

Trends in peripheral vascular procedures in the Veterans Health Administration, 1989–1998

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Abstract—Objective: To assess trends in peripheral vascular procedures performed in Veterans Health Administration (VHA) facilities. **Methods:** All discharges with peripheral vascular procedures recorded for 1989–1998 were analyzed. The VHA user population was used to calculate age-specific rates. Trends were evaluated using frequency tables and Poisson regression. **Results:** The VHA had 55,916 discharges with peripheral vascular procedures performed almost exclusively in men. Indications included peripheral vascular disease (53.7%), gangrene (19.3%), surgical complications (13.3%), and ulcers and infection (9.6%). The VHA age-specific rates were higher than US population rates for persons 45 to 64 years, similar for those 65 to 74 years, and lower for those 75 years and older. The age-specific rates declined slightly over the 10 years of observation, with the greatest decline noted in men age 45 to 65. **Conclusion:** The VHA provides almost 8% of all US peripheral vascular procedures in males. The VHA age-specific rates differ from the US rates with a shift to younger patients. The rates decreased for all age groups between 1989–1998.

Key words: angioplasty, diabetes, epidemiology, vascular bypass, veterans.

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INTRODUCTION

Several population-based investigations have noted a steady increase in the number of peripheral vascular procedures provided in the United States and Europe. In a study of hospital discharges in Maryland, the number of hospitalizations with peripheral bypass surgery doubled between 1979 and 1989, and the rate of angioplasties in the lower limb increased over twentyfold (1). An analysis of a US national sample from 1979 to 1996 demonstrated that angioplasties tripled over the observed time period, and peripheral bypass procedures increased until the mid-1980s, then stabilized, while aorta-femoral bypass procedures remained fairly stable.

The Veterans Health Administration (VHA) provides health care to a significant proportion of older males with chronic medical problems. In a recent analysis we reported that the VHA provided 10 percent of all amputations to men in the United States. Similar information is not available on peripheral vascular procedures provided within the VHA facilities. Also, no data is available on the demographic characteristics of those who utilize peripheral vascular procedures within VHA hospitals.

To address this lack, we undertook this analysis of hospital discharge records from the Veterans Health Care System to assess the number of peripheral vascular interventions for lower-limb problems in veterans between 1989 and 1998. We also describe the demographics of the

veterans who underwent peripheral vascular procedures and the indications for these procedures.

METHODS

Discharge records contained in the Patient Treatment File from all VHA hospitals between fiscal years 1989 and 1998 were obtained. This file permits up to five codes for each operation and up to ten diagnosis codes for the hospitalization. Eleven diagnosis codes were available for 1997 and 1998 data. The quality of this data set has been validated (2).

Vascular bypass procedures of the lower limb during fiscal year 1989-1998 were identified using two ICD-9-CM codes. Proximal bypass procedures were identified using ICD-9-CM code 39.29, "bypass involving the aorta-iliac-femoral-popliteal vessels." Distal bypass procedures were identified using ICD-9-CM code 39.25, "other peripheral vascular bypass surgery, other than aorta-iliac-femoral bypass to the tibial, peroneal or dorsal artery." This code also designates vascular bypass procedures in the upper limb. In another study, we examined over 300 hospital discharge records with an ICD-9-CM code and only three did not have a distal lower-limb bypass procedure.

Angioplasty was identified using two different codes. Before 1996, angioplasty of peripheral vessels was identified with ICD-9-CM code 39.59, "other vascular repair." In 1996, ICD-9-CM code 39.00, "angioplasty or atherectomy of non-coronary vessel with stent(s) or stent graft," was employed. To insure that we were not identifying coronary artery bypass procedures and AV fistula procedures for renal replacement access, we excluded any discharge with ICD-9-CM 39.6, "extracorporeal circulation, AV fistula for dialysis or for vessel repairs for conditions other than peripheral vascular disease, i.e., surgical misadventures, radical tumor surgery, *et cetera*."

