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Functional Outcomes After Lower Extremity Revascularization in Nursing Home Residents A National Cohort Study

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Abstract

IMPORTANCE—Lower extremity revascularization often seeks to allow patients with peripheral arterial disease to maintain the ability to walk, a key aspect of functional independence. Surgical outcomes in patients with high levels of functional dependence are poorly understood.

OBJECTIVE—To determine functional status trajectories, changes in ambulatory status, and survival after lower extremity revascularization in nursing home residents.

DESIGN—Using full Medicare claims data for 2005 to 2009, we identified nursing home residents who underwent lower extremity revascularization. With the Minimum Data Set for Nursing Homes activities of daily living summary score, we examined changes in their ambulatory and functional status after surgery. We identified patient and surgery characteristics associated with a composite measure of clinical and functional failure—death or nonambulatory status 1 year after surgery.

SETTING—All nursing homes in the United States participating in Medicare or Medicaid.

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Author Contributions: Dr Finlayson had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Oresanya, Fries, Conte, Finlayson.

Acquisition, analysis, or interpretation of data: Oresanya, Zhao, Gan, Fries, Goodney, Covinsky, Finlayson.

Drafting of the manuscript: Oresanya.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Oresanya, Zhao, Gan, Finlayson.

Administrative, technical, or material support: Fries, Goodney.

Study supervision: Finlayson.

Conflict of Interest Disclosures: None reported.

PARTICIPANTS—Nursing home residents who underwent lower extremity revascularization.

MAIN OUTCOMES AND MEASURES—Functional status, ambulatory status, and death.

RESULTS—During the study period, 10 784 long-term nursing home residents underwent lower extremity revascularization. Prior to surgery, 75% of the residents were not walking; 40% had experienced functional decline. One year after surgery, 51% of patients had died, 28% were nonambulatory, and 32% had sustained functional decline. Among 1672 residents who were ambulatory before surgery, 63% had died or were nonambulatory at 1 year; among 7188 who were nonambulatory, 89% had died or were nonambulatory. After multivariate adjustment, factors independently associated with death or nonambulatory status were 80 years or older (adjusted hazard ratio [AHR], 1.28; 95% CI, 1.16–1.40), cognitive impairment (AHR, 1.23; 95% CI, 1.18–1.29), congestive heart failure (AHR, 1.16; 95% CI, 1.11–1.22), renal failure (AHR, 1.09; 95% CI, 1.04–1.14), emergent surgery (AHR, 1.29; 95% CI, 1.23–1.35), nonambulatory status before surgery (AHR, 1.88; 95% CI, 1.78–1.99), and decline in activities of daily living before surgery (AHR, 1.23; 95% CI, 1.18–1.28).

CONCLUSIONS AND RELEVANCE—Of nursing home residents in the United States who undergo lower extremity revascularization, few are alive and ambulatory 1 year after surgery. Most who were still alive had gained little, if any, function.

Lower extremity peripheral arterial disease is a common condition among nursing home residents,[1, 2] and a substantial number of such individuals are at risk for critical limb ischemia. Lower extremity revascularization is frequently performed with the goal of preserving functional independence through limb preservation. These procedures, however, are frequently associated with operative risk, and their benefit in terms of maintaining the ability to walk is variable.[3, 4] Because nursing home residents, in general, have high levels of functional dependence unrelated to peripheral arterial disease and higher rates of mortality after most invasive procedures,[5–7] a thorough examination of the outcomes of lower extremity revascularization is needed to inform the use of these procedures.

Although numerous studies[8–10] have shown that functional dependence is associated with postoperative mortality and complications, information about functional outcomes after lower extremity revascularization in such patients is sparse. A review of studies evaluating functional outcomes following lower extremity revascularization identified only 107 non-ambulatory patients and 195 functionally dependent patients for whom ambulatory or functional status following lower extremity revascularization was reported.[11] Recently, Vogel et al[12] reported outcomes following lower extremity revascularization in 702 nursing home residents. Our study, however, focused on a comparison of functional outcomes between open and endovascular revascularization procedures in a selected subset of residents.

