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ORIGINAL ARTICLE

Do outcomes for heart transplantation differ based on donor and recipient race?

David Blitzer[1] | J'Undra N. Pegues[2] | Seth T. Lirette[3] | David A. Baran[4] | Monica Colvin[5] | Awori Hayanga[6] | Hannah Copeland[7,8]

[1]Columbia University, Department of Surgery, Division of Cardiovascular Surgery, New York, New York, USA

[2]University of Mississippi Medical Center, Department of Surgery, Jackson, Mississippi, USA

[3]Fulcrum, Jackson, Mississippi, USA

[4]Cleveland Clinic Heart Vascular and Thoracic Institute, Weston, Florida, USA

[5]Department of Medicine, Division of Cardiology, University of Michigan, Ann Arbor, Michigan, USA

[6]West Virginia University, Department of Cardiovascular and Thoracic Surgery, Morgantown WV, USA

[7]Lutheran Hospital, Fort Wayne, Indiana, USA

[8]Indiana University School of Medicine – Fort Wayne (IUSM-FW), Fort Wayne, Indiana, USA

Correspondence
Hannah Copeland, Surgical Director Heart Transplantation and Mechanical Circulatory Support, Director of Extracorporeal Membrane Oxygenation, Lutheran Hospital, Fort Wayne, IN, USA. 7910 W. Jefferson Blvd, MOB 2, Suite 102, Fort Wayne, IN 46804, USA. Assistant Professor of Surgery, Indiana University School of Medicine, Fort Wayne, Fort Wayne, Indiana, USA.
Email: hannahcopeland411@gmail.com

Abstract

Purpose: There are limited data examining the impact of both donor and recipient race on outcomes following orthotopic heart transplant (OHT). The purpose of this study was to evaluate the relationship between donor and recipient race and OHT outcomes.

Methods: The United Network for Organ Sharing (UNOS) database was retrospectively reviewed from January 2000 to March 2018 for donor hearts. A comparison was conducted based on donor and recipient race (White, Black, Hispanic, Other/Unknown). Races for which there were limited numbers were excluded from the analysis (Asian, $n = 1292$; American Indian, $n = 132$; Pacific Islander, $n = 132$, Multiple ethnicities, $n = 225$). The primary endpoint was survival at 30 days, 1 year survival, and post-transplant rejection. Logistic and Cox models were used to quantify survival endpoints.

Results: A total of 41 841 OHT were included. Of the recipients, 29 894 (71%) were White, 8475 (20%) were Black, and 3472 (8%) were Hispanic. Of the donors 27 783 (66%) were White, 6277 (15%) were Black, 6576 (16%) were Hispanic, and 1205 (3%) were Unknown/Other race. In a comparison of recipient demographics, White recipients were older (54.09 ± 12.21 years) compared to Black (49.44 ± 12.83 years) and Hispanic (49.97 ± 13.27 years) recipients. All other differences between groups were not clinically significant. Black recipients were more likely to receive a heart with an "urgent" status (probability .80) compared to White (.73) and Hispanic (.75) recipients ($p < .001$). Hispanic recipients were more likely to receive a transplant when listed as "non-urgent" (Probability .47) compared to White (.37) and Black (.30) recipients ($p < .001$). In terms of outcomes, compared to White recipients, Hispanic patients experienced a decreased 30-day survival (OR 1.27; $p = .011$) and 1-year survival (OR 1.17; $p = .016$). In comparing Donor/Recipient combinations compared to a White Donor/White Recipient combination, overall survival was decreased in White donor/African American recipient (HR 1.36; $p < .001$), African American donor/African American recipient (HR 1.41; $p < .001$) and Hispanic donor/African American recipient (HR 1.30; $p < .001$) combinations (Table 1).

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Conclusions: African American and Hispanic recipients have decreased survival compared to White recipients after heart transplant. The African American donor does not decrease survival. Racial differences still exist in donor and recipient characteristics and recipient outcomes after OHT. Increasing the donor pool for all races and ethnicities would potentially benefit all recipients. Continued study is warranted in order to minimize these differences among recipients and identify factors that could be contributing to decreased survival, in order to optimize outcomes for African American and Hispanic recipients post-transplant and eliminate disparities.