Procedures with identical codes performed on the same day in the same person were counted as only one procedure. Although this could indicate bilateral procedures, it could also indicate typographical errors. Multiple procedures during the same anesthetic were categorized using a hierarchical system: a) angioplasty alone, b) proximal bypass alone or with angioplasty, and c) distal bypass with or without proximal bypass or angioplasty. Multiple procedures during the same hospitalization were categorized with the same hierarchy. The

vascular procedures were analyzed by hospital discharge unless stated otherwise. Discharges were excluded if the first two diagnosis fields carried a diagnosis of cancer or major trauma (ICD-9-CM codes E8* (except for E87*), E9*, 820, 835-839, 890-897, 904, 905.4, 906.1, 907.5, and 928-929).

The indications for the vascular procedure were identified using a hierarchical classification system:

a) nonspecific atherosclerosis (ICD-9-CM 440.*, 44*.**) and peripheral vascular disease (ICD-9-CM 443.8, 443.89, 440.21).

b) uncomplicated wounds (chronic ulcers or wounds ICD-9-CM codes 707.0, 707.1, 707.9, 891-894), superficial infection (abscess and/or cellulitis 681.10, 681.11, 682.6, and 682.7), and deep infection, fasciitis, osteomyelitis (ICD-9-CM 729.4, 730.*, 731.*), or ulcer due to atherosclerosis (440.23).

c) gangrene (nonspecific or gas gangrene ICD-9-CM codes 785.4 and 040.0) and rest pain ICD-9-CM 440.22.

d) complications of prior lower-limb surgery (residual-limb infection, amputation complications, ICD-9-CM code 768, 997.6) or a prior vascular graft (ICD-9-CM 440.3, 996.62, 996.7, 996.74, E878.2).

e) miscellaneous conditions.

Many discharges with a vascular bypass procedure also had one, or more, lower-limb amputation procedures performed during the hospitalization. Lower-limb amputations were identified as toe (ICD-9-CM code 84.11), transmetatarsal (ICD-9-CM code 84.12), transtibial (ICD-9-CM 84.13-84.17), and transfemoral (ICD-9-CM codes 84.18-84.19) amputations. When multiple amputations were recorded, the most proximal level was used for analysis. A scrambled social security number for each individual during the year allowed aggregation of all hospitalizations for an individual during the year. Any person with a hospitalization diagnosis code for diabetes (ICD-9-CM 250.***) was identified for the entire year as having diabetes.

The VHA user population was defined as veterans with one or more registered outpatient visits at a VA facility during the fiscal year; each veteran was counted only once. Age-specific procedure rates were calculated using this unduplicated VHA user population.

Frequency tables were used to describe the characteristics of those who underwent amputation, vascular bypass, and angioplasty. Statistical significance was

tested with Pearson's chi-square test. Trends in continuous variables (amputation number) were tested using linear regression, trends in dichotomous outcomes (i.e., re-operation) were tested with logistic regression, and trends in rates (i.e., amputation) were tested with Poisson regression.

RESULTS

Between fiscal years 1989 and 1998, a total of 55,916 hospital discharges from VA hospitals included one or more peripheral vascular bypass procedures. Of these, 14,454 (25.9 percent) were angioplasties alone, 11,947 (21.4 percent) were proximal bypass procedures (which may have included an angioplasty), and 29,515 (52.8 percent) were distal bypass procedures (which may have included a proximal bypass procedure and/or angioplasty). The numbers of hospital discharges are shown by year and type of surgical procedure in **Table 1**. The number of hospital discharges with a peripheral vascular procedure by diabetes status is shown in **Figure 1**. The number of discharges of persons with diabetes remained fairly stable, while the number of procedures in persons without diabetes declined steadily over the 10 years of observation.

The major indications for the three procedures are shown in **Table 2**, along with the frequency of repeat vas-

cular procedures and amputations during the same hospitalization and comorbid conditions. Peripheral vascular disease without mention of ulceration, infection, or gangrene was the primary indication for 52.8 percent of angioplasties, 78.5 percent of the proximal bypass procedures, and 43.9 percent of the distal bypass procedures. Ulceration or infection was noted in 6.5 percent, 4.8 percent, and 13.2 percent, respectively, and gangrene was noted in 10.6 percent, 9.8 percent, and 27.5 percent of the angioplasties, proximal bypass, and distal bypass procedures, respectively. Surgical complication from previous vascular or orthopedic surgery was identified in 18.3 percent of the angioplasties, 6.2 percent of the proximal bypass procedures, and 13.7 percent of the distal bypass procedures.

