

Influence of Recipient Insurance on the Outcome of Simultaneous Pancreas and Kidney Transplantation

Abstract

Simultaneous Pancreas-Kidney (SPK) transplantation is an established treatment for insulin-requiring diabetics with either advanced chronic or End Stage Kidney Disease (ESRD). The outcomes of SPK transplantation may vary according to socioeconomic factors such as funding sources. The aim of this study was to assess the association between insurance payer of transplant recipients and outcomes of SPK transplantation in the USA. All adult primary Simultaneous Pancreas-Kidney (SPK) transplants performed in the USA between 1 January, 1988 and 31 December, 2017 were included, using data from the national Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) database. A total of 19,849 adult Simultaneous Pancreas-Kidney (SPK) transplant recipients were included in the study, after excluding patients who had insurance sources other than medicaid, medicare or private, dual insurance or were lost at 90-day follow-up. Post-transplant outcomes were analyzed in terms of allograft and recipient survival. Private insurance had a significant positive impact on long term survival after controlling for multiple covariates. Recipients with private insurance demonstrated superior death-censored kidney and pancreas graft survival compared to those with Medicaid or Medicare even after adjusting for multiple confounding factors. Moreover, private insurance was associated with a lower risk of late death.

Keywords: SPK transplantation; Health economics; Recipient insurance

Introduction

Simultaneous Pancreas and Kidney (SPK) transplantation is a well-established treatment modality for patients with End Stage Renal Disease (ESRD) and type 1 diabetes [1-3]. Successful SPK transplantation can potentially reduce complications associated with diabetes, improve cardiovascular outcomes and improve patient survival [4-10]. More effective immunosuppression strategies and maintenance therapies have led to a decrease in

graft rejection and an improvement in graft and patient survival [11,12].

Disparities in healthcare are seen as a hurdle in the USA with increasing attention from physicians and federal health agencies [13]. Differential access to medical care, treatment modalities and variable outcomes among different racial, ethnic and socioeconomic groups has been validated in numerous studies [14]. Socioeconomic status can be determined by education level, household income and occupation and is a strong predictor of patient morbidity and mortality across a number of diseases [15]. Social determinants such as income, access to healthcare and education impact the outcomes and consequences of medical intervention [16].

These disparities in health care result from deficits in quality and access to a wide range of effective and surgical and medical procedures [17]. Transplantation success is linked to the multidisciplinary care of the patient [18]. Inadequate support or non-compliance in any aspect of this care threatens allograft or patient survival. The aim of this study was to assess the impact of insurance status, as a proxy for socioeconomic status, on patient and allograft survival in adult patients undergoing first time simultaneous pancreas-kidney transplantation. We undertook a retrospective analysis of national registry data to determine payer specific graft survival and mortality risk among SPK transplant patients.

Methods

We included all adult primary Simultaneous Pancreas-Kidney (SPK) transplants performed in the USA between 1 January, 1988 and 31 December, 2017, using data from the national Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) database. The SRTR data system contains comprehensive information on all donors, wait-listed candidates and transplant recipients in the US, submitted by OPTN members and overseen by the Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services (HHS). The OPTN database is de-identified and publicly available. Therefore, this study was exempt from Institutional Review Board (IRB) approval.

Separate analyses were conducted for early and late graft failure outcomes. Early graft failure was defined as kidney and/or pancreas graft loss within the first 90 days post-transplant. Causes of early and late graft failure were examined separately. Baseline recipient and donor characteristics were analyzed and included in multivariate models as appropriate covariates. Transplant centers were grouped by annual SPK transplant volume and used as a covariate.

Demographic and baseline characteristics were compared between insurance groups using one-way Analysis of Variance (ANOVAs) and chi-square tests. For early graft failure, multivariate logistic regression models adjusted for center volume were used to identify associated risk factors. For late outcomes in recipients surviving beyond 90 days with functioning grafts, conditional Kaplan-Meier survival and multivariate Cox proportional hazards regression with backward selection were performed for the composite outcome of graft failure (kidney and/or pancreas) and death, as well as for death-censored graft and patient survival. Finally, causes of late kidney and pancreas graft loss were identified and multivariate logistic regression assessed risk factors for acute and chronic rejection-related graft loss. All analyses were conducted using SPSS v29 software, with statistical significance defined as $p \leq 0.05$.

