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Impact of Insurance Type on Initial Rejection Post Heart Transplant

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Abstract

Background—Heart transplantation allocation is often restricted from patients with low socioeconomic status (SES) due to concern for worse outcomes. We hypothesized that comorbidities would have a greater impact on risk of severe rejection post-orthotopic heart transplant than would Medicaid insurance and Median Household Income (MHI).

Methods—A retrospective study of 171 patients who underwent orthotopic heart transplant between 7/1999–11/2013 at our facility were followed until 9/2014 for rejection hospitalizations or death. Survival and multivariable analyses with adjustment for age, race, and gender were performed to estimate the risk of severe cellular rejection, 2r (hazard ratio [HR], 95% confidence interval [CI]).

Results—Eighteen percent of patients had Medicaid, and 72% of patients had low or medium MHI. Severe rejection occurred in 23% of patients. In the univariable analysis, Medicaid and diabetes were associated with increased risk of rejection while age >60 years, Caucasian race, and male sex were associated with reduced risk [Medicaid 2.32(1.20,4.51), diabetes 2.49(1.09,5.69), age 0.41(0.20,0.84), Caucasian 0.44(0.21,0.93), male 0.49(0.26,0.92)]. Median Household Income had no correlation [MHI 0.79(0.51,1.23)]. In the multivariable adjusted model, Medicaid was not associated with rejection [1.65(0.79,3.41)]; diabetes was strongly associated with risk of severe rejection [3.9(1.59,9.39)], and age >60 years was associated with risk reduction [0.42(0.20,0.82)].

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Conclusions—Medicaid insurance and MHI were not associated with increased risk of severe cellular rejection requiring hospitalization post-orthotopic heart transplant in the adjusted model. Rather the presence of diabetes and age > 60 years were associated with increased risk.

Keywords

Socioeconomic status; Outcomes; Diabetes

Introduction

Hospitalized rejection is associated with worse outcomes post-orthotopic heart transplant. [1–3] Efforts to improve survival have led to further restrictions on patients who are offered advanced therapies.[3–6] Often, underinsured populations are excluded from access to orthotopic heart transplant. In 2003, uninsured patients provided 16.9% of donor organs yet comprised 0.8% of transplant recipients.[6] State safety-net programs and Medicaid allow for some parity in organ allocation. However, some of the existing literature show that underinsurance and low socioeconomic status (SES) are associated with worse outcomes in heart allograft patients particularly from diverse racial/ethnic backgrounds.[2–5,7] We sought to evaluate if comorbidities had a greater impact on initial severe cellular rejection readmission post-orthotopic heart transplant than insurance status and median household income (MHI).

Methods

This study had institutional review board approval. A retrospective evaluation of 171 consecutive patients who underwent orthotopic heart transplant at The Ohio State University Wexner Medical Center from 7/1999 – 11/2013 was performed. Follow-up was through 9/2014 for the outcome of severe cellular rejection requiring hospitalization, classified as International Society for Heart & Lung Transplantation (ISHLT) grade 2r on endomyocardial biopsy by center pathologists and cardiologists, or competing risk of death. Insurance status, Medicaid or Non-Medicaid (includes Medicare and private payors) and MHI, which was estimated by the patient's zip code and corresponding United States 2013 Census data, were assessed. Median Household Income was divided into three even tertiles based upon range of MHI: low MHI was <\$38,371, medium MHI was \$38,371 – \$56,890, and high MHI was >\$56,890. Median Household Income was chosen as an estimate of SES given comparable precision to complex neighborhood models for assessment of SES in contemporary studies.[8,9] One patient had no MHI data given the absence of a population in their zip code at the time of the census collection; there were 171 patients with insurance data and 170 patients with MHI data.