Miscellaneous conditions were listed for 11.8 percent of the angioplasties, 0.8 percent of the proximal bypass procedures, and 1.8 percent of the distal bypass procedures. At least one other vascular procedure was performed during the same hospitalization in 3.0 percent of the angioplasties, 1.9 percent of the proximal bypass procedures, and 8.9 percent of the distal bypass procedure hospitalizations. Amputation was performed during the same hospitalization in 6.8 percent of the discharges with angioplasty, 4.5 percent of the discharges with proximal bypass, and 21.0 percent of the discharges with distal bypass procedures. **Table 2** outlines the amputation level for each type of vascular intervention. Diabetes was

Table 1.

Number of hospital discharges with peripheral vascular procedure by type of procedure and year, Veterans Health Administration, 1989–1998.

Year	Angioplasty alone*	Proximal bypass**	Distal bypass***	Total
1989	1,391	1,440	3,254	5,985
1990	1,485	1,381	3,024	5,784
1991	1,375	1,332	2,946	5,529
1992	1,303	1,201	2,774	5,153
1993	1,373	1,151	2,699	5,122
1994	1,510	1,194	2,922	5,517
1995	1,526	1,138	2,979	5,554
1996	1,725	1,167	2,927	5,728
1997	1,486	1,006	2,767	5,183
1998	1,280	937	2,580	4,733
Total	14,454	11,947	29,515	55,916

*For years 1989–1995: ICD-9-CM code 39.59 "Other vascular repair"; for years 1996–1998, ICD-9-CM code 39.50 "Angioplasty or atherectomy of noncoronary vessel with stent(s) or stent graft."

** ICD-9-CM code 39.25 "Aorta-iliac-femoral-popliteal bypass." Hospitalization may have included an angioplasty.

*** ICD-9-CM code 39.29 "Other (peripheral) vascular shunt or bypass, which may have included upper limb. Hospitalization may have included a proximal bypass and/or angioplasty."

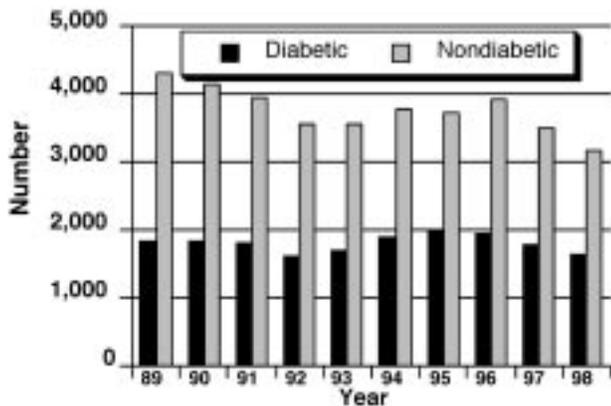


Figure 1.
Total discharges with peripheral vascular procedures by diabetes status, VHA, 1989–1998.

present in 32.1 percent of the discharges with angioplasty, 16.6 percent of those with proximal bypass, and 38.7 percent of those with distal bypass procedures. Renal disease was present in 9.5 percent, 4.5 percent, and 5.7 percent, respectively, of the hospitalizations with angioplasty, proximal bypass, and distal bypass.

The demographic characteristics of age and race are compared for discharges with the three peripheral vascular procedures in **Table 3**. Less than 3 percent of the discharges were in veterans 44 years of age and younger. The majority of hospital discharges with peripheral vascular procedures were in veterans 55 to 75 years of age. The racial designations in discharges for proximal bypass were listed as White, 82.1 percent; African American, 10 percent; and other/unspecified race, 7.7 percent. The dis-

Table 2.

Indications for vascular procedure, repeat procedures, amputation, and comorbid conditions by type of vascular procedure, column percent, VHA, FY 1989–1998.

