Racial disparities in the use of revascularization before leg amputation in Medicare patients

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Objective: **Black patients with peripheral arterial disease undergo amputation at two to four times the rate of white patients. In order to determine whether differences in attempts at limb salvage might contribute to this disparity, we studied the limb care received prior to amputation by black patients compared with whites.**

Methods: **Using inpatient Medicare data for the years 2003 through 2006, we identified a retrospective sample of all beneficiaries who underwent major lower extremity amputation. "Limb salvage care" was defined as limb-related admissions and procedures that occurred during the 2 years prior to amputation. We used multiple logistic regression to compare rates of revascularization and other limb care received by black versus white amputees, adjusting for individual patient characteristics. We then controlled for hospital referral region in order to assess whether differences in care might be attributable to the geographic regions in which black and white patients received care. Finally, we examined the timing of revascularization relative to amputation for both races.**

Results: **Our sample included 24,600 black and 65,881 white amputees. Compared with whites, black amputees were more likely to be female and had lower socioeconomic status. Average age, rates of diabetes, and levels of comorbidity were similar between races. Black amputees were significantly less likely than whites to have undergone revascularization (23.6% vs 31.6%; $P < .0001$), any limb-related admission (39.6% vs 44.7%; $P < .0001$), toe amputation (12.9% vs 13.8%; $P < .0005$), or wound debridement (11.6% vs 14.2%; $P < .0001$) prior to amputation. After adjusting for differences in individual patient characteristics, black amputees remained significantly less likely than whites to undergo revascularization (odds ratios [OR], 0.72 [95% confidence interval, .68-.76]), limb-related admission (OR, 0.81 [0.78-0.84]), or wound debridement prior to amputation (OR, 0.80 [0.75-0.85]). Timing of revascularization relative to amputation was similar between races. Observed differences in care were shown to exist within hospital referral regions and were not accounted for by regional differences in where black and white patients received care.**

Conclusion: **Black patients are much less likely than whites to undergo attempts at limb salvage prior to amputation. Further studies should explore whether this disparity might be attributable to race-related differences in severity of arterial disease, patient preferences, or physician decision making. (J Vasc Surg 2011;54:420-6.)**

Black patients with peripheral arterial disease (PAD) undergo amputation at two to four times the rate of white patients.[1-4] Reasons for this disparity are likely multifaceted and may include differences in insurance coverage, socioeconomic status, comorbid conditions, pattern or severity of disease at presentation, and characteristics of the institutions or providers from whom black and white patients receive care. Studies that have adjusted for any or all of these factors, however, have not been able to eliminate a persistent difference in amputation rates due to race.[2-4]

Alternatively, higher amputation rates among blacks may be the result of less aggressive limb salvage care. A growing body of literature shows that black patients are less likely than whites to receive aggressive care for early-stage lung cancer,[5] coronary artery disease,[6] and prostate cancer.[7] It is unknown whether blacks are also less likely to receive aggressive surgical care when the option for limb salvage is present.

In this context, we examined the limb salvage care received by elderly black versus elderly white patients with PAD. Using Medicare data, we compared the preamputation limb interventions received by patients who ultimately required an amputation—examining, in effect, whether blacks might face higher rates of amputation because they are less likely to receive aggressive care aimed at preventing their amputations in the first place.

METHODS

We performed this retrospective study using the Medicare Provider Analysis and Review (MEDPAR) files for 2003 through 2006. MEDPAR files include all inpatient claims for fee-for-service Medicare beneficiaries; thus, our study excludes the 15% of the Medicare population covered

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under managed care plans. Because Medicare coverage begins at the age of 65, we included only beneficiaries between the ages of 67 and 99 years in our study population, so as to ensure at least 2 years of retrospective data for each patient in our sample.

Using the relevant International Classification of Diseases, ninth edition (ICD-9) procedure codes, our study sample was selected to include all beneficiaries who underwent major lower extremity amputation (84.15-17: below-the-knee, above-the-knee, and disarticulation at knee). Beneficiaries who carried an accompanying diagnosis of lower extremity trauma (820. *-828. *, 928. *, 945.0*, 945.3*, 945.4*, 945.5*, 897. *) or malignancy (170.7-8, 171.3, 172.7, 173.7, 195.5, 209.34) were excluded.

