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Association of State Medicaid Expansion Policies with Pediatric Liver Transplant Outcomes

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Abstract

Children from minoritized/socioeconomically deprived backgrounds suffer disproportionately high rates of uninsurance and graft failure/death after liver transplant. Medicaid expansion was developed to expand access to public insurance. Our objective was to characterize the

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Dr. Sharad Wadhwani conceptualized and designed the study, obtained funding, acquired, analyzed, and interpreted the data, carried out the statistical analyses, critically reviewed the manuscript for important intellectual content, and provided supervision.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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DISCLAIMER:

The data reported here have been supplied by the Hennepin Healthcare Research Institute (HHRI) as the contractor for the Scientific Registry of Transplant Recipients (SRTR). The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy of or interpretation by the SRTR or the U.S. Government.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

impact of Medicaid expansion policies on long-term graft/patient survival after pediatric liver transplantation. All pediatric patients (<19 years) who received a liver transplant between 1/1/2005-12/31/2020 in the US were identified in the Scientific Registry of Transplant Recipients (N=8489). Medicaid expansion was modeled as a time-varying exposure based on transplant and expansion dates. We used Cox proportional hazards models to evaluate the impact of Medicaid expansion on a composite outcome of graft failure/death over 10 years. As a sensitivity analysis, we conducted an intention-to-treat analysis from time of waitlisting to death (N=11901). In multivariable analysis, Medicaid expansion was associated with a 30% decreased hazard of graft failure/death (HR: 0.70; 95%CI: 0.62,0.79; p<0.001), after adjusting for Black race, public insurance, neighborhood deprivation, and living in a primary care shortage area. In intention-to-treat analyses, Medicaid expansion was associated with a 72% decreased hazard of patient death (HR: 0.28; 95%CI: 0.23-0.35; p<0.001). Policies that enable broader health insurance access may help improve outcomes and reduce disparities for children undergoing liver transplantation.

1. INTRODUCTION

Each year, around 550 children undergo liver transplantation in the U.S.[1,2] After transplant, children remain on lifelong immunosuppression medication and remain at risk for immunosuppression-related complications, graft failure, and death.[3-5] Previous studies have demonstrated disparities in pediatric liver transplantation outcomes, with Black and minority children, children from socioeconomically deprived neighborhoods, and children from primary care shortage areas having higher rates of waitlist mortality pre-transplant, and increased risk of graft failure and death after transplant.[6-10]

Disparities also exist in the rates of children who are uninsured or underinsured. For example, Hispanic and Black children, and children from socioeconomically deprived backgrounds, experience disproportionately high uninsured rates.[11] The Patient Protection and Affordable Care Act (PPACA) was signed into law in 2010 with a primary goal of reducing the number of uninsured people in the U.S.[12] In 2012, states were given the choice to expand income eligibility for Medicaid and the Children's Health Insurance Program (CHIP), thereby giving a greater number of people access to public insurance.[13] States enacted this policy at varying time points beginning in 2014. As of February 2022, 39 states, including the District of Columbia, had adopted Medicaid expansion.[12]

In 2020, children in states that did not expand Medicaid were over twice as likely to be uninsured as those in expansion states.[11] While data sufficiently show that Medicaid expansion policies increase insurance rates,[11,14] few studies evaluate the association between expansion policies and health outcomes in pediatric or transplant populations. In adult liver transplant, one study demonstrated decreased wait-listing rates for patients in Medicaid expansion states, but only in a specific population of Black patients with Hepatitis C.[15] Pediatric liver transplantation offers an ideal model to study the impact of national policies on health outcomes because federal mandates require robust data collection once someone enters the transplant waitlist, thus enabling the study of an entire population of children with advanced liver disease.

In this study, we examined the impact of state Medicaid expansion policies on long-term graft and patient survival in pediatric liver transplant recipients in the U.S. We hypothesized that Medicaid expansion would be associated with improved posttransplant outcomes and that this would disproportionally benefit Black and socioeconomically deprived children.

2. MATERIALS AND METHODS

2.1 Data Source

This study used data from the Scientific Registry of Transplant Recipients (SRTR).[16] 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.

2.2 Study Population

We identified pediatric patients (<19 years) who received a liver transplant between 01/01/2005—12/31/2020 in the U.S. (N=8,724). Patients (N=235) were excluded if their home state could not be identified in SRTR. Excluded patient characteristics are listed in Table S1. Excluded patients were more likely to be Hispanic, have “other” insurance, have higher MELD/PELD scores at transplant, receive a living donor transplant, and lower cold ischemia time and were less likely to be Black race, live in a primary care shortage area, and have biliary atresia than included patients. 8,489 children were included in the final analyses.