Results

A total of 19,849 adult Simultaneous Pancreas-Kidney (SPK) transplant recipients were included in the study after excluding patients who had insurance sources other than Medicaid, Medicare or Private, dual insurance or were lost at 90-day follow-up. The final cohort had 901 (4.5%) having Medicaid, 9,672 (48.7%) having Medicare and 9,276 (46.8%) having private insurance. **Table 1** shows the baseline demographic and clinical characteristics of study population. Compared to patients with Medicare and private insurance, Medicaid patients were younger females (mean age Medicaid 37 years vs. Medicare 40 and private insurance 42 years, $p < 0.001$) and had a lower Body Mass Index (BMI) (24.2 kg/m^2 vs. 24.6 and 25.1 kg/m^2 , $p < 0.001$). Medicaid patients also had a shorter duration of diabetes (Medicaid 24 years vs. Medicare 26 years and private insurance

27 years, $p < 0.001$) and a lower proportion of patients with type 1 diabetes mellitus when compared to private. (Medicaid 90.8% vs. Medicare 88.9% and private insurance 91.6%, $p < 0.001$).

Regarding race and ethnicity, Medicaid patients had a higher proportion of black, non-Hispanic (Medicaid 24% vs. Medicare 20.5% and private insurance 10%) and Hispanic/Latino (Medicaid 14.2% vs. Medicare 11.3% and private insurance 6.1%) recipients compared to Medicare and private insurance patients, respectively ($p < 0.001$). Medicaid patients were also more likely to have a lower educational attainment, with 52.7% having a high school education or below, compared to 42.7% for Medicare and 28.9% for private insurance ($p < 0.001$).

There were no significant differences in donor characteristics, such as Body Mass Index (BMI), gender and the presence of hypertension or stroke, among the three insurance groups. However, Medicaid patients received organs from donors with a slightly higher proportion of black race, compared to Medicare and private insurance (17.2% vs. 16.1% and 14.9% respectively, $p = 0.005$) and a lower proportion of donors with a smoking history of >20 pack-years (Medicaid 18.1% vs. Medicare 18.1% and private insurance 19.9%, $p = 0.005$). The cold ischemia time was shorter for Medicaid patients (Medicaid 11.9 hours vs. Medicare 12.17 and private insurance 12.5 hours, $p < 0.001$) and there was no significant difference in the number of Human Leukocyte Antigen (HLA) mismatches among the groups.

The volume of Simultaneous Pancreas-Kidney (SPK) transplants performed by transplant centers across the USA varies from as few as 0 to as many as 160 per year during the study period (mean 21 and median 14). Regarding center volume, private insurance patients were more likely to receive their transplant at higher-volume centers (>20 transplants per year: Medicaid 33.6% vs. Medicare 27.7% and private insurance 8.9%, $p < 0.001$).

The use of steroids as part of the immunosuppressive regimen was lower for Medicaid patients (67.5%) compared to private insurance patients (69.2%), but higher than Medicare insurance patients (66.7%) ($p < 0.001$).

Table 1: Baseline demographic and clinical characteristics of study population.

