Major Lower Extremity Amputation in Veterans Affairs Medical Centers

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Our objective was to assess outcomes for 8696 patients who underwent 9236 above- (AKA) and/or below-knee (BKA) amputations during a 4-year period for disorders of the circulatory system. Veterans Affairs (VA) Patient Treatment File (PTF) data were acquired for all patients in Diagnosis Related Groups (DRGs) 113 and 114 hospitalized in VA medical centers (VAMCs) during fiscal years 1991-1994. Data were further analyzed by Patient Management Category (PMC) software, which measured illness severity, patient complexity, and relative intensity score (RIS), a measure of resource utilization. The results of this analysis showed that mortality and morbidity rates remain high after AKA and BKA. Differing amputation practice patterns found in this study warrant further investigation. (Ann Vasc Surg 2000;14:216-222.)
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INTRODUCTION

Although improvements in outcomes have been reported at some centers, postoperative mortality has been substantial after major lower extremity amputation.[1-11] The purpose of this study was to define outcomes after above-knee (AKA) and below-knee amputation (BKA) for circulatory disease in all Veterans Affairs medical centers (VAMCs).

PATIENTS AND METHODS

Abstracted discharge data were collected from the Veterans Affairs Patient Treatment File (PTF) from inpatients assigned to Diagnosis Related Groups (DRGs) 113 and 114 during fiscal years 1991-1994. DRG 113 included patients undergoing amputation, except of the upper limb and toe, for circulatory system disorders. DRG 114 included patients undergoing upper limb and toe amputation for circulatory system disorders. DRG 114 was included because several patients assigned to DRG 114 underwent AKA or BKA in addition to upper extremity amputation. Clinical outcomes were then defined for 8696 veterans who underwent 9236 AKA and/or BKA in all VAMCs.

Patient Management Category (PMC) software was used to categorize clinically similar patient categories (PMCs) with distinct diagnostic and therapeutic strategies using abstracted discharge data. The software program assigned one or more PMCs, which included comorbidities and complications, using the first 10 ICD-9-CM diagnosis as well as the first 10 procedure codes from the PTF data. The greater the number of assigned PMCs, the greater the patient complexity.[12,13] PMC software also defined illness severity.[12,13] A relative intensity score (RIS) was calculated by the software program, which served as a measure of resource utiliza-

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Table I. Regional variations in AKA ratio, age, severity of illness, patient complexity, and mortality

	Patients (n)	AKA ratio[a]	Age (years)	Illness severity	PMC count	Mortality[b] (%)
Region 1	1965	0.55	68.4 ± 0.2	5.27 ± 0.03	3.16 ± 0.03	15.8
Region 2	1911	0.55	68.3 ± 0.2	5.14 ± 0.03	3.08 ± 0.03	13.0
Region 3	3710	0.57	68.0 ± 0.2	5.06 ± 0.02	2.87 ± 0.02	12.4
Region 4	1110	0.46	67.4 ± 0.3	5.24 ± 0.04	3.09 ± 0.04	13.1

[a]AKA ratio is AKA/total number of amputees with BKA and/or AKA.
[b]Mortality is quantified as least-squares means ± SE.

tion.[12,13] RIS was a cost-based, relative weight assigned to each patient hospitalization, which differentiated resource needs.[12,13]

Study data included level of amputation (BKA or AKA), age, length of stay, hospital, hospital type, and region. The presence and number of postoperative complications based on ICD-9-CM complication coding and PMC assignments were assessed. Systat software was used to provide descriptive statistics, basic data analysis, and logistic regression analysis. SAS was used to analyze the distribution of AKA and BKA across individual VAMCs in the Veterans Affairs healthcare system.

