Published in final edited form as:

Ann Vasc Surg. 2020 January ; 62: 142–147. doi:10.1016/j.avsg.2019.08.068.

Association of Race and Ethnicity with Vascular Access Type Selection and Outcomes

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Abstract

Background: Black end-stage renal disease (ESRD) patients represent 30.5% of the prevalent ESRD population in the United States, despite only accounting for 18% of the total population. Black patients are less likely to have pre-ESRD care compared to their white counterparts, and are 3 to 4 times more likely to progress from chronic kidney disease to ESRD than whites, suggesting black patients are particularly vulnerable to disparities in outcomes related to hemodialysis and ESRD. The objective of this study is to examine the association of race with outcomes of hemodialysis access and selection of arteriovenous fistula versus arteriovenous graft.

Methods: Patients with chronic kidney disease who initiated dialysis through a tunneled hemodialysis catheter (THC) were identified in the Optum Clinformatics database (2011–2017). The odds of arteriovenous fistula (AVF) versus arteriovenous graft (AVG) creation and the odds of repeat vascular access creation were analyzed using logistic regression. Time from initial AVF/AVG to THC removal and time to repeat AVF/AVG were analyzed using Cox proportional hazards.

Results: 7,584 vascular access patients met the inclusion criteria: 5,852 (77%) AVF and 1,732 (23%) AVG. Median follow-up was 583 days overall (range 1–2,543), 589 days among AVF patients (range 1–2,543), and 260 days among AVG patients (range 1–2,529). Between races there was no clinically significant variation in characteristics or comorbidities, with the exception of a much lower rate of obesity among Asians. Black patients had 36% lower odds of index AVF versus index AVG ($P < 0.001$). Patients 70 or older and patients with diabetes had lower odds of index AVF, while men and obese patients had greater odds of receiving AVF. Overall, graft patients were 73% more likely to have a shorter time to THC removal than fistula removal than whites. Patients with diabetes, cardiac arrhythmia patients, and obesity were more likely to have a longer time to THC removal. 1,589 (21%) patients underwent a repeat vascular access creation

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Meeting: Vascular & Endovascular Surgery Society, Winter Meeting 2019, Jan. 31 through Feb. 3, 2019

during the follow-up period: 19% of whites (n=802), 26% of blacks (n=483), 19% of Hispanics (n=250), 19% of Asians (n=54) ($p<0.001$). Multivariate analysis demonstrated black patients had 58% greater odds of requiring a second access than white patients ($p<0.001$). Graft patients, patients 70 or older, and men had lower odds of repeat access. Black patients were 45% more likely to have a shorter time until second access creation. Graft patients, patients age 70 or older, and men were more likely to have a longer time until second access. Patients with obesity were more likely to have a shorter time until second access.

Conclusion: This study's findings suggest that after initial vascular access, compared to whites, blacks have no difference in time to index access success, but their access fails earlier and more frequently, independent of access type, age, and co-morbidities. Given blacks constitute 30.5% of the hemodialysis population in the United States, it is imperative future research investigate the root causes of these disparities.

Introduction

The United States Census Bureau estimates that Blacks constitute approximately 18% of the nation's total population. However, Blacks represent 30.5% of the prevalent end-stage renal disease (ESRD) population in the US.¹ Despite the disproportionate representation of Blacks in the ESRD population, little investigation has been performed in the association of race with outcomes of hemodialysis vascular access. At the same time, extensive investigation has been performed regarding the association of other demographic factors including age and sex with vascular access outcomes.²⁻⁴

Blacks have been shown to have a similar prevalence to non-Blacks in the early stages of chronic kidney disease, but are 3–4 times more likely to progress to ESRD.⁵ Black patients are also more likely to have no pre-ESRD care compared to their non-Black counterparts.⁵ Furthermore, Blacks are significantly less likely to undergo arteriovenous fistula v graft compared to non-Blacks.¹ The objective of this study is to examine the association of race and ethnicity with likelihood of fistula creation, time to tunneled catheter removal, likelihood of repeat vascular access and time to repeat vascular access in a population of privately-insured patients initiating hemodialysis with a tunneled catheter.

Material and Methods

The Optum Clinformatics Data Mart claims database from 2011 through 2017 was used to conduct this retrospective analysis. The database is comprised of commercial claims from 47 million unique individuals enrolled in plans from a single national insurance carrier, with 15 to 18 million covered individuals in each year of claims. Medicare Advantage enrollees in the Clinformatics database account for approximately one-quarter of all Medicare Advantage geographic location were available.