Characteristics	Medicaid (N=901)	Medicare (N=9672)	Private (N=9276)	p-Value
Age (years \pm SD)	37 \pm 8	40 \pm 8	42 \pm 8	<0.001
Gender (males in%)	517 (57.4%)	6061 (62.7%)	5520 (59.5%)	<0.001
Body Mass Index (kg/m^2 \pm SD)	24.2 \pm 3.9	24.6 \pm 3.9	25.1 \pm 3.9	<0.001
Duration of diabetes (years \pm SD)	24 \pm 8	26 \pm 8	27 \pm 9	<0.001
Patients with type 1 diabetes mellitus (%)	818 (90.8%)	8594 (88.9%)	8497 (91.6%)	<0.001
Race (%)				

White, non-Hispanic	532 (59.0%)	6366 (65.8%)	7601 (81.9%)	<0.001
Black, non-Hispanic	216 (24%)	1981 (20.5%)	929 (10.0%)	
Hispanic/Latino	128 (14.2%)	1094 (11.3%)	570 (6.1%)	
Others	25 (2.8%)	23 (2.4%)	176 (1.9%)	
Education (%)				
High school/ below	475 (52.7%)	4129 (42.7%)	2681 (28.9%)	<0.001
Higher education	260 (28.9%)	3905 (40.4%)	4910 (52.9%)	
Not reported	166 (18.4%)	1638 (17%)	1685 (18.1%)	
Donor age (years \pm SD)	26 \pm 10	26 \pm 10	26 \pm 11	<0.001
Donor BMI (kg/m ² \pm SD)	23.8 \pm 4.1	23.9 \pm 4.0	23.9 \pm 4.1	0.666
Donor gender, male (%)	596 (66.1%)	6588 (68.1%)	6275 (67.6%)	0.436
Donor race (%)				
White, non-Hispanic	620 (68.8%)	6521 (67.4%)	6497 (70%)	0.005
Black, non-Hispanic	155 (17.2%)	1558 (16.1%)	1385 (14.9%)	
Hispanic/Latino	105 (11.7%)	1325 (13.7%)	1159 (12.5%)	
Others	21 (2.3%)	268 (2.8%)	235 (2.5%)	
Donor smoking, >20 pack years (%)	163 (18.1%)	1746 (18.1%)	1843 (19.9%)	0.005
Donor hypertension (%)	56 (6.2%)	488 (5.0%)	517 (5.6%)	0.134
Donor stroke (%)	176 (19.5%)	1747 (18.1%)	1739 (18.7%)	0.331
Cold Ischemia Time (h \pm SD)	11.9 \pm 5.4	12.17 \pm 6.0	12.5 \pm 5.9	<0.001
HLA mismatches (SD)	4 \pm 1	4 \pm 1	4 \pm 1	0.088
Center volume (number/year, in%)				
\leq 10	335 (37.2%)	4202 (43.4%)	2998 (32.3%)	<0.001
11-20	263 (29.2%)	2789 (28.8%)	2668 (28.8%)	
>20	303 (33.6%)	2681 (27.7%)	3610 (38.9%)	
Steroids, yes (%)	608 (67.5%)	6452 (66.7%)	6419 (69.2%)	<0.001

Table 2 demonstrates risk factors associated with early graft failure within 90 days after transplantation.

A total of 2,119 (10.7%) pancreas and 902 (5.4%) kidney transplants were lost in the first 90 days, the most common conjoined reason being thrombosis. For early kidney graft failure, higher recipient Body Mass Index (BMI), Operation Review (OR) 1.04, 95% CI 1.02, 1.06, $p < 0.001$, longer cold ischemia

time (OR 1.03, 95% CI 1.02, 1.04, $p < 0.001$), older donor age (OR 1.01, 95% CI 1.01, 1.02, $p < 0.001$), donor history of hypertension (OR 1.46, 95% CI 1.12, 1.92, $p = 0.01$) and donors who died of stroke (OR 1.32, 95% CI 1.09, 1.60, $p = 0.01$) were all associated with an increased risk. While being a male recipient was associated with lower odds of kidney graft failure in the first 90 days (OR 0.85, 95% CI 0.74, 0.99, $p = 0.03$).