Using data from national Medicare claims and the Minimum Data Set for Nursing Homes (MDS), we examined survival, changes in ambulatory status, and functional trajectories after lower extremity revascularization in nursing home residents in the United States between 2005 and 2008, with follow-up through 2009. With regression techniques, we identified factors associated with poor functional outcomes following revascularization.

Methods

Patients and Databases

We linked data from the full Medicare Inpatient Files with the MDS (version 2.0) to identify long-term nursing home residents undergoing lower extremity revascularization. The Medicare Inpatient File contains discharge abstracts for all fee-for-service inpatient hospitalizations for Medicare beneficiaries. The MDS is a mandatory assessment of all nursing home residents who reside in facilities participating in Medicare or Medicaid programs—virtually all US nursing homes. The MDS assessments are completed at admission, readmission, quarterly, and when the resident experiences a change in clinical status. The study was approved by the University of California, San Francisco, Human Research Protection Program.

Residents undergoing lower extremity revascularization were identified in the Medicare Inpatient File by *International Classification of Diseases, 9th Edition* (*ICD-9*) procedure codes for open (*ICD-9* codes 38.08, 38.18, 39.29) and endovascular (*ICD-9* codes 39.50, 39.99) revascularization. Nursing home residents were classified as long-term if they underwent 2 or more consecutive full or quarterly MDS assessments performed over 90 days apart during the 6 months before surgery, indicating a preoperative nursing home length of stay greater than 90 days. To exclude residents who had recently undergone prior revascularization attempts, residents who had undergone a lower extremity revascularization procedure in the 2 years preceding the study period were excluded from analysis. Based on these criteria, we identified all long-term nursing home residents older than 67 years undergoing lower extremity revascularization procedure in the United States between 2005 and 2008, with follow-up to 2009.

Outcomes

The outcomes were survival, functional status, and ambulatory status. Outcomes were assessed at 3, 6, 9, and 12 months after surgery. Death was determined using date of death information from the Medicare Denominator file. We defined ambulatory as a score of 0 (independent), 1 (supervision), or 2 (limited assistance) in the MDS ambulation domain. Conversely, we defined nonambulatory as a score of 3 (extensive assistance), 4 (total dependence), or 8 (activity did not occur).

Functional status was measured using MDS assessments of self-performance of activities of daily living (ADLs). Data on ADL performance in the MDS includes information about mobility in 7 ADLs: mobility while in bed, transferring, ambulation, dressing, eating, toileting, and personal hygiene. The resident's performance of each of these ADLs is rated using a scoring system of 0 to 4 points, with 0 indicating independence and 4 indicating total dependence. The sum of these 7 scores—the MDS-ADL score—has been validated against standardized measures of functional independence.[13] Possible total scores range from 0 to 28, with 0 indicating independence in all ADLs and 28 indicating total dependence in all ADLs. Residents were classified as having functional decline if they had a 2-point or greater increase in their MDS-ADL score. This definition of functional decline is consistent with those in prior studies[14] and identifies nursing home residents who have a clear decline in

function. For example, a patient who previously required supervision with bathing and now requires extensive assistance with bathing has experienced a 2-point decline. Maintenance of functional status was defined as no change or a 1-point change (positive or negative), and improvement in functional status was defined as a 2-point or more decrease in the MDS-ADL score. We defined 2 distinct adverse clinical outcomes: (1) a combined measure of nonambulatory status or death at 1 year and (2) functional decline among 1-year survivors.