2.3 Primary Exposures

Our primary exposure was Medicaid expansion. We used recipient home state at the time of transplant as listed in SRTR to determine expansion status and date of expansion implementation for each patient. Medicaid expansion status was analyzed as a time-dependent exposure based on the date of policy enactment for each state (50 states + the District of Columbia). We modeled Medicaid expansion as a binary time-varying exposure because the status of Medicaid expansion may change after time zero (i.e., the date of transplant). This way, if a child was transplanted during a time of Medicaid non-expansion, but the state later adopted an expansion policy, that child could contribute to both pre- and post-expansion periods based on how long they spent under each policy (Figure S1). Supplementary table 2 displays the number of children whose Medicaid expansion status changed over time. This allowed us to more accurately isolate the effect of a policy with varying dates of implementation. Expansion status and date of enactment by state are displayed in Figure 1.

2.4 Primary Outcomes

Our primary outcome was a composite endpoint of graft failure and patient death. This measure was defined as time from liver transplant to graft failure or death from any cause, whichever occurred first.[17,18] For patients without documented graft failure, graft survival

was censored at the last date of follow-up. We applied administrative censoring at 10 years posttransplant for patients followed longer than 10 years.

2.5 Covariates

We created a directed acyclic graph to select covariates for inclusion in the multivariable models to estimate the direct effect of Medicaid expansion on graft failure (Figure 2). We consider race a social construct (i.e., effects resulting from structural and interpersonal racism),[19-21] and we included race in our adjusted models as a proxy for these social effects. Since area-level socioeconomic conditions may confound the relationship between Medicaid expansion and graft failure, we measured the neighborhood socioeconomic deprivation index at the ZIP code level using data from the U.S. Census Bureau's 2015 American Community Survey and modeled this as a continuous variable.[17,22,23] We considered insurance status (classified as "public," "private," or "other") as a surrogate for individual-level socioeconomic status. We have previously found that residing in a primary care health professional shortage area (HPSA) is associated with poor outcomes after pediatric liver transplant.[6] We included residence in an HPSA in our multivariable model because we hypothesized that Medicaid expansion may help mitigate the adverse effects of living in an HPSA by increasing healthcare access. HPSAs, defined by the Health Resources and Services administration as areas with a population-to-provider ratio of >3500:1, or >3000:1 in areas with "unusually high needs," were analyzed as dichotomous measures.[24,25] Laboratory Model for End Stage Liver Disease (MELD)/Pediatric End Stage Liver Disease (PELD) and allocation MELD/PELD were used as measures of disease severity.

2.6 Sensitivity Analyses

To account for unmeasured confounding in comparing outcomes across states that did or did not expand Medicaid (e.g., other state-specific policies), we conducted several sensitivity analyses. First, we compared pre- and post-expansion outcomes over a three-year time horizon in states that implemented Medicaid expansion in January 2014. We chose a subset of children who were transplanted between 01/01/2010-12/31/2017. This allowed us to compare the outcomes in children transplanted in a three-year pre-expansion period (01/01/2010-12/31/2012) and children transplanted in a three-year post-expansion period (01/01/2015-12/31/2017), while accounting for a two-year washout period from 01/01/2013-12/31/2014 (the year before and after implementation). Because all states in this analysis enacted Medicaid expansion on the same date, we used traditional Kaplan-Meier analyses and Cox-proportional hazard models.

Second, we conducted an intention-to-treat analysis[26] from the time of waitlisting to death using the date a child was listed for transplant and the date of policy enactment. We hypothesized that the effects of Medicaid expansion may be seen before transplant (demonstrated in a patient's disease status at the time of listing and ability to get listed). For these sensitivity analyses, we applied administrative censoring at 10 years post listing for patients still alive.

Finally, given that the first year posttransplant is an especially high risk period due to technical and surgical complications, we conducted a landmark analysis[27] and only included those patients who survived past one year posttransplant.

2.7 Statistical Analyses

Patient characteristics were compared between those residing in Medicaid expansion states and non-expansion states (as of 2022) using Wilcoxon rank-sum tests for continuous variables and chi-square tests for categorical variables (Table 1). We evaluated the associations between state Medicaid expansion and graft and patient survival using Cox models with time dependent covariates. In our multivariate Cox regression models, we included race, insurance status, HPSA status, and neighborhood deprivation as time-independent covariates. Given that the first year posttransplant is an especially high risk period due to technical and surgical complications, we conducted a landmark analysis[27] and only included those patients who survived past one year posttransplant. We had less than 10% missingness for all covariates and outcome variables; thus, we did not make any adjustments for missing data. Statistical significance was defined as two-sided p-value <0.05. Statistical analyses were performed in R using the Survival package (Version 4.1.0, The R Project for Statistical Computing).

This study was deemed exempt from review by the University of California San Francisco Institutional Review Board.

3. RESULTS

3.1 Study Population

A total of 8,489 children were included in our analyses. Baseline characteristics are shown in Table 1. About 70% of our cohort (5,873 children) were transplanted in states that had either enacted Medicaid expansion at the time of transplant or during follow-up post-transplant. Children from these states were more likely to be White and non-Hispanic, have private insurance, and were less likely to live in a primary care shortage, rural, and high-poverty area.