The following was assessed during initial heart transplantation hospitalization using the institutional Information Warehouse which is populated from the medical record: demographics (age >60 years [which was chosen given a previous study supporting reduced risk of rejection with age >60 years[2]], race, and sex), presence of common comorbid diseases (atherosclerosis, cerebral vascular accident, diabetes, hypertension, and myocardial infarction), receipt of immunosuppression (tacrolimus, cyclosporine, mycophenolate

mofetil, azathioprine, and prednisone), and laboratory values on date of transplant (bilirubin, creatinine, hemoglobin, sodium, and white blood cell count).

Statistical Analysis

Baseline patient characteristics were compared among insurance type and MHI, using chi-square tests for categorical variables and analysis of variance for continuous variables. Cox proportional hazards multivariable analysis with adjustment for age, race, and gender was performed to assess risk of severe rejection (hazard ratio [HR], 95% confidence interval [CI]). Patients were censored at the time of death if death preceded hospitalization as a competing risk. Kaplan-Meier analyses were performed to compare survival times. Statistical analyses were performed using SAS 9.4 (Cary, NC), and the significance level was set at 0.05 for all tests.

Results

Out of a cohort of 171 patients from 1999–2013, the insurance and MHI distribution was the following: Medicaid 18%, Non-Medicaid 82%, Low MHI 22%, Medium MHI 50%, High MHI 27%. Across insurance and MHI groups, there were some significant differences (Table 1). Medicaid patients were on average 14 years younger ($p<0.0001$), less likely to be Caucasian ($p=0.002$), and more likely to be a male ($p=0.01$). Medicaid patients were more likely to be prescribed azathioprine ($p=0.04$). Otherwise there were no differences in comorbidities, remaining medications, or labs across insurance and MHI groups.

Twenty-three percent had severe rejection requiring hospitalization, and 22% died over the 15-year follow-up. Forty-one percent of patients with Medicaid had severe rejection, and 19% of patients with other insurance had severe rejection ($p=0.01$) (Table 2, Figure 1). There were significant differences in the ages of patients who had severe rejection ($p=0.009$). Nineteen percent of male patients compared to 37% female patients had severe rejection ($p=0.02$). There were differences in medications provided during initial transplant hospitalization for those who developed severe rejection. Patients taking mycophenolate mofetil ($p=0.04$) and prednisone ($p=0.03$) compared to patients not taking these medications had higher rates of severe rejection. There were no differences in severe rejection based upon MHI (Figure 2), other comorbidities, nor other medications. Patients taking cyclosporine compared to patients not taking this medication had higher rates of death ($p=0.02$); otherwise there were no other significant differences between who survived and those who did not (Table 2, Figures 3 and 4).

In the univariable analysis, Medicaid, but not MHI, was associated with increased risk of admission for severe rejection [Medicaid 2.32 (1.20, 4.51), MHI 0.79 (0.51, 1.23)], but neither had a significant difference in average time to severe rejection [insurance $p=0.73$, MHI $p=0.61$] (Figures 1 and 2). Covariates associated with reduced risk included age >60 years, Caucasian race, and male sex [age 0.41 (0.20, 0.84), Caucasian 0.44 (0.21, 0.93), male 0.49 (0.26, 0.92)]. Diabetes predicted increased risk of admission for severe rejection [2.49 (1.09, 5.69)] (Figure 5). Other demographics, comorbidities and medications had no significant association with severe rejection. In the unadjusted multivariable model, Medicaid insurance remained associated with increased risk [2.29 (1.17, 4.50)]. Meanwhile,

age >60 years, male sex, and diabetes remained significant [age 0.42 (0.19, 0.91), male 0.49 (0.26, 0.94), diabetes 2.6 (1.14, 5.96)]. However, after adjusting for age, race, and sex in the multivariable model, Medicaid no longer was associated with risk of severe rejection [1.65 (0.79, 3.41)], and male sex was not associated with reduced risk [0.59 (0.30, 1.15)]. The only variables associated with severe rejection in the fully adjusted model were diabetes, increasing risk by nearly four-fold [3.9 (1.59, 9.39)] and age >60 which significantly reduced risk [0.42 (0.20, 0.82)] (Figure 6).