Covariates

Demographic data (age, sex, and race), the admission acuity (elective, or urgent or emergent), and the nature of the procedure (open or endovascular) were obtained from Medicare files. Comorbid diagnoses were obtained from Medicare Provider Analysis and Review files for the surgical hospitalization and MDS assessments performed prior to surgery. We examined factors commonly associated with adverse outcomes after vascular surgery, including congestive heart failure, diabetes mellitus, cerebrovascular disease, chronic obstructive pulmonary disease, coronary artery disease, renal failure, and cognitive impairment.[15, 16] Baseline functional and ambulatory status were based on the MDS assessment before the surgical hospitalization. Residents were classified as having preoperative functional decline if they had a 2-point or greater MDS-ADL score increase in the 6 months before their surgical admission. Residents were defined as having cognitive impairment if they met at least 1 of 3 criteria: disease diagnosis of dementia on MDS assessment, *ICD-9* diagnosis code for dementia in Medicare claims, or a MDS cognitive performance scale score (CPS) of 3 or greater. The MDS-CPS is a validated scale of cognitive function generated from 5 items in the MDS. Possible scores range from 0 to 6, with 0 indicating intact cognitive function and 6 indicating very severe cognitive impairment.[17] ACPS score of 3 indicates moderate cognitive impairment.

Statistical Analysis

We compared descriptive variables by using χ^2 analysis for dichotomous categorical variables and analysis of variance for categorical and continuous variables. The composite measure of death or nonambulatory status was defined as a “time to event” outcome. If the resident died, the death date was the event date. If the resident survived 1 year, nonambulatory status on the last assessment was the event and date of assessment was the event date. We used the Kaplan-Meier method to estimate cumulative death or nonambulatory status at 1 year and Cox proportional hazards models to estimate the risk associated with individual resident characteristics and being nonambulatory or dead at 1 year after surgery. We fitted log Poisson regression models to estimate the relative risks of functional decline among 1-year survivors associated with individual resident and procedure characteristics.

Functional trajectories before and after surgery were explored using the mixed-effects spline models to incorporate multiple measurements for each patient. Specifically, restricted cubic spline models with 5 knots placed at 3 months and 1 month before surgery and 1, 4, and 12 months after surgery were used. Models included fixed and random effects for the coefficients of the spline, implying that each person’s measurements were scattered around a patient-specific smooth curve; these patient-specific smooth curves were then departures

from the average smooth trajectory for the population. Fixed effects for age, sex, race, and comorbidity were also included, allowing the population trajectory to shift based on the baseline characteristics. To account for residents who were alive but did not have ADL assessments (missing assessments) in months 9 to 12, we used multiple imputations to predict MDS-ADL scores at 12 months.

For all analyses, $P = .05$ on 2-sided significance test was considered statistically significant. The University of California at San Francisco committee on human research approved this study.

Results

Characteristics of the Nursing Home Residents

Between 2005 and 2008, 10 784 nursing home residents underwent lower extremity revascularization. Their mean age was 82 years, 37% were men, and 80% were white. Comorbid disease was common; 60% had cognitive impairment, 57% had congestive heart failure, and 29% had renal failure (Table 1). Revascularization was performed electively in 67% of cases, and over one-half of all procedures were performed using an endovascular approach. Prior to surgery, 75% of patients were nonambulatory. The mean baseline MDS-ADL score was 14.5, indicating a high level of preoperative functional dependence. A substantial proportion of residents (40%) had experienced functional decline in the 6 months prior to surgery.

Adverse Clinical Outcomes: Death or Nonambulatory Status

Overall 1-year mortality was 51% to 43% among ambulatory residents and 53% among nonambulatory residents (Figure 1). One year after surgery, 82% of residents had either died or were nonambulatory. Among residents who were ambulatory before surgery, 63% had died or were nonambulatory. Among residents who were nonambulatory prior to surgery, 89% had died or were nonambulatory. In multivariate analysis, preoperative ambulatory status had the strongest association with this measure of clinical failure (hazard ratio [HR], 1.88; 95% CI, 1.78–1.99) (Table 2). When compared with open surgery, an endovascular approach was associated with a lower likelihood of clinical failure (HR, 0.88; 95% CI, 0.85–0.92). Among nursing home residents who were alive 1 year after surgery, 34% who were ambulatory at baseline became nonambulatory, and 24% who were nonambulatory at baseline became ambulatory.

Adverse Clinical Outcomes: Functional Decline

The mean MDS-ADL impairment score for the cohort increased from 14.5 points at baseline to 16.7 points at 1 year following revascularization; the 2.2-point change represents a clinically significant decline in function. In the mixed-effects model, the greatest functional decline occurred within the first 3 months following surgery, during which the mean MDS-ADL score increased to 17.8. By 6 months, the mean MDS-ADL score decreased slightly to 17.2, followed by a small gradual functional improvement among patients who were alive 1 year after revascularization.

