Published in final edited form as:

Clin Transplant. 2017 February ; 31(2): . doi:10.1111/ctr.12875.

Impact of insurance status on heart transplant wait-list mortality for patients with left ventricular assist devices

Sitaramesh Emani^{1,2}, Dmitry Tumin^{2,3,4}, Randi E. Foraker^{1,2,5}, Don Hayes Jr^{1,2,3,6,7}, and Sakima A. Smith^{1,2}

¹Department of Internal Medicine (Division of Cardiology), The Ohio State University College of Medicine, Columbus, OH, USA

²Center for the Epidemiological Study of Organ Failure and Transplantation, Nationwide Children's Hospital, Columbus, OH, USA

³Department of Pediatrics, The Ohio State University College of Medicine, Columbus, OH, USA

⁴Department of Anesthesiology & Pain Medicine, Nationwide Children's Hospital, Columbus, OH, USA

⁵Division of Epidemiology, The Ohio State University College of Public Health, Columbus, OH, USA

⁶Department of Surgery, The Ohio State University College of Medicine, Columbus, OH, USA

⁷Section of Pulmonary Medicine, Nationwide Children's Hospital, Columbus, OH, USA

Abstract

Objectives—To test the hypotheses that receipt of Medicaid or Medicare (versus private insurance or self-pay) and low socioeconomic status (SES) leads to increased mortality and lower chances of transplantation among heart transplant (HTx) candidates with bridge to transplant left ventricular assist devices (BTT LVADs).

Background—Survival while awaiting HTx has improved with the use of BTT LVADs. However, it is unknown whether benefits extend uniformly across patient groups based on insurance status.

Methods—Data from the United Network of Organ Sharing (UNOS) registry between 2006 and 2015 were examined for first-time HTx candidates 18 and <65 years who had LVAD support while wait-listed. Multivariable survival analysis was conducted on competing outcomes of mortality and time to transplant stratified by insurance source at the time of listing. Additional covariates included demographic information and SES.

Correspondence: Sakima A. Smith, MD, MPH, Department of Internal Medicine (Division of Cardiology), The Ohio State University Wexner Medical Center, Columbus, OH, USA., sakima.smith@osumc.edu.

CONFLICT OF INTEREST

None.

DISCLOSURES

SAS is a consultant with Relypsa and XDx, Inc. SE is a consultant with Thoratec and XDx, Inc.

Results—A total of 4626 patients met inclusion criteria, with 3353 being used for multivariable analysis. A majority of patients (68%) underwent HTx during the study period. BTT LVAD wait-list mortality was found to be greater among Medicaid beneficiaries vs. private insurance (SHR 1.57, $P<.05$) and did not diminish with the inclusion of neighborhood SES. Transplantation as an outcome demonstrated no difference by insurance status.

Conclusion—Medicaid insurance status is associated with worse survival on the HTx wait-list among patients with BTT LVADs, although access to transplant was not different among insurance groups. The disparity is not reflective of SES in general and therefore points to other barriers inherent to Medicaid beneficiaries.

Keywords

bridge to transplant; left ventricular assist device; Medicaid; wait-list

1 | INTRODUCTION

Heart failure (HF) is a national epidemic, with adults having a one in five chance of developing this disease in their lifetime.¹ Despite optimal therapy, estimates suggest between 7% and 10% of affected patients will progress to advanced stages of HF.² For some of these patients, cardiac transplantation can be a life-saving option, with one-year survival rate approaching 90%.³ The process of donor heart allocation is intended to be equitable, yet there exist differences in survival after heart transplantation (HTx) by race and health insurance status.^{4,5} For example, in nonelderly adults, 10-year post-transplant survival is lowest among Medicaid recipients, followed by those covered by Medicare, and highest among those privately insured.⁵ Additionally, African American transplant recipients have worse survival after HTx compared to Caucasian patients, even after risk adjustment.⁴