The claims database was queried to identify all adult patients with an International Classification of Diseases, 9th edition (ICD-9) or 10th edition (ICD-10) diagnostic code for chronic kidney disease and at least one claim for hemodialysis vascular access creation, as identified by Current Procedural Terminology (CPT) codes for AVF (36818, 36819, 36820, 36821) and AVG (36830). Inclusion criteria consisted of having had at least one claim for

outpatient hemodialysis within 90 days of permanent vascular access creation, a minimum of twelve months of continuous plan enrollment without any claims for hemodialysis or vascular access prior to the index AVF/AVG, and placement of a THC without removal any time prior to the initial outpatient hemodialysis claim. THC removal and replacement within seven days was treated as continuous THC dependence.⁶

Though two years of additional data was available, only index AVF/AVG occurring between January 1, 2012 and December 31, 2016 were identified to allow for a 12-month hemodialysis- and vascular access-free period of continuous plan enrollment prior to the index AVF/AVG, and a minimum of 12-months of potential follow-up after index AVF/AVG. Patients were excluded from the study if they had discontinuous insurance enrollment post-index AVF/AVG. To avoid biasing the sample towards with longer enrollment times post-index AVF/AVG, no minimum amount of insurance enrollment after index AVF/AVG was imposed. Primary and non-primary ICD-9 and ICD-10 diagnostic codes on all patient claims were used to identify patient comorbidities.

Four outcomes were modeled: (1) Likelihood of AVF creation versus AVG creation; (2) days from index AVF/AVG creation to THC removal; (2) repeat hemodialysis access creation after index AVF/AVG; and (4) days from index AVF/AVG creation to repeat hemodialysis access creation. Due to the limitations of defining patency in claims data, repeat access creation was used a surrogate measure for patency. The primary regressor was race/ethnicity. Patients were coded as non-Hispanic white, non-Hispanic black, Hispanic of any race, or non-Hispanic Asian. All Hispanic patients were included in the Hispanic classification, irrespective of racial classification (e.g. white, black, or Asian). Herein, “race” refers to the combination of race and ethnicity coded within this variable. White race was used for the reference class in all regression models.

Other covariates included in the multivariate models were age, sex, diabetes, cardiac arrhythmia (CA), congestive heart failure (CHF), peripheral vascular disease (PVD), and obesity. Given nearly all patients in the study had hypertension, it was not included as a covariate in any models. In the regression models, a dichotomous age measure (age <70 and age ≥ 70) was used to provide greater clarity for any potential age-related policy implications. In the models that did not include access type as the outcome variable, interaction terms between race and access type were evaluated and included in the model if there was at least one significant interaction effect.

Univariate differences between racial groups were assessed using chi-squared tests and Kruskal Wallis tests, as appropriate. Likelihood of AVF creation versus AVG creation and likelihood of repeat vascular access were analyzed using logistic regressions. Factors associated with variations in time to THC removal and time to repeat access creation were assessed using cox proportional hazards models. Patients were censored either at date of kidney transplant or at the termination of insurance plan enrollment, whichever came first. Sample selection was conducted using SAS 9.2 (SAS institute, Cary, NC) and statistical analysis was performed using Stata 15.1 (StataCorp, College Station, TX).

Results

7,584 vascular access met the inclusion criteria: 5,852 (77%) AVF and 1,732 (23%) AVG. Median follow-up was 583 days overall (range 1–2,543), 589 days among AVF patients (range 1–2,543), and 260 days among AVG patients (range 1–2,529). 5,510 patients had Medicare advantage insurance, 71% of AVF patients (n=4,140) and 79% of AVG patients (n=1,370). Though there was significant variation in access type, sex, age, and comorbidities ($p<0.05$), the variation was generally not of clinical significance, with the exception of much lower rates of obesity among Asians (Table 1).

In a multivariate logistic regression of likelihood of index AVF versus index AVG (Table 2), black patients had 36% lower odds of AVF versus AVG ($P<0.001$), elderly patients (Age 70) had 31% lower odds of AVF than younger patients ($p<0.001$), and patients with diabetes had 19% lower odds of AVF ($p=0.011$). Men had 85% greater odds of receiving AVF than women ($p<0.001$) and obese patients had 21% greater odds of receiving AVF than non-obese patients ($p=0.001$).

The multivariate Cox proportional hazards model of time to THC removal was the only regression model that demonstrated a significant interaction between race and access type, with Hispanic graft patients being 25% more likely to have a shorter time to THC removal than white graft patients ($p=0.017$) (Table 3). In general, graft patients were 73% more likely to have a shorter time to THC removal ($p<0.001$). Among fistula patients, there was no significant difference in time to THC removal between races. Diabetic patients were 9% more likely to have a longer time to THC removal ($p=0.010$), patients with cardiac arrhythmia were 9% more likely have a longer time to THC removal ($p=0.016$).