Discussion

The key findings include: 1) neither Medicaid nor MHI were associated with increased risk of severe rejection post-orthotopic heart transplantation in fully adjusted models; 2) diabetes and age > 60 years were the only factors associated with increased risk of severe rejection in the fully adjusted model. This suggests that patients with differing forms of health care insurance including safety-net coverage like Medicaid and various MHI backgrounds can have equitable outcomes post-orthotopic heart transplant. However patients with an age > 60 years and history of diabetes may require additional scrutiny of the immunosuppression regimen, given their heightened risk for severe rejection.

Access to insurance does not equal access to care. Medicaid insurance is the primary form of healthcare coverage for up to 20% of US citizens as of 2015. [10,11] It is a US form of public insurance offered to low income adults, families, pregnant women, children, and disabled citizens.[12] However Medicaid eligibility and coverage policies differ by state.[12] Some state forms of Medicaid are eliminating the option to support advanced therapies like heart transplantation due to concerns for high costs and poor outcomes.[13,14] Several studies have shown that underinsurance and low MHI are associated with worse outcomes post-orthotopic heart transplantation.[2,3] Low socioeconomic status is thought to correlate with: poor follow-up care and reduced adherence to immunosuppression leading to increased risk of allograft rejection.[2,3] Ultimately this trajectory is leading towards greater inequalities in access to care for the poor population.[15]

Our contemporary data suggest that outcomes can be equitable regardless of insurance type and MHI. First, this program employs a multidisciplinary approach to evaluate and manage heart transplantation patients including: assistance with finding financial resources if indicated prior to transplantation (eligibility for Medicaid, Medicare, insurance through a family member, and fund-raising), social support evaluation (inclusion and education of care-giver), formal psychosocial evaluation with Stanford Integrated Psychosocial Assessment for Transplantation scoring and initiation of psychological therapy if indicated, easy access to transplant coordinators pre and post-operatively, and standard multi-medical specialty evaluations. Other centers have also shown that a comprehensive multidisciplinary approach can lead to equity in outcomes across different forms of insurance.[5,16] While utilization of available resources may be higher in lower SES groups, outcomes can still be similar.[5,16]

Second, Medicaid coverage in Ohio is different from other states. Ohio Medicaid ranks in the middle third for eligibility, quality, services offered, and reimbursement compared to the

rest of the country.[17,18] The cost of living in Ohio is lower than many states, ranking in the top third of states with the lowest cost of living.[19] Patients with Medicaid in Ohio may have more resources than patients from states that offer lesser Medicaid coverage and have higher costs of living.

Age 60 years was linked with a high risk of severe rejection. In our adjusted model, which included age, Medicaid was not associated with risk of rejection. In this study, Medicaid patients were younger than Non-Medicaid patients, which is representative of national profiles given age eligibility requirements for Medicare.[20] Several studies have also shown that younger adults are at higher risk for rejection.[21–23] This has been hypothesized to be largely secondary to immunosenescence, which is a distinct property of aging rather than socioeconomic factors.[21,24] This further highlights the need for fastidious management of immunosuppression regimen in patients 60 years regardless of insurance or MHI type.

Diabetes was the only comorbidity associated with risk of severe rejection. While a pre-transplant hemoglobin A1C was not available for this analysis, the institutional protocol followed ISHLT Guidelines by avoiding transplantation in patients with end-organ disease secondary to diabetes and hemoglobin A1C >7.5 at the time of listing.[25] Although the risk of rejection in the setting of pre-transplant diabetes has been mixed in the literature, most studies support the findings of increased risk of rejection with pre-transplant diabetes especially if there is diabetes-related end-organ dysfunction post-transplant.[26–30] In addition, de novo diabetes post-transplant is known to be related to immunosuppression medications and further increases comorbid risks and fatalities.[27,31] This reinforces the need for individual management plans of immunosuppression in the patient with a history of diabetes regardless of insurance type, in addition to good glucose control and management of associated cardiovascular risk factors.[32]