Due to a severe shortage of donor organs, the time on the wait-list may be considerable; consequently, some candidates die while waiting for an organ. The risk of death while on the wait-list has decreased significantly;⁶ yet Hispanic HTx candidates, for example, incur a higher risk of wait-list mortality.⁷ Thus, while overall wait-list mortality has decreased, disparities among ethnic groups have remained. The modern era of continuous flow left ventricular assist devices (LVADs) has improved the quality of life and functional capacity of severely ill HF patients on the HTx wait-list⁸ and has resulted in 37% of HTx recipients having been supported by a bridge to transplant (BTT) LVAD.³ While short- and long-term mortality after LVAD implantation improves overall survival among Medicare beneficiaries,⁹ information regarding the Medicaid population is scant. Pretransplant, single-center data have demonstrated socioeconomic disparities in outcomes of patients with LVADs.¹⁰ With BTT LVADs available across the range of insurance types, it is unclear whether there are further disparities in wait-list outcomes by insurance type specifically, or by socioeconomic status (SES) more generally, among HTx candidates with LVADs.

Individual and neighborhood-level socioeconomic factors may lead to adverse outcomes for patients post-transplant, and likewise for patients who are currently listed for HTx. Yet, the particular impacts of insurance status and SES on the survival of LVAD recipients listed for HTx are unclear. SES has been measured by education, insurance status, and household

income, and recent data suggest these variables (particularly educational attainment) influence outcomes in heart transplant recipients.⁵ Organs available for transplantation are scarce, and identifying risk factors for adverse outcomes while waiting for an organ is important for optimizing short-and long-term survival among patients with advanced HF. In this study, we test the hypotheses that receipt of Medicaid or Medicare (versus private insurance or self-pay) and low SES lead to increased mortality and lower chances of transplantation among HTx candidates with a BTT LVAD.

2 | MATERIALS AND METHODS

2.1 | Data

De-identified data from the United Network of Organ Sharing (UNOS) registry was analyzed with approval from the local Institutional Review Board with a waiver of individual consent (IRB14-00716). First-time adult candidates (age ≥ 18 years) for HTx listed from June 2006 up to March 2015 were considered for inclusion, with follow-up of patient survival, transplantation, or removal from the wait-list available until June 2015. Access date was June 26, 2015. Patients of age 65 or older were excluded due to their eligibility for age-based Medicare coverage. Patients with LVAD support who were on the HTx wait-list were included in the analysis, whether they had LVAD support at the time of listing or had an LVAD implanted while on the wait-list. Other exclusion criteria were extracorporeal membrane oxygenation (ECMO) or right ventricular assist device (RVAD) support at listing; projected payment type other than private insurance, Medicare, Medicaid, or self-pay; and, for multivariable analyses, missing data on covariates.

2.2 | Analytic approach

Outcomes of patients supported by LVAD while on the HTx wait-list included time to mortality and time to transplantation, respectively. Patients entered the survival analysis at listing, if they were supported by LVAD at that time; or at LVAD implantation, if this had occurred after listing for HTx. Survival durations of 0 days were recoded as arbitrarily short durations <1 day for inclusion in survival analysis. Patients were stratified according to projected source of payment for HTx, as reported at the time of listing: private insurance or self-payment, Medicaid, or Medicare. Continuous variables were expressed as means with standard deviations and compared across insurance type using ANOVA, while categorical variables were expressed as counts with percentages, and compared across insurance type using chi-square tests.

Multivariable survival analyses were performed using Fine-Gray competing-risks models to account for the competing outcomes of HTx and wait-list mortality, and subhazard ratios (SHR) were estimated by fitting the model using the cumulative incidence function. Covariates entered in the multivariable analyses included HTx candidate age (continuous, years), gender, and race (African American, Caucasian, or others); cardiac output and pulmonary capillary wedge pressure (PCWP) at listing; inotrope use at listing; and intra-aortic balloon pump (IABP) usage at listing; candidate educational attainment at listing (high school only, some college, or college degree); candidate history of cigarette use; and whether the candidate had RVAD implanted while awaiting HTx. In addition to individual

measures of SES (insurance type, educational attainment), the median household income (MHI) according to candidates' ZIP code of permanent residence, as reported at the time of listing, was ascertained from 2000 U.S. Census data and recoded into quintiles for inclusion in multivariable analyses. Stata/IC 13.1 (StataCorp LP, College Station, TX, USA) was used for all analyses, and $P < .05$ was considered statistically significant.