KEYWORDS
disparities, donation, donors, United Network for Organ Sharing (UNOS)

1 | INTRODUCTION

Heart failure disproportionately affects African Americans. When compared to other ethnic groups, this group has the highest rates of heart failure and greatest mortality.[1–6] Orthotopic heart transplantation is the treatment of choice for end stage heart disease.[7] Despite improvements overall in heart transplant outcomes over time, these improvements have not been distributed evenly across racial groups, with studies showing that despite improvements in short term survival, long term survival in African Americans and Hispanic recipients lags behind that of Caucasians.[8–10] This study aimed to examine the impact of donor race on heart transplantation outcomes.

2 | METHODS

We conducted a retrospective review of the United Network of Organ Sharing (UNOS) database regarding heart transplant recipients from January 1, 2000 to March 3, 2018. We examined the effects of racial concordance and discordance in donor and recipient pairings. Exclusion criteria were donor age < 15 years, recipient age < 18 years, multiple organ transplantations, and donor or recipient race for which there were limited numbers (Asian, $n = 1292$; American Indian, $n = 132$; Pacific Islander, $n = 132$, Multiple ethnicities, $n = 225$). Insurance status was also examined separately as a factor in recipient outcomes, with public versus private insurance being compared. Public insurers included Medicaid, Medicare, Children's Health Insurance Program (CHIP), and other government insurance. Recipients with insurance provider listed as self-pay, donation, free care, pending, foreign government, or unknown were excluded from this analysis. After exclusion criteria 41 841 orthotopic heart transplants remained and were reviewed for this study cohort.

Status listing at the time of transplant was also considered as a major part of this analysis. Urgent status was defined as Status 1A in the previous 3 tier allocation system and Status 1, 2, or 3 in the new 6 tier allocation system which was started in October 2018. Somewhat urgent status was defined as 1B in the previous allocation system and Status 4 or 5 in the new system. Non-urgent was defined as Status 2 in the previous allocation system and Status 6 in the new system.

2.1 | Statistical methods

Summary statistics were compiled where appropriate and simple comparisons were made with *t*-tests or chi-squared tests. The probabilities of receiving a transplant for the various race/status combinations were calculated by interacting these terms in a logistic regression model with transplant (y/n) as the outcome and calculating the predicted marginal probabilities. The primary endpoints of this study were survival at 30 days, 1 year survival, and post-transplant rejection. Logistic regression models were used to predict 30 day and 1 year survival, while Cox proportional hazards models were employed to analyze time to death and time to transplant rejection. These models were adjusted for donor age, sex, history of diabetes, hypertension, and stroke, and ischemic time as well as recipient age, sex, ethnicity, length of stay, UNOS region, ventricular assist devices (VAD), creatinine, and days on the waiting list. Appropriate linear combinations were constructed to examine comparisons of interest. All statistical analyses were done with Stata v17.0.

3 | RESULTS

A total of 41 841 OHT were included. Of the recipients, 29 894 (71%) were White, 8475 (20%) were Black, 3472 (8%) were Hispanic. Of the donors 27 783 (66%) were White, 6277 (15%) were Black, 6576 (16%) were Hispanic, and 1205 (3%) were Unknown/Other race (Table 1).

In a comparison of recipient demographics, White recipients were older (54.1 ± 12.2 years) compared to Black (49.4 ± 12.8 years) and Hispanic (50.0 ± 13.3 years) recipients. Statistically significant differences in recipient length of stay, donor age, recipient gender, baseline creatinine, diabetic recipient status, donor left ventricular ejection fraction, donor hypertension, donor smoking status, and recipient days on waiting list were noted but not deemed to be clinically significant

TABLE 1 Breakdown of donor and recipient matches.

	White recipient	Black recipient	Hispanic recipient	Total recipient
White Donor	20 658	5335	1790	27 783
	49%	13%	4%	66%
Black Donor	4204	1649	424	6277
	10%	4%	1%	15%
Hispanic Donor	4219	1266	1091	6576
	10%	3%	3%	16%
Unknown/Other Donor	813	225	167	1205
	2%	1%	0%	3%
Total Donor	29 894	8475	3472	41 841
	71%	20%	8%	100%

findings (Table 2). No differences were observed in the racial discordance effects on outcomes between sexes (all $p > .100$), UNOS regions (all $p > .106$), patient on temporary mechanical circulatory support (all $p > .414$), nor inotropic medications (all $p > .112$). Hispanic recipients were more likely to have a peak educational attainment of high school or less (64%) compared to African Americans or (50%) or Whites (42%) ($p < .001$). Compared to African Americans and Hispanics, White recipients were more likely to have a high educational level of Bachelor's degree (15% vs. 10% vs. 21%; $p < .001$) or doctorate (6% vs. 3% vs. 10%; $p < .001$). African Americans were more likely than White or Hispanic recipients to have an LVAD prior to transplant (35% vs. 27% vs. 27%; $p < .001$). As for insurance provider, White recipients were more likely to have private insurance compared to African Americans or Hispanics (58% vs. 42% vs. 41%; $p < .001$).

