Disparities in Level of Amputation Among Minorities: Implications for Improved Preventative Care

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Objectives: The purpose of this study was to evaluate the relationship between race and level of amputation and to discuss the implications if a disparity was found.

Methods: From the 2003 Healthcare Cost and Utilization Nationwide Inpatient Sample, 80845 (weighted) discharges with a diagnosis of vascular disease and black or white race were evaluated for a disparity in level of amputation. Level of amputation was categorized using *International Classification of Diseases, Ninth Revision, Clinical Modification* procedure codes into above-knee and below-knee amputation. SPSS 15.0 complex samples software (SPSS Inc, Chicago, Illinois) was used for univariate and multivariate statistical analysis.

Results: Bivariate ($p < .001$) and logistic regression ($p < .001$; OR, 1.51; 95% CI, 1.4-1.7) analyses revealed a significant association between race and level of amputation. Other covariates were also significant for influencing level of amputation and include age ($p < .001$; OR, 1.03; 95% CI, 1.02-1.03), female gender ($p < .001$; OR, 1.33; 95% CI, 1.2-1.5), Charlson Comorbidity Index ($p < .001$; OR, 1.12; 95% CI, 1.1-1.2), Medicare ($p < .017$; OR 1.34; 95% CI, 1.1-1.9), Medicaid ($p < .003$; OR, 1.63; 95% CI, 1.2-2.2, peripheral arterial disease ($p < .001$; OR, 1.22. CI, 1.1-1.4) and cerebrovascular disease ($p < .001$; OR, 1.80; 95% CI, 1.5-2.1).

Conclusions: Black race is significantly more associated with above-knee amputation when compared to white race. The consequences of higher-level evaluation could lend to disparities in overall health between the black and white races.

Keywords: health disparities ■ race/ethnicity ■ amputation ■ vascular

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INTRODUCTION

Although there is evidence to support a greater prevalence of lower-extremity arterial disease and increased rate of amputation among minority patients, no study has yet determined specifically the relationship between race and level of amputation. Whether or not amputations occur above or below the knee joint has substantial implications. Energy expenditure, balance confidence, and overall mobility are all impacted as the height of amputation increases.[1-6] In addition, the loss of the knee joint, which occurs with above-knee amputation, has a significant influence on a return to functional activities and performance of activities of daily living.[7-10]

The increased rate of amputation among minority patients could be a reflection of the increased overall prevalence of arterial disease,[11] while an increased level of amputation could be an indication of an increased severity of disease presentation. As racial-based disparities are widespread across the health care system, with provider, societal and individual level variables lending to inequities in health,[12-14] an increased level of amputation could be a reflection of an intrinsic disadvantage among the minority patients with regards to access to appropriate preventative screening. For example, not only does lower-extremity peripheral arterial and cardiovascular disease occur at a substantially increased rate among minorities,[15,16] but black race is also associated with lower ankle brachial index values,[17] which could indicate a more significant disease process among this population.

Evaluation of the literature on the relationship between race and rate of amputation revealed that black race increases likelihood of an amputation by approximately 1.5 to 3.3 times when compared to white race.[18,19] Black race is also significantly associated with decreased likeliness to receive limb-sparing procedures, such as angioplasty and lower-extremity bypass.[20,21] Furthermore, black race is associated with an increased likelihood of amputation at a younger age and are more likely to undergo a revision of amputation.[22,23] All of these studies support the possibility of a more severe disease process and a decreased access to preventative care among minority

patients, but no study has quantified an outcome such as a significant difference in level of amputation.

A disparity in severity of disease outcome may be preventable. Increased use of inexpensive screening tools and increased access to preventative care may avert a higher-level amputation. Therefore, the purpose of this study was to examine the possible presence of a health disparity in level of amputation and to determine the race at greatest risk for higher-level amputation. The hypothesis of this study was that black race will more often be associated with an above-knee amputation when compared to white race.