3 | RESULTS

There were 17 463 first-time candidates for HTx listed between June 2006 and December 2013, of whom 5204 were supported by LVAD while on the wait-list. After excluding 314 candidates with ECMO or RVAD support at listing and 234 candidates with projected payment type other than private insurance, Medicaid, Medicare, or self-pay, there remained 4626 patients in the analytic sample, of whom 3353 had complete data on covariates. Of the 4626 patients, 2718 (59%) were supported by an LVAD at listing, while 1908 (41%) had an LVAD implanted after listing. In the latter group, median time from listing until LVAD implantation was 25 days. Although the majority of candidates in this cohort were transplanted (3126/4626, 68%), there were 444 (10%) deaths on the wait-list. Median follow-up time in the overall cohort (ie, time to transplantation, wait-list mortality, or censoring) was 253 days, with the longest recorded follow-up being 3127 days.

Compared to privately insured patients, those with Medicaid insurance were distinguished by younger age at listing, a lower likelihood of LVAD support at listing, earlier time to LVAD implantation after listing, lower educational attainment, and lower neighborhood MHI (Table 1). Candidates with Medicare insurance were distinguished by lower educational attainment, greater likelihood of past cigarette use, and lower neighborhood MHI, compared to candidates who were privately insured. A comparison of the unadjusted cumulative incidence of mortality since LVAD implantation (or listing, if LVAD was present at that time) demonstrated elevated early mortality in the Medicaid group (Figure 1). Unadjusted cumulative incidences of HTx in each insurance group identified delayed transplantation in the Medicare group compared to patients with Medicaid or private insurance (Figure 2), with the overall proportion of patients transplanted differing significantly across insurance groups (Table 1; $P < .001$).

In multivariable competing-risks models, the hazard of wait-list mortality was found to be greater among patients with Medicaid insurance than patients with private insurance (Table 2, Model 1; SHR=1.57; 95% CI=1.15, 2.16; $P=.006$). The adjusted association between Medicaid insurance and the hazard of wait-list mortality did not diminish after adding neighborhood MHI quintile as a covariate (Table 2, Model 2). In the final model of wait-list mortality, risk factors apart from Medicaid insurance included RVAD implantation while on the wait-list (SHR=4.72; 95% CI=3.16, 7.05, $P < .001$) and older age at listing (HR=1.01; 95% CI=1.00, 1.02; $P=.011$). Patients from neighborhoods in the second-lowest quintile of MHI were more likely to die on the wait-list than patients in the lowest quintile (SHR=1.62; 95% CI=1.01, 2.58; $P=.044$), although there were no further differences in the hazard of wait-list mortality by neighborhood SES. Multivariable analyses of transplantation demonstrated no statistically significant differences in this outcome by insurance status, with or without adjustment for MHI quintile (Table 3). The final model of access to

transplantation revealed lower hazard of HTx associated with African American ethnicity and permanent residence in a neighborhood in the second-lowest quintile of MHI.

4 | DISCUSSION

Our data demonstrate that Medicaid insurance status is associated with worse survival on the HTx wait-list among patients with BTT LVADs. After adjusting for confounding variables, no association was found between insurance status and access to HTx among patients supported by LVAD. Additionally, we found that significantly more Medicaid recipients receive LVADs after being listed for HTx than patients with private insurance or self-pay. While a BTT strategy has clearly been identified as a method to decrease wait-list mortality,¹¹ these benefits may be less evident among Medicaid participants.