We defined "limb salvage care" as limb-related admissions and procedures that occurred during the 2 years prior to amputation. Limb-related admissions included those with principal ICD-9 diagnoses such as atherosclerosis with or without tissue loss, bypass graft-related event, osteomyelitis, ulcer, or open wound of the lower extremity. Limb-related procedures included lower extremity open revascularizations, endovascular angioplasty and stenting, wound debridements, and toe amputations, as identified by the relevant ICD-9 procedure codes. (See Appendix [online only] for a complete list of the selected ICD-9 diagnosis and procedure codes.) Primary outcome measure was revascularization during the 2 years prior to amputation, while secondary outcome measures included limb-related admission, toe amputation, and wound debridement during the same time period.

We used multiple logistic regression to assess the effect of race on the likelihood of receiving limb salvage care prior to amputation. Separate regression models were derived for each component of limb salvage care, adjusting for patient characteristics, including age, gender, socioeconomic status (SES), presence or absence of diabetes, presence or absence of gangrene at the time of amputation, and Elixhauser comorbidity index.[8] SES was assigned by zip code based on a composite measure of education, income, and occupation from US census data.[9] The Elixhauser comorbidity index is a simple sum of the number of diagnoses carried by a patient from among a list of 30 inpatient comorbidities shown to correlate with increased length of stay, hospital charges, and/or risk of mortality. These 30 comorbidities range from congestive heart failure to renal failure to depression, among many others. In this study, Elixhauser comorbidity index was calculated based on diagnoses at the time of amputation, as well as from hospital admissions during the previous 2 years.

In exploring potential reasons for differences in rates of care, we compared the timing of revascularization relative to amputation among blacks versus whites. If, for example, a large proportion of revascularizations among white patients were found to occur immediately prior to amputation, this might suggest that white patients are more likely than blacks to be offered the option of revascularization even when it has a low probability of success. We compared the overall rates of revascularization in black versus white patients over 30-day, 60-day, 1-year, and 2-year intervals prior to amputation. We subsequently compared the proportion of black versus white revascularizations that occurred within these same time intervals.

We considered the possibility that the intensity of limb salvage care received by a given patient might be attributable to the region in which they live, rather than to their race, individual characteristics, or pattern of disease. Geographic variation in medical care is a well-described phenomenon for many diseases.[10-14] Because blacks and whites often live in different regions,[15] differences in the limb salvage care that they receive might simply be a reflection of the physician density and/or practice styles in the regions in which they live, as opposed to a true race-based disparity. For purposes of examining whether any differences in rates of limb salvage care might be explained by geographic differences in where care was obtained, each patient in our study sample was assigned to a hospital referral region (HRR) based on their zip code. As originally defined in the Dartmouth Atlas of Healthcare,[16] a hospital referral region refers to a geographic area containing one or more referral hospital(s) to which most patients in the surrounding zip codes are referred for cardiovascular and neurosurgical procedures. In accordance with this definition, there are 307 HRRs across the United States. We assessed "within HRR" race effects by including HRR indicator variables in our logistic regression models. These fixed-effects models control for any HRR-level factor, whether measured or unmeasured, that affects the likelihood of receiving limb salvage care for all patients within an individual HRR (eg, vascular surgeon density). Any racial disparity described by these models thus suggests that even within the same geographic region, black and white patients are treated differently. On the other hand, if these models that control for HRR eliminate any racial disparities in care, this would suggest that any differences in care among blacks and whites should be attributed to the fact that they tend to receive care in different regions.

Institutional Review Board approval for this study was waived, given that the data used were deidentified and publically available.

RESULTS

Our sample of Medicare beneficiaries included 24,600 black and 65,881 white amputees (Table I). Average age was similar between races (79.3 vs 79.1 years; $P < .005$). Compared with whites, black amputees were more likely to be female (58.3% vs 45.6%; $P < .0001$); more likely to live in an area of low SES (58.0% vs 27.9%; $P < .001$); in slightly poorer health, as measured by Elixhauser comorbidity index (5.6 vs 5.4; $P < .0001$); more likely to carry a diagnosis of diabetes (63.7% vs 60.8%; $P < .0001$); and more likely to have undergone above-knee amputation (61.1% vs 51.4%; $P < .001$), as opposed to more distal amputation.