When considering early pancreas graft failure, Hispanic/Latino recipients had a lower risk compared to white, non-Hispanic recipients (OR 0.69, 95% CI 0.57, 0.84, $p<0.001$), while male recipients also had a lower risk (OR 0.87, 95% CI 0.78, 0.96, $p<0.001$). Factors associated with an increased risk of early pancreas graft failure included higher recipient BMI (OR 1.05, 95% CI 1.03, 1.06, $p<0.001$), longer cold ischemia time (OR 1.03, 95% CI 1.02, 1.04, $p<0.001$), older donor age (OR 1.02, 95% CI

1.02, 1.03, $p<0.001$), donor history of hypertension (OR 1.44, 95% CI 1.20, 1.74, $p<0.001$) and donors who died of stroke (OR 1.25, 95% CI 1.10, 1.43, $p<0.001$).

Transplant center volume also played a role in early pancreas graft failure. Centers performing more than 20 SPK transplants per year had a lower risk of early pancreas graft failure compared to centers performing ≤ 10 transplants per year (OR 0.72, 95% CI 0.64, 0.81, $p<0.001$).

Table 2: Risk factors associated with early graft failure within 90 days after transplantation.

Variables	Kidney graft loss			Pancreas graft loss		
	OR	95% CI	p-Value	OR	95% CI	p-Value
Recipient insurance						
Medicaid	Ref	Ref	Ref	Ref	Ref	Ref
Medicare	1	0.70, 1.43	0.98	1.01	0.79, 1.28	0.95
Private	0.94	0.65, 1.34	0.72	1	0.79, 1.28	0.97
Recipient race						
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	1.02	0.83, 1.25	0.72	0.89	0.77, 1.02	0.1
Hispanic/Latino	0.74	0.55, 0.98	0.2	0.69	0.57, 0.84	<0.001
Others	0.9	0.54, 1.51	0.86	1.01	0.72, 1.40	0.97
Recipient gender (male)	0.85	0.74, 0.99	0.03	0.87	0.78, 0.96	<0.001
Recipient BMI (kg/m ² ± SD)	1.04	1.02, 1.06	<0.001	1.05	1.03, 1.06	<0.001
Cold ischemia time (h)	1.03	1.02, 1.04	<0.001	1.03	1.02, 1.04	<0.001
Donor age (years)	1.01	1.01, 1.02	<0.001	1.02	1.02, 1.03	<0.001
Donor race						
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	1.17	0.96, 1.43	0.13	1.05	0.91, 1.20	0.51
Hispanic/Latino	1.21	0.97, 1.50	0.1	1.04	0.89, 1.21	0.63

Others	1.44	0.97, 2.14	0.07	0.98	0.72, 1.32	0.88
Donor hypertension	1.46	1.12, 1.92	0.01	1.44	1.20, 1.74	<0.001
Donor stroke	1.32	1.09, 1.60	0.01	1.25	1.10, 1.43	<0.001
Center volume (number/year) (%)						
≤ 10	Ref	Ref	Ref	Ref	Ref	Ref
11-20	0.87	0.72, 1.04	0.12	0.99	0.88, 1.11	0.82
>20	0.84	0.71, 1.01	0.12	0.72	0.64, 0.81	<0.001

During subsequent follow-up at 1 year, 1659 (8.4%) kidney and 3009 (15.2%) pancreas grafts were lost among SPK transplant recipients. There was a significant difference in late graft survival between recipients with different insurance types (Figures 1A-1C), log-rank, $p < 0.0001$). This difference was mainly due to lower death-censored graft failure rates among private insurance recipients for both kidney and pancreas grafts.

1.29, $p < 0.001$) and donors with a smoking history of more than 20 pack-years (HR 1.15, 95% CI 1.09, 1.22, $p < 0.001$) were all associated with an increased risk of late kidney graft loss. Conversely, longer duration of diabetes was associated with a lower risk of late kidney graft loss (HR 0.99, 95% CI 0.99, 1.00, $p < 0.001$) (Figure 2).