4.1 | SES disparities in the LVAD population

In the broader population of patients with LVADs, a previous single-center report found that insurance status had no impact on adverse events, including mortality,¹⁰ while analysis of the National Inpatient Sample data demonstrated that older age, African American ethnicity, admission to a nonacademic medical center, and geographic region—but not insurance status—influenced access to LVAD therapy.¹² By contrast, insurance status influenced wait-list outcomes of patients with LVAD listed for HTx in this analysis, and apart from insurance status, there were no socioeconomic gradients in wait-list outcomes by individual or community measures of SES (education and MHI, respectively). We hypothesize that barriers specific to Medicaid status may influence wait-list survival, including delay to listing, costs associated with travel to the transplant center for routine surveillance, and delays to obtaining emergency Medicaid status for young uninsured patients. Notably, in our study, patients with Medicare or private insurance received earlier LVAD implantation, which may have improved overall survival in this group.¹¹ The delay to LVAD implantation for HTx candidates with Medicaid insurance could indicate worsening cardiovascular status or overall burden of illness, which could partly explain the observed increase in mortality among Medicaid participants. Our data demonstrate that after listing for HTx, Medicaid recipients on average received a LVAD 100 days earlier than Medicare recipients or those with private insurance. This suggests that the initial delay to LVAD implantation in Medicaid recipients led to clinical deterioration while on the wait-list, hence necessitating earlier LVAD implantation once these patients were listed. Clinical data to support this conclusion were unfortunately unavailable through the UNOS database. Ideally, data on referral for transplantation and listing, as well as INTERMACS profiles, would be included in an analysis of disparities in wait-list mortality.

4.2 | SES disparities in the BTT/HTx population

Previous data in the HTx population have demonstrated that long-term mortality was higher in Medicare and Medicaid patients vs patients using private insurance or self-pay.⁵ Medicaid recipients had the lowest 10-year survival (49.2%), followed by Medicare (50.6%), and private insurance (59.2%). Whereas HTx recipients' insurance status did not affect early post-transplant death,⁴ there was increased pretransplant mortality with Medicaid recipients among HTx candidates supported by LVAD. Previous studies using UNOS data in the

Medicaid/Medicare population have described poor outcomes and graft dysfunction after transplant, likely due to barriers to medical care, cost concerns, and subsequent compliance issues.^{13–15} The mechanisms underlying insurance disparities in post-transplant survival are complex, as these disparities persisted even after adjusting for center-reported immunosuppression nonadherence.¹⁶ In addition, recipient college education was associated with improved post-HTx survival, but in our study, this covariate was not a significant predictor of HTx wait-list survival among LVAD recipients.

HTx candidates supported by LVADs who had Medicaid insurance were more likely to be listed with LVADs already implanted, as opposed to receiving LVAD support while on the wait-list. Medicaid insurance participation may be related to delayed referral for HTx, possibly explaining this survival disparity. This opens up the possibility of selection bias by transplant centers, as some institutions may use the ability to achieve event-free survival on a LVAD as a litmus test for HTx eligibility in the Medicaid population. Data from the lung transplant literature demonstrate that patients with low SES or receipt of Medicaid were much less likely to be accepted for lung transplant, and were also less likely to be referred for transplant if they had Medicaid insurance.^{17,18} Inadequate social support and noncompliance with medical regimens represent two additional key contraindications to HTx candidacy and are thought to be significant barriers in the Medicaid population. Follow-up rates with physicians are lowest among patients with high socioeconomic deprivation,¹⁹ limiting such patients' ability to be considered for HTx.

4.3 | Significance

Our analysis demonstrates a clear association between insurance status at the time of listing for HTx and mortality while on the wait-list. Previous data demonstrate improved overall survival on the wait-list with an LVAD, but SES factors may lead to worse outcomes in this population, tempering the benefit of LVAD implantation. Indeed, insurance status exerts a pervasive influence on the composition and outcomes of the transplant recipient population, as publicly insured patients are less likely to be referred to transplant centers even if they are medically acceptable candidates.¹⁸ It is imperative that we identify these causal factors to reduce mortality in this group of patients who appear to be at risk for worse outcomes.