As shown in Fig 1, elderly black amputees were significantly less likely than whites to have undergone one (23.6% vs 31.6%; $P < .0001$), two (7.4% vs 11.3%; $P < .0001$), or three or more revascularizations (2.4% vs 4.2%; $P < .0001$)

Table I. Demographics: Medicare amputees (2003-2006; n = 90,481)

	Black (n = 24,600)	*White (n = 65,881)*	P
Age (years)	79.3 (SD 8.2)	79.1 (SD 7.8)	< .005
Female (%)	58.3	45.6	< .0001
Socioeconomic status (%)			< .001
Low	58.0	27.9	
Middle	22.9	31.4	
High	19.1	40.7	
Number of Elixhauser comorbidities	5.6 (SD 2.5)	5.4 (SD 2.5)	< .0001
Diagnosis of diabetes (%)	63.7	60.8	< .0001
Level of amputation			
Above-the-knee (%)	61.1	51.4	< .0001
Below-the-knee or disarticulation at knee (%)	38.9	48.6	< .0001

SD, Standard deviation.

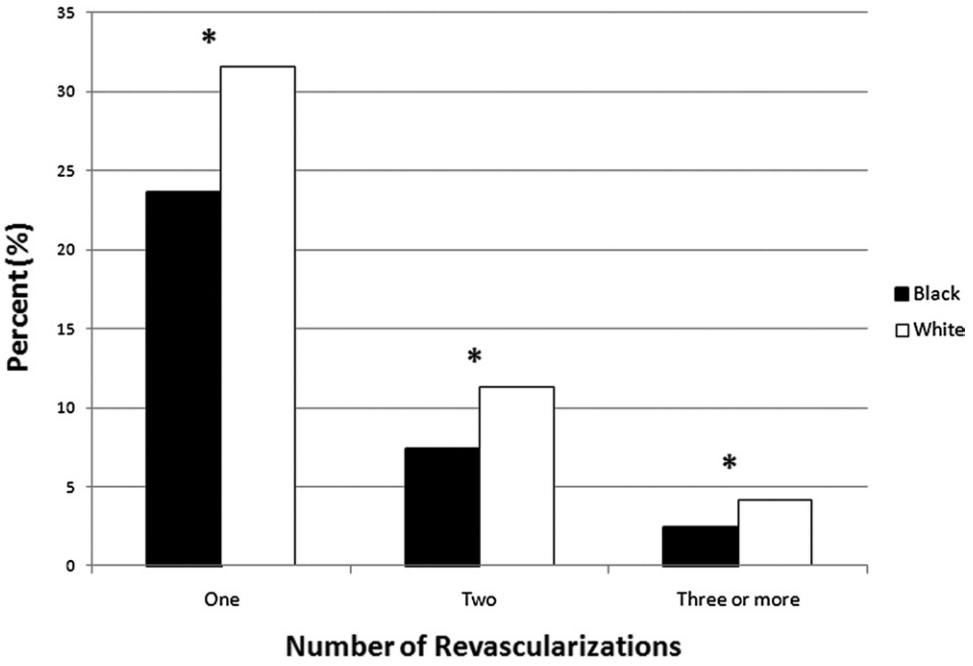

Fig 1. Percentage of patients undergoing revascularization prior to amputation. *$P < .0001$.

prior to amputation. As shown in Table II, after adjusting for differences in individual patient characteristics, black amputees remained significantly less likely than whites to have undergone at least one revascularization prior to amputation (odds ratio [OR], 0.73 [95% confidence interval, 0.69-0.78]).

The length of time between revascularization and eventual amputation was similar between races. Almost identical proportions of black and white revascularizations occurred within 30-day, 60-day, 1-year, and 2-year intervals prior to amputation (Fig 2). Demonstrated another way, black patients underwent revascularization at a lower rate than whites in similar proportions whether we examined 30-day, 60-day, 1-year, or 2-year time intervals prior to amputation (Fig 3).

As shown in Fig 4, elderly black amputees received care at a significantly lower rate than whites across all secondary components of limb salvage care, including limb-related admission (39.6% vs 44.7%; $P < .0001$), toe amputation (12.9% vs 13.8%; $P < .0005$), and wound debridement (11.6% vs 14.2%; $P < .0001$). Similar to the case of revascularization, after adjusting for differences in individual patient characteristics, black amputees remained significantly less likely than whites to undergo limb-related admission (OR, 0.81 [0.78-0.84]) or wound debridement (OR, 0.79 [0.74-0.84]) prior to amputation (Table II). The results related to toe amputation were equivocal (OR, 0.94 [0.89-1.00]).