3.2 Posttransplant Patient and Graft Survival

The overall 1-, 5-, and 10-year posttransplant patient and graft survival in our cohort was 84%, 79%, and 77%, respectively. Patients from Medicaid expansion states compared to those in non-Medicaid expansion states had higher estimated graft survival rates at 1 year (89% vs. 87%, p<0.001), 5 years (84% vs. 80%, p<0.001), and 10 years (81% vs. 77%, p<0.001). In univariable time-dependent Cox regression, Medicaid expansion was associated with a 32% decreased hazard of graft failure/death (HR: 0.68; 95%CI: 0.61,0.76; p<0.001) (Table 2). In univariable Cox models with time dependent covariates, Black race, public insurance, neighborhood deprivation, and living in a primary care shortage area were associated with increased hazard of graft failure/death. In multivariable analysis, Medicaid expansion was associated with a 30% (HR: 0.70; 95%CI: 0.62,0.79; p<0.001) decreased hazard of graft failure/death, after adjusting for Black race, public insurance, neighborhood deprivation, and living in a primary care shortage area (Table 3). The effect of Medicaid

expansion did not significantly vary across races (interaction term p=0.23), insurance types (interaction term p=0.75), rural vs. urban areas (interaction term p=0.54), or primary care shortage areas (interaction term p=0.90).

3.3 Sensitivity Analysis: Comparing Pre- and Post-Expansion Outcomes in a Subset of States that were Early Adopters of Medicaid Expansion

In states that implemented Medicaid expansion in January 2014, a total of 4,130 children were transplanted between 01/01/2010 and 12/31/2018. In univariable analysis, being transplanted in a post-expansion time period was associated with a 33% decreased hazard of graft failure/death (HR: 0.67; 95%CI: 0.51,0.88; p=0.003) compared to the pre-expansion period, while being transplanted during the washout period (from 01/01/2013-12/31/2014) was not associated with a significant survival benefit (HR: 0.86; 95%CI: 0.67,1.08; p=.20). In multivariable analysis adjusting for race, insurance type, neighborhood deprivation, and primary care shortage area status, post-expansion transplantation was associated with a 34% decreased hazard of graft failure/death (HR: 0.66; 95%CI: 0.49,0.88; p=0.004) compared to pre-expansion transplantation (Table S3). A Kaplan-Meier curve of three-year graft/patient survival by policy time period during which transplant was performed is displayed in figure 3.

3.4 Sensitivity Analysis: Intention to Treat

A total of 11,901 children were listed for liver transplantation between 01/01/2005 and 12/31/2020. In an intention-to-treat time-dependent analysis of these children, Medicaid expansion was associated with a 72% decreased hazard of patient death (HR: 0.28; 95%CI: 0.23,0.35; p<0.001). In multivariable analysis adjusting for patient-reported race, insurance status, neighborhood deprivation, and primary care shortage area status, Medicaid expansion was still associated with a 72% decreased hazard of patient death (HR: 0.28; 95%CI: 0.23,0.35; p<0.001). In this same multivariable model, public insurance was associated with an increased hazard of patient death (HR: 1.74; 95%CI: 1.50,2.00), p<0.001), while other social factors were not significantly associated with an increased risk of death (Table 3).

3.5. Sensitivity Analysis: Landmark Analysis at 1-Year Post-Transplant

A total of 991 children experienced graft failure/death or were lost to follow-up within the first year after transplant. In a landmark analysis excluding these patients, Medicaid expansion was associated with a 25% decreased hazard of graft failure/death (HR: 0.75; 95%CI: 0.63,0.88; p<0.001) (Table 3). In multivariable analysis, Medicaid expansion was associated with a 19% decreased hazard of graft failure/death (HR: 0.81; 95%CI: 0.68,0.95; p=0.01), when adjusting for race, insurance type, neighborhood deprivation, and primary care shortage area status. In this adjusted model, Black race was associated with a 61% increased hazard of graft failure/death (HR: 1.61; 95%CI: 1.34,1.93; p<0.001), while the effect size of the other social factors decreased.

4. DISCUSSION

We found that Medicaid expansion was associated with improved survival outcomes for children after liver transplant—a finding that persisted in our multivariable analyses. This

finding held in our three sensitivity analyses (pre- and post-expansion analysis, landmark analysis, and intention-to-treat analysis), suggesting that Medicaid expansion itself, rather than unmeasured state-level confounders (e.g., social safety net programs), enables improved survival for children with end-stage liver disease. Indeed, for early adopter states that expanded Medicaid in 2014, we observed improved survival for children transplanted after adoption of Medicaid expansion, compared to those transplanted before. Similarly, we observed a benefit in our landmark and intention-to-treat analyses—further evidence that expanded public insurance leads to improved outcomes. In all our analyses, we observed a decreased effect size for other social factors in our multivariable models, however, the effect size of Medicaid expansion remained nearly the same. This enduring effect of Medicaid expansion on these survival outcomes suggests that increased access to quality health insurance may be a durable solution to improving long-term outcomes and narrowing disparities within pediatric liver transplant.