Black recipients were more likely to receive a heart with "urgent" status (probability .80) compared to White (.73) and Hispanic (.75) recipient ($p < .001$). Compared to White recipients, Black recipients were less likely to receive a heart transplant with somewhat urgent (.72 vs. .76; $p < .001$) or non-urgent (.30 vs. .37; $p < .001$) status. Hispanic recipients were more likely to receive a transplant when transplanted as "non-urgent" (Probability .47) compared to White (.37) and Black (.30) recipient ($p < .001$) (Table 3, Figure 1). Hispanic recipients were less likely than White recipients to receive a heart with somewhat urgent status (.73 vs .76; $p = .012$).

Outcomes compared to white recipients were analyzed both prior to and after the 2018 allocation policy change. Prior to the 2018 allocation policy change, African American recipients experienced increased overall mortality (HR 1.30; $p < .001$) and post-transplant rejection (HR 1.30; $p < .001$) (Table 4). Hispanic recipients experienced increased 1 year mortality (OR 1.17; $p = .021$). Similarly, Hispanic donors demonstrated increased 1-year mortality (OR1.11; $p = .048$), overall mortality (HR 1.06; $p = .034$) and post-transplant rejection (HR 1.07; $p = .018$) compared to White donors. African American donors were associated with increased overall mortality (HR 1.08; $p = .007$) and post-transplant rejection (HR 1.08; $p = .005$). Regarding Donor/Recipient combinations, when compared to a White Donor/White Recipient combination, White donor/African American recipient combinations

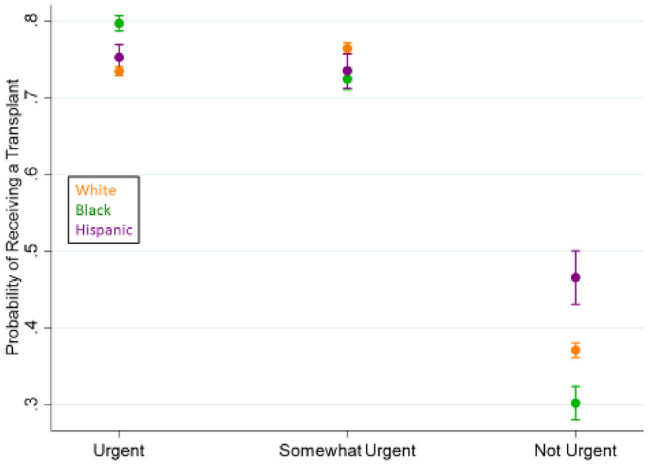


FIGURE 1 Probably of receiving a transplant, by clinical status for White, Black, and, Hispanic recipients.

demonstrated increased overall mortality (HR 1.32; $p < .001$) and post-transplant rejection (HR 1.32; $p < .001$) White Donor/Hispanic Recipient combinations experienced increased 30-day mortality (OR 1.29; $p = .045$) and 1-year mortality (OR1.31; $p = .002$). African American donor/African American recipient combinations demonstrated increased overall mortality (HR 1.42; $p < .001$) and increased post-transplant rejection (HR 1.41; $p < .001$). Hispanic donor/African American recipient combinations experienced increased 1 year mortality (OR 1.30; $p = .012$), overall mortality (HR 1.29; $p < .001$), and post-transplant rejection (HR 1.28; $p < .001$) (Figure 2).

After the 2018 allocation policy change, African American recipients experienced decreased 30-day mortality (OR .57; $p = .001$) but increased overall mortality (HR 1.71; $p < .001$) and post-transplant rejection (HR 1.69; $p < .001$) (Table 5). Compared to White Donor/White Recipient pairings, White Donor/African American recipients experienced decreased 30-day mortality (OR .47; $p = .001$) with increased overall mortality (HR 1.77; $p < .001$) and post-transplant rejection (HR 1.69; $p = .001$). African American Donor/African American Recipient pairings experienced increased

TABLE 2 Participant characteristics.