RESULTS

Basic Data Analyses

The 8696 veterans undergoing major limb amputation for disorders of the circulation were 68.0 ± 9.5 (mean ± 1 SD) years of age with a range of 26-104 years. Those undergoing AKA only were 69.0 ± 9.3 years of age, which was older than the 66.5 ± 9.5 years for those undergoing BKA only ($p < 0.001$). In-hospital mortality rates were 16.5% (694/4202) after AKA alone and 9.7% (383/3954) after BKA alone ($p < 0.001$). The incidence of ICD-9-CM coded postoperative complications did not differ between those with AKA (15.5%; 651/4202) and those with BKA (15.6%; 615/3954).

In this study, an additional 540 patients underwent both AKA and BKA, with a 16.3% mortality rate (88/540). Because of limitations in ICD-9-CM coding, it was unknown how often these amputations were ipsilateral or contralateral. Those with both AKA and BKA, however, had a markedly higher complication rate (35.9%; 194/540) than those with either AKA or BKA alone (15.5%; 1266/8156; $p < 0.001$). Length of stay (LOS) after AKA alone was 28.2 ± 31.1 days and after BKA alone was 32.0 ± 28.3 days ($p < 0.001$). The LOS was 49.8 ± 38.0 days in the 540 patients undergoing both AKA and BKA. For veterans undergoing major lower extremity amputation for circulatory disorders (n = 8696), the presence of any postoperative complication was associated with increased hospital mortality (15.2% vs. 13.0%; $p = 0.028$) and LOS (43.8 ± 36.9 vs. 28.8 ± 28.7 days; $p < 0.001$).

The PMC-derived severity of illness was slightly, though significantly, greater for those undergoing only AKA (5.19 ± 1.32) than for those with BKA (5.10 ± 1.30; $p = 0.003$). The PMC count, an indicator of patient complexity, for those undergoing only AKA was also minimally, though significantly, higher (3.10 ± 1.44) than for those having BKA only (2.91 ± 1.41; $p < 0.001$). The RIS for those undergoing AKA only was 2.84 ± 0.79 and was 2.74 ± 0.75 for BKA only ($p < 0.001$). Though a small difference numerically, the estimated resource utilization was significantly greater for those with AKA.

Analyses of Amputation Practices at Regional and Hospital Levels

The AKA ratio was calculated as the total number of AKA performed divided by the total number of major lower extremity amputations (AKA/AKA + BKA + both). For the whole group of patients, the AKA ratio was 0.55 (4742/8696). At the time the data were collected, there were four VA regions. In VA regions 1, 2, and 3, the AKA ratios were 0.55, 0.55, and 0.57, respectively. In VA region 4, which involved the western half of the United States, the ratio was 0.46, which differed from the other regions ($p < 0.001$). The lower AKA ratio in region 4 was not explained by lower illness severity (Table I).

Hospital types within the VA system have been defined by the Resource Allocation Methodology (RAM) group to which they were assigned. For RAM group 1, the AKA ratio was 0.52 and for RAM group 2 the value was 0.54. RAM group 3 had a lower AKA ratio, which was 0.48. The highest proportion of AKAs were found in RAM group 4, which had a 0.55 ratio. RAM group 5, which included the largest metropolitan hospitals with the greatest degree of affiliation with medical schools, had an AKA ratio of 0.45. Compared with the other hospital types, RAM group 5 had a significantly lower frequency of AKA ($p < 0.005$).

Further analysis at the individual hospital level revealed that the distribution of AKA and BKA was not random among all VAMCs ($p < 0.001$). The hospital volume of major amputations ranged from 3 to 274 over the 4 years of the study, with a mean of 66 amputations performed per VAMC. In separate analyses, the distribution of AKA and BKA varied even among VAMCs within each separate region ($p < 0.009$).