	Indication for Amputation			Total n=55,916
	Angioplasty alone* n=14,454	Proximal bypass** n=11,947	Distal bypass*** n=29,515	
Indication for procedure#				
Peripheral vascular disease without ulcer or tissue loss	52.8	78.5	43.9	53.6
Ulcer, infection or osteomyelitis	6.5	4.8	13.2	9.6
Gangrene and rest pain	10.6	9.8	27.5	19.3
Surgical complication	18.3	6.2	13.7	13.3
Miscellaneous conditions	11.8	0.8	1.8	4.2
Total	100.0	100.0	100.0	100.0
Repeat vascular procedures#				
>=2 peripheral vascular procedures during the same hospitalization	3.0	1.9	8.9	5.9
Amputation during the same hospitalization#				
None	93.2	95.5	79.0	86.2
Toe	2.3	1.8	10.3	6.5
Transmetatarsal	0.7	0.5	3.2	1.9
Transtibial	2.1	1.0	3.6	2.7
Transfemoral	1.8	1.2	4.0	2.8
Total	100.0	100.0	100.0	100.0
Comorbid conditions				
Diabetes#	32.1	16.6	38.7	32.3
Renal disease#	9.5	4.5	5.7	6.4

*For years 1989–1995: ICD-9-CM code 39.59 “Other vascular repair”; for years 1996–1998, ICD-9-CM code 39.50 “Angioplasty or atherectomy of noncoronary vessel with stent(s) or stent graft.”

** ICD-9-CM code 39.25 “Aorta-iliac-femoral-popliteal bypass.” Hospitalization may have included an angioplasty.

*** ICD-9-CM code 39.29 “Other (peripheral) vascular shunt or bypass, which may have included upper limb. Hospitalization may have included a proximal bypass and/or angioplasty. #p<0.01

Table 3.

Demographic characteristics by type of peripheral vascular procedure, percent, VHA, FY 1989-1998, continued.

	Angioplasty alone*	Proximal bypass**	Distal bypass***	Total
	n=14,454	n=11,947	n=29,515	n=55,916
Age#				
<44 years	4.7	2.6	2.2	2.9
45-54 years	15.0	13.3	9.8	11.9
55-64 years	33.2	35.6	31.6	32.9
65-74 years	36.4	40.1	43.1	40.7
75-84 years	10.1	8.2	12.6	11.0
85+ years	0.6	0.3	0.7	0.6
Total	100.0	100.0	100.0	100.0
Race#				
African American	2.9	10.1	16.6	11.7
White	16.11	82.1	70.0	58.7
Other/Unspecified	81.0	7.7	13.3	29.6
Total	100.0	100.0	100.0	100.0
Comorbid conditions#	54.9	53.6	51.5	52.8

*For years 1989-1995: ICD-9-CM code 39.59 "Other vascular repair"; for years 1996-1998, ICD-9-CM code 39.50 "Angioplasty or atherectomy of noncoronary vessel with stent(s) or stent graft."

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charges with distal bypass were White, 70 percent; African American, 17 percent; and other/unspecified race, 13.3 percent. Racial data on angioplasties is incomplete because the Procedure File, where more angioplasties are recorded, has incomplete data on race. Almost all of the patients were male (99.6 percent, not shown); approximately half were married (52.8 percent), with no significant difference noted between the types of procedures.

Between 1989 and 1998, the total user population (veterans with one or more outpatient visits) increased an average of 63,231 veterans per year ($p=0.0001$). This user population was used to calculate age-specific rates for the three procedures using the VHA user population. Data for the same procedures in the US population from 1989 to 1996 were obtained from the National Hospital Discharge Survey. Age-specific rates for the US were calculated using estimates of the male population from the US Census Bureau. Age-specific rates for both the VHA and US populations were calculated for ages 45 to 64 years, 65 to 74 years, and 75 years and older.

The age-specific rates for angioplasty are shown in **Figure 2**. The VHA rates for persons age 45 to 64 years were almost 10 times higher than rates for the US male

population, while the VHA rates for persons age 65 to 74 years were slightly lower than US male rates for the same age group. The VHA rates for persons age 75 and older were roughly half the rate for the US male population. The rates for proximal bypass in VA user population are compared with US male population rates in **Figure 3**. The VA rates were several-fold higher for persons age 45 to 64 years and 65 to 74 years, while rates for persons age 75 years of age and older were similar to the US male population. The VHA rates declined steadily over the 10 years of observation. Age-specific rates for distal bypass were compared with US national data in **Figure 4**. When the VHA rates for distal bypass are compared to the US male population, the VHA rates were several-fold higher for persons age 45 to 64 years, similar in persons age 65 to 74 years, and considerably lower for persons age 75 years and older. Rates in the VHA declined steadily for veterans age 45 to 64 years, while rates for older veterans declined only slightly over the 10 years analyzed.