	White recipient N = 29853	Black recipient N = 8465	Hispanic recipient N = 3467	p-value
Recipient LOS	20.88 (24.97)	21.75 (23.82)	21.03 (25.20)	.019
Ischemic time	3.22 (1.05)	3.18 (1.06)	3.18 (1.07)	.004
Distance	178.68 (212.60)	177.45 (205.15)	171.79 (221.86)	.190
Donor age	32.43 (11.58)	32.07 (11.04)	31.76 (11.31)	<.001
Age (years)	54.09 (12.21)	49.44 (12.83)	49.97 (13.27)	<.001
Male recipient	22935 (77%)	5625 (66%)	2571 (74%)	<.001
Male donor	21282 (71%)	6034 (71%)	2303 (66%)	<.001
Region				
Region1	1484 (5%)	196 (2%)	131 (4%)	<.001
Region2	3705 (12%)	1295 (15%)	268 (8%)	
Region3	3133 (10%)	1416 (17%)	553 (16%)	
Region4	2841 (10%)	896 (11%)	613 (18%)	
Region5	4283 (14%)	764 (9%)	1089 (31%)	
Region6	1113 (4%)	81 (1%)	47 (1%)	
Region7	2939 (10%)	657 (8%)	144 (4%)	
Region8	2084 (7%)	369 (4%)	85 (2%)	
Region9	1692 (6%)	627 (7%)	420 (12%)	
Region10	3047 (10%)	580 (7%)	42 (1%)	
Region11	3532 (12%)	1584 (19%)	75 (2%)	
VAD				
No VAD	16266 (54%)	4394 (52%)	2072 (60%)	<.001
LVAD	8184 (27%)	2976 (35%)	923 (27%)	
RVAD	70 (0%)	15 (0%)	6 (0%)	
TAH	213 (1%)	73 (1%)	28 (1%)	
LVAD + RVAD	631 (2%)	172 (2%)	73 (2%)	
Unspecified	1214 (4%)	220 (3%)	70 (2%)	
Unknown	3275 (11%)	615 (7%)	295 (9%)	
Creatinine	1.27 (.59)	1.35 (.69)	1.21 (.97)	<.001
Diabetic recipient	7321 (25%)	2245 (27%)	1058 (31%)	<.001
Diabetic donor	980 (3%)	253 (3%)	113 (3%)	.397
Donor LVEF (%) (please add units and clarify what is in parentheses)	61.56 (7.09)	61.23 (7.00)	61.92 (7.30)	<.001
Donor hypertension	4329 (15%)	1279 (15%)	437 (13%)	.002
Donor smoking	5562 (19%)	1365 (16%)	528 (15%)	<.001
Days on waiting list	226.41 (382.52)	219.58 (369.96)	200.72 (370.19)	.001
Removed from waitlist due to death	7970 (51%)	1619 (43%)	682 (45%)	.001

Note: Means (standard deviations) for continuous variables. Counts (%) for categorical variables.

overall mortality (HR 1.89; $p = .010$) and post-transplant rejection (HR 2.01; $p = .004$). Hispanic Donor/African Americans Recipient pairings were associated with increased post-transplant rejection (HR 1.77; $p = .038$).

Separate analysis was performed to compare the impact of private ($n = 24\ 202$) versus public insurance ($n = 22\ 546$) (Table 6). A comparison of recipient demographics for these two cohorts revealed that recipients with private insurance had a shorter length of stay (20.66 ± 24.84 days vs. 22.23 ± 25.63; $p < .001$), were younger (51.54 ± 11.93 vs. 54.15; $p < .001$), had lower rates of diabetes (23 vs. 29%; $p < .001$), and spent less time on the waiting list (201.66 ± 357.44 days vs. 235.13 ± 400.01; $p < .001$). Non-white recipients were more likely to have public insurance than private insurance (39% vs. 26%, $p < .001$). There were statistically significant differences in donor age,

TABLE 3 Probabilities of receiving a transplant by race and status.

	White	Black		Hispanic		
Status	Probability	Probability	*p*-value versus White	Probability	*p*-value versus White	*p*-value versus Black
Urgent	.73	.80	<.001	.75	.045	<.001
	.73–.74	.79–.81		.74–.77		
Somewhat urgent	.76	.72	<.001	.73	.012	.428
	.76–.77	.71–.74		.71–.76		
Non-urgent	.37	.30	<.001	.47	<.001	<.001
	.36–.38	.28–.32		.43–.50		