The proportion of nursing home residents whose function declined from preoperative levels was greatest during the first 3 months after surgery: 40% of the entire cohort and 56% of surviving residents (Figure 2). Three months after surgery, 29% of residents had died and 32% had improved or maintained baseline function. Six months after surgery, 39% of residents had died and 51% of the survivors had functional decline. At 1 year, 50% of residents had died, 36% of survivors had improved or maintained ADL function, and 64% of survivors had experienced decline. After multivariate adjustment, nonambulatory status before surgery had the strongest association with functional decline among survivors (adjusted relative risk, 3.12; 95% CI, 2.84–3.43) (Table 3).

Discussion

We found that a substantial number of nursing home residents in the United States undergo lower extremity revascularization, and many gain little, if any, function. The mortality rate, however, is high, with half of residents dying within a year of surgery. One year after surgery, 13% of the initial cohort was ambulatory and 18% had maintained or improved on their baseline functional status. Residents who were ambulatory prior to revascularization had better outcomes than those who were nonambulatory; revascularization rarely allowed a nonambulatory resident to become ambulatory.

Outcomes in nursing home residents are substantially worse than those in the general population of patients undergoing lower extremity revascularization. The Vascular Study Group of Northern New England (VSGNNE) registry[10] prospectively collects data on all lower extremity revascularization procedures performed within the region. A study[10] evaluating ambulatory function 1 year after lower extremity bypass showed that 83% of patients were alive and walking 1 year after open lower extremity bypass. In our cohort, only 17% of patients were alive and walking 1 year after undergoing lower extremity revascularization.

Several groups have been reported series in which patients—even the most elderly—had excellent outcomes following lower extremity revascularization. For example, Pomposelli et al[18] and Ballotta et al[19] reported excellent outcomes after revascularization in octogenarians and nonagenarians. The 1-year mortality rates in these studies were 5% and 9%, respectively, and the rates of maintenance of ambulatory function were 78% and 80%. These studies, however, examined outcomes in a group of selected older adults at a single institution. The study by Vogel et al[12] examined a highly selected subset of nursing home residents: their cohort excluded residents who underwent non-elective procedures, had a hospital stay of more than 30 days, died in the hospital, or had more than 20 hospital stays during the study period. Our study examined a population-based cohort of nursing home residents who underwent revascularization across a variety of hospitals.

Our findings are consistent with those of previous studies that found that individuals who are ambulatory prior to lower extremity revascularization have better outcomes that those who are nonambulatory, and that revascularization only rarely allows a patient who is nonambulatory to become ambulatory postoperatively.[20, 21] Even among the nursing home residents who were ambulatory before revascularization, however, we identified a high rate

of mortality and functional decline. It is unclear whether the poor outcomes were a result of revascularization per se or the insufficient physiologic reserve of many of the patients who underwent the procedure.

Our study has several limitations. We lacked detailed information about the indication for surgery. Although it might be presumed that most nursing home patients undergoing lower extremity revascularization would have critical limb ischemia, not claudication, we have no information about the severity of ischemia and the prevalence and duration of nonhealing wounds or gangrene. In addition, we were not able to identify patients with critical limb ischemia who did not undergo surgery and who were treated with either palliative amputation or simply pain control and localized wound care. As dismal as the outcomes may seem, we were unable to compare the changes in the ability to walk and functional decline in patients undergoing revascularization with patients treated with either amputation or palliation. Although it is possible that the stress of surgery and hospitalization in patients who are already frail may worsen their functional dependence, it is also possible that nursing home residents with critical limb ischemia who do not undergo revascularization may experience greater functional decline.