The trends in the surgical specialty of the primary surgeon performing the operation are depicted in **Figure 5**. The number performed by vascular surgeons increased over the 10 years of observation, while those performed by general surgeons declined. A substantial number of

vascular procedures had no surgical specialty identified. These were primarily angioplasty procedures recorded in the procedure file, which has no field for specialty.

DISCUSSION

Between 1989 and 1998, more than 5,000 hospital discharges each year from Veterans Health Affairs hos-

pitals included at least one peripheral vascular procedure. The most common of the procedures were distal bypass (52.8 percent), followed by angioplasty alone (26 percent), and then proximal bypass (21 percent). The true number of vascular procedures in veterans who use VHA services is undoubtedly higher than what we report because we did not capture data on veteran users who undergo vascular procedures at non-VHA

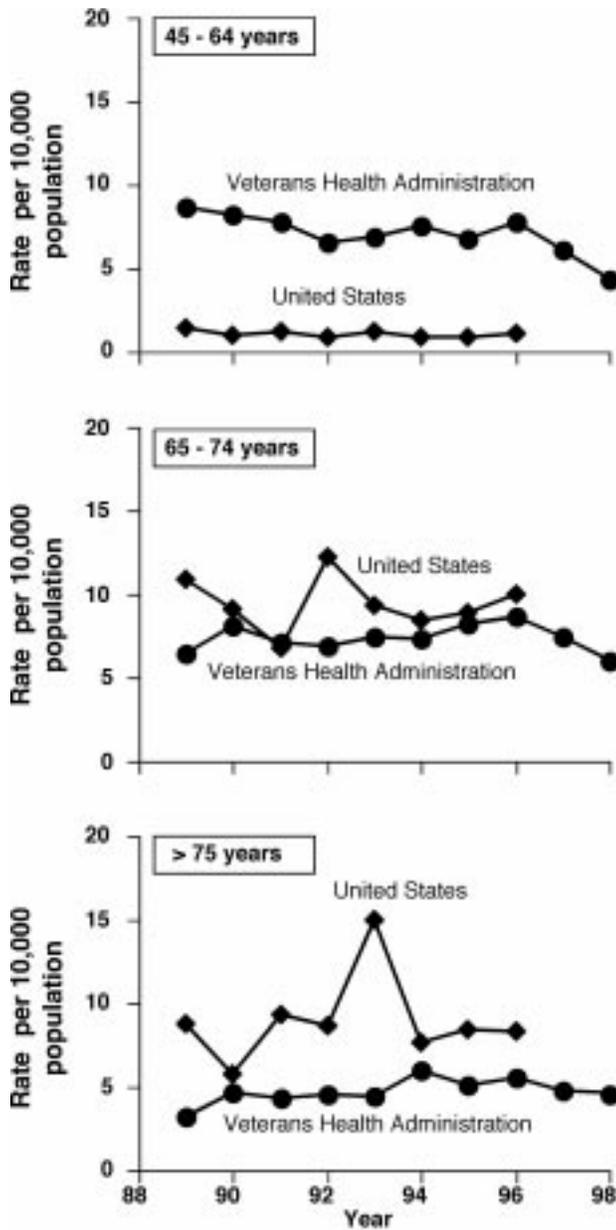


Figure 2. Age-specific rates for angioplasty, VHA and US males, 1989–1998.