The immunosuppression regimen was associated with outcomes, but the implications are limited in the absence of adherence data. Both mycophenolate mofetil and prednisone are typical medications prescribed upon discharge from heart transplantation hospitalization to prevent rejection, but are also augmented for rejection during initial hospitalization prior to discharge[32]. The increased risk of rejection seen in patients taking mycophenolate mofetil and prednisone may be related to analytical bias. Furthermore, cyclosporine was associated with increased mortality in this study. Cyclosporine usage has been largely replaced by tacrolimus in the heart transplant population due to its known risk of higher mortality, rejection, and comorbidities[33,34].

There are limitations in representing a single center's experience, which could underestimate the role of insurance type and MHI in post-orthotopic heart transplant outcomes. It is acknowledged that MHI is a crude proxy for SES given that values are obtained via zip code rather than direct patient confirmation; yet this is an accepted form of assessing risks associated with MHI for a given population.[8,9,35–37] Furthermore, a single variable measure, such as MHI, is representative of diverse populations since an index measure, as proposed by Diez-Roux et al., must be validated in each population via factor analysis.[38] Outcomes were based on insurance type and MHI at heart transplantation; thus any possible post-transplantation switchover was not included in this analysis. Adherence to the

medication regimen and immunosuppression drug levels was not tracked, but the discharge regimen is still useful to assess risk of admission for severe rejection in this adult population with typically high adherence rates.[39,40] Operative risk factors (pre-operative hospitalization or inotropes, recipient organ sex-mismatch, ischemic time), body mass index, smoking history, and recipient education level were not included given limitations to the retrospective dataset. However at the time of listing, transplant patients cannot be active smokers and generally must have a body mass index of 35 or less.[25] Considering that this analysis was performed in a moderate-sized heart transplantation program (n=10.5–47 transplants/year)[41] spanning approximately 15 years with similar demographics to the average program, the results are meaningful.

Conclusions

In this single center transplant population, Medicaid insurance and MHI were not associated with increased risk of severe cellular rejection requiring hospitalization post-orthotopic heart transplant. The presence of diabetes and age ≥ 60 years conferred increased risk. Further investigation is needed to improve transplant management of patients who are young and diabetic. Additional study across transplant programs with comprehensive multidisciplinary teams would be warranted to validate these results.

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References

1. Parra AV, Rodrigues V, Cancelli S, Cordeiro JA, Bestetti RB. Impact of socioeconomic status on outcome of a Brazilian heart transplant recipients cohort. *Int J Cardiol.* 2008; 125:142–3. DOI: 10.1016/j.ijcard.2007.01.038 [PubMed: 17399819]
2. Allen JG, Weiss ES, Arnaoutakis GJ, Russell SD, Baumgartner WA, Shah AS, 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. DOI: 10.1016/j.healun.2011.07.019 [PubMed: 21959122]
3. Singh TP, Givertz MM, Semigran M, DeNofrio D, Costantino F, Gauvreau K. Socioeconomic Position, Ethnicity, and Outcomes in Heart Transplant Recipients. *Am J Cardiol.* 2010; 105:1024–9. DOI: 10.1016/j.amjcard.2009.11.015 [PubMed: 20346325]
4. Morris AA, Cole RT, Veledar E, Bellam N, Laskar SR, Smith AL, et al. Influence of Race/Ethnic Differences in Pre-Transplantation Panel Reactive Antibody on Outcomes in Heart Transplant Recipients. *J Am Coll Cardiol.* 2013; 62:2308–15. DOI: 10.1016/j.jacc.2013.06.054 [PubMed: 23994416]
5. Pamboukian SV, Costanzo MR, Meyer P, Bartlett L, Mcleod M, Heroux A. Influence of race in heart failure and cardiac transplantation: Mortality differences are eliminated by specialized, comprehensive care. *J Card Fail.* 2003; 9:80–6. DOI: 10.1054/jcaf.2003.11 [PubMed: 12751127]
6. Herring AA, Woolhandler S, Himmelstein DU. Insurance Status of U.S. Organ Donors and Transplant Recipients: The Uninsured Give, but Rarely Receive. *Int J Health Serv.* 2008; 38:641–52. DOI: 10.2190/HS.38.4.d [PubMed: 19069285]