Conclusions

Treatment decisions for elderly, frail patients with critical limb ischemia are complex; shared decision-making is needed. Our findings can inform conversations between physicians, patients, and families about the risks and expected outcomes of surgery and whether the surgery is likely to be worthwhile. Our findings also highlight the importance of carefully considering a prognosis independent of vascular disease and assessing the goals of care. Ambulatory function, although clearly an important goal, may not be the primary objective of treatment and may be impossible to attain. Nonambulatory patients with refractory ischemic rest pain, wounds that do not heal despite months of nursing care, or worsening gangrene seek palliation for the relief of symptoms. Among the treatment options, palliative care, primary amputation, and lower extremity revascularization are associated with different risks, benefits, and expected outcomes. Thus, our findings should be interpreted cautiously; successful relief of pain, healing of wounds, and avoidance of major amputation may benefit some of the patients who underwent lower extremity revascularization.

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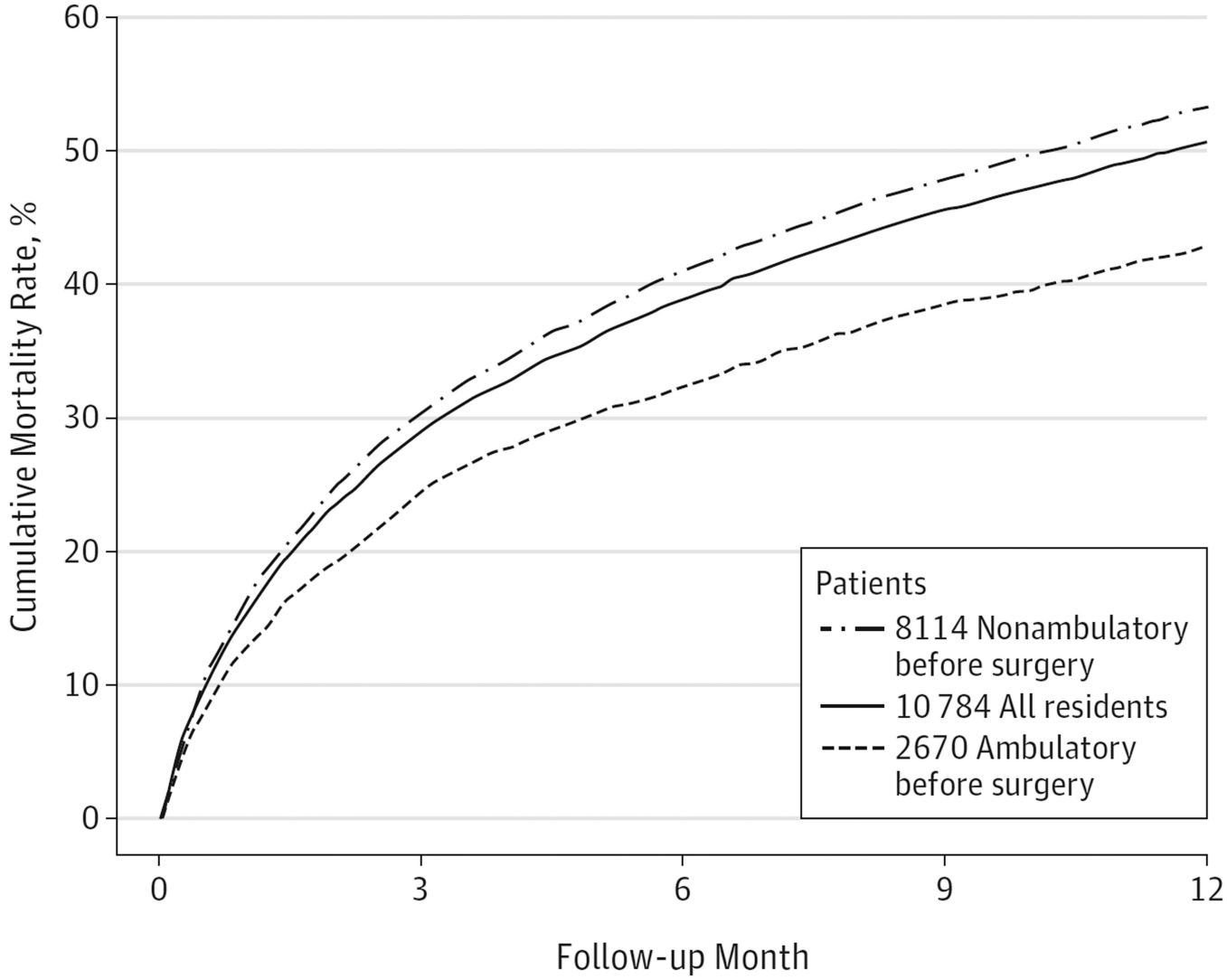