This study is not without limitations. Due to the scope of the UNOS database, there is the potential for missing data, and our analysis is limited to variables collected in this registry. Additionally, our analysis included insurance status at the time of listing, but it is possible that insurance coverage changed while patients were on the wait-list, leading to misclassification. After listing, the UNOS registry does not track insurance status unless a patient receives a transplant.²⁰ Assessing changes in insurance status among transplant recipients, our group has recently reported that switching from public to private insurance by 1 year post-transplant occurred in 11% of HTx recipients who had Medicaid at listing and that switching from public to private insurance after HTx was associated with improved outcomes.²⁰ Further research is needed to understand whether a similar improvement in wait-list outcomes may occur when patients switch from public to private insurance before HTx. Finally, selection bias in this study was a concern, based on individual transplant center's selection criteria regarding LVADs and HTx eligibility. Yet, due to the limitations of

previous single-center studies, this analysis of UNOS registry data significantly enriches our understanding of SES influences on outcomes among patients with BTT LVAD.

4.4 | Conclusion

In conclusion, we examined outcomes related to insurance status in a national cohort of HTx candidates, and found that recipients of Medicaid insurance have an increased risk of pretransplant mortality. The disparity is not reflective of SES in general and therefore points to other barriers inherent to Medicaid beneficiaries; this observation warrants further investigation.

4.5 | Clinical perspectives

Patients who are recipients of Medicaid insurance at the time of listing for heart transplantation have an increased risk of mortality while on the wait-list. Our data suggest these individuals warrant close monitoring and follow-up while waiting for a donor heart.

4.6 | Translational outlook

It is imperative for clinicians to identify the factors which may lead to increased mortality for Medicaid recipients while on the wait-list, and to establish causality. Future studies to address these issues should be conducted in a prospective manner. Due to the limitations of single-center studies in the transplant population, we propose that multi-institutional collaborations should be established to address these concerns.

Acknowledgments

This work was supported by the Robert Wood Johnson Harold Amos Faculty Development Grant (SAS). The data reported here have been supplied by the United Network for Organ Sharing as the contractor for the Organ Procurement and Transplantation Network. 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 OPTN or the U.S. Government.

Funding information

Robert Wood Johnson Harold Amos Faculty Development Grant (SAS)

References

1. Mozaffarian D, Benjamin EJ, Go AS, et al. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics-2016 update: a report from the American heart association. *Circulation*. 2016; 133:447–454. [PubMed: 26811276]
2. Miller LW, Guglin M. Patient selection for ventricular assist devices: a moving target. *J Am Coll Cardiol*. 2013; 61:1209–1221. [PubMed: 23290542]
3. Lund LH, Edwards LB, Kucheryavaya AY, et al. The registry of the international society for heart and lung transplantation: thirty-second official adult heart transplantation report–2015; focus theme: early graft failure. *J Heart Lung Transplant*. 2015; 34:1244–1254. [PubMed: 26454738]
4. Allen JG, Weiss ES, Arnaoutakis GJ, et al. The impact of race on survival after heart transplantation: an analysis of more than 20,000 patients. *Ann Thorac Surg*. 2010; 89:1956–1963. [PubMed: 20494056]
5. Allen JG, Weiss ES, Arnaoutakis GJ, et al. Insurance and education predict long-term survival after orthotopic heart transplantation in the United States. *J Heart Lung Transplant*. 2012; 31:52–60. [PubMed: 21959122]