7. Allen JG, Weiss ES, Arnaoutakis GJ, Russell SD, Baumgartner WA, Conte JV, et al. The Impact of Race on Survival After Heart Transplantation: An Analysis of More Than 20,000 Patients. *Ann Thorac Surg*. 2010; 89:1956–64. DOI: 10.1016/j.athoracsur.2010.02.093 [PubMed: 20494056]
8. Foraker RE, Patel MD, Whitsel EA, Suchindran CM, Heiss G, Rose KM. Neighborhood Socioeconomic Disparities and 1-year Case Fatality after Incident Myocardial Infarction: The Atherosclerosis Risk in Communities (ARIC) Community Surveillance (1992–2002). *Am Heart J*. 2013; 165:102–7. DOI: 10.1016/j.ahj.2012.10.022 [PubMed: 23237140]
9. 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; 191:302–8. DOI: 10.1016/j.jss.2014.05.004 [PubMed: 24932840]
10. Medicaid Enrollment Surges Across the U.S. *US News World Rep*; n.d. <http://www.usnews.com/news/articles/2015/02/24/medicaid-enrollment-surges-across-the-us> [accessed August 21, 2015]
11. [accessed August 21, 2015] Total Monthly Medicaid and CHIP Enrollment. n.d. <http://kff.org/health-reform/state-indicator/total-monthly-medicaid-and-chip-enrollment/>
12. (DCD) DCD. Who is eligible for Medicaid?. *HHS.gov*; 2015. <http://www.hhs.gov/answers/medicare-and-medicaid/who-is-eligible-for-medicaid/index.html> [accessed May 10, 2016]
13. *organdonor.gov*. [accessed July 30, 2015] Organ Transplantation: The Process. 2014. <http://www.organdonor.gov/about/transplantationprocess.html>
14. Allen, JE.; Unit, ANM. Arizona Medicaid Cuts Transplants. *ABC News*; 2010. http://abcnews.go.com/Health/Health_Care/medicaid-cuts-make-organ-transplants-unaffordable/story?id=12177059 [accessed July 30, 2015]
15. Deaton, A. *The Great Escape: Health, Wealth, and the Origins of Inequality*. Princeton University Press; 2015. Reprint edition
16. Dew MA, Goycoolea JM, Harris RC, Lee A, Zomak R, Dunbar-Jacob J, et al. An internet-based intervention to improve psychosocial outcomes in heart transplant recipients and family caregivers: development and evaluation. *J Heart Lung Transplant*. 2004; 23:745–58. DOI: 10.1016/j.healun.2003.07.002 [PubMed: 15366436]
17. Arellano, AR.; de Wolfe, S. [accessed May 4, 2016] Unsettling Scores, A Ranking of State Medicaid Programs. 2007. http://www.citizen.org/hrg1807#national_results
18. Weissman JS, Zaslavsky AM, Wolf RE, Ayanian JZ. State Medicaid Coverage and Access to Care for Low-income Adults. *J Health Care Poor Underserved*. 2008; 19:307–19. DOI: 10.1353/hpu.2008.0021 [PubMed: 18264004]
19. Cost of Living Data Series 2015 Annual Average. *Missouri Economic Research and Information Center*; n.d.
20. Medicare C. Baltimore MS 7500 SB, Usa M: 2014. <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/CMS-Statistics-Reference-Booklet/2014.html> [accessed August 21, 2015]
21. Renlund DG, Gilbert EM, O'Connell JB, Gay WA, Jones KW, Burton NA, et al. Age-associated decline in cardiac allograft rejection. *Am J Med*. 1987; 83:391–8. [PubMed: 3310619]
22. George JF, Pamboukian SV, Tallaj JA, Naftel DC, Myers SL, Foushee MT, et al. Balancing rejection and infection with respect to age, race, and gender: Clues acquired from 17 years of cardiac transplantation data. *J Heart Lung Transplant*. 2010; 29:966–72. DOI: 10.1016/j.healun.2010.05.003 [PubMed: 20580261]
23. Kobashigawa JA, Kirklin JK, Naftel DC, Bourge RC, Ventura HO, Mohanty PK, et al. Pretransplantation risk factors for acute rejection after heart transplantation: a multiinstitutional study. The Transplant Cardiologists Research Database Group. *J Heart Lung Transplant Off Publ Int Soc Heart Transplant*. 1993; 12:355–66.
24. Bradley BA. Rejection and recipient age. *Transpl Immunol*. 2002; 10:125–32. [PubMed: 12216942]
25. Mehra MR, Canter CE, Hannan MM, Semigran MJ, Uber PA, Baran DA, et al. The 2016 International Society for Heart Lung Transplantation listing criteria for heart transplantation: A 10-year update. *J Heart Lung Transplant Off Publ Int Soc Heart Transplant*. 2016; 35:1–23. DOI: 10.1016/j.healun.2015.10.023
26. Rhenman MJBR. Diabetes and heart transplantation. *J Heart Transplant*. 2006; 7:356–8.