METHODS

Selection of Study Population

Data for this study came from the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Dataset (NIS) for fiscal year 2003. This data set contains deidentified records of independent hospital discharges selected from 994 hospitals in 37 US states by means of stratified, single-stage cluster sampling.[24] The data used in this study include discharge records containing a diagnosis of vascular disease and a procedure of a lower-extremity amputation. Records were further restricted by including only persons of black or white race who were older than 30 years of age.

The final data set consisted of 17 586 unweighted observations representing 83 787 (weighted) discharges of black or white race that also underwent amputation in the HCUP database for the year 2003. Weighting of the data allows for the HCUP database of discharges from 37 states to be a reflection of the entire population of the United States. The study population included 12 687 (unweighted)/60 725 (weighted) discharges representing white race and 4899 (unweighted)/23 061 (weighted) discharges representing black race. Exclusion criteria included 3702 (unweighted)/17 696 (weighted), or 13.3% were Hispanic, Asian, Pacific Islander, Native American, or other. Records were identified as having a below-knee amputation by *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) procedure codes 84.11-84.15, and as having an above-knee amputation by *ICD-9-CM* procedure codes 84.16-84.19. Individuals with the codes for traumatic amputation were excluded from this study. Inclusion criteria also limited the data set by restricting inclusion to discharges identified as having a form of vascular disease by one of the following *ICD-9-CM* diagnosis codes: hypertension (401.00-405.11), diabetes (250.00-250.90), peripheral arterial disease (440.00-441.00), myocardial infarction (410.00-410.90), congestive heart failure (428.00-429.00), ulcers (707.00-707.90), osteomyelitis (730.00-730.20), gangrene (785.40), or cerebrovascular disease (430.00-438.00). These inclusion criteria were based upon a significant study in the literature evaluating the relationship between race and lower-extremity nontraumatic amputation in the veterans administration hospitals.[25-27]

As this study examined disparities between black and white races, records from persons with other races were not retained for analysis, and records with missing race data (n = 6469, unweighted) were also not included in the final data set.

Statistical Analysis

Descriptive statistics are reported on the measures examined in this study, with χ^2 tests performed to assess differences in these measures between the group that underwent a below-knee amputation and the group that underwent an above-knee amputation. Logistic regression was then used to assess the association between the covariates mentioned and the likelihood of receiving an above-knee amputation (as opposed to a below-knee amputation). Race (black vs white) was the primary covariate of interest, with the other covariates acting primarily as control variables. The weighting of the original data was taken into account when testing for bivariate and multivariate associations using SPSS 15.0 (SPSS Inc, Chicago, Illinois) complex samples software.

The covariate measures that are included in the HCUP NIS and retained for this study as possible factors mitigating the relationship between race and level of amputation are gender, age, level of illness (as measured by the Charlson Comorbidity Index), income level, and presence of specific vascular disease diagnoses. The Charlson Comorbidity Index consists of 19 categories of comorbidities defined by *ICD-9* codes and each with an associated weight based on the adjusted risk of 1-year mortality.[28]

RESULTS

Table 1 shows descriptive statistics for a weighted sample of 80 845 discharges for black or white race with vascular disease undergoing an amputation in 2003. Among the overall study group, almost three-quarters (74.2%) received a below-knee amputation, with the remaining quarter receiving an above-knee amputation. A little more than one-quarter of the study group (27.8%) was of black race. Table 1 also delineates differences between subgroups based on whether or not they had an above-knee amputation or below-knee amputation and also demonstrates the significant differences found upon univariate analysis. Among the significant differences, persons receiving above-knee amputation, as a group, were proportionately more likely to be black, older, female, in lower-income zip codes, and have higher Charlson Comorbidity Index scores consistent with the hypothesis of this study. Univariate analysis demonstrated that race (Figure 1) was significantly associated with higher-level amputation among this population sample.