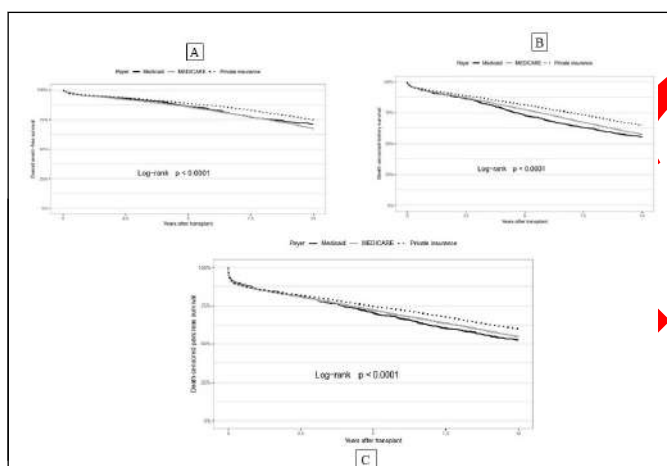


Figure 1: Difference in late graft survival between recipients with different insurance types **Note:** (A): Overall event-free survival; (B): Death censored kidney graft survival; (C): Death censored pancreatic graft survival.

Multivariate Cox regression analyses adjusting for confounding factors demonstrated that for late kidney graft loss, recipients with private insurance had a lower risk compared to those with Medicaid (Hispanic recipients (HR) 0.74, 95% CI 0.66, 0.83, $p < 0.001$). Black, non-Hispanic recipients had a higher risk of late kidney graft loss compared to white, non-Hispanic Recipients (HR 1.20, 95% CI 1.12, 1.28, $p < 0.001$), while Hispanic/Latino recipients had a lower risk (HR 0.89, 95% CI 0.82, 0.97, $p = 0.01$). Older recipient age (HR 1.00, 95% CI 1.00, 1.01, $p = 0.02$), higher degree of HLA mismatch (HR 1.02, 95% CI 1.00, 1.04, $p = 0.03$), older donor age (HR 1.01, 95% CI 1.01, 1.01, $p < 0.001$), black, non-Hispanic donors (HR 1.21, 95% CI 1.13,

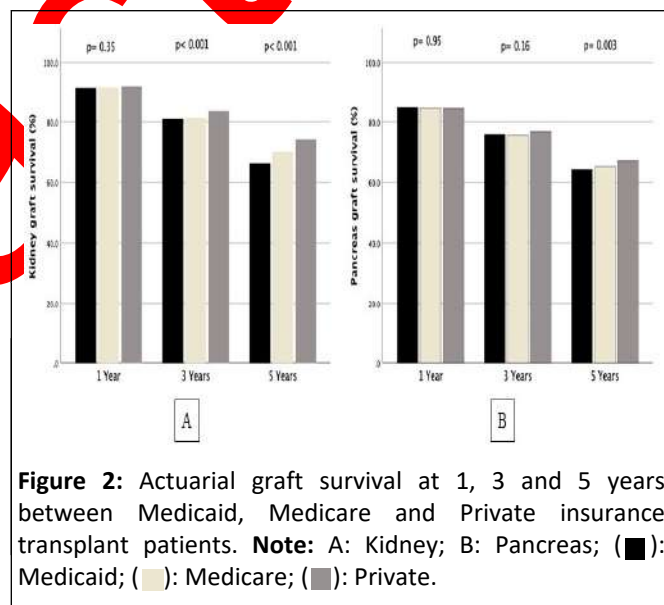


Figure 2: Actuarial graft survival at 1, 3 and 5 years between Medicaid, Medicare and Private insurance transplant patients. **Note:** A: Kidney; B: Pancreas; (■): Medicaid; (■): Medicare; (■): Private.

Table 3 demonstrates risk factors associated with late graft loss among SPK transplant patients who survived up to 90 days with both graft functions. When considering late pancreas graft loss, recipients with private insurance had a lower risk compared to those with Medicaid (HR 0.77, 95% CI 0.69, 0.87, $p < 0.001$). Black, non-Hispanic recipients had a higher risk of late pancreas graft loss compared to white, non-Hispanic recipients (HR 1.09, 95% CI 1.02, 1.17, $p = 0.01$), while Hispanic/Latino recipients had a lower risk (HR 0.82, 95% CI 0.75, 0.90, $p < 0.001$). Older donor age (HR 1.01, 95% CI 1.01, 1.01, $p < 0.001$), black, non-Hispanic donors (HR 1.24, 95% CI 1.16, 1.32, $p < 0.001$) and donors with a smoking history of more than 20 pack-years (HR 1.11, 95% CI 1.04, 1.18, $p < 0.001$) were all associated with an increased risk of late pancreas graft loss.