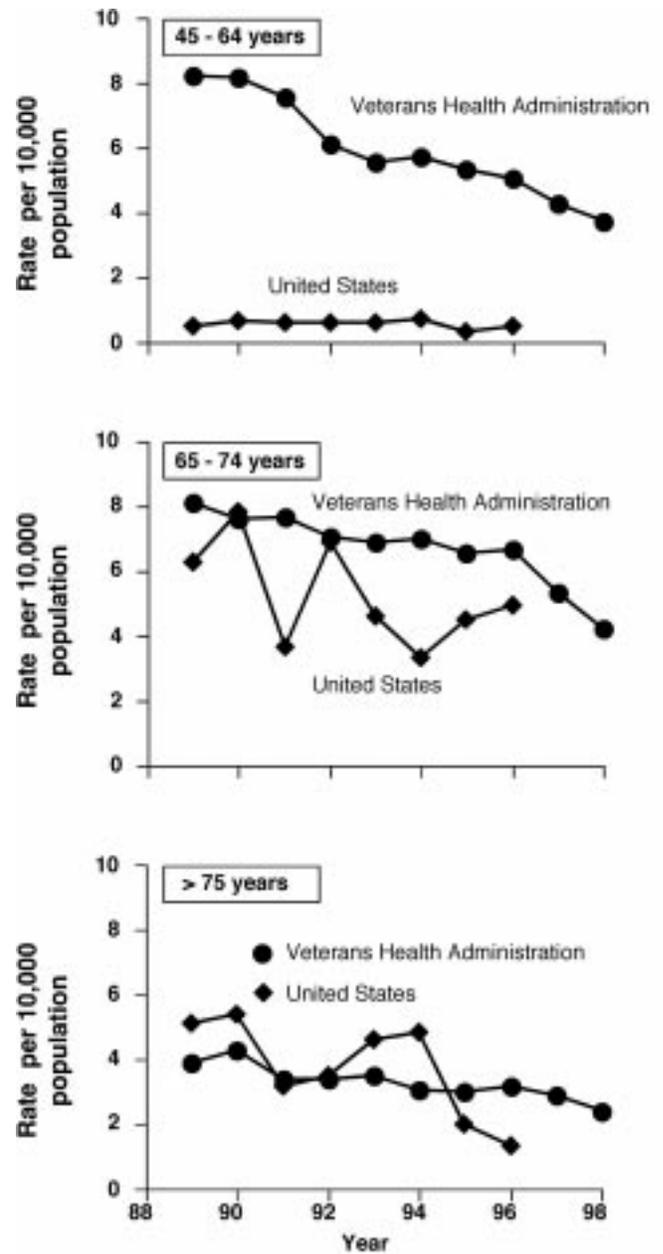


Figure 3. Age-specific rates for aorto-iliac-femoral bypass, VHA and US males, 1989–1998.

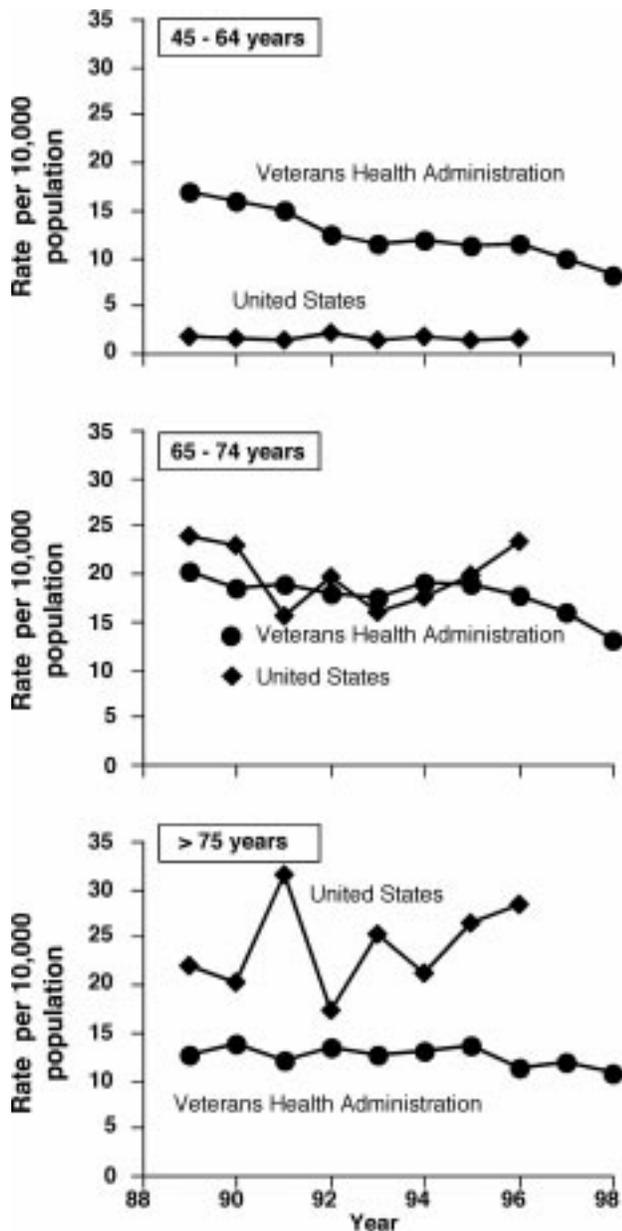


Figure 4. Age-specific rates for "other peripheral vascular bypass procedures," VHA and US, 1989–1998.

facilities using Medicare or Medicaid coverage. Prior investigations of dual-use of surgical procedures between VHA and Medicare-reimbursed services for veterans over 65 years of age suggest that approximately 25 percent of nonemergent procedures for the veteran user population are obtained in non-VHA facilities (3).