27. Moro JA, Martínez-Dolz L, Almenar L, Martínez-Ortiz L, Chamorro C, García C, et al. Impact of Diabetes Mellitus on Heart Transplant Recipients. *Rev Esp Cardiol*. 2006; 59:1033–7. [PubMed: 17125713]
28. Saraiva J, Sola E, Prieto D, Antunes MJ. Diabetes as an outcome predictor after heart transplantation. *Interact Cardiovasc Thorac Surg*. 2011; 13:499–504. DOI: 10.1510/icvts.2010.256321 [PubMed: 21835844]
29. Morgan JA, John R, Weinberg AD, Colletti NJ, Mancini DM, Edwards NM. Heart transplantation in diabetic recipients: a decade review of 161 patients at Columbia Presbyterian. *J Thorac Cardiovasc Surg*. 2004; 127:1486–92. DOI: 10.1016/j.jtcvs.2003.11.063 [PubMed: 15116012]
30. Russo MJ, Chen JM, Hong KN, Stewart AS, Ascheim DD, Argenziano M, et al. Survival After Heart Transplantation Is Not Diminished Among Recipients With Uncomplicated Diabetes Mellitus An Analysis of the United Network of Organ Sharing Database. *Circulation*. 2006; 114:2280–7. DOI: 10.1161/CIRCULATIONAHA.106.615708 [PubMed: 17088463]
31. Marchetti P. New-onset diabetes after transplantation. *J Heart Lung Transplant Off Publ Int Soc Heart Transplant*. 2004; 23:S194–201. DOI: 10.1016/j.healun.2004.03.007
32. Costanzo MR, Costanzo MR, Dipchand A, Starling R, Anderson A, Chan M, et al. The International Society of Heart and Lung Transplantation Guidelines for the care of heart transplant recipients. *J Heart Lung Transplant*. 2010; 29:914–56. DOI: 10.1016/j.healun.2010.05.034 [PubMed: 20643330]
33. Grimm M, Rinaldi M, Yonan NA, Arpesella G, Arizón Del Prado JM, Pulpón LA, et al. Superior prevention of acute rejection by tacrolimus vs. cyclosporine in heart transplant recipients--a large European trial. *Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg*. 2006; 6:1387–97. DOI: 10.1111/j.1600-6143.2006.01300.x
34. Penninga L, Møller CH, Gustafsson F, Steinbrüchel DA, Gluud C. Tacrolimus versus cyclosporine as primary immunosuppression after heart transplantation: systematic review with meta-analyses and trial sequential analyses of randomised trials. *Eur J Clin Pharmacol*. 2010; 66:1177–87. DOI: 10.1007/s00228-010-0902-6 [PubMed: 20882273]
35. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health*. 1992; 82:703–10. [PubMed: 1566949]
36. Foraker RE, Rose KM, Kucharska-Newton AM, Ni H, Suchindran CM, Whitsel EA. Variation in rates of fatal coronary heart disease by neighborhood socioeconomic status: the atherosclerosis risk in communities surveillance (1992–2002). *Ann Epidemiol*. 2011; 21:580–8. DOI: 10.1016/j.annepidem.2011.03.004 [PubMed: 21524592]
37. Wagstaff A, Watanabe N. What difference does the choice of SES make in health inequality measurement? *Health Econ*. 2003; 12:885–90. DOI: 10.1002/hec.805 [PubMed: 14508873]
38. Diez Roux AV, Merkin SS, Arnett D, Chambless L, Massing M, Nieto FJ, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med*. 2001; 345:99–106. DOI: 10.1056/NEJM200107123450205 [PubMed: 11450679]
39. Kl G, AJCW-W. Patient compliance at one year and two years after heart transplantation. *J Heart Lung Transplant Off Publ Int Soc Heart Transplant*. 1998; 17:383–94.
40. Blanca Martínez Pérez A, López Suárez A, Rodríguez Rodríguez J, Sobrino Márquez JM, Lage Gallé E. Medication adherence in patients who undergo cardiac transplantation. *Transplant Proc*. 2013; 45:3662–4. DOI: 10.1016/j.transproceed.2013.11.006 [PubMed: 24314989]
41. Russo MJ, Iribarne A, Easterwood R, Ibrahimiyeh AN, Davies R, Hong KN, et al. Post-Heart Transplant Survival Is Inferior at Low-Volume Centers Across All Risk Strata. *Circulation*. 2010; 122:S85–91. DOI: 10.1161/CIRCULATIONAHA.109.926659 [PubMed: 20837931]