1,589 (21%) patients underwent a repeat vascular access creation during the follow-up period: 19% of whites (n=802), 26% of blacks (n=483), 19% of Hispanics (n=250), 19% of Asians (n=54) ($p<0.001$). Multivariate logistic regression of likelihood of repeat vascular access creation showed black patients had 58% greater odds of requiring a second access than white patients ($p<0.001$) (Table 4). Graft patients had 64% lower odds of repeat access compared to fistula patients ($p<0.001$), patients 70 or older had 21% lower odds of repeat access ($p<0.001$), and men had 23% lower odds of repeat access ($p<0.001$).

A multivariate Cox proportional hazards model of time to repeat vascular access showed black patients were 45% more likely to have a shorter time until second access creation (Table 5). Graft patients were 59% more likely to have a longer time until second access than fistula patients ($p<0.001$), patients age 70 or older were 19% more likely to have a longer time until second access ($p<0.001$), and men were 20% more likely to have a longer time until second access ($p<0.001$). Patients with obesity were 12% more likely to have a shorter time until second access ($p=0.032$).

Discussion

In 2003, the Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care published a book detailing the results of a study that assessed the extent of racial and ethnic differences in healthcare, sources of racial and ethnic

disparities and provided recommendations for interventions.⁷ Despite the increased focus being placed on racial and ethnic disparities, it would appear that disparities have not shifted has been conducted on the association of race and vascular access outcomes.

Black patients were significantly less likely to undergo AVF compared to whites. This has been demonstrated repeatedly in the literature and through the United States Renal Data System Database (USRDS).^{1, 8, 9} Nevertheless, it is unclear why this is the case. Some authors have suggested the cause relates to blacks having smaller vein diameters, but the evidence is far from conclusive.^{10, 11} It may be the case that vein diameters influence access selection and outcomes of vascular access. However, the literature is unclear on this subject and unfortunately, the claims database did not include data to address this question. Further work must be done in this area to determine whether the disparity is due to anatomic differences, or more insidious factors, such as underlying disparities in access to care or socioeconomic status.

We found that Hispanic patients who undergo graft have a shorter time to THC removal than white patients who undergo graft. Very little has been reported regarding the association between Hispanic ethnicity and vascular access outcomes. Other authors have shown that Hispanics are less likely to use an AVF or AVG versus a THC when initiating hemodialysis.¹² Otherwise, it is unclear why Hispanic patients undergoing graft have a shorter time to THC removal. This may be a reflection of an unmeasured confounder in this retrospective analysis. At the same time, there was no difference in time to catheter removal for blacks, suggesting that maturation time for blacks was not significantly different from other race. Again, little has been previously reported regarding the association of race and vascular access maturation making it difficult to place this finding in the context of the existing literature. Diabetes, cardiac disease and obesity were associated with longer times to THC removal, suggesting that these comorbidities are associated with longer time to maturation which is consistent with previous reports.¹³⁻¹⁵

Blacks were also found to be more likely to undergo repeat access and have a shorter time to repeat access. This is consistent with other studies using Medicare data that demonstrate greater risk of access failure in blacks.^{8, 16} Similarly, blacks have been shown to be at significantly higher risk of graft failure after lower extremity bypass, in both dialysis dependent and non-dialysis dependent populations.¹⁷⁻¹⁹ The reason for this disparity is unclear. Black patients have been shown to have higher serum levels of lipoprotein(a) which has variable associations with risk of atherosclerosis and myocardial infarction.^{20, 21} However, it is uncertain whether lipoprotein(a) is responsible for increased risk of dialysis access and/or lower extremity bypass graft failure; it does not appear that this has been specifically investigated in the literature.

The primary limitation of this study is its use of medical claims data, which limits identification of clinical measures, prevents assessment of mortality, and prevents clarity in identifying the specific reasons for repeat vascular access procedures. Furthermore, we were unable to examine the incidence of other complications such as thrombosis and access related hand ischemia due to the unreliable coding of these diagnoses in claims data. Although all covariates available in claims data were controlled for in the multivariable

models, it is possible the findings are a result of an unmeasured confounder and not a true association between race/ethnicity and the outcomes. Nevertheless, the findings regarding black race and AVF prevalence and access failure are consistent with previously reported literature. There are factors that are associated with outcomes of vascular access, namely anatomic factors, that are unavailable in claims.

Conclusion

This study found that after initial vascular access, compared to whites, blacks have no different in initial time to tunneled catheter removal, but their access fails earlier and more frequently, independent of access type, age, and co-morbidities. The tendency towards earlier and more frequent access failure among blacks reaffirms findings in prior literature. Given blacks constitute 30.5% of the hemodialysis population in the United States, it is imperative future research investigate the root causes of the disparities in outcomes of vascular access.

Acknowledgement

This research was supported by the National Institute of Health (NIDDK 1K08DK107934) and NIH National Center for Advancing Translational Science (NCATS) UCLA CTSI Grant Number TL1TR001883.