Almost all of the procedures were performed for peripheral vascular disease. However, the demographics

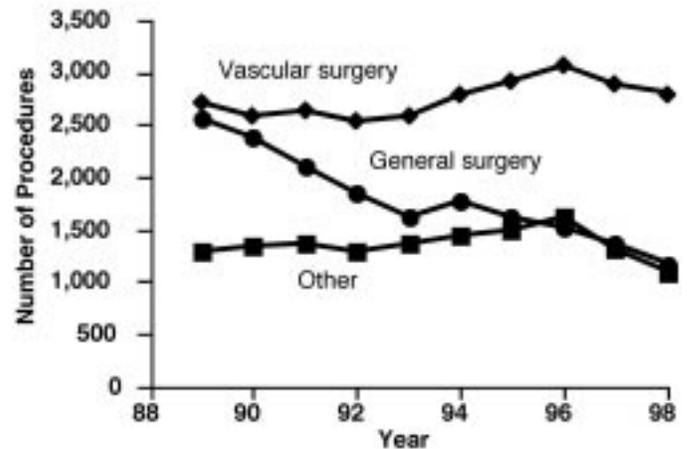


Figure 5. Trends in surgeon specialty performing vascular procedures, VHA, 1989–1998.

and severity of the peripheral vascular disease varied among the three procedures. Angioplasty tended to be performed on younger people with peripheral vascular disease without ulcerations, while distal bypass was more likely to be performed on older persons with more complicated diseases of ulceration, infection, or surgical complications. Hospital discharges with distal bypass were also more likely to include repeat vascular procedures (8.9 percent *versus* 3.0 percent and 1.9 percent) and lower-limb amputation (21.0 percent *versus* 6.8 percent and 4.5 percent) during the same hospitalization when compared to discharges with angioplasty and proximal bypass, respectively. Diabetes was more likely in hospital discharges with distal bypass (38.7 percent *versus* 32.1 percent and 16.6 percent) and less likely in angioplasties as compared to proximal bypass.

Comparisons of age-specific rates between the VHA population and US male population demonstrated some interesting differences. Men 45 to 64 years of age in the VHA population had a rate roughly 10 times higher for all three vascular procedures as compared to the US male population. This astonishing difference between the populations reflects the exceptionally high rate of comorbidity in the veteran user population. Veterans under 65 years of age with multiple chronic health problems and disability usually have few other options for health care coverage and rely heavily upon VHA services, creating an adverse mix of patients for this age group.

The age-specific rates for men 65 years of age and older for the VHA population are roughly similar to the US male population for all three procedures. Veterans over the age of 65 years have the option of using Medicare to pay for care in non-VHA facilities, which distributes high-risk patients more evenly between the VHA and non-VHA providers. In addition, the overall rates of vascular disease rise dramatically in this age group, which also helps to even out the rates. Birkmeyer found the rate of lower-limb revascularization to be 2.14 per 1,000 Medicare enrollees over the age of 65 (4). The contrast between the VHA rates for the over 65 years of age population as compared to the under 65 years of age population underscores the value of comparing age-specific rates, rather than an overall mean or summary rate.

One of the major risk factors for peripheral vascular disease is tobacco use. Unfortunately, the hospital discharge data did not include this information. However, other reports on veteran tobacco use suggest a higher prevalence of tobacco abuse among veterans (5). Certainly, tobacco cessation programs would be expected to decrease the expression of peripheral vascular disease and need for bypass procedures. Another major risk for peripheral vascular disease is diabetes, and we have found that over one-third of the procedures were being performed in persons with diabetes.