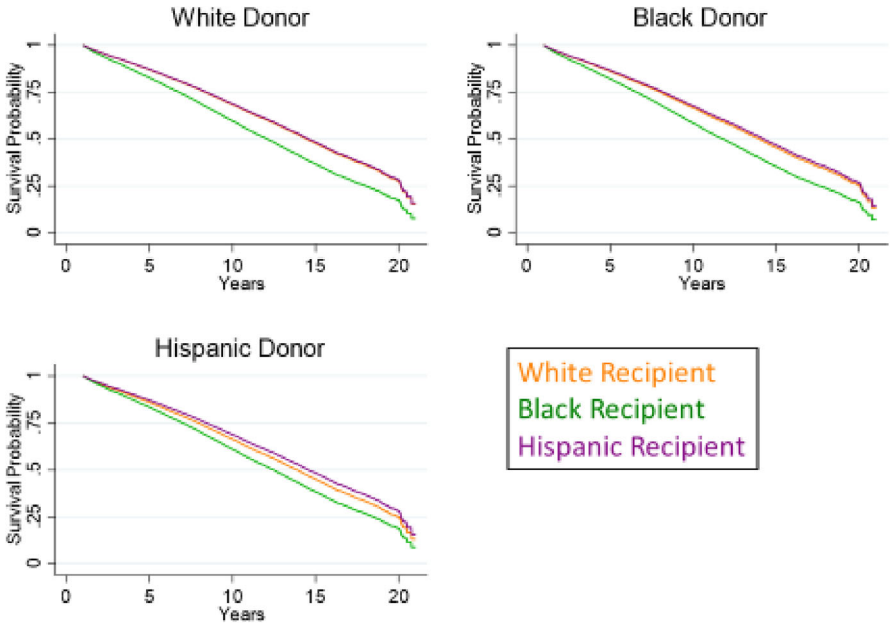


FIGURE 2 Survival association for donor/recipient pairings across the full study period.

recipient gender, preoperative ECMO support, donor inotropic support, and donor diabetes status. A comparison of recipient outcomes was then performed based on insurance status (Table 7). When pooled across races, public insurance was associated with increased mortality at 1 year (OR 1.13, $p < .001$) and post-transplant rejection (HR 1.31, $p < .001$). This effect remained when stratified by race: white recipients with public insurance had increased 1 year mortality (OR 1.13, $p = .003$) and post-transplant rejection (HR 1.35, $p < .001$). In addition, white recipients with public insurance had increased 30-day mortality (OR 1.16, $p = .029$). In nonwhite recipients, public insurance was associated with increased 1-year mortality (OR 1.14, $p = .031$) and post-transplant rejection (HR 1.23, $p < .001$).

4 | DISCUSSION

This is a retrospective review of a large database examining differences in outcomes of racially concordant and discordant donor-recipient pairings. We demonstrated differences in clinical status of OHT recipients based on race as well as differences in 30-day survival, 1 year survival, and post-transplant rejection. Racial disparities in heart failure and OHT have been well documented in the past, and although the 2018 changes in the allocation policies were intended to ideally help to mitigate these changes, the early studies of its impact have been insufficient in decreasing these disparities.[11–15] While our results demonstrated some improvements there is still work that remains to be done.

This analysis is unique for its inclusion of donor/recipient racially discordant and concordant pairings in its analysis, with significant differences based on race when compared to outcomes for racially concordant white donor/white recipient pairings. As mentioned, several studies have revealed differences in outcomes based on OHT recipient race.[16,17] The impact of donor-recipient concordance has been the subject of limited inquiry to this point. Chouairi performed an analysis of the UNOS database from 2011 to 2020 for outcomes based on donor and recipient race.[15] Their analysis included 32 353 patients and demonstrated that the proportion of Black and Hispanic patients increased over the study period but that Black patients were less likely

TABLE 4 Survival associations for various predictors across four models prior to the 2018 allocation policy change.