Figure 1.
Mortality After Surgery, Stratified by Ambulatory Status

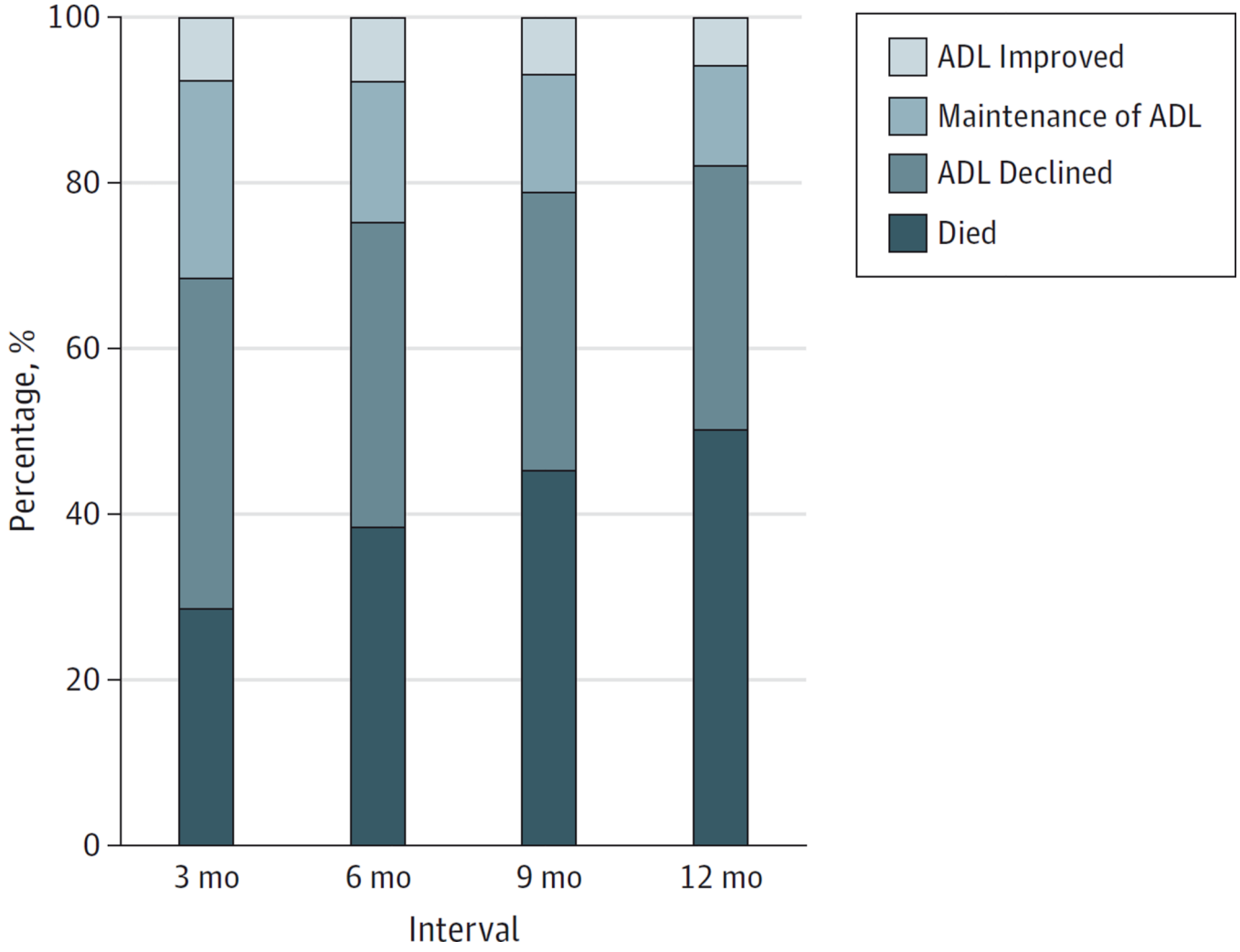

Figure 2.