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Table 1:

Patient characteristics and comorbidities by race

	White (n=4,182)	Black (n=1,831)	Hispanic (n=1,286)	Asian (n=285)	Overall (n=7,584)	
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>	<i>p-value</i>
Mean Age (SD)	69.5 (12.3)	66.6 (12.9)	68.2 (12.9)	67.7 (14.4)	68.5 (12.7)	<0.001
Fistula (vs. Graft)	3305 (79)	1278 (70)	1043 (81)	226 (79)	5852 (77)	<0.001
Male	2492 (60)	869 (48)	762 (59)	177 (62)	4300 (57)	<0.001
Diabetes	3347 (80)	1573 (86)	1163 (90)	238 (84)	6321 (83)	<0.001
Cardiac Arrhythmia	3344 (80)	1393 (76)	928 (72)	204 (72)	5869 (77)	<0.001
Congestive Heart Failure	3421 (82)	1488 (81)	1033 (80)	214 (75)	6156 (81)	<0.001
Peripheral Vascular Disorders	3035 (73)	1326 (72)	1003 (78)	204 (72)	5568 (73)	0.035
Obesity	1743 (42)	780 (43)	513 (40)	64 (23)	3100 (41)	0.001

Table 2:

Logistic regression of likelihood of fistula (versus graft)

Characteristic	Odds Ratio	95% CI
Race		
White	Reference	
Black	0.641 ***	0.564, 0.728
Hispanic	1.165	0.991, 1.369
Asian	1.035	0.766, 1.399
Age 70 (vs Age < 70)	0.688 ***	0.613, 0.773
Male (vs Female)	1.848 ***	1.655, 2.064
Diabetes	0.814 *	0.696, 0.953
Cardiac arrhythmia	0.987	0.858, 1.135
Congestive heart failure	0.95	0.815, 1.107
Peripheral vascular disease	0.905	0.795, 1.031
Obesity	1.209 **	1.076, 1.358

*
p<0.05**
p<0.01***
p<0.001

Table 3:

Cox proportional hazards model of time until tunneled hemodialysis catheter removal

Characteristic	Hazard Ratio	95% CI
Race		
White (Fistula)	Reference	
Black (Fistula)	0.979	0.906, 1.057
Hispanic (Fistula)	1.051	0.967, 1.141
Asian (Fistula)	1.016	0.867, 1.191
Graft (vs Fistula [Among Whites])	1.729***	1.583, 1.888
Race & Graft Interaction		
White (Graft)	Reference	
Black (Graft)	1.004	0.868, 1.162
Hispanic (Graft)	1.246*	1.04, 1.493
Asian (Graft)	1.033	0.723, 1.475
Age ≥ 70 (vs Age < 70)	0.995	0.94, 1.052
Male (vs Female)	1.131***	1.07, 1.195
Diabetes	0.907*	0.843, 0.977
Cardiac arrhythmia	0.913**	0.854, 0.976
Congestive heart failure	1.005	0.935, 1.081
Peripheral vascular disease	0.986	0.925, 1.05
Obesity	0.933*	0.882, 0.987

*
p<0.05**
p<0.01***
p<0.001

Table 4:

Logistic regression of likelihood of repeat access

Characteristic	Odds Ratio	95% CI
Race		
White	Reference	
Black	1.579 ***	1.382, 1.805
Hispanic	0.98	0.834, 1.152
Asian	1.025	0.751, 1.398
Graft (vs Fistula)	0.362 ***	0.307, 0.427
Age ≥ 70 (vs Age < 70)	0.794 ***	0.706, 0.893
Male (vs Female)	0.771 ***	0.687, 0.865
Diabetes	1.076	0.916, 1.265
Cardiac arrhythmia	1.09	0.945, 1.258
Congestive heart failure	0.965	0.827, 1.125
Peripheral vascular disease	1.208 **	1.055, 1.383
Obesity	1.194 **	1.061, 1.343

*
p<0.05**
p<0.01***
p<0.001

Table 5:

Cox proportional hazards model of time until second access creation

Characteristic	Hazard Ratio	95% CI
Race		
White	Reference	
Black	1.445 ***	1.289, 1.620
Hispanic	0.944	0.818, 1.090
Asian	0.978	0.742, 1.290
Graft (vs Fistula)	0.407 ***	0.349, 0.474
Age 70 (vs Age < 70)	0.805 ***	0.726, 0.892
Male (vs Female)	0.798 ***	0.722, 0.882
Diabetes	1.044	0.905, 1.205
Cardiac arrhythmia	1.044	0.921, 1.183
Congestive heart failure	0.96	0.839, 1.098
Peripheral vascular disease	1.06	0.941, 1.193
Obesity	1.119 *	1.010, 1.240

*
p<0.05**
p<0.01***
p<0.001