	30 day death (OR)	1 year death (OR)	Overall mortality (HR)	Post Tx rejection (HR)
Recipient (vs. White)				
AA	.87 $p = .060$ (.75,1.01)	1.06 $p = .187$ (.97,1.17)	1.30 $p < .001$ (1.24,1.37)	1.30 $p < .001$ (1.24,1.37)
Hispanic	1.21 $p = .054$ (1.00,1.48)	1.17 $p = .021$ (1.02,1.34)	.99 $p = .833$ (.92,1.07)	1.02 $p = .676$ (.94,1.09)
Donor (vs. White)				
AA	.99 $p = .914$ (.85,1.16)	1.07 $p = .168$ (.97,1.19)	1.08 $p = .007$ (1.02,1.13)	1.08 $p = .005$ (1.02,1.14)
Hispanic	1.06 $p = .442$ (.91,1.24)	1.11 $p = .048$ (1.00,1.23)	1.06 $p = .034$ (1.00,1.12)	1.07 $p = .018$ (1.01,1.13)
Donor/Recipient (vs. W/W)				
W/B	.88 $p = .153$ (.74,1.05)	1.06 $p = .333$ (.94,1.18)	1.32 $p < .001$ (1.24,1.40)	1.32 $p < .001$ (1.24,1.40)
W/H	1.29 $p = .045$ (1.01,1.67)	1.31 $p = .002$ (1.11,1.56)	1.02 $p = .770$ (.92,1.12)	1.01 $p = .810$ (.91,1.12)
B/W	1.05 $p = .576$ (.88,1.26)	1.13 $p = .052$ (1.00,1.27)	1.06 $p = .078$ (.99,1.13)	1.06 $p = .061$ (1.00,1.14)
B/B	.79 $p = .132$ (.57,1.08)	1.09 $p = .351$ (.91,1.32)	1.42 $p < .001$ (1.29,1.56)	1.41 $p < .001$ (1.28,1.55)
B/H	1.05 $p = .859$ (.60,1.85)	.92 $p = .697$ (.62,1.37)	1.01 $p = .952$ (.82,1.24)	1.06 $p = .608$ (.86,1.30)
H/W	1.05 $p = .645$ (.86,1.26)	1.10 $p = .129$ (.97,1.25)	1.09 $p = .006$ (1.03,1.16)	1.10 $p = .006$ (1.03,1.17)
H/B	1.02 $p = .910$ (.73,1.42)	1.30 $p = .012$ (1.06,1.59)	1.29 $p < .001$ (1.15,1.45)	1.28 $p < .001$ (1.14,1.44)
H/H	1.20 $p = .303$ (.85,1.69)	1.16 $p = .201$ (.92,1.46)	1.02 $p = .718$ (.91,1.15)	1.08 $p = .200$ (.96,1.21)

Abbreviations: OR, odds ratio; HR, hazard ratio.

to be transplanted than White patients and also suffered a greater risk mortality. These findings and our own point to the importance of improving care for minorities for also the need for greater recruitment of donors from different races and ethnicities, which could also serve to improve recipient outcomes.[18] In general, these studies confirm that although there has been increased attention to racially disparate outcomes in heart transplant, more work remains to be done to eliminate those disparities and to improve outcomes for all racial groups.

Our analysis included an evaluation of the impact of insurance status on clinical outcomes and demonstrated worse outcomes for recipients on public insurance plans. Some studies have pointed to an impact of socioeconomics as a factor in heart transplant outcomes.[19–21] Wayda et al performed an analysis of the UNOS database from 1994 to 2014 to determine the impact of socioeconomic factors on heart transplant outcomes.[22] With 33 893 recipients included adjusted models revealed neighborhood socioeconomic status, Medicare, Medicaid, and college education as significant predictors of death or re-transplantation. As in the studies cited previously, they demonstrated an improvement in outcomes overtime but not for the lowest socioeconomic status patients.

Our analysis revealed that African American recipients were more likely to have an LVAD prior to transplant and that non-White recipients were more likely to undergo urgent transplant. These findings reflect previously described differences in not only the incidence and outcomes for heart failure in the African American community, with this population experiencing the highest rate of HF related morbidity and mortality and delayed presentation, but also perhaps differential application of advanced therapies.[3,23–25] Although African Americans with HF tend to be less often referred for advanced therapies in general, when deciding between LVAD and transplant, there appears to be a tendency to offer Black patients LVAD.[3,26] While there may be racial differences in the pathophysiology of heart failure, the differences in outcomes cannot be attributed solely to biologic differences[27–29] Furthermore, we demonstrated that non-white recipients were more

TABLE 5 Survival associations for various predictors across four models after the 2018 allocation policy change.