In 2020, over four million children were uninsured despite a great majority of children in the U.S. being eligible for Medicaid or CHIP in both expansion and non-expansion states.[11] A major predictor of a child's health insurance coverage is their parents' or guardians' coverage status.[28,29] Previous research has demonstrated increased rates of insurance coverage in children when Medicaid eligibility is expanded for their parents or guardians, a concept known as the "welcome mat" effect.[29-32] Preventive health care visits and healthcare utilization have also been shown to increase in children after parental Medicaid expansion, another important spillover effect.[33] Despite 98% of our cohort being insured at the time of transplant, and most children already being eligible for Medicaid or CHIP before Medicaid expansion, we still found improved posttransplant outcomes with Medicaid expansion. It is possible that expanded Medicaid eligibility increased coverage for the entire family, allowing better attention to the transplanted child and reduced financial stressors, or allowed children to switch from inadequate private insurance to public insurance with better coverage. Additionally, previous work has shown that transplant families incur additional non-medical costs, such as parking fees, hospital food, and childcare.[34] These expenses are not always covered by existing support structures at transplant centers. While Medicaid expansion may not directly impact these center-specific support structures, it may alleviate the financial burden on transplant families. Finally, we must also consider that Medicaid expansion may be a surrogate for larger state-level social safety-nets in states that were early adopters of Medicaid expansion.

In line with previous studies,[6,9] we find that public insurance is associated with an increased risk of poor outcomes compared to private insurance. Interestingly, this risk persisted despite Medicaid expansion conferring a decreased risk for poor outcomes. In a study done in pediatric cancer patients, Medicaid expansion was associated with increased public insurance coverage—primarily from children with private insurance switching to Medicaid, with a smaller number of children switching from no insurance to Medicaid.[14] While our time-varying models and our survival analysis of pre- and post-expansion periods in expansion states suggest a direct effect from Medicaid expansion, other policies and programs differentially present in Medicaid expansion states may still be influencing transplant outcomes. Because we were unable to assess changes in insurance status on an individual patient level, one must consider whether other factors, such as more generous/

inclusive state-level policies play a role in improved health outcomes. Political ideologies, which affect public and health policy, have been shown to influence population health outcomes.[35,36] For example, governments with strong commitments to redistributive policies (i.e., social policies encouraging high employment rates, family-oriented services such as child and home care, early childhood education, paid maternity leave, etc.) are associated with better health outcomes.[35]

It is well documented that Black and minority children have poorer outcomes after liver transplantation[9] and higher rates of uninsurance[11] than White children. Medicaid expansion and the PPACA have been shown to increase coverage for Black and Hispanic patients to a greater extent than White patients, thereby helping to reduce racial and ethnic disparities within health insurance coverage.[37] Although there is still an increased risk of poor outcomes in Black children when adjusting for Medicaid expansion and other social factors, this risk is decreased by over 10%, suggesting that access to health insurance may be an important contributor to structural racism and racial disparities in pediatric liver transplant. Race, a social construct, is a surrogate for structural, institutional, and interpersonal racism.[20,21,38] Structural racism, which encompasses the ways in which overlapping systems (e.g., education, healthcare, housing, employment, wealth distribution, media, criminal justice, etc.) promote and reinforce discrimination on the basis of race,[39] also includes access to health insurance and healthcare utilization. Additionally, in our multivariate model, the effect sizes of other social factors such as neighborhood-level socioeconomic deprivation and neighborhood-level primary care shortages also decreased. Notably, living in a more socioeconomically deprived neighborhood was not significantly associated with adverse effects in our adjusted model ($p=0.26$), and the effect size of living in a primary care shortage area decreased by close to fifteen percentage points in multivariable models. More accessible health insurance coverage may help reduce disparities felt by populations who face additional social adversity.

Medicaid and CHIP provide insurance coverage for around 35% of all children in the U.S.[40] and over 50% of pediatric liver transplant recipients. Importantly, for healthy children and especially children with complex healthcare needs such as those undergoing transplantation, Medicaid provides comprehensive coverage that may exceed even what is typically covered by private employer-sponsored plans.[40] Millions of children rely on Medicaid for insurance coverage, and we see improved health outcomes and reduced racial and socioeconomic disparities with Medicaid expansion. Future policy reform should strongly prioritize the needs of the pediatric population, and children's health should be at the forefront when considering additional changes to Medicaid policies.