The Proportion of Residents Who Died, Had Activities of Daily Living (ADL) Score Decline, Maintained ADL Score, or Had ADL Improvement Over Time

Functional status was measured using Minimum Data Set for Nursing Homes assessments of self-performance of ADLs. Residents were classified as having functional decline if they had a 2-point or greater increase in their MDS-ADL score, maintenance of functional status was defined as no change or a 1-point change (positive or negative), and improvement in functional status was defined as a 2-point or greater decrease in the MDS-ADL score.

Table 1

Characteristics of 10 785 Nursing Home Residents Undergoing Lower Extremity Revascularization

Baseline Characteristic	%
Age, mean (SD), y	82.1 (7.5)
Male sex	37.0
Race	
White	80.4
Black	15.4
Other	4.2
Admission type	
Elective	67.3
Urgent or emergent	32.7
Operative approach	
Open	44.3
Endovascular	55.7
Comorbidity	
Cognitive impairment	59.6
Congestive heart failure	57.0
Diabetes mellitus	54.4
Cerebrovascular disease	42.9
Chronic obstructive pulmonary disease	41.7
Coronary artery disease	36.5
Renal failure	29.4
Charlson score, mean (SD)[a]	5.3 (2.3)
Baseline ADL quartile[b]	
0–10	26.6
11–16	25.9
17–21	28.5
22–28	19.0
Functional decline before surgery	37.9
Ambulatory before surgery	24.8

Abbreviation: ADLs, activities of daily living.

[a]Range of Charlson scores: 0–15.

[b]The ADL performance in the Minimum Data Set for Nursing Homes includes information about mobility in 7 activities: mobility while in bed, transferring, ambulation, dressing, eating, toileting, and personal hygiene. Performance of each of these ADLs is rated using a scoring system of 0 to 4 points, ranging from 0, indicating independence, to 4, indicating total dependence. Possible total scores range from 0, for independence in all ADLs, to 28, indicating total dependence in all ADLs.

Table 2

Patient and Procedure Characteristics Associated With Nonambulatory Status or Death Following Lower Extremity Revascularization

Characteristic	Dead or Nonambulatory, %	(95% CI) HR	(95% CI) AHR	*P* Value for Global
Age, y				
67–69	77.5	1 [Reference]	1 [Reference]	<.001
70–79	78.9	1.06 (0.96–1.16)	1.04 (0.95–1.14)	
≥80	84.2	1.34 (1.22–1.46)	1.28 (1.16–1.40)	
Sex				
Male	82.7	1 [Reference]	1 [Reference]	.01
Female	81.8	1.00 (0.96–1.05)	0.94 (0.90–0.99)	
Race				
White	81.3	1 [Reference]	1 [Reference]	.76
Black	86.5	1.01 (0.96–1.07)	0.98 (0.92–1.04)	
Other	83.6	1.02 (0.92–1.14)	1.01 (0.91–1.12)	
Comorbidity				
Cognitive impairment	86.3	1.33 (1.27–1.38)	1.23 (1.18–1.29)	<.001
Congestive heart failure	83.4	1.17 (1.12–1.22)	1.16 (1.11–1.22)	<.001
Diabetes mellitus	84.0	1.04 (1.00–1.09)	1.02 (0.98–1.07)	.34
Cerebrovascular disease	83.9	1.05 (1.01–1.10)	1.00 (0.95–1.04)	.82
Chronic obstructive pulmonary disease	80.8	0.96 (0.92–1.00)	0.96 (0.92–1.01)	.11
Coronary artery disease	80.9	1.01 (0.97–1.06)	1.00 (0.96–1.05)	.97
Renal failure	83.5	1.12 (1.07–1.17)	1.09 (1.04–1.14)	<.001
Procedure type				
Open	83.3	1 [Reference]	1 [Reference]	<.001
Endovascular	81.3	0.90 (0.86–0.94)	0.88 (0.85–0.92)	
Admission status				
Elective	80.3	1 [Reference]	1 [Reference]	<.001
Urgent or emergent	86.0	1.21 (1.16–1.26)	1.29 (1.23–1.35)	
Nonambulatory before surgery				
No	62.6	1 [Reference]	1 [Reference]	<.001
Yes	88.6	1.94 (1.84–2.05)	1.88 (1.78–1.99)	
ADL decline before surgery[a]				
No	78.7	1 [Reference]	1 [Reference]	<.001
Yes	87.4	1.32 (1.27–1.38)	1.23 (1.18–1.28)	

