and late, while overestimating the risk for those who lost Medicare on time, in accordance with the 3-year policy.

The net effect of our analysis, in the context of previous analyses, suggests that extending Medicare coverage "as-is" to all patients beyond 3 years posttransplant may not have the anticipated effect on graft outcomes and cost, unless the financial safety net currently in place for patients who cannot pay their Medicare premiums, let alone medication co-pays, is taken into account. Given that recipients who should otherwise have access to Medicare before 3 years posttransplant are losing coverage, and that they are up to 17 times as likely to lose the graft and return to dialysis as recipients who remain on Medicare, it is imperative that we examine ways to ensure continued access to medical care and medications. The dependence on the time of Medicare loss challenges previous cost-effectiveness analyses that assumed all Medicare loss was essentially equal with regard to risk, and that qualifying for Medicare ensures equal access to immunosuppressive medication.

Since 1986, the US has determined that providing access to transplant for patients with ESKD, through access to Medicare, is important, regardless of ability to pay.[25] Failure to further examine

TABLE 2 Hazard ratios (95% confidence intervals) for early, on-time, and late Medicare loss by demographic group

	Loss of Medicare coverage		
	Early	**On-Time[a]**	**Late**
Age, y			
<18	0.85 (0.63-1.2)	4.7 (4.5-5)	11 (8.5-14)
18-34	1.2 (1.0-1.4)	1.3 (1.2-1.3)	1.7 (1.5-1.9)
35-49 (ref)	1 (1-1)	1 (1-1)	1 (1-1)
50-64	1.1 (0.98-1.3)	0.84 (0.81-0.87)	0.55 (0.49-0.62)
Race			
White (ref)	1 (1-1)	1 (1-1)	1 (1-1)
Black	1.4 (1.3-1.6)	0.59 (0.57-0.62)	0.81 (0.72-0.91)
Hispanic	1 (0.86-1.2)	0.77 (0.73-0.81)	0.99 (0.87-1.1)
Asian	0.52 (0.37-0.73)	1 (0.97-1.1)	1.1 (0.92-1.4)
Unknown	1.1 (0.71-1.8)	0.75 (0.65-0.87)	1 (0.69-1.5)
Dialysis duration, y			
0	1 (0.84-1.2)	2.1 (2-2.2)	1.7 (1.4-2)
0-1	1.1 (0.97-1.4)	1.4 (1.3-1.5)	1.6 (1.4-1.9)
1-3 (ref)	1 (1-1)	1 (1-1)	1 (1-1)
3-5	0.8 (0.67-0.94)	0.69 (0.65-0.72)	0.85 (0.74-0.99)
5-10	0.92 (0.79-1.1)	0.65 (0.62-0.69)	0.91 (0.78-1.1)
>10	0.85 (0.71-1)	0.78 (0.74-0.83)	1 (0.88-1.2)
Cause of kidney disease			
Congenital	0.9 (0.66-1.2)	2.7 (2.5-2.9)	1.4 (1.1-1.9)
Diabetes	1 (0.86-1.2)	0.75 (0.71-0.8)	0.47 (0.4-0.55)
Glomerulonephritis	0.85 (0.73-0.99)	1.5 (1.5-1.6)	1.3 (1.1-1.5)
Hypertension (ref)	1 (1-1)	1 (1-1)	1 (1-1)
Other	0.75 (0.64-0.87)	1.6 (1.5-1.6)	1.2 (1-1.3)
Education level			
Grade school/none	0.66 (0.51-0.87)	1.6 (1.5-1.8)	1.2 (0.94-1.4)
High school (ref)	1 (1-1)	1 (1-1)	1 (1-1)
Post-high school degree	1.1 (0.92-1.2)	1.8 (1.7-1.9)	1.5 (1.3-1.7)
Technical	1.1 (0.94-1.2)	1.1 (1.1-1.2)	1.1 (1-1.3)
Unknown	0.82 (0.67-1)	1.3 (1.2-1.4)	1.2 (1-1.4)
Median income by zip code, $			
1: < 35k	1.1 (0.93-1.3)	0.51 (0.48-0.54)	0.68 (0.57-0.8)
2: 35-45k	1.1 (0.92-1.3)	0.63 (0.59-0.66)	0.81 (0.7-0.94)
3: 45-55k	1.1 (0.91-1.3)	0.72 (0.69-0.76)	0.95 (0.82-1.1)
4: 55-70k	1.1 (0.96-1.3)	0.86 (0.82-0.91)	0.92 (0.79-1.1)
5: > 70k (ref)	1 (1-1)	1 (1-1)	1 (1-1)
Pharmacy claims fills (any) posttransplant	0.94 (0.78-1.1)	1.1 (1-1.2)	0.99 (0.83-1.2)