4.1 Strengths and Limitations

Study strengths include our use of a robust national dataset with reliable and objective health outcomes, a time-dependent statistical approach which allowed us to isolate the direct effect of a national policy with varying dates of implementation, multiple sensitivity analyses, and a large sample size with adequate follow-up. Limitations that are common to all registry studies include data completeness and quality. However, the SRTR database is the most exhaustive data source currently available for transplant recipients. It also provides one of

the most objective and complete datasets for studying pediatric health outcomes in general. Second, we were unable to assess insurance changes on an individual level. Although population-level data are necessary to characterize the effects of national policies, there is the risk of ecologic fallacy (i.e., extrapolating conclusions to individuals based on group-level findings).[41] Future work should focus on uncovering the reasons Medicaid expansion conferred a decreased risk of poor outcomes by assessing post-transplant insurance changes, as well as measures that specifically assess access to care (such as patient follow-up encounters and prescription refills). Additionally, future studies characterizing the overall level of public insurance quality, taking into account differential levels of hospital and transplant center-level support, have on posttransplant outcomes are warranted. Third, because residential mobility is not available in SRTR, we were unable to account for this second time-dependent covariate. However, in 2020, just 1% of Medicaid enrollees moved to a different state in the U.S., thus it is unlikely that this limitation will substantially bias our findings.[42] What's more, there are more states (39) that have implemented Medicaid expansion than not (12). This means that if there is no specific pattern in which people move from state to state (which we do not expect), then more families would move from non-expansion to expansion states than the other way around, resulting in a bias toward the null.

4.2 Conclusions

Medicaid expansion is associated with decreased waitlist mortality and decreased rates of graft failure and patient death in children after liver transplantation. Policies that enable broader health insurance access may help improve long-term outcomes and reduce disparities for children undergoing liver transplantation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data are not shared.

ABBREVIATIONS:

CHIP	Children's Health Insurance Program

CI	confidence interval
HPSA	health professional shortage area
HR	hazard ratio
HRSA	Health Resources and Services Administration
MELD	Model for End Stage Liver Disease
OPTN	Organ Procurement and Transplantation Network
PELD	Pediatric End Stage Liver Disease
PPACA	Patient Protection and Affordable Care Act
SRTR	Scientific Registry of Transplant Recipients

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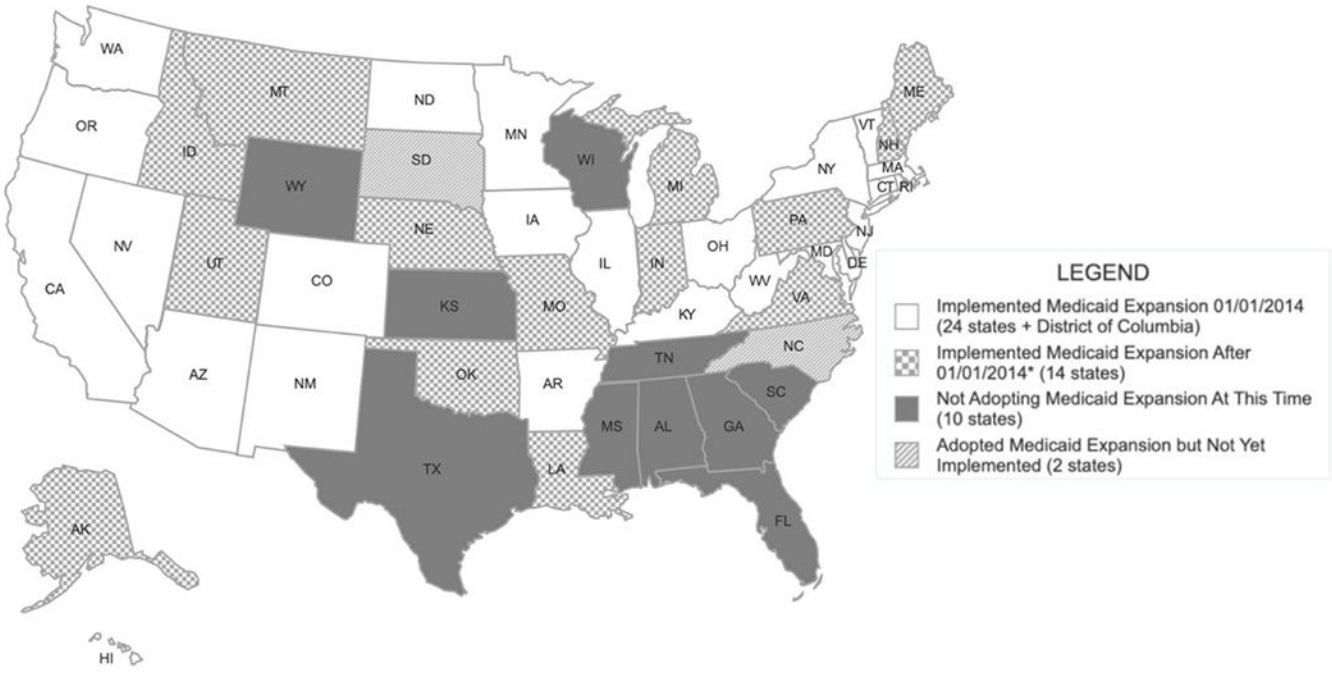

Figure 1. Medicaid expansion status by state and date of implementation.