	Mean Time to Rejection Years (SD)	P-value
Medicaid	1.78 (0.45)	0.73
Non-Medicaid	1.58 (0.32)	

Figure 1. Time to Severe Rejection Based On Insurance Type

This represents unadjusted time to severe rejection based upon having Medicaid or Non-Medicaid health care insurance over 15 years. Patients were censored at the time of death if death preceded hospitalization as a competing risk. The mean time to rejection based upon insurance is also shown.

Figure 2. Time to Severe Rejection Based On MHI

This represents unadjusted time to severe rejection based upon MHI tiers of low, medium, and high over 15 years. MHI indicates median household income. Patients were censored at the time of death if death preceded hospitalization as a competing risk. The mean time to rejection based upon MHI is also shown.

Figure 3. Time to Death Based On Insurance Type

This represents unadjusted time to death based upon having Medicaid or Non-Medicaid health care insurance over 15 years.

Figure 4. Time to Death Based On MHI

This represents unadjusted time to death based upon MHI tiers of low, medium, and high over 15 years. MHI indicates median household income.

Figure 5. Univariable Analyses of Predictors For Severe Rejection Admission

Demographics, comorbidities, and medications were used in the univariable analysis. Only Insurance, MHI, and significant covariates are shown. CI, indicates confidence interval; P, p-value; **Bold Hazard Ratio**, statistical significance with $p < 0.05$.

Figure 6. Multivariable Adjusted Analyses of Predictors For Severe Rejection Admission

The model is adjusted for age, race, and gender. CI, indicates confidence interval; P, p-value;

Bold Hazard Ratio, statistical significance with $p < 0.05$.

