The adverse effects of race, insurance status, and low income on the rate of amputation in patients presenting with lower extremity ischemia

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Objectives: **A consequence of delay in the diagnosis of peripheral vascular disease limb loss. This study was undertaken to determine the correlation of low socioeconomic status and race on the severity of ischemic presentation and the subsequent amputation rate.**
Methods: **Data from the Nationwide Inpatient Sample (NIS) from 1998 to 2002 on patients from urban hospitals with the diagnosis of lower extremity ischemia were evaluated. The population was divided into two groups: the amputation group (AMP) and lower extremity revascularization group (LER). Comorbidities, age, gender, race, ischemic gangrene at presentation, insurance status (no/noncommercial or commercial), and income status at admission were determined. These variables were compared using multivariate logistic regression analyses of the data for risk adjustment.**
Results: **Of 691,833 patients presenting with lower extremity ischemia, 363,193 underwent revascularization (66.3%) or amputation (33.7%). Univariate analysis correlated a statistically significant ($P < .0001$) higher rate of amputation and multivariate analysis associated significantly higher odds of amputation with the following variables: nonwhites (1.91, 95% confidence interval [CI], 1.65, 2.20), low-income bracket (1.41, 95% CI, 1.18, 1.60), and Medicare & Medicaid (1.81, 95% CI, 1.66, 1.97). Adjusting for other variables of statistical significance, multivariate regression analysis showed a statistically significant risk for amputation based on the nonteaching status of the institution (odds ratio [OR], 1.17, 95% CI, 1.08, 1.30).**
Conclusions: **Primary amputation was performed with a higher frequency on patients with lower extremity ischemia who were nonwhite, low income, and without commercial insurance. The observed advanced ischemia among these economically disadvantaged patients suggests a delayed diagnosis of peripheral vascular disease, probably due to lack of access to adequate primary care or vascular surgery providers, or both. Better education of the general population and primary care providers to the symptoms and consequences of PVD may reduce the amputation rate in this group. (J Vasc Surg 2007; 45:55-9.)**

Late presentation and delay in diagnosis and treatment of peripheral vascular disease (PVD) may lead to limb loss. In addition to the immense psychologic toll of amputation, the yearly cost of providing care to amputees is estimated at $4.3 billion.[1] Furthermore, 25% to 60% of amputees never ambulate with a prosthesis and another 30% have reamputation or die ≤12 months of the initial procedure.[1] Despite many advances in the fields of vascular and endovascular surgery during the past decade, an alarming increase in the number of amputations has been reported.[2]

Studies evaluating disparities of amputation rates among PVD patients with different sociodemographic variables have shown continuous differences in the per capita rate of amputation among different races,[3-7] income levels,[6,8] and gender.[4] Some of the racial disparities can be attributed to the higher prevalence of diabetes[9] or difficult-to-control diabetes among nonwhite patients,[10-13] or to racial differences in the severity and characteristics of PVD at the time of presentation to a vascular surgeon.[14-18] However, there is no evidence to suggest that inherent genetic differences between races or ethnicities can account for disparities of outcome such as limb salvage vs revascularization.[19]

Rather, many studies have shown that a decrease in amputation rates is possible with appropriate primary care, timely referral to vascular surgical centers, adequate foot and wound care, and aggressive limb arterial revascularization therapies, regardless of the presence of cormorbidites.[20-25] Reported inconsistencies in amputation rates therefore suggest that barriers to appropriate, effective, and timely care exist across the racial and sociodemographic spectrum. The purpose of this study was to determine how income level, insurance status, and race correlate with amputation rates in patients with lower extremity ischemia who present to urban hospitals.

METHODS

Data source. The Nationwide Inpatient Sample (NIS), a stratified, cross-sectional database resulting from a federal, state, and private industry partnership, includes approximately 20% of all nonfederal hospital discharges in the United States.[26] The database, which includes information on 100% of discharges at participating hospitals, is stratified by geographic region, urban or rural hospital location,

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hospital teaching status, hospital ownership status, and hospital size. Data for this study were derived from the NIS database from 1998 to 2002, inclusive.

The databases were searched initially to identify all inpatient admissions for which the primary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) indicated a diagnosis code for peripheral vascular disease (443.9), atherosclerosis, and lower extremity ischemia with or without gangrene (440.20, 21, 23, 24; 440-30, 31, 32). Patients presenting with traumatic ischemia or arterial embolism were excluded. To minimize the potential for bias owing to coding variations among the participating hospitals and to address the possibility of overlap between groups, 13 distinct codes were used to identify patients.

To assess the effect of race, the study was limited to urban hospitals, which generally have a more racially diverse patient population than rural settings (www.census.org).