6. Singh TP, Almond CS, Taylor DO, Graham DA. Decline in heart transplant wait list mortality in the United States following broader regional sharing of donor hearts. *Circ Heart Fail.* 2012; 5:249–258. [PubMed: 22247484]
7. Singh TP, Almond CS, Taylor DO, Milliren CE, Graham DA. Racial and ethnic differences in wait-list outcomes in patients listed for heart transplantation in the United States. *Circulation.* 2012; 125:3022–3030. [PubMed: 22589383]
8. Rogers JG, Aaronson KD, Boyle AJ, et al. Continuous flow left ventricular assist device improves functional capacity and quality of life of advanced heart failure patients. *J Am Coll Cardiol.* 2010; 55:1826–1834. [PubMed: 20413033]
9. Lampropoulos JF, Kim N, Wang Y, et al. Trends in left ventricular assist device use and outcomes among Medicare beneficiaries, 2004–2011. *Open Heart.* 2014; 1:1–10. e000109-2014-000109.
10. Smith SA, Hasan AK, Binkley PF, Foraker RE. The impact of insurance and socioeconomic status on outcomes for patients with left ventricular assist devices. *J Surg Res.* 2014; 191:302–308. [PubMed: 24932840]
11. Trivedi JR, Cheng A, Singh R, Williams ML, Slaughter MS. Survival on the heart transplant waiting list: impact of continuous flow left ventricular assist device as bridge to transplant. *Ann Thorac Surg.* 2014; 98:830–834. [PubMed: 25087934]
12. Joyce DL, Conte JV, Russell SD, Joyce LD, Chang DC. Disparities in access to left ventricular assist device therapy. *J Surg Res.* 2009; 152:111–117. [PubMed: 18466923]
13. Goldfarb-Rumyantsev AS, Koford JK, Baird BC, et al. Role of socioeconomic status in kidney transplant outcome. *Clin J Am Soc Nephrol.* 2006; 1:313–322. [PubMed: 17699222]
14. Yoo HY, Thuluvath PJ. Outcome of liver transplantation in adult recipients: influence of neighborhood income, education, and insurance. *Liver Transpl.* 2004; 10:235–243. [PubMed: 14762861]
15. Allen JG, Arnaoutakis GJ, Orens JB, et al. Insurance status is an independent predictor of long-term survival after lung transplantation in the United States. *J Heart Lung Transplant.* 2011; 30:45–53. [PubMed: 20869264]
16. Tumin D, McConnell PI, Galantowicz M, Tobias JD, Hayes D Jr. Reported nonadherence to immunosuppressive medication in young adults after heart transplantation: a retrospective analysis of a national registry. *Transplantation.* 2016 Epub ahead of print.
17. Quon BS, Psoter K, Mayer-Hamblett N, Aitken ML, Li CI, Goss CH. Disparities in access to lung transplantation for patients with cystic fibrosis by socioeconomic status. *Am J Respir Crit Care Med.* 2012; 186:1008–1013. [PubMed: 22983958]
18. Ramos KJ, Quon BS, Psoter KJ, et al. Predictors of non-referral of patients with cystic fibrosis for lung transplant evaluation in the United States. *J Cyst Fibros.* 2016; 15:196–203. [PubMed: 26704622]
19. Stewart S, Murphy NF, McMurray JJ, Jhund P, Hart CL, Hole D. Effect of socioeconomic deprivation on the population risk of incident heart failure hospitalisation: an analysis of the Renfrew/Paisley study. *Eur J Heart Fail.* 2006; 8:856–863. [PubMed: 16713336]
20. Tumin D, Foraker RE, Sakima S, Tobias JD, Hayes D Jr. Health insurance trajectories and long-term survival after heart transplantation. *Circ Cardiovasc Qual Outcomes.* 2016; 9:576–584. [PubMed: 27625403]

FIGURE 1. Cumulative incidence of wait-list mortality. Cumulative incidence of mortality on the heart transplant waiting list among adult candidates supported by a left ventricular assist device, over time since device implantation

FIGURE 2. Cumulative incidence of transplantation. Cumulative incidence of heart transplantation among adult candidates supported by a left ventricular assist device, over time since device implantation

Characteristics of nonelderly adults listed for heart transplantation between left ventricular assist device while on the waiting list, by projected payment type (N=4626)