Table 1

Baseline Characteristics Stratified By Insurance Type and MHI

Variable	Medicaid % N=31	Non-Medicaid % N=140	MHI		
			Low % N=38	Medium % N=85	High % N=47
Demographics					
Age, mean (SD)	41 (2.2)**	55 (1.02)**	52 (1.8)	54 (1.4)	52 (2.3)
Age Range	17–64	18–70	18–70	17–69	21–70
<i>Race</i>					
Caucasian	69**	90**	74	87	91
<i>Sex</i>					
Male	55*	47*	66	79	81
Comorbidities					
Atherosclerosis	13	14	18	9	17
CVA	9	6	13	5	6
Diabetes Mellitus	66	74	61	76	74
Hypertension	6	10	5	7	17
MI	9	29	0	6	4
Medications					
<i>Immunosuppression Medications</i>					
All CNI	69	67	66	68	66
Tacrolimus	41	42	42	40	47
Cyclosporine	35	32	26	36	34
Mycophenolate Mofetil	68	72	68	69	68
Azathioprine	3*	0*	3	0	0
Prednisone	68	72	71	68	66
Labs, mean (SD)					
Bilirubin mg/dL	1.19 (0.25)	1.14 (0.65)	1.2 (1.27)	1.2 (0.62)	1.1 (0.84)
Creatinine mg/dL	1.19 (0.7)	1.58 (1.4)	1.68 (1.5)	1.47 (1.4)	1.43 (0.8)
Hemoglobin g/dL	10.8 (0.4)	11.4 (0.5)	11.2 (1.9)	11.4 (2.2)	11.2 (2.0)
Sodium mmol/L	136.1 (0.6)	136 (0.3)	136.4(3.8)	136 (3.3)	135.8(3.7)

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Variable	Medicaid % N=31	Non-Medicaid % N=140	MHI		
			Low % N=38	Medium % N=85	High % N=47
WBC K/uL	11.1 (1.3)	9.3 (0.4)	9.9 (6.4)	9.3 (4.7)	9.8 (5.5)

CNI indicates calcineurin inhibitors; CVA, cerebral vascular accident; DL, deciliter; G, gram; K, kilo; L, liter; Mg, milligram; MHI, median household income; MI, myocardial infarction; Mmol, millimol; p, p-value; uL, microliter; WBC, white blood cell count. **Bold***, indicates statistical significance with $p < 0.05$; **bold****, $p < 0.001$.

Table 2

Covariates Based Upon Severe Rejection or Death

	Severe Rejection % N=40	p	Death % N= 38	p
Demographics				
Medicaid				
(Yes)	41	0.01	18	0.6
(No)	19		23	
MHI				
(Low)	26	0.51	21	0.93
(Medium)	26		24	
(High)	17		21	
Age				
Mean (SD)	48 (13.8)	0.009	54 (13.6)	0.53
Caucasian				
(Yes)	21	0.08	21	0.38
(No)	38		29	
Male sex				
(Yes)	19	0.02	22	0.96
(No)	37		22	
Atherosclerosis				
(Yes)	30	0.39	26	0.63
(No)	22		22	
CVA				
(Yes)	42	0.12	25	0.81
(No)	22		22	
DM				
(Yes)	27	0.11	20	0.29
(No)	15		28	
Hypertension				
(Yes)	6	0.09	6	0.11
(No)	25		24	
MI				
(Yes)	14	0.56	0	0.15
(No)	24		23	
Immunosuppression Medications				
Tacrolimus				
(Yes)	31	0.06	18	0.26
(No)	18		25	
Cyclosporine				
(Yes)	24	0.87	33	0.02

	Severe Rejection % N=40	p	Death % N= 38	p
(No)	23		17	
Mycophenolate Mofetil				
(Yes)	28	0.04	24	0.48
(No)	13		19	
Azathioprine				
(Yes)	24	0.58	100	0.06
(No)	0		22	
Prednisone				
(Yes)	38	0.03	19	0.43
(No)	13		24	

CVA indicates cerebral vascular accident; DM, diabetes mellitus; MHI, median household income; MI; myocardial infarction; p, p-value; SD, standard deviation. **Bold**, indicates statistical significance with $p < 0.05$.