Of the 307 HRRs across the US, 285 included both white and black amputees, and thus were included in our regression analyses. (Twenty-two HRRs contained exclusively white amputees, and thus were automatically excluded from the regression models.) The number of elderly amputees per HRR ranged from 21 to 1,576. Adjusting for

Table II. Odds ratios for blacks relative to whites for four components of limb salvage care

	Crude OR (95% CI)	*OR adjusted for patient characteristics*[a]	*OR Adjusted for patient characteristics,*[a] *Individual HRR*
Revascularization	0.67 (0.63-0.72)	0.73 (0.69-0.78)	0.71 (0.68-0.74)
Endovascular	0.70 (0.65-0.75)	0.73 (0.68-0.78)	0.71 (0.67-0.75)
Open	0.69 (0.65-0.74)	0.76 (0.71-0.81)	0.73 (0.70-0.76)
Limb-related admission	0.81 (0.78-0.85)	0.81 (0.78-0.84)	0.83 (0.80-0.86)
Wound debridement	0.79 (0.74-0.85)	0.79 (0.74-0.84)	0.80 (0.76-0.84)
Toe amputation	0.92 (0.88-0.97)	0.94 (0.89-1.00)	0.96 (0.91-1.01)

HRR, Hospital referral region; *OR,* odds ratio.
[a]Age, gender, socioeconomic status, presence or absence of diabetes, presence or absence of gangrene at the time of amputation, and Elixhauser comorbidity index.[8]

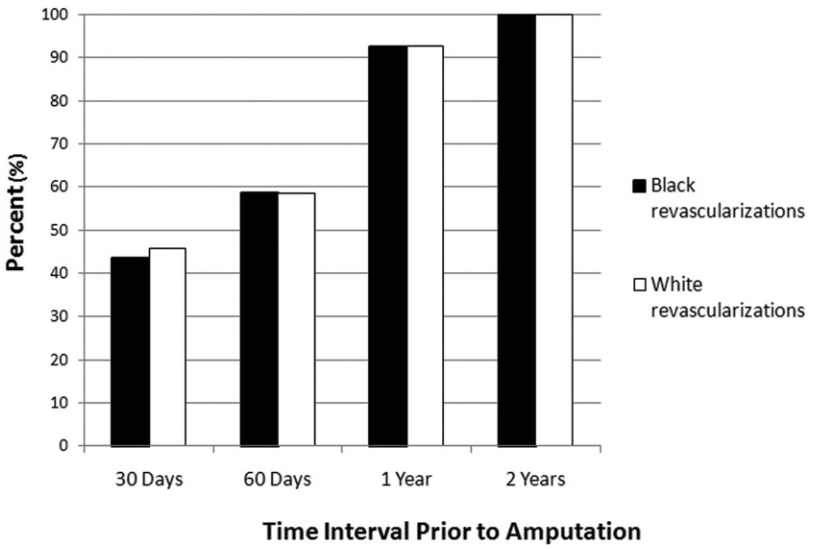

Fig 2. Timing of revascularization: Proportion of revascularizations occurring within specific time intervals relative to amputation.

the HRR in which patients lived (Table II, final column) had minimal or no effect on each of our results, indicating that differences in rates of care were due to differences in how black and white patients were treated within HRRs, and not due to regional differences in where they received care. Sensitivity analyses, in which we included only those HRRs with at least 50 or at least 100 amputees in our regression models, had no effect on our results.

DISCUSSION

Our results show that elderly black patients undergo fewer revascularizations than whites leading up to amputation. This disparity does not appear to be due to regional differences in where black and white patients receive care.

Many studies have evaluated what happens to black and white patients who present to a hospital with limb ischemia. In general, these studies have shown that black patients more frequently undergo amputation, and whites more frequently undergo revascularization.[1-4] Our study is the first to examine a sample of black and white amputees and look retrospectively at the care that they received leading up to amputation—comparing, in effect, the intensity of limb salvage care received before the eventual amputations were performed.