Table 3: Risk factors associated with late graft loss among SPK transplant patients who survived up to 90 days with both graft functions.

Variables	Kidney graft loss			Pancreas graft loss		
	OR	95% CI	p-Value	OR	95% CI	p-Value
Recipient insurance						
Medicaid	Ref	Ref	Ref	Ref	Ref	Ref
Medicare	0.94	0.84, 1.05	0.26	0.97	0.87, 1.08	0.56
Private	0.74	0.66, 0.83	<0.001	0.77	0.69, 0.87	<0.001
Recipient race						
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	1.20	1.12, 1.28	<0.001	1.09	1.02, 1.17	0.01
Hispanic/Latino	0.89	0.82, 0.97	0.01	0.82	0.75, 0.90	<0.001
Others	0.99	0.84, 1.18	0.94	0.92	0.77, 1.10	0.38
Recipient age (years)	1.00	1.00, 1.01	0.02	1.00	1.00, 1.01	0.10
Duration of diabetes (years)	0.99	0.99, 1.00	<0.001	1.00	1.00, 1.00	0.39
HLA mismatch (zero)	1.02	1.00, 1.04	0.03	1.01	0.99, 1.03	0.40
Donor age, (years)	1.01	1.01, 1.01	<0.001	1.01	1.01, 1.01	<0.001
Donor race						
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	1.21	1.13, 1.29	<0.001	1.24	1.16, 1.32	<0.001
Hispanic/Latino	0.97	0.90, 1.05	0.46	1.01	0.93, 1.09	0.86
Others	0.94	0.80, 1.09	0.41	0.98	0.84, 1.15	0.83
Donor smoking, (>20 pack years)	1.15	1.09, 1.22	<0.001	1.11	1.04, 1.18	<0.001

Table 4 demonstrates risk factors associated with late death among SPK transplant patients who survived 90 days with both graft functions. Recipients with private insurance had a lower risk of late death compared to those with Medicaid (HR 0.73, 95% CI 0.65, 0.82, $p < 0.001$). (**Figure 1(A)**, log-rank, $p < 0.0001$).

Hispanic/Latino recipients had a lower risk of late death compared to white, non-Hispanic recipients (HR 0.85, 95% CI 0.78, 1.13, $p < 0.001$). Older recipient age was associated with an increased risk of late death (HR 1.03, 95% CI 1.02, 1.03, $p < 0.001$).

Table 4: Risk factors associated with late death among SPK trans-plant patients who survived 90 days with both graft functions.

Variables	HR	95% CI	p
Recipient insurance			
Medicaid	Ref	Ref	Ref
Medicare	1.05	0.94, 1.18	0.34
Private	0.73	0.65, 0.82	<0.001
Recipient race			
White, non-Hispanic	Ref	Ref	Ref
Black, non-Hispanic	1.06	0.99, 1.13	0.08
Hispanic/Latino	0.85	0.78, 1.13	<0.001
Others	0.91	0.75, 1.09	0.3
Recipient age, (years)	1.03	1.02, 1.03	<0.001
Donor stroke, yes (no)	1.17	1.11, 1.23	<0.001
Donor race			
White, non-Hispanic	Ref	Ref	Ref
Black, non-Hispanic	1.23	1.16, 1.31	<0.001
Hispanic/Latino	0.98	0.91, 1.05	0.62
Others	0.99	0.86, 1.15	0.93

Donors who died of stroke had an increased risk of late death among SPK transplant recipients (HR 1.17, 95% CI 1.11, 1.23, $p < 0.001$). Black, non-Hispanic donors were also associated with an increased risk of late death compared to white, non-Hispanic donors (HR 1.23, 95% CI 1.16, 1.31, $p < 0.001$).