Although the number of veteran users is increasing, the number of angioplasty procedures is relatively stable and the numbers of proximal- and distal-bypass procedures are actually declining. The age-specific rates that reflect the decline are highest for persons age 45 to 64 years, with slower rates of decline for the older veterans. These trends seen in the VHA population differ from other population-based reports. An analysis of Maryland hospital discharges between 1979 and 1989 noted a twenty-fourfold increase in angioplasty and a doubling of peripheral bypass surgery (1). Analysis of US population data from 1979 to 1996 noted a rapid increase in vascular procedures before 1989 but stable rates over the 1990s (6).

Several institutional case-series reports have suggested an association between increasing vascular procedures and a reduced risk of amputations (7,8), while population-based analyses have not supported this hypothesis (1,6). Our analysis of VHA user population suggests that both the vascular procedures rates and amputation rates are declining in the VHA population (9). Our data do not permit us to comment further on the relationship between vascular procedures and amputation. Other investigators have noted that the

major benefit of peripheral vascular procedures is improvement in the quality of life (10). The decline in age-specific rates in the VHA population could indicate an improvement in health status, leading to less demand for these procedures, or that the availability of procedures was limited by lack of personnel, facility resources, or informal policies, which would restrict availability of vascular procedures to certain age or racial groups.

Our analysis represents the first systematic evaluation of vascular procedures performed in VHA facilities and suggests trends that are not reported elsewhere in the United States. We noted differences in certain demographic features between those undergoing peripheral vascular procedures and those undergoing amputation. Approximately one-third of the discharges with vascular procedures are in persons with diabetes while two-thirds of all VHA discharges with amputations are in persons with diabetes (9). This disparity between vascular procedures and amputation may be due to several factors. Persons with diabetes tend to have more distal, diffuse disease, which is less amenable to surgical correction (11). Persons with diabetes may also be thought to be less suitable candidates for vascular interventions, or may be more likely to have comorbid conditions such as renal disease, which limits the value of vascular interventions. This disparity may reflect that persons with diabetes may not have claudication symptoms, possibly due to neuropathy, and thus not present early for surgical evaluation, but rather present with more extensive disease and gangrene that demands an amputation.

A similar discrepancy was found between the proportions of vascular procedures and amputations performed on African Americans. Although 12 percent of the discharges with vascular procedures were in African Americans, 24 percent of discharges with amputations were in African Americans (9). African Americans experience a higher prevalence of diabetes and hypertension (12,13), which are both risk factors for peripheral vascular disease. The lower rates of peripheral vascular procedures in African Americans has been noted by others (14–16). Although a higher rate of amputation in African Americans was reported from California hospital discharge records (17), a study of a California HMO showed no difference in amputation rates by race for persons with diabetes, suggesting that access to care may play an important role in observed differences (18).

Our analysis has several limitations imposed by the secondary data. The procedure codes do not indicate laterality, so we were unable to ascertain whether repeat vascular procedures or amputations during the same hospitalization were performed on the same limb. It is possible that an amputation performed on one limb was accompanied by a vascular procedure on the contralateral limb to preserve at least one functional limb. The trends in age-specific rates for the VHA population are limited to the degree that the VA records capture the unique veteran's information. We identified the social security number of every veteran who received ambulatory care during the year and calculated the number of unique persons for each year. However, the VHA has recently relaxed eligibility criteria, actively recruited veterans to expand enrollment, and increased efforts to accurately capture every patient encounter. These efforts may inflate the user population and bias the results, particularly during 1997 and 1998 when enrollment grew rapidly. Our method of calculating the user population may also underestimate the true user population if many veterans use VHA ambulatory care less than once a year or not at all (the so called "noncompliant" patient), but are admitted for peripheral vascular procedures in a VHA facility.

In a study of 79 diabetic amputees discharged from three VHA facilities in 1994 and 1995, 92 percent indicated that the VHA was their usual source of foot care and 85 percent considered it their usual source for general medical care (19). Better information on dual use between VHA and other insurance programs would strengthen our confidence in both the numerators and denominators used to construct these amputation trends.

CONCLUSION

In summary, age-specific rates for vascular procedures in the VHA population are higher than the general population for persons age 45 to 64 years, similar for those 65 to 74 years, and somewhat less for those age 75 years and older. The number of lower-limb vascular procedures in the VHA user population is decreasing, despite the increase in eligible users of VHA facilities, creating decreasing age-specific rates of peripheral vascular procedures. The decrease appears to be occurring in mainly nondiabetic persons and those under 65 years of age.

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