Patients were divided into two groups by operative procedure. The first group included patients with primary ICD-9-CM procedure codes for lower extremity amputation (84.1, 84.10, 15-19) (AMP). Patients with toe amputations or partial foot or ankle amputations were excluded. The second group included those with a lower extremity revascularization (39.25, 39.29) (LER). Patients who had both procedures—revascularization and amputation—at the index admission were also excluded from this analysis.

Statistical analysis. All statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, NC) software. Because the NIS databases are stratified probability samples of US community hospitals, calculations were adjusted to reflect the survey sampling characteristics (probability weights, cluster sampling, and stratification). Probability weights were provided for each record in the NIS database. Stratification was performed for geographic region, teaching status, ownership, and hospital size; hospitals were used as cluster units.

Factors such as hospital type, initial presentation, comorbidities, age, gender, race, income status, and insurance payer mix were compared among the two procedure groups. Race was identified as a dichotomous variable: white vs nonwhite. Univariate analyses, using χ^2 testing, were performed to compare theses variables among groups during the index admission, and statistically significant variables ($P < .05$) were analyzed further. The elimination multiple logistic regression analyses of statistically significant variables—controlling and adjusting risk across each study population—were performed, and (odds ratios [ORs], 1.17, 95% CI, 1.08, 1.30) were generated.

RESULTS

According to NIS data, 691,833 patients presented with the primary diagnosis of lower extremity ischemia or gangrene to urban hospitals during the study period. Of these 363,193 underwent either lower extremity revascularization (240,740; 66.3%) or amputation (122,453; 33.7%) as the primary procedure during the index admission. Selected comorbidities are summarized in Table I.

Table I. Nationwide Inpatient Sample data (1998-2000) for patients presenting to urban hospitals with the diagnosis of lower extremity ischemia who subsequently had a procedure

Characteristics	*Overall** (%)	*Amputation** (%)	*Vascularization** (%)
Weighted frequency (n)	363,193	122,453	240,740
Average age (year)	70.6	74.5*	68.9*
Female sex	45.4	49.7*	43*
Race			
White	74.1*	61.2*	80*
Nonwhite	25.9*	38.8*	20*
Diabetes	42.1	49.7*	38.9*
CRF	2.7	4.8*	1.7*
Hypertension	50.3	40.7*	54.3*
CHD	10.8	9.3*	11.5*
COPD	1.8	1.1*	2.2*
Ischem w/o gangrene	66.3	23.6*	84.3*
Ischemic gangrene	37.2	76.4*	15.6*
Hospital type			
Teaching	53.8	39.9*	60.1*
Nonteaching	46.2	45.2*	54.8*

CRF, Chronic renal failure; *CHD,* chronic heart disease; *COPD,* chronic obstructive pulmonary disease.
*$P < .001$.

The average patient age was 70.6 years, with a statistically significant difference ($P < .0001$) in the mean ages of the LER (68.9, 95%) and AMP (73.2, 95%) groups. Although most patients were men (54.6%), more AMP patients were women (49% vs 43.9%, $P < .001$); conversely, more men were in the LER group (57% vs 51%, $P < .001$). Diabetes and chronic renal failure were more common among the AMP group, and chronic obstructive pulmonary disease, hypertension, and coronary artery disease were more common in the LER group.

The racial composition of the groups is also summarized in Table I. At 80.0%, the LER group included a significantly higher percentage of white patients ($P < .001$) compared with the general population (74.1%) and the AMP (61.2%) group. Conversely, nonwhite patients were more prominently represented in the AMP group (38.8% vs 25.9% and 20% for LER; $P < .001$). Initial ischemic presentation significantly differed among the two procedure groups, as a significantly higher percentage of AMP patients (76.4%) presented with ischemic gangrene compared with the LER group (15.6%, $P < .001$).

More than half of the patients (53.6%) were treated at teaching hospitals, and 60.1% underwent revascularization. The reverse was true at nonteaching hospitals, where amputation rates were statistically significantly higher (45.2% vs 39.9%, $P < .0001$). Adjusting for other variables of statistical significance, multivariate regression analysis for OR estimates showed a statistically significant risk (OR = 1.17, 95% CI, 1.08, 1.30) for amputation based on the nonteaching status of the institution where patients were cared for (Table II).

Table II. Multiple logistic regression analysis results for amputation vs. lower extremity revascularization using Nationwide Inpatient Sample data, 1998-2000

Sociodemographic factors	*OR*	*95% Wald CL*
Age >70	1.43	1.13, 1.55
Female	1.139	1.02, 1.11
Nonwhite	1.90	1.75, 2.05
Diabetes	1.15	1.09, 1.22
CRF	1.39	1.19, 1.64
Hypertension	0.67	0.63, 0.68
COPD	0.61	0.52, 0.71
Ischemic gangrene	15.04	12.14, 14.32
Income ZIP*		
<$24,999	1.41	1.18, 1.60
$25,000-$34,999	1.22	1.10, 1.36
$35,000-$44,999	1.15	1.01, 1.27
Medicaid	1.91	1.65, 2.20
Medicare	1.81	1.66, 1.97

OR, Odds ratio; *CL*, confidence limits; *CRF*, chronic renal failure; *COPD*, chronic obstructive pulmonary disease.
*Patient's postal ZIP code was used as a proxy for socioeconomic status.