The cohort included 78 761 kidney-alone recipients on Medicare at transplant, aged younger than 65 years at transplant, who underwent transplant between January 1, 2008, and December 31, 2014.[b]

[a]Three years posttransplant.

[b]Multiple imputation (10 iterations) accounted for missing data.

how safety nets function to maintain kidney transplant recipients' access to Medicare or alternative insurance has significant cost, both financially, given the substantially greater expense of dialysis compared with maintained kidney transplant,[8] and with regard to human life, given the significant mortality and quality of life benefits of kidney transplant over dialysis. This policy has racial equity implications as well, given our finding that the risk of early Medicare loss was nearly 40% higher for African American than for white recipients.

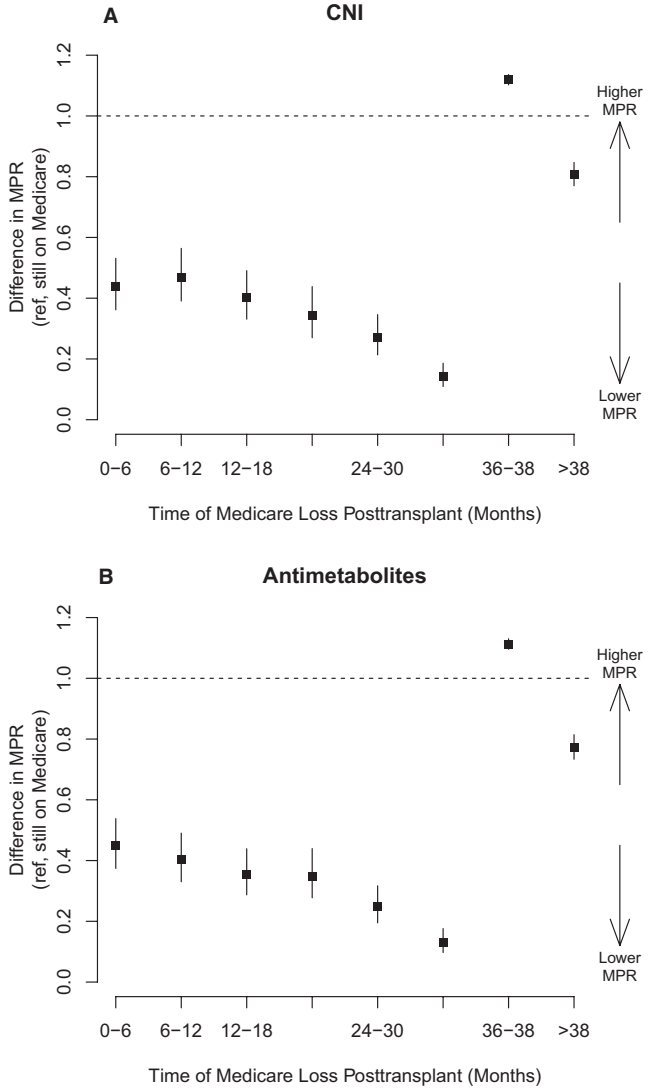


FIGURE 3 Association of the timing of Medicare loss and subsequent (A) calcineurin-inhibitor-specific and (B) antimetabolite-specific medication possession ratio in the Symphony database. The cohort included kidney-alone recipients with at least one fill in the Symphony database who were on Medicare at transplant, aged younger than 65 years at transplant, and who underwent transplant between January 1, 2008, and December 31, 2014