There are several potential explanations for our results. First, our results may suggest a biological difference in the pattern or progression of arterial disease among black vs white patients. It may be, for example, that blacks tend to suffer from small vessel or otherwise more distal disease, which precludes revascularization as a viable means of preventing or delaying amputation. Similarly, blacks may be less likely than whites to engage in primary or preventive medical care, resulting in a diagnosis of PAD at a comparatively later stage, and a lower likelihood of receiving antithrombotic and lipid-lowering medications that might alter the course of their disease. While we know that all of the patients in our sample ultimately developed end-stage PAD requiring amputation, we do not know when, in relation to the timing of their amputation, they first presented to a physician with evidence of vascular disease. If late presen-

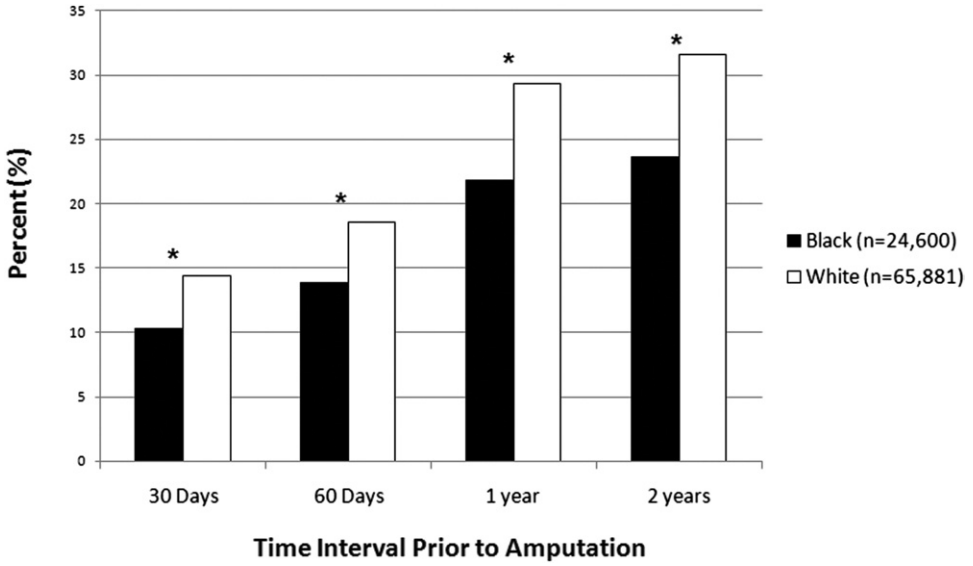

Fig 3. Timing of revascularization: Percentage of patients undergoing revascularization within specific time intervals prior to amputation. *$P < .0001$.

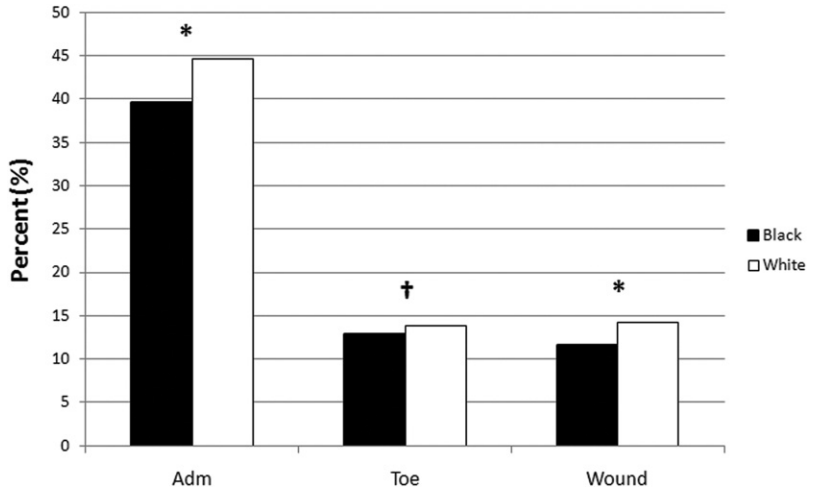

Fig 4. Percent of patients receiving other components of limb salvage care prior to amputation. *Adm*, Limb-related admission; *Toe*, toe amputation; *Wnd*, wound debridement. *$P < .0001$; †$P < .0005$.

tation by black patients were the primary reason for the differences that we found, however, then we would expect that the degree of difference in care between blacks and whites would grow larger as the length of time prior to amputation increased. Fewer blacks than whites would have undergone revascularization within 30 days prior to amputation; and an even smaller proportion, compared with whites, would have undergone revascularization within 60 days, 1 year, or 2 years prior to amputation. The fact that the degree of difference between blacks and whites is proportional across all time intervals examined (Fig 3) suggests against the idea that late presentation by blacks explains the differences in care that we found.