	30 day death (OR)	1 year death (OR)	Overall mortality (HR)	Post Tx rejection (HR)
Recipient (vs. White)				
AA	.57 $p = .001$ (.41,.80)	.84 $p = .077$ (.70,1.02)	1.71 $p < .001$ (1.33,2.21)	1.69 $p < .001$ (1.31,2.19)
Hispanic	1.46 $p = .060$ (.98,2.17)	1.22 $p = .143$ (.94,1.58)	1.09 $p = .719$ (.69,1.70)	1.27 $p = .266$ (.83,1.96)
Donor (vs. White)				
AA	.92 $p = .640$ (.66,1.30)	1.02 $p = .852$ (.83,1.26)	1.12 $p = .495$ (.81,1.53)	1.20 $p = .249$ (.88,1.64)
Hispanic	1.01 $p = .959$ (.72,1.42)	1.04 $p = .698$ (.85,1.29)	1.07 $p = .674$ (.78,1.47)	1.07 $p = .675$ (.78,1.48)
Donor/Recipient (vs. W/W)				
W/B	.47 $p = .001$ (.30,.72)	.84 $p = .140$ (.66,1.06)	1.77 $p < .001$ (1.30,2.42)	1.69 $p = .001$ (1.23,2.31)
W/H	1.49 $p = .107$ (.92,2.43)	1.10 $p = .567$ (.79,1.55)	1.02 $p = .943$ (.56,1.88)	1.29 $p = .372$ (.74,2.24)
B/W	.79 $p = .272$ (.51,1.21)	1.01 $p = .968$ (.78,1.30)	1.19 $p = .412$ (.79,1.80)	1.29 $p = .225$ (.86,1.94)
B/B	.80 $p = .448$ (.45,1.42)	.85 $p = .410$ (.59,1.24)	1.89 $p = .010$ (1.16,3.08)	2.01 $p = .004$ (1.25,3.23)
B/H	1.24 $p = .688$ (.44,3.47)	1.40 $p = .289$ (.75,2.59)	.39 $p = .353$ (.05,2.82)	.40 $p = .365$ (.06,2.89)
H/W	1.00 $p = .981$ (.66,1.50)	1.01 $p = .969$ (.77,1.31)	1.04 $p = .848$ (.68,1.60)	.97 $p = .903$ (.62,1.52)
H/B	.57 $p = .130$ (.27,1.18)	.85 $p = .439$ (.57,1.28)	1.64 $p = .077$ (.95,2.85)	1.77 $p = .038$ (1.03,3.02)
H/H	1.33 $p = .436$ (.65,2.72)	1.39 $p = .153$ (.88,2.18)	1.59 $p = .165$ (.83,3.07)	1.78 $p = .083$ (.93,3.44)

Abbreviations: OR, odds ratio; HR, hazard ratio.

likely to have public insurance and that public insurance was associated with inferior outcomes. These findings are in contrast to recent findings which report increased access to care and decreased medical debt with public insurance, but this remains controversial in the literature.[30,31] The public insurance offerings are varied and more granular analysis is limited by the data. Undoubtedly the implications of public insurance should be considered during ongoing discussion of expansion of public health insurance and the impact of any change should be a topic of continued investigation moving forward.

4.1 | Limitations

This is a retrospective database-driven study and relied on previously collected data. An important weakness was that all the data points were not available or collected since the beginning, particularly the insurance information which was not collected prior to 1994. Similarly, the information on acute rejection was only available after 2004. Although we used insurance as an important surrogate of socioeconomic status, we could not perform an analysis to evaluate its impact if there was a change in the insurance type during follow-up and its impact on post-transplant survival.

This study has additional limitations in addition to being retrospective. First, differences between races about key social determinants of health, including access to care, social support systems, and income could not be assessed because of limitations of the UNOS database. Second, while we found that the percentage of Black and Hispanic patients listed and receiving cardiac transplantation has increased, these improvements do not necessarily reflect the proportion of patients living with advanced heart failure. Our analysis of the UNOS database includes only patients accepted for listing by a transplant center. Third, while UNOS does capture other racial categories such as Asian and Pacific Islander, we a priori decided to focus on the three previously defined patient populations. In addition, we recognize that race

TABLE 6 Patient characteristics for private versus publicly insured heart transplant recipients.