*Specific dates of implementation: Alaska: 9/1/2015; Idaho: 1/1/2020; Indiana: 2/1/2015; Louisiana: 7/1/2016; Maine: 7/2/2018; Michigan: 4/1/2014; Missouri: 7/1/2021; Montana: 1/1/2016; Nebraska: 10/1/2020; New Hampshire: 8/15/2014; Oklahoma: 7/1/2021; Pennsylvania: 1/1/2015; Utah: 1/1/2020; Virginia: 1/1/2019

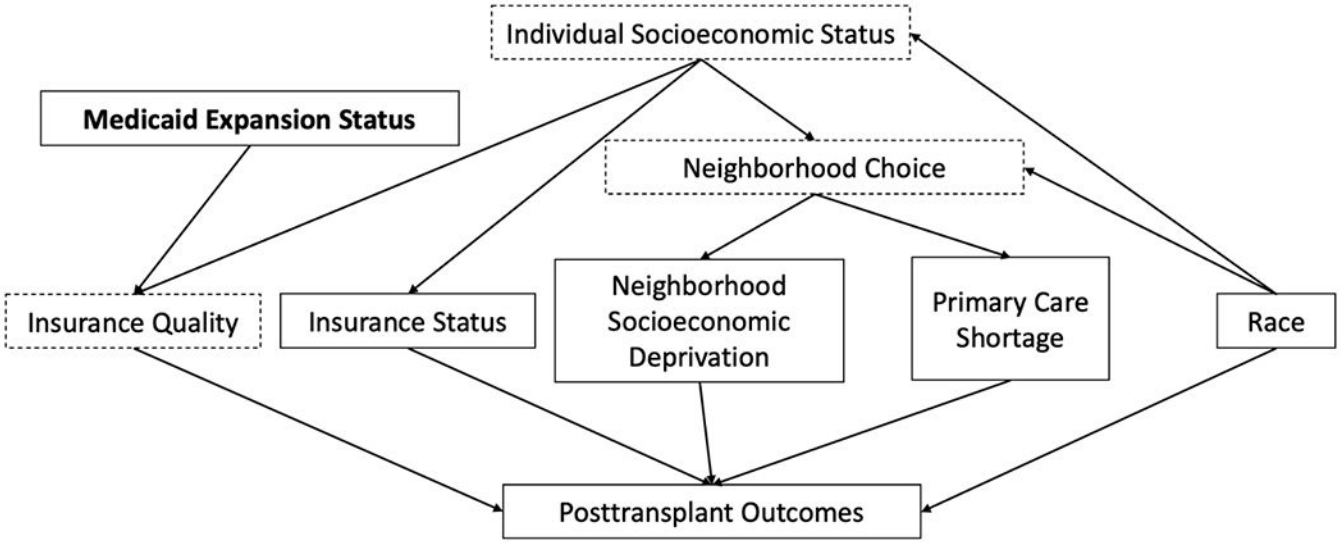

Figure 2. Directed acyclic graph of hypothesized causal pathway.

Legend: The solid boxes indicate measurable variables while the dotted boxes indicate unmeasurable variables within the Scientific Registry for Transplant Recipient data system. This diagram is the theoretical model of the hypothesized causal pathway for the impact of Medicaid Expansion on pediatric liver transplant survival.