Abbreviations: ADL, activities of daily living; AHR, adjusted hazard ratio; HR, hazard ratio.

[a]Residents were classified as having ADL decline before surgery if they had a 2-point or greater Minimum Data Set for Nursing Homes–ADL score increase in the 6 months before their surgical admission.

Table 3

Patient and Procedure Characteristics Associated With Functional Decline Following Lower Extremity[a] Revascularization Among Nursing Home Residents Alive 1 Year After Surgery

Characteristic	Functional Decline, %	(95% CI) RR	(95% CI) ARR	*P* Value for Global
Age, y				
67–69	63.7	1 [Reference]	1 [Reference]	.93
70–79	63.6	0.99 (0.86–1.13)	0.99 (0.86–1.13)	
≥80	63.8	0.98 (0.86–1.12)	1.01 (0.88–1.15)	
Sex				
Male	65.8	1 [Reference]	1 [Reference]	<.001
Female	62.5	0.90 (0.84–0.96)	0.88 (0.82–0.95)	
Race				
White	60.8	1 [Reference]	1 [Reference]	<.001
Black	75.7	1.42 (1.31–1.55)	1.24 (1.14–1.35)	
Other	68.0	1.22 (1.04–1.43)	1.14 (0.97–1.34)	
Comorbidity				
Cognitive impairment	69.9	1.36 (1.27–1.46)	1.22 (1.14–1.31)	<.001
Congestive heart failure	63.1	0.97 (0.91–1.04)	1.02 (0.95–1.10)	.60
Diabetes mellitus	67.9	1.27 (1.19–1.36)	1.15 (1.07–1.24)	<.001
Cerebrovascular disease	67.9	1.21 (1.13–1.29)	1.05 (0.98–1.13)	.14
Chronic obstructive pulmonary disease	60.4	0.86 (0.80–0.92)	0.86 (0.80–0.93)	<.001
Coronary artery disease	59.9	0.88 (0.82–0.95)	0.89 (0.83–0.96)	.003
Renal failure	62.8	0.98 (0.91–1.06)	0.91 (0.84–0.98)	.02
Procedure type				
Open	64.1	1 [Reference]	1 [Reference]	.94
Endovascular	63.5	1.00 (0.93–1.07)	1.00 (0.93–1.07)	
Admission status				
Elective	62.0	1 [Reference]	1 [Reference]	<.001
Urgent or emergent	68.0	1.12 (1.04–1.21)	1.22 (1.13–1.31)	
Nonambulatory before surgery				
No	34.4	1 [Reference]	1 [Reference]	<.001
Yes	75.5	3.20 (2.91–3.52)	3.12 (2.84–3.43)	
ADL decline before surgery[b]				
No	63.7	1 [Reference]	1 [Reference]	.93
Yes	63.6	0.99 (0.86–1.13)	0.99 (0.86–1.13)	

Abbreviations: ADL, activities of daily living; ARR, adjusted relative risk; MDS, Minimum Data Set for Nursing Homes; RR, relative risk.

[a]See the Outcomes subsection in the Methods section. Residents were classified as having functional decline if they had a 2-point or greater increase in their MDS-ADL score.

[b]Residents were classified as having ADL decline before surgery if they had a 2-point or greater MDS-ADL score increase in the 6 months before their surgical admission.