TABLE 1

Variable	Cases with complete data	Private insurance or self-pay (n=2703)		Medicaid (n=729)		Medicare (n=1194)		P ^a
		N (%) or mean (SD)	N (%) or mean (SD)	N (%) or mean (SD)	N (%) or mean (SD)	N (%) or mean (SD)	N (%) or mean (SD)	
LVAD present at listing	4626	1108 (41%)	268 (37%)	532 (45%)				.003
Died on wait-list	4626	251 (9%)	78 (11%)	115 (10%)				.516
Transplanted	4626	1900 (70%)	476 (65%)	750 (63%)				<.001
Male gender	4626	2128 (79%)	534 (73%)	918 (77%)				.006
Race								
White	4626	1930 (71%)	344 (47%)	670 (56%)				<.001
Black		534 (20%)	267 (37%)	413 (35%)				
Other		239 (9%)	118 (16%)	111 (9%)				
Educational attainment								
High school or less	4057	931 (39%)	411 (67%)	600 (57%)				<.001
Some college		680 (29%)	132 (21%)	326 (31%)				
College degree		769 (32%)	72 (12%)	136 (13%)				
RVAD implanted on wait-list	4626	98 (4%)	32 (4%)	37 (3%)				.338
History of cigarette use	4626	1288 (48%)	370 (51%)	686 (57%)				<.001
IABP at listing	4626	149 (6%)	29 (4%)	64 (5%)				.249
Inotropes at listing	4626	691 (26%)	159 (22%)	314 (26%)				.067
Age at listing (years)	4626	50.6 (11.4)	44.4 (13.0)	52.0 (9.6)				<.001
PCW at listing (mm/Hg)	4043	20.7 (9.5)	21.2 (9.6)	20.7 (9.7)				.494
CO at listing (L/min)	4281	4.5 (1.5)	4.4 (1.5)	4.5 (1.5)				.025
Days on wait-list	4626	420.5 (470.8)	382.5 (434.2)	409.1 (431.2)				.133

Variable	Cases with complete data	Private insurance or self-pay (n=2703) N (%) or mean (SD)	Medicaid (n=729) N (%) or mean (SD)	Medicare (n=1194) N (%) or mean (SD)	P ^a
Days to LVAD implantation ^b	1908	181.7 (350.6)	123.9 (239.7)	165.2 (331.0)	.036
MHI quintile of permanent residence ZIP code					
1 (lowest)	4480	183 (7%)	124 (17%)	186 (16%)	<.001
2		298 (11%)	110 (15%)	187 (16%)	
3		446 (17%)	162 (23%)	228 (20%)	
4		624 (24%)	151 (21%)	263 (23%)	
5 (highest)		1056 (41%)	173 (24%)	289 (25%)	

^a P-values from chi-square tests (categorical variables) or ANOVA (continuous variables).

^b Among patients with LVAD support beginning after listing for heart

SD, standard deviation; LVAD, left ventricular assist device; RVAD, right ventricular assist device; MHI, median household income; IABP, intra-aortic balloon pump; PCW, pulmonary capillary wedge; CO, cardiac output.

Multivariable competing-risks regression of mortality on the heart transplant waiting list among nonelderly adults supported by a left ventricular assist device, with transplantation as a competing outcome (N=3353)

TABLE 2

Variable	Model 1		Model 2	
	SHR	95% CI	SHR	95% CI
Projected payment				
Private insurance or self-pay	Ref.		Ref.	
Medicaid	1.57	(1.15, 2.16)	1.56	(1.14, 2.14)
Medicare	1.12	(0.85, 1.48)	1.12	(0.84, 1.48)
Male gender				
	0.73	(0.56, 0.96)	0.74	(0.56, 0.97)
Race				
White	Ref.		Ref.	
Black	0.99	(0.76, 1.28)	1.02	(0.78, 1.34)
Other	0.68	(0.43, 1.08)	0.70	(0.44, 1.11)
Educational attainment				
High school or less	Ref.		Ref.	
Some college	1.06	(0.80, 1.39)	1.08	(0.82, 1.43)
College degree	1.16	(0.87, 1.56)	1.20	(0.89, 1.61)
RVAD implanted on wait-list				
	4.56	(3.05, 6.81)	4.72	(3.16, 7.05)
History of cigarette use				
	1.00	(0.79, 1.26)	0.99	(0.79, 1.25)
IABP at listing				
	0.98	(0.60, 1.61)	0.96	(0.59, 1.56)
Inotropes at listing				
	1.76	(1.36, 2.28)	1.75	(1.36, 2.27)
Age at listing (years)				
	1.01	(1.00, 1.02)	1.01	(1.00, 1.02)
PCW at listing (mm/Hg)				
	1.01	(0.99, 1.02)	1.01	(0.99, 1.02)
CO at listing (L/min)				
	1.11	(1.02, 1.21)	1.11	(1.02, 1.20)