Apart from their own initiative (or lack thereof) to engage the health care system, the black patients in our sample may have had less access to intensive primary care and/or vascular surgical care. While Medicare should have provided similar insurance coverage to all the patients in our sample, we did not have data to evaluate differences in levels of adjunct, private insurance coverage. Similarly, although we adjusted for HRR, which should have adjusted for differences in the availability of primary care physicians or vascular surgeons among regions, HRR may be too large a unit of analysis to properly adjust for differences in physician density. It is conceivable, for example, that a single HRR contains both urban and rural settings, or areas of

both high- and low-physician density. Unfortunately, we did not have sufficient power to allow for adjustment at a smaller geographic level (eg, zip code).

Alternatively, some might suggest that differences in limb salvage care among elderly black versus white patients can be attributed to patient preferences. Previous work has shown that blacks are more likely than whites to decline aggressive surgical treatment for early-stage lung cancer.[5] Similarly, black patients with advanced prostate cancer are more likely than whites to pursue conservative management, rather than aggressive surgical therapy.[17] A similar scenario, in relation to limb salvage, is not entirely implausible: If amputation seems inevitable over the long term, perhaps black patients more frequently prefer to proceed with amputation and adjust to life with a prosthesis, sooner rather than later. Clearly, many revascularization attempts fail within a short time period—as suggested by our data, in which 60% of revascularizations occurred within 60 days of amputation (Fig 2). While there is, at present, no empiric evidence to suggest that black patients are less inclined to attempt limb salvage before proceeding with amputation, this remains an open question that might be explored through qualitative research.

Finally, given that patients' decisions are necessarily confined to the options offered by their physicians, racial differences in limb salvage care might be attributable to differences in physician decision making. There are some data to suggest lower vein graft patency rates in black patients compared to whites.[18,19] A patient's race, therefore, may influence a vascular surgeon's judgment about the efficacy of revascularization in preventing or delaying amputation. Similarly, a higher proportion of black patients in our sample were of low SES, which correlates with tobacco use,[20-22] and we know that continued tobacco use increases the risk of lower extremity graft failure approximately three-fold.[23] It is possible that a higher proportion of black patients in our sample were smokers who refused to quit, in which case vascular surgeons would be much less likely to offer them the option of revascularization. While Medicare data include an ICD-9 diagnosis code for tobacco use, the prevalence in our study sample was approximately 2%, suggesting that this code was grossly unreliable as a means of directly measuring and adjusting for tobacco use.

It is perhaps notable that toe amputation is the single procedure for which black and white patients saw similar rates prior to major lower extremity amputation (Table II). After all, toe amputations could arguably be considered the least-discretionary component of limb salvage care. One can exercise some level of individualized decision making when it comes to admitting a patient for wound care or thrombolysis, or attempting revascularization before proceeding with a major amputation. If a toe exhibits wet gangrene, however, it generally must be amputated. In our opinion, the fact that blacks received lower rates of limb salvage care when discretion was involved (as in the case of limb-related admissions, revascularizations, and wound debridements), but underwent equivalent rates of obligatory toe amputations, suggests the possibility of a true racial disparity not attributable to unmeasured confounders.

Our study has several limitations. First, administrative claims data lack information on illness severity and the anatomic details of PAD. Thus, our study is flawed in the extent to which differences in the feasibility of revascularization might account for differences in rates. Second, Medicare data does not identify the side of the body (right vs left) to which a given diagnosis or intervention refers. It may be that some of the limb interventions included in our results were actually performed on the opposite limb, and not on the limb that was eventually amputated. Given the large number of patients in our sample, however, it seems reasonable to us to assume that any such misclassifications would be equivalent among black and white patients, and thus would not change the results of our comparisons between racial groups. Finally, our study uses the MEDPAR files, which include only inpatient data. Certainly a large portion of limb salvage care, including wound care and many endovascular procedures, can be performed in the outpatient setting and would not be reflected in MEDPAR claims. It seems unlikely to us, however, that inclusion of outpatient claims would change the result that black patients receive less care than whites leading up to amputation. Perhaps more importantly, outpatient claims data might have allowed us to adjust for any differences in the utilization of primary and preventive medical care among black versus white patients. As explained above, later presentation by blacks and/or a lower likelihood of receiving preventive medical therapy might partially explain their lower rates of revascularization prior to amputation.