Table 2 breaks the study group down by race (black and white). Where Table 1 showed that there was a dis-

proportionately high black representation among the above-knee amputation subgroup, Table 2 indicates that the rate of above-knee amputation was higher among persons of black race in the study group (31.1% vs 23.8%). Table 2 also shows numerous other race-based differences. So, despite the higher rates of above-knee amputation, the black subgroup was younger. The black subgroup was also significantly more likely to be female, live in zip codes with lower median incomes, and have higher scores on the Charlson Comorbidity Index.

Table 3 summarizes the results of the logistic regression analysis and provides adjusted odds ratios (ORs) for the measures in Tables 1 and 2 for the likelihood of receiving an above-knee amputation (as compared to a

Table 1. Crosstabular Bivariate Analysis of Level of Amputation Among Variables of Interest From Healthcare Cost and Utilization Project Nationwide Inpatient Dataset 2003 (Weighted)

	Total Population (N = 80 844)	Persons Receiving Below-Knee Amputation (N = 59 971)	Persons Receiving Above-Knee Amputation (N = 20 873)	χ^2
Level of amputation				
Above knee	25.8%	0%	100%	
Race				94.0[a]
Black	27.8%	25.8%	33.5%	
Age, y				927.3[a]
30-56	23.5%	27.7%	11.3%	
57-67	25.1%	26.6%	20.9%	
68-77	24.9%	24.5%	26.2%	
≥78	26.5%	21.2%	41.6%	
Gender				187.0[a]
Female	39.6%	36.6%	48.3%	
Insurance status				492.1[a]
Medicare	69.4%	65.0%	82.1%	
Medicaid	8.1%	8.5%	7.0%	
Private/HMO	18.0%	21.2%	8.7%	
No insurance	4.5%	5.3%	2.2%	
Income level				
<$35 999	32.9%	31.9%	35.9%	30.4[a]
$36 000-$45 999	26.6%	26.5%	26.8%	
$46 000-$59 999	23.6%	24.1%	22.0%	
≥$60 000	16.9%	17.5%	15.3%	
Location				15.7
Metropolitan >1 000 000	53.2%	53.8%	51.5%	
Metropolitan <1 000 000	29.1%	29.2%	28.8%	
Micropolitan	10.8%	10.4%	11.8%	
Rural	6.9%	6.6%	7.8%	
Charlson Comorbidity Index				162.2[a]
1-3	73.4%	75.9%	66.1%	
3-6	21.7%	19.5%	28.1%	
≥6	4.9%	4.6%	5.8%	
Vascular disease				
Hypertension	58.7%	59.1%	57.5%	3.2
Peripheral vascular disease	58.4%	53.1%	73.7%	565.2[a]
Diabetes	69.4%	75.7%	51.4%	906.9[a]
Coronary artery disease	42.2%	42.6%	40.9%	3.7
Ulcers	47.1%	48.2%	43.7%	26.2[a]
Osteomyelitis	31.3%	38.7%	10.1%	1238.4[a]
Gangrene	31.5%	34.3%	23.7%	167.2[a]
Myocardial infarction	7.1%	7.2%	6.8%	0.908
Congestive heart failure	22.7%	20.6%	28.7%	121.6[a]
Cerebrovascular disease	6.7%	4.7%	12.5%	316.8[a]

[a] $p < .001$.

below-knee amputation). Even after controlling for these factors, black race still was associated with substantially increased odds for receiving above-knee amputation (OR, 1.51, 95% confidence interval [CI], 1.4-1.7). Other covariates with interesting and significant associations with amputation level included female gender (OR, 1.33; 95% CI, 1.2-1.5), Medicaid (OR, 1.63; 95% CI, 1.2-2.2), peripheral arterial disease (OR, 1.23; 95% CI, 1.1-1.4). Covariates associated with a decreased odds of receiving an above-knee amputation included the presence of vascular disease-related conditions such as hypertension (OR, 0.80; 95% CI, 0.737-0.875), gangrene (OR, 0.64; 95% CI, 0.570-0.718), and diabetes (OR, 0.41; 95% CI, 0.374-0.450). Although these diseases have been linked with higher rates of amputation, the findings of this study indicate that they are not linked with above-knee amputation.