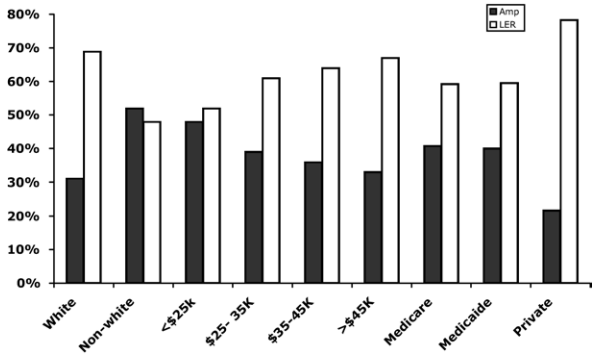

Fig 1. Rate of amputation *(AMP)* or lower extremity revascularization *(LER)* compared among different socioeconomic variables.

Socioeconomic factors such as patient income and the insurance payer mix were also found to be significantly different between the AMP and LER groups (Fig 1). The NIS-reported median income of each patient's postal ZIP code was used as a proxy for socioeconomic status to divide the patient population was into three economic groups. Of these, 36.1% were in the highest income group (>$45,000/year), and 8% were in the lowest (<$24,999/year). The LER group, however, contained fewer patients from the lowest income category (6.5%) compared with the AMP group (10.6%), a statistically significant difference ($P < .0001$).

The two procedure subgroups also had disparate primary payer compositions. Among this patient population, Medicare was the most common provider (71.2%), and the second most common was a combination of private insurance or Health Maintenance Organization (private/HMO, 21.4%). Medicaid beneficiaries were 5.8% of the group; the remaining 1.6% was excluded because no insurance type was documented. Notably, the AMP group included 82.2%

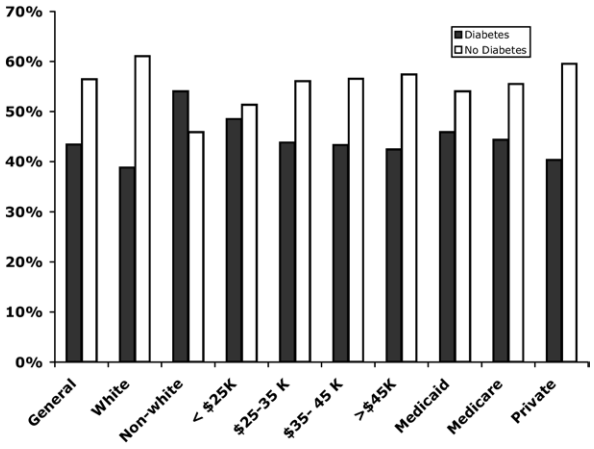

Fig 2. Rate of diabetes among different socioeconomic variables.

Medicare patients and 10.6% private/HMO patients, and the LER group had 66.4% Medicare and 26% private/HMO patients. Univariate analysis showed a statistically significant association between the procedure performed during the index admission and the primary payer ($P < .0001$). Similarly, Medicare recipients had the highest rate of amputation and lowest rate of revascularization (34.1% AMP, 65.1% LER) compared with Medicaid (31%, 68.9%) and private/HMO beneficiaries (14.8%, 85.2%; Fig 1).

Table II summarizes the multiple logistic regression analyses data. Independently, age >70, female sex, diabetes, chronic renal failure, hospital type, and ischemic gangrene were found to significantly increase the risk of undergoing amputation. Initial presentation of ischemic gangrene was the most important determinant, increasing the odds of having an amputation 15-fold. This analysis, which controls for the simultaneous effect of diabetes, gangrene, and chronic renal failure, indicates that the race and socioeconomic factors evaluated here (income and payer mix) independently increase the risk of having amputation. Low-income patients have a 1.41-fold risk of having an amputation compared with high-income patients (OR, 1.41, 95% CI, 1.18, 1.60). This odds ratio gradually decreases as patient income increases (Table II).

Compared with private/HMO patients, both Medicaid (1.9-fold) and Medicare (1.8-fold) patients were more likely to have amputations (Table II); among the latter two, Medicaid patients have the highest OR for amputation than Medicare recipients ($P < .001$). Although Medicare patient age (74.6 years) was significantly higher ($P < .001$) than Medicaid (59.2 years) and private/HMO patients (61.3 years), the Medicaid patients had the highest OR for amputation ($P < .001$).