Discussion

This is the largest study to date reporting the effect of health insurance on outcomes in SPK transplantation. Socioeconomic factors have been demonstrated to affect health care outcomes [19,20]. Factors that may affect graft and patient survival include low education level, poverty and unemployment. The Affordable Care Act (ACA) has led to a significant increase in the number of patients receiving Medicaid. As a result, a large number of previously uninsured patients have health care coverage and are eligible for transplantation [21-24]. Although there is better access to a higher number of vulnerable patients, there is a disparity in the frequency of solid organ transplants in Medicaid patients, with most States not performing solid organ transplants in a proportion equal to the percentage of patients insured by Medicaid [25-27].

Similar studies looking at UNOS data, specifically those focusing on kidney and liver transplant recipients, have shown that patients

with Medicaid overall had worse outcomes in terms of both graft and patient survival [28-30].

Several factors may lead to worse outcomes. Improving outcomes may be in part related to earlier referral in Medicaid patients. Patients of lower socioeconomic status are less likely to consider organ transplantation as an option and complete the pre-transplant evaluation. Those that do undergo transplantation are more likely to have indirect markers of late referral patterns that includes at time of listing severe organ failure, longer duration on dialysis and shorter wait times for transplantation [31]. Earlier diagnosis and referral to transplant centers in this group of patients may lead to better outcomes.

There may be several other factors why Medicaid patients have worse post transplantation outcomes. Across a variety of medical diagnoses, including myocardial infarction and asthma, Medicaid beneficiaries are less likely to receive optimal therapy [32,33]. Patients with Medicaid have lower household income, lower level of education, both of which impact the number of household members and type of employment household members may have [34]. Households with members of lower income may have a higher proportion of jobs such as unskilled labor, increasing the risk of patients and household members being exposed to infections that impact health outcomes in

transplant patients. Noncompliance with medications due to cost, accessibility to pharmacies, as well as inability to follow up due to transportation limitations may contribute to worse outcomes [35]. Patient factors associated with lower income is a factor but access to medical care related to lower reimbursement to providers and variation in Medicaid benefits between states may also impact patient outcomes.

Medicare generally covers elderly and disabled patients and Medicaid covers younger patients living at or near poverty levels. Patients with ESRD are an exception as many are eligible for Medicare without age being a criterion.

To improve outcomes in the Medicaid and Medicare population, transplant programs should consider publicly sponsored insurance status as a marker of poorer post-transplant survival in order to implement changes in post-transplant strategies. This may involve addressing deficits in patient education, transportation to appointments, improving patient compliance and more frequent follow up. Post-transplant patients with Medicaid are younger and theoretically have more life years to be gained following transplantation if post survival rates can be improved.

This study has several limitations. This was a retrospective study and selection bias for transplantation may influence the findings. Although this was a large retrospective analysis there may be inaccuracies related to missing and potentially misclassified data. Patients with missing data with regard to payer were excluded from the analysis. However, the results are likely still valid due to the large number of remaining subjects. An additional limitation is that the UNOS database did not have data that may reflect patient outcomes including patient compliance with medications and follow up, opportunistic infection rates, blood pressure and glycemic control. As with all retrospective analyses independent variables can only demonstrate association rather than causality and lead to the need for additional studies.

Conclusion

Based on the findings of this comprehensive study using the OPTN/SRTR database, recipient insurance status significantly influenced long-term outcomes after Simultaneous Pancreas-Kidney (SPK) transplantation. Recipients with private insurance demonstrated superior death-censored kidney and pancreas graft survival compared to those with Medicaid or Medicare even after adjusting for multiple confounding factors. Moreover, private insurance was associated with a lower risk of late death.

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Authors' Contributions

All authors have read and agreed to the published version of the manuscript.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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