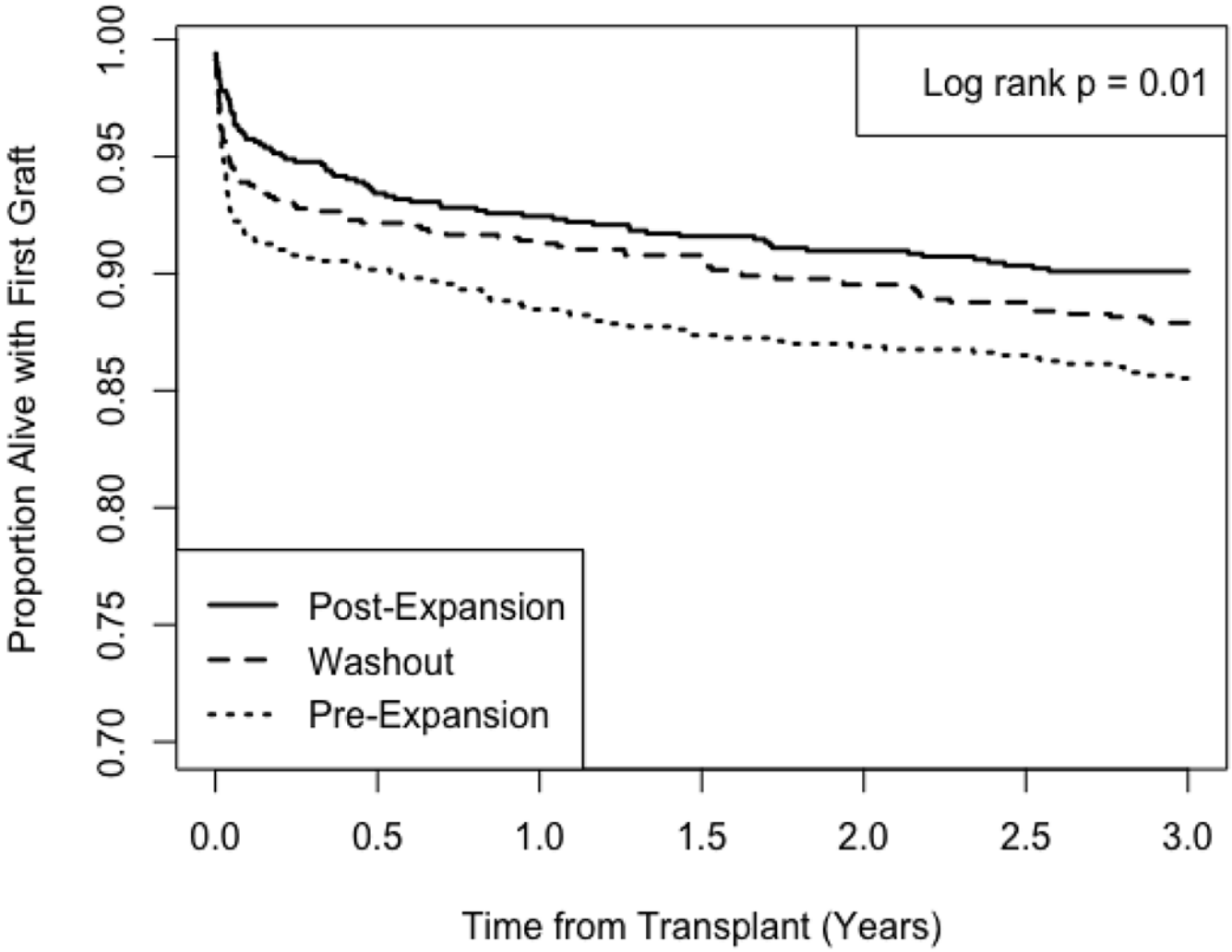

Figure 3. Pre- and post-expansion outcomes in a subset of states that were early adopters of Medicaid expansion modeled over a 3-year time horizon.

Legend: Pre-expansion: 01/01/2010-12/31/2012; Washout: 01/01/2013-12/31/2014; Post-expansion: 01/01/2015-12/31/2017

Table 1.

Baseline characteristics by Medicaid expansion status.

Characteristic	Overall	Medicaid Expansion	Non-Medicaid Expansion	p-value
N	8489	5873 (69.2)	2616 (30.8)	
Age at transplant, yrs	2.6 (0.9, 10.0)	2.6 (0.8, 10.3)	2.6 (1.0, 9.4)	0.43
Sex				
Female	4243 (50.0)	2919 (49.7)	1324 (50.6)	0.45
Ethnicity				
Hispanic	1923 (22.7)	1292 (22.0)	631 (24.1)	0.03
Race				
White	6268 (73.8)	4398 (74.9)	1870 (71.5)	<0.001
Black	1420 (16.7)	818 (13.9)	602 (23.0)	
Other	801 (9.4)	657 (11.2)	144 (5.5)	
Primary Insurance				
Private	3696 (43.5)	2757 (46.9)	939 (35.9)	<0.001
Public	4611 (54.3)	2964 (50.5)	1647 (63.0)	
Other	182 (2.1)	152 (2.6)	30 (1.1)	
Neighborhood Deprivation *	0.38 (0.30, 0.46)	0.36 (0.28, 0.45)	0.41 (0.34, 0.48)	<0.001
HPSA	3742 (44.1)	2198 (37.4)	1544 (59.0)	<0.001
Rurality				
Urban	6498 (76.5)	4489 (76.4)	2009 (76.8)	<0.001
Rural	1226 (14.4)	738 (12.6)	488 (18.7)	
Recipient Diagnosis				
Biliary Atresia	2643 (31.1)	1858 (31.6)	785 (30.0)	0.08
Other Cholestatic	1656 (19.5)	1136 (19.3)	520 (19.9)	
Acute Liver Failure	859 (10.1)	564 (9.6)	295 (11.3)	
Metabolic	932 (11.0)	668 (11.4)	264 (10.1)	
Tumor	712 (8.4)	496 (8.4)	216 (8.3)	
Autoimmune Hepatitis	372 (4.4)	261 (4.4)	111 (4.2)	
Other	1292 (15.2)	874 (14.9)	418 (16.0)	
Laboratory MELD/PELD at transplant	15 (3, 25)	15 (4, 25)	14 (3, 24)	0.008
Allocation MELD/PELD at transplant	28 (18, 35)	29 (18, 35)	26 (18, 33)	<0.001
Status 1a/1b	2602 (30.7)	1832 (31.2)	770 (29.4)	0.10
Donor Age at Transplant, yrs	11 (2, 22)	14 (2, 24)	7 (1, 17)	<0.001
Living Donor Transplant	907 (10.7)	816 (13.9)	91 (3.5)	<0.001
Cold Ischemia Time, hrs	6.5 (4.9, 8.1)	6.4 (4.7, 8.1)	6.5 (5.1,8.1)	<0.001

Legend: Values are represented as median (IQR) or number (%). Empty cells in p-value column are because p-value represents comparison across all categories of a variable. Abbreviations: HPSA, primary care health professional shortage area; IQR, interquartile range; MELD, Model for End-Stage Liver Disease; PELD, pediatric end-stage liver disease.