	Overall (*N* = 46748)	Private insurance (*N* = 24202)	Public insurance (*N* = 22546)	*p*-value
Recipient LOS	21.42 (25.24)	20.66 (24.84)	22.23 (25.63)	<.001
Ischemic time	3.24 (1.07)	3.25 (1.06)	3.24 (1.08)	.446
Distance	186.56 (217.20)	184.91 (217.18)	188.33 (217.21)	.089
Donor age	32.31 (11.35)	32.07 (11.34)	32.57 (11.35)	<.001
Age	52.80 (12.67)	51.54 (11.93)	54.15 (13.28)	<.001
Male recipient	34782 (74%)	17881 (74%)	16901 (75%)	.008
Male donor	33055 (71%)	17037 (70%)	16018 (71%)	.122
Non white recipient	15003 (32%)	6318 (26%)	8685 (39%)	<.001
Non white donor	16040 (34%)	8203 (34%)	7837 (35%)	.049
Region				
Region1	2023 (4%)	1077 (4%)	946 (4%)	<.001
Region2	5733 (12%)	3272 (14%)	2461 (11%)	
Region3	5541 (12%)	2658 (11%)	2883 (13%)	
Region4	4743 (10%)	2418 (10%)	2325 (10%)	
Region5	7410 (16%)	4120 (17%)	3290 (15%)	
Region6	1453 (3%)	726 (3%)	727 (3%)	
Region7	4133 (9%)	2112 (9%)	2021 (9%)	
Region8	2834 (6%)	1531 (6%)	1303 (6%)	
Region9	3142 (7%)	1525 (6%)	1617 (7%)	
Region10	3956 (8%)	2086 (9%)	1870 (8%)	
Region11	5780 (12%)	2677 (11%)	3103 (14%)	
VAD				
No VAD	26179 (56%)	13878 (57%)	12301 (55%)	<.001
LVAD	13694 (29%)	6086 (25%)	7608 (34%)	
RVAD	107 (0%)	57 (0%)	50 (0%)	
TAH	337 (1%)	204 (1%)	133 (1%)	
LVAD + RVAD	956 (2%)	587 (2%)	369 (2%)	
ECMO	894 (2%)	557 (2%)	337 (1%)	<.001
IABP	4982 (11%)	2626 (11%)	2356 (10%)	.161
Donor on inotropic support	21927 (49%)	11513 (50%)	10414 (48%)	<.001
Creatinine	1.27 (.65)	1.26 (.64)	1.28 (.65)	.031
Diabetic recipient	12101 (26%)	5669 (23%)	6432 (29%)	<.001
Diabetic donor	1544 (3%)	745 (3%)	799 (4%)	.005
Donor LVEF	61.55 (7.06)	61.59 (7.05)	61.52 (7.06)	.327
Days on Waiting List	217.80 (378.93)	201.66 (357.44)	235.13 (400.01)	<.001

Note: Means (standard deviations) for continuous variables. Counts (%) for categorical variables.

is often an imprecise term, and that we have not included individuals who identified as having a mixed racial background.

5 | CONCLUSION

African American recipients have decreased survival compared to white recipients after heart transplant. Hearts transplanted from African Americans donors have equal survival conditional on the recipient's race. Increasing the donor pool of all minority race and ethnic groups will further assist respective minority race and ethnic recipients. Differences in outcomes still exist based on donor and recipient race. The reasons for these differences are multi-factorial. Continued study is warranted in order to minimize these differences and disparities and to improve outcomes for all patients.

TABLE 7 Survival associations for various predictors across four models.

	Death within 30 d (OR)		Death within 1 year (OR)		Overall hazard of death (HR)		Overall hazard of post Tx rejection (HR)	
Public versus Private insurance (Pooled Across Race)	1.10 $p = .080$ (.99,1.23)		1.13 $p < .001$ (1.06,1.21)		1.33 $p < .001$ (1.28,1.38)		1.31 $p < .001$ (1.27,1.36)	
Public versus Private insurance (White)	1.16 $p = .029$ (1.01,1.32)	Interaction $p = .192$	1.13 $p = .003$ (1.04,1.23)	Interaction $p = .948$	1.37 $p < .001$ (1.31,1.43)	Interaction $p = .027$	1.35 $p < .001$ (1.29,1.41)	Interaction $p = .026$
Public versus Private insurance (NonWhite)	.99 $p = .902$ (.81,1.20)		1.14 $p = .031$ (1.01,1.28)		1.25 $p < .001$ (1.17,1.34)		1.23 $p < .001$ (1.15,1.32)	

Note: Adjusted for: Donor age, sex, ethnicity, ischemic time, as well as recipient age, sex, ethnicity, LOS, region, VAD, creatinine, days on waiting list, and status at transplant.
Abbreviations: OR, odds ratio; HR, hazard ratio.

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CONFLICT OF INTEREST STATEMENT

Hannah Copeland has been a speaker for Paragonix and Abbott. David Baran has received consulting fees from Getinge, Livanova, Abbott and Abiomed. He is on the Steering Committee for Procyrion, and Care Dx. He has been a speaker for Pfizer. All other authors have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in UNOS at https://unos.org/data/.

ORCID

David Blitzer https://orcid.org/0000-0002-3785-5470
David A. Baran https://orcid.org/0000-0002-7754-9953
Hannah Copeland https://orcid.org/0000-0002-3753-5194

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