TABLE 3 Hazard ratios of allograft loss by timing of Medicare loss with age and donor-type matched controls who have not yet lost Medicare

Timing of Medicare loss, months posttransplant	Hazard ratio (95% confidence interval)
0-6	10.94 (8.19-14.63)
7-12	15.18 (10.64-21.67)
13-24	17.33 (12.74-23.56)
25-36	12.42 (8.99-17.16)
37-38	0.99 (0.91-1.07)
39-48	2.42 (1.94-3.03)
49-60	2.72 (1.80-4.10)
61-72	8.38 (3.63-19.34)

The cohort included 78 761 kidney-alone recipients on Medicare at transplant, aged younger than 65 years at transplant, who underwent transplant between January 1, 2008, and December 31, 2014.

Our analysis has several important limitations. Because the pharmacy claims dataset includes only participating pharmacies, we may not have the complete medication fill history for all transplant recipients. However, we found that recipients in the pharmacy claims database were healthier, with higher median household income, and less likely to lose Medicare early. This suggests that the association between Medicare loss and MPR may be greater if all recipients were included. Second, because we were unable to identify recipients with disability coverage or Medicaid eligibility, we were unable to determine whether recipients who did not lose Medicare at 3 years posttransplant actually had disability coverage. The specific reasons for Medicare loss were not known; although the reasons for early or late loss are limited, we cannot confirm that recipients lost Medicare before 3 years posttransplant due to nonpayment of premiums, and we cannot separate recipients who lost Medicare after 3 years due to nonpayment or loss of disability status from those who transitioned to private insurance. Similarly, some immunosuppression for some recipients may have been discontinued intentionally by the providers, as sometimes occurs with CNI or antimetabolites, which could confound the MPR analysis. However, we found the association between Medicare loss timing and MPR across all immunosuppression classes. Finally, an optimal control group is elusive. Recipients covered by Medicare at the time of transplant may not be as healthy as privately insured recipients, but recipients with private insurance at transplant may be a suboptimal control group for investigating a potential increase in the hazard of losing Medicare coverage at 3 years posttransplant. Conversely, comparing recipients who lose Medicare on time with those who continue Medicare after 3 years may be comparing healthier patients with sicker patients who qualify for disability, and underestimate a deleterious effect of the 3-year Medicare policy. Ideally, one would compare recipients who lose Medicare coverage due to the 3-year policy with recipients who are guaranteed Medicare coverage after 3 years regardless of disability status or ability to pay, but such a control group does not exist. Finally, as with all observational studies, residual confounding, which we have not accounted for, may exist. For example, recipients with poorly functioning grafts but not graft failure may be more likely to lose Medicare early.

In conclusion, we found that kidney transplant recipients receiving Medicare who lost coverage before or after the current 3-year policy time point filled immunosuppressive medications at a significantly lower rate and had a higher risk of allograft failure, while those who lost coverage on time were not. This finding has substantial policy implications, suggesting that closer examination of the risks of Medicare loss, as well as medical coverage safety nets and access to immunosuppressive medications, beyond simply extending Medicare eligibility for transplant recipients, is critical.

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DISCLOSURE

The authors of this manuscript have no conflicts of interest to disclose as described by the *American Journal of Transplantation*.

DATA AVAILABILITY STATEMENT

Scientific Registry of Transplant Recipients and United States Renal Data System data are publicly available free of charge from the Scientific Registry of Transplant Recipients and the United States Renal Data System Coordinating Center, respectively. Symphony Health data are available for a fee from https://symphonyhealth.prahs.com.

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SUPPORTING INFORMATION

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

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