* The neighborhood deprivation index is a scale that ranges from 0-1, where a higher number represents greater deprivation.

Table 2.

Univariable Cox models on composite outcome of graft failure/death (whichever occurred first) at 10 years posttransplant.

	Graft Failure or Death		
Characteristic	**HR**	**95% CI**	**p-value**
Medicaid Expansion *	0.68	0.61, 0.76	<0.001
Age at transplant, yrs	1.00	1.00, 1.001	0.03
Sex			
Male	1.01	0.92, 1.11	0.8
Ethnicity			
Hispanic	0.99	0.88, 1.11	0.8
Race			
White	REF	REF	
Black	1.24	1.10, 1.40	<0.001
Other	0.95	0.80, 1.12	0.53
Primary Insurance			
Private	REF	REF	
Public	1.31	1.19, 1.44	<0.001
Other	1.09	0.76, 1.55	0.64
Neighborhood Deprivation [a]	1.11	1.06, 1.16	<0.001
HPSA	1.29	1.16, 1.42	<0.001
Rurality			
Urban	REF	REF	
Rural	1.20	1.05, 1.36	0.007
Recipient Diagnosis			
Biliary Atresia	REF	REF	
Other Cholestatic	1.88	1.63, 2.17	<0.001
Acute Liver Failure	1.99	1.69, 2.36	<0.001
Metabolic	1.06	0.86, 1.29	0.59
Tumor	1.95	1.63, 2.34	<0.001
Autoimmune Hepatitis	1.93	1.53, 2.42	<0.001
Other	1.90	1.63, 2.21	<0.001
Laboratory MELD/PELD at transplant	1.01	1.01, 1.01	<0.001
Allocation MELD/PELD at transplant	1.00	1.00, 1.00	0.24
Status 1a/1b	1.30	1.18, 1.44	<0.001
Donor Age at Transplant, yrs	1.00	1.00, 1.01	0.21
Living Donor Transplant	0.63	0.52, 0.75	<0.001
Cold Ischemia Time, hrs	1.02	1.01, 1.04	<0.001

Legend: Abbreviations: HR, hazard ratio; 95% CI, 95% confidence interval; HPSA, primary care health professional shortage area; MELD, Model for End-Stage Liver Disease; PELD, pediatric end-stage liver disease.

[*] Medicaid Expansion was modeled as a time-dependent covariate.

[a] The neighborhood deprivation index is a scale that ranges from 0-1, where a higher number represents greater deprivation. The HR was scaled to represent a 0.1 increase in deprivation.

Table 3.

Multivariable Cox models on posttransplant outcomes (N=8,489), intention-to-treat survival analysis (N=11,901), and landmark analysis excluding patients (N=991) with graft failure/death/loss to follow-up in the first year posttransplant (N=7,498)

	Posttransplant Graft Failure/Patient Death			Intention-to-treat Waitlist Mortality Analysis			Landmark Analysis		
Variable	**HR**	**95% CI**	**P-value**	**HR**	**95% CI**	**P-value**	**HR**	**95% CI**	**P-value**
Medicaid Expansion *	0.70	0.62, 0.79	<0.001	0.28	0.23, 0.35	<0.001	0.81	0.68, 0.95	0.01
Race									
White	REF	REF	REF	REF	REF	REF	REF	REF	REF
Black	1.13	1.00, 1.29	0.05	1.06	0.90, 1.24	0.48	1.61	1.34, 1.93	<0.001
Other	1.01	0.85, 1.21	0.88	1.11	0.89, 1.39	0.35	0.98	0.73, 1.31	0.89
Insurance									
Private	REF	REF	REF	REF	REF	REF	REF	REF	REF
Public	1.18	1.05, 1.32	0.004	1.74	1.50, 2.00	<0.001	1.08	0.90, 1.28	0.41
Other	1.01	0.69, 1.48	0.95	1.06	0.66, 1.71	0.81	1.35	0.80, 2.28	0.26
Neighborhood Deprivation [a]	1.35	0.80, 2.28	0.26	1.05	0.55, 1.99	0.89	1.10	0.92, 1.31	0.30
HPSA	1.16	1.04, 1.30	0.01	1.14	0.99, 1.32	0.06	2.58	1.16, 5.71	0.02

Legend: Abbreviations: HR, hazard ratio; 95% CI, 95% confidence interval; HPSA, primary care health professional shortage area.

*Medicaid Expansion was modeled as a time-dependent covariate.

[a]The neighborhood deprivation index is a scale that ranges from 0-1, where a higher number represents greater deprivation. The HR was scaled to represent a 0.1 increase in deprivation.