Fig 2 shows that diabetes, an independent predictor of amputation, was more common among nonwhites (53.1% vs 37.1%, $P < .001$), Medicaid (45.9% vs 39.4% [private], or 44.4% [Medicare], $P < .001$ and $P < .05$, respectively), and the lowest-income group ($P < .001$). The diabetes rate

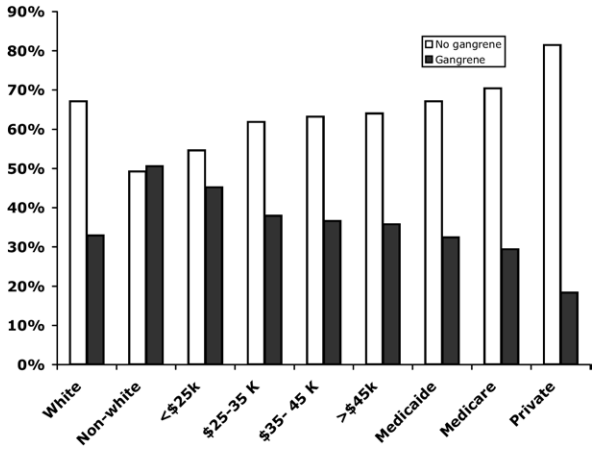

Fig 3. Initial presentation of ischemia with or without gangrene among different socioeconomic variables.

decreases as income increases. As shown in Fig 3, nonwhite (50.7% vs 33%, $P < .001$) and low-income patients (46.3% vs 36.9%, $P < .001$) presented more commonly with ischemic gangrene, as did Medicaid patients compared with Medicare recipients (50.7% vs 23%, $P < .001$).

DISCUSSION

The purpose of this study, which examined data collected in urban hospitals from 1998 to 2002, was to determine the correlation of low socioeconomic status and race on the severity of ischemic presentation and subsequent amputation rate in patients presenting with lower extremity ischemia. Comorbidities, including diabetes, chronic renal failure, and gangrene, were significantly associated with amputation. Age, gender, income level, and insurance status also were found to independently affect amputation rates.

Age as a risk factor for amputation may be due to the prevalence of PVD in older patients, reported by Selvin and Erlinger[27] to increase from <7% in adults younger than age 70 to >14.5% in older adults. Increased amputation risk for women, also reported previously[6], may reflect the inclusion of more women in this older, PVD-susceptible group. Underprivileged patients in this study, such as nonwhites, low-income, or Medicaid recipients, presented more commonly with diabetes, chronic renal failure, or gangrene, as reported previously.[3,6,7,9,12,13,19,21,28] The observed advanced ischemia among these economically disadvantaged patients suggests a delayed diagnosis of PVD, probably owing to lack of access to adequate primary care or vascular surgery providers, or both, as well cultural distrust.[30-32] Better education of the general population, particularly minorities, and primary care providers on the symptoms and consequences of PVD may reduce the amputation rate in this group.

Medicare and Medicaid patients exhibited a higher rate of amputation compared with patients with private insurance. Age and diabetes in these two groups may partly account for this trend, but delayed presentation appears to play a significant role, especially among Medicaid patients, who often receive care in the emergency department.[33]

Several shortcomings of this study stem from errors inherent in using NIS data, including coding errors,[34] changes in sampling and weighting strategies owing to an expansion in the number of participating sites during the study, administrative errors resulting from changes in ICD-9 codes (partially addressed by using 13 different codes), and missing data on racial makeup. In addition, the inability to track prior or subsequent hospitalization/revascularization of individual patients may affect the findings because a single patient may at different time points be a member of one or another group. From that perspective, the study as designed provides a snapshot of the NIS database, which can be used to draw conclusions about population tendencies. The results obtained here are consistent with previous reports using different methodology and databases,[3,6,7] suggesting that they accurately reflect the overall picture.

CONCLUSION

The data suggest there is a disparity of care provided to patients with PVD on the basis of race, income, and insurance status. Unlike more affluent white patients who undergo revascularization, those who are nonwhite, poor, and Medicaid recipients are more likely to undergo amputation. The elimination of barriers to appropriate medical care along with better education of the consequences of diabetes and the signs and symptoms of PVD may lead to earlier presentation and significantly decrease amputation rates.[29]

AUTHOR CONTRIBUTIONS

Conception and design: ME
Analysis and interpretation: ME, MZ, GF
Data collection: MZ
Writing the article: ME
Critical revision of the article: ME
Final approval of the article: ME
Statistical analysis: MZ, GF
Obtained funding: Not applicable
Overall responsibility: ME

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