Variable	Model 1			Model 2		
	SHR	95% CI	P	SHR	95% CI	P
MHI quintile of permanent residence ZIP code						
1 (lowest)				Ref.		
2				1.62	(1.01, 2.59)	.044
3				1.51	(0.96, 2.38)	.075
4				1.21	(0.77, 1.92)	.410
5 (highest)				1.23	(0.78, 1.92)	.373

SHR, subhazard ratio; CI, confidence interval; RVAD, right ventricular assist device; MHI, median household income; IABP, intra-aortic balloon pump; PCW, pulmonary capillary wedge; CO, cardiac output.

TABLE 3

Multivariable competing-risks regression of heart transplantation among nonelderly adult candidates supported by a left ventricular assist device, with wait-list mortality as a competing outcome (N=3353)

Variable	Model 1			Model 2		
	SHR	95% CI	P	SHR	95% CI	P
Projected payment						
Private insurance or self-pay	Ref.			Ref.		
Medicaid	0.96	(0.84, 1.09)	.508	0.96	(0.84, 1.09)	.539
Medicare	0.93	(0.85, 1.03)	.184	0.94	(0.85, 1.04)	.196
Male gender	1.19	(1.07, 1.32)	.002	1.19	(1.07, 1.32)	.002
Race						
White	Ref.			Ref.		
Black	0.82	(0.74, 0.91)	<.001	0.82	(0.74, 0.91)	<.001
Other	1.01	(0.88, 1.15)	.909	1.00	(0.88, 1.15)	.954
Educational attainment						
High school or less	Ref.			Ref.		
Some college	0.99	(0.90, 1.10)	.908	0.99	(0.90, 1.09)	.818
College degree	0.94	(0.85, 1.05)	.267	0.93	(0.84, 1.04)	.191
RVAD implanted on wait-list	0.85	(0.63, 1.13)	.258	0.84	(0.63, 1.13)	.249
History of cigarette use	1.04	(0.95, 1.13)	.423	1.04	(0.95, 1.13)	.397
IABP at listing	1.06	(0.86, 1.32)	.586	1.07	(0.86, 1.32)	.559
Inotropes at listing	0.79	(0.72, 0.87)	<.001	0.79	(0.72, 0.87)	<.001
Age at listing (years)	1.00	(0.99, 1.00)	.144	1.00	(0.99, 1.00)	.137
PCW at listing (mm/Hg)	0.99	(0.99, 1.00)	<.001	0.99	(0.99, 1.00)	<.001
CO at listing (L/min)	0.96	(0.94, 0.99)	.018	0.96	(0.94, 0.99)	.018
MHI quintile of permanent residence ZIP code						

Variable	Model 1			Model 2		
	SHR	95% CI	P	SHR	95% CI	P
1 (lowest)				Ref.		
2				0.88	(0.74, 1.05)	.153
3				0.95	(0.81, 1.12)	.537
4				0.96	(0.82, 1.12)	.586
5 (highest)				0.99	(0.85, 1.15)	.902

SHR, subhazard ratio; CI, confidence interval; RVAD, right ventricular assist device; MHI, median household income; IABP, intra-aortic balloon pump; PCW, pulmonary capillary wedge; CO, cardiac output.