DISCUSSION

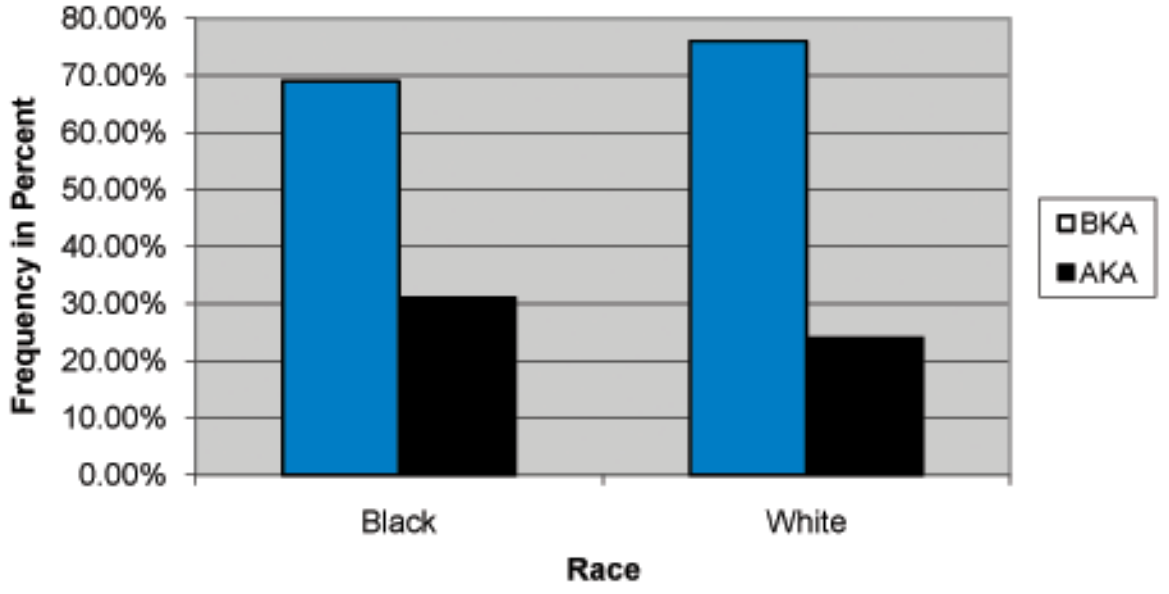
The findings of this study show, among persons receiving a lower-extremity amputation, that black race was associated with a 51% higher risk of an above-knee amputation after controlling for different demographic, comorbid, and socioeconomic factors. In addition, these findings showed that race remains a factor in level of amputation even after taking into account the prevalence of different vascular diseases. Interestingly, having Medicaid also had a higher OR for increased level of amputation when compared to black race, indicating the role of socioeconomic status in this health disparity.

Above-knee amputation was associated with increased mortality and morbidity compared to below-knee amputation.[29] In addition, higher-level amputation has been associated with decreased ability to return to work, increased energy costs of ambulation, decreased balance confidence, and decreased satisfaction with use of the prosthesis.[30-32] Therefore, the findings of this study notably delineate that racial disparities in level of amputation were of serious concern and had implications that influence multiple areas of an individual's health and well-being.