By design, our study does not address the question of the relationship between rates of revascularization and amputation rates. Given our results, however, we hypothesize that differential attempts at limb salvage might contribute to the known disparity in amputation rates among black and white patients. In future work, we plan to examine the relationship between regional rates of preamputation limb interventions and amputation rates in order to investigate whether high intervention rates represent "wasteful" care that might be curtailed, or effective care that should be extended to blacks on a more equitable basis.

CONCLUSIONS

Elderly black patients are much less likely than whites to undergo attempts at limb salvage prior to amputation. Future work should explore whether this disparity is attributable to differences in the pattern or severity of arterial disease, access to medical care, patient preferences, or physician decision making. Further study will be necessary to determine whether fewer revascularizations play a causal role in elevated amputation rates among blacks.

AUTHOR CONTRIBUTIONS

Conception and design: KH, PH, JB
Analysis and interpretation: KH, PH, JD, JB
Data collection: KH
Writing the article: KH, PH

Critical revision of the article: KH, PH, JD, JB
Final approval of the article: KH, PH, JD, JB
Statistical analysis: KH, JD
Obtained funding: JB
Overall responsibility: PH

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Additional material for this article may be found online at www.jvascsurg.org.

Appendix (online only). Limb-related admission and procedure ICD-9 codes

Principal Admission Diagnosis	*Related ICD-9 diagnosis code(s)*
ASO	• 440.20-22,29 (ASO of extremities unspecified, with IC, with rest pain; and other ASO of extremities); • 440.4∗ (chronic total occlusion of artery of the extremities); • 443.89, 443.9 (PVD)
Graft-related event	• 440.3∗ (ASO of BPG of extremities)
ASO with tissue loss	• 440.23,24 (ASO ext with ulceration/gangrene)
Osteomyelitis	• 730.06-07, 16-17, 26-27 (acute, chronic, unspecified osteomyelitis of lower leg, ankle, foot); • 730.36-37 (Periostitis without osteomyelitis involving lower leg, ankle foot); • 730.86-87, 96-97 (other or unspecified infection of bone involving lower leg, ankle, foot)
Lower extremity ulcer	• 707. 10-19 (ulcer of lower limb except pressure ulcer)
Lower extremity open wound	• 890.∗-894.∗ (open wound of lower limb)
Procedure	*Related ICD-9 procedure code(s)*
Open revascularizations	• 38.08, 18, 38, 48, 68, 88 (Incision of vessel, endarterectomy, resection of vessel with anastomosis, resection of vessel with replacement, other excision of vessels, or other surgical occlusion of vessels on lower limb arteries) • 39.29,49,56-59,99 (Other vascular shunt or bypass, other revision of vascular procedure, repair of blood vessel with patch graft, or other operation on vessel)†
Aorto-Femoral Bypass	• 39.25 (Aorta-iliac-femoral bypass) -NOT including procedures accompanied by the following diagnosis codes, which would indicate repair of thoracic, abdominal, and/or iliac artery aneurismal disease: 441.3-9, 442.2
Endovascular revascularization	• 39.50, 79 (angioplasty or atherectomy of noncoronary vessel, other endovascular repair of other vessels)†
Endovascular stenting	• 00.55, 39.90 (insertion of drug-eluting or nondrug-eluting, non-coronary artery stent[s])†
Toe amputation	• 84.11 (amputation of toe)
Wound debridement	• 86.22,28 (excisional or nonexcisional debridement of wound, infection, or burn) - IF accompanied by one of the followingdiagnosis codes: 707.10-19 (ulcer of lower limb except pressure ulcer), 890.∗-894.∗ (open wound of lower limb).

ASO, atherosclerosis; *ICD-9,* International Classification of Diseases, 9th edition.

†If accompanied by one of the following diagnosis codes: ASO of extremities (440.2*), ASO of BPG of extremities (440.3*), chronic total occlusion of artery of the extremities (440.4*), DM with PVD (250.7*), PVD (443.89, 443.9).