Although gender, age, level of illness, income, peripheral arterial disease, and cerebrovascular disease demonstrated increased tendency towards higher-level amputation, diabetes, gangrene, and osteomyelitis were protective variables towards above-knee amputation. There are many reasons that could account for this finding. First of all, this study does not evaluate frequency of amputation, but only severity. Therefore, the results of this study do not indicate that a diagnosis of diabetes, osteomyelitis, or gangrene results in avoidance of amputation, but rather the amputations associated with these diagnoses may tend to be less severe, often being below the knee. There are several explanations for this result. For example, improved screening by primary care practitioners has increased for patients with diabetes in the last several years. In addition, a patient with a diagnosis of osteomyelitis and ulcers would be more likely to consult a physician earlier than an individual with peripheral arterial disease due to the increased pain associated with those conditions. If caught earlier, decreased level of amputation could result. This is a possible explanation based on the findings of this study.

The results of this study provide intriguing information with regards to the association between race and

Figure 1. Frequency in Percent of Below- and Above-Knee Amputation by Race



Abbreviations: AKA, above-knee amputation; BKA, below-knee amputation.
Source: Healthcare Cost and Utilization Project Nationwide Inpatient Dataset, 2003.

level of amputation. Racial disparities in level of amputation are troubling because of the implications that higher level of amputation have on subsequent functional mobility and quality of life. Evidence suggests that disparities in this area build on other disparate measures of disease and outcomes related to vascular disease. Addressing a treatable and reversible health disparity in level of amputation may combat many of the factors that lend to health disparities in the first place, including a person's ability to access medical care, maintain employment, and return to an active lifestyle.

Limitations

The limited availability of covariates in public databases is acknowledged in the literature,[32] and this data set is no exception. Particularly with socioeconomic factors, median zip code income and insurance type are indirect indicators. More-precise measures of income or education would make a stronger case that the racial effect found here exists independent of socioeconomic status. And while a range of vascular diseases and a measure of health status are included here to control for health-related factors, additional measures for items related to health risk behaviors could have further isolated the impact of race.

Table 2. Frequency Distribution of Population by Race Among Variables of Interest From Healthcare Cost and Utilization Project Nationwide Inpatient Dataset, Fiscal Year 2003 (Weighted)

	Total Population (N = 80844)	Persons of White Race (N = 58367)	Persons of Black Race (N = 22477)	χ^2
Race				
Black	25.8%	0%	100%	
Level of amputation				94.0[a]
Above knee	25.8%	23.8%	31.1%	
Age, y				77.7[a]
30-56	23.5%	22.1%	27.1%	
57-67	25.1%	24.5%	26.6%	
68-77	24.9%	25.7%	23.0%	
≥78	26.5%	27.7%	23.3%	
Gender				127.2[a]
Female	39.6%	37.0%	46.5%	
Insurance status				218.2[a]
Medicare	69.4%	69.8%	68.4%	
Medicaid	8.1%	6.4%	12.6%	
Private/HMO	18.0%	19.5%	14.0%	
No insurance	4.5%	4.3%	5.0%	
Income level				
<$35999	32.9%	24.4%	54.9%	1484.3[a]
$36000-$45999	26.6%	28.3%	22.1%	
$46000-$59999	23.6%	27.1%	14.5%	
>$60000	16.9%	20.2%	8.5%	
Location				454.0[a]
Metropolitan >1000000	53.2%	48.2%	63.3%	
Metropolitan <1000000	29.1%	31.8%	22.2%	
Micropolitan	10.8%	12.1%	7.2%	
Rural	6.9%	7.9%	4.4%	
Charlson Comorbidity Index				48.3[a]
1-3	73.4%	75.8%	72.4%	
3-6	21.7%	21.1%	22.1%	
6+	4.9%	3.2%	5.6%	
Vascular disease				
Hypertension	58.7%	54.7%	68.9%	283.9[a]
Peripheral vascular disease	58.4%	56.6%	63.2%	62.3[a]
Diabetes	69.4%	68.7%	71.4%	11.5[a]
Coronary artery disease	42.2%	45.5%	33.4%	205.8[a]
Ulcers	47.1%	47.6%	45.7%	4.9
Osteomyelitis	31.3%	33.1%	26.6%	67.8[a]
Gangrene	31.5%	30.0%	35.5%	46.7[a]
Myocardial infarction	7.1%	7.7%	5.5%	23.9[a]
Congestive heart failure	22.7%	23.6%	20.2%	23.2[a]
Cerebrovascular disease	6.7%	6.2%	8.1%	20.5[a]

[a] $p < .001$.

CONCLUSIONS

This study adds to a body of research which shows racial disparities in the prevalence of peripheral arterial disease, the risk for incurring an amputation, and the likelihood of receiving limb-sparing procedures. The findings support the significant relationship between black race and higher-level amputation, even when controlling for different demographics, including comorbidities and socioeconomic factors. Based on this research outcome, it is critical to evaluate which factors may be influencing the increased severity of amputation seen among the minority patients. Thus, this study supports the possibility of exaggerated disease manifestation, possibly due to inadequate preventative care or could be indicative of flaws in the patient physician relationship, such as lack of trust by the patient on unconscious bias on the part of the practitioner.[33,34]

Physician diagnosis of peripheral arterial disease is, unfortunately, low. Additionally, appropriate and early diagnosis of peripheral arterial disease, especially among minorities, is deficient.[35] In contrast, preventative screening of lower-extremity ischemia has been found to decrease rates of amputation, decrease cardiovascular morbidity and mortality, reduce the severity of vascular illnesses, and improve quality of life as seen in highly successful community outreach and screening programs. These programs have been very successful in targeting individuals who would benefit from intervention to prevent or treat lower-extremity ischemia.[36] In addition, highly sensitive, specific, reliable, and valid screening tools such as the ankle brachial index, Walking Impairment questionnaire and Edinburgh Claudication questionnaire are available to primary care practitioners to assist with screening objectively for diseases that could directly lead to amputation.[37-39]

Further research is necessary to better understand the specific dynamics that account for this disparity, but in the

Table 3. Logistic Regression Analysis for Effect of Independent Variables on Level of Amputation

	Adjusted Odds Ratio	Confidence Interval
Race	1.51	1.35-1.70
Black		
Age, y	1.03	1.03-1.03[b]
Gender	1.33	1.22-1.45[b]
Female		
Insurance status		
Medicare	1.39	1.06-1.87[a]
Medicaid	1.63	1.18-2.25[a]
Private/HMO	0.99	0.73-1.34
No Insurance	1.00	.
Median income of residential zip code		
<$35 999	1.08	0.93-1.25
$36 000-$45 999	1.06	0.92-1.23
$46 000-$59 999	0.98	0.85-1.14
>$60 000	1.00	.
Location		
Metropolitan >1 000 000	0.86	0.68-1.08
Metropolitan <1 000 000	0.88	0.71-1.09
Micropolitan	1.03	0.81-1.31
Rural	1.00	.
Charlson Comorbidity Index	1.12	1.08-1.16[b]
Vascular disease		
Hypertension	0.80	0.74-0.88[b]
Peripheral vascular disease	1.22	1.08-1.37[b]
Diabetes	0.41	0.37-0.45[b]
Coronary artery disease	0.95	0.86-1.04
Ulcers	0.98	0.90-1.07
Osteomyelitis	0.22	0.19-0.25[b]
Gangrene	0.64	0.57-0.72[b]
Myocardial infarction	0.98	0.81-1.18
Congestive heart failure	1.09	0.99-1.20
Cerebrovascular disease	1.80	1.55-2.09[b]

[a] $p < .01$.
[b] $p < .001$.

meantime the outcome of higher level of amputation may be reduced with use of and access to the appropriate screening tools, prescriptive medications, and therapeutic interventions. An evaluation of the use of these tools in vulnerable populations among primary care physicians might lead to appropriate methods to reduce the rate of health disparities in amputation and improve quality of life for a multitude of individuals diagnosed with vascular diseases. Greater attention to the provision of this type of preventative care to at-risk populations such as persons of black race is a start towards eliminating this and other disparities related to the diagnosis and care of vascular disease.

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