Table II. Logistic regression model of factors altering the likelihood that above-knee amputation was performed

Parameter	Odds ratio (95% bounds)
Guillotine amputation	0.268 (0.155-0.462)
VA region 4	0.628 (0.550-0.718)
Gangrene	0.644 (0.576-0.719)
RAM 5 hospital	0.827 (0.754-0.906)
Age	1.030 (1.025-1.035)
Severity	1.094 (1.056-1.134)
Acute thromboembolism	1.475 (1.227-1.774)
Admission source (nursing home)	2.267 (1.936-2.654)

Amputation, Vascular Reconstruction, and PMC Assignments Related to Acuity

Vascular reconstruction. In this study, a total of 1193 patients underwent peripheral vascular reconstructive procedures (based on ICD-9-CM procedure codes 38.04, 38.06, 38.08, 38.14, 38.16, 38.18, 38.44, 38.46, 38.48, 39.25, 39.26, 39.29, 39.49, 39.57, 39.58, or 39.59) during the same hospitalization as major lower extremity amputation. Because of ICD-9-CM coding limitations, it cannot be determined whether the reconstructions were done ipsilateral, contralateral, or prior to the major amputations.

Veterans who underwent vascular reconstruction and amputation had an AKA ratio of 0.56 (665/1193) compared to 0.54 (4077/7503) for those with amputation and no vascular reconstruction (n.s.). For those undergoing arterial reconstruction and amputation, mortality was 13.4% (160/1193), which did not differ from the 13.4% (1005/7503) mortality rate for those with amputation alone (n.s.).

Indications and acuity of reconstruction. The ICD-9-CM procedure codes noted above do not discriminate between elective versus urgent surgical procedures, therefore PMC assignments were used to help define this issue. Among those undergoing amputation in this study, a number of patients were assigned to PMC 4101, which is a PMC that includes patients undergoing a variety of elective vascular procedures.[13] Those undergoing amputation who were also in PMC 4101 ($n = 1724$) had atherosclerotic occlusive disease, which was managed by elective vascular operation in 197 patients. The likelihood of AKA was statistically greater in those in PMC 4101 who underwent elective arterial reconstruction and amputation (AKA ratio = 0.66) than in those in PMC 4101 who did not undergo reconstruction (AKA ratio = 0.58; $p < 0.035$). The mortality rate was 11.0% for those undergoing arterial reconstructions and 9.0% for those who did not (n.s)

An additional 659 patients were assigned to PMC 4113 and presented with acute extremity ischemia from arterial thromboembolism, and 263 of these patients underwent urgent vascular surgery during the same admission as that for amputation. The AKA ratio for patients undergoing urgent arterial surgery was 0.66, which did not differ from those not undergoing vascular reconstruction for acute arterial thromboembolism (0.67). The mortality rates were virtually the same (17.1%) for those undergoing urgent reconstruction as for those who did not (17.2%) in PMC 4113.

The largest percentage of patients in this study were in PMC 4141 and had gangrene ($n = 6013$). Of those with gangrene, 648 underwent vascular surgery as well as amputation. For those amputees with gangrene, the AKA ratio was 0.48 in those undergoing vascular reconstruction and 0.52 in those who did not ($p = 0.025$). Mortality with gangrene was not higher with vascular reconstruction and amputation (13.0%) than for amputation alone (14.3%; n.s.).

Logistic Regression Analyses

A logistic model was created to evaluate several clinical and administrative parameters that might impact the decision to perform AKA (Table II). Included in this evaluation were the source of admission (nursing home versus other sources), region of the country (in this case, region 4, the western region, versus the remaining three regions), hospital type (RAM group 5, the largest and most highly

Table III. Logistic regression model of factors influencing the likelihood of mortality after major lower extremity amputation (AKA or BKA or both)

Parameter	Odds ratio (95% bounds)
Admission source (nursing home)	0.563 (0.439-0.722)
Peripheral vascular occlusive disease (elective arterial reconstruction or PTA; PMCs 4101 and 4106)	0.762 (0.627-0.927)
Age	1.032 (1.024-1.040)
Patient complexity (PMC count)	1.190 (1.125-1.259)
Acute arterial thromboembolism (PMC 4113)	1.331 (1.039-1.705)
Illness severity	1.448 (1.343-1.561)
Surgical complications, heart (ICD-9-CM 997.10)	1.507 (1.033-2.198)
AKA	1.545 (1.348-1.771)
Surgical complications, respiratory system (ICD-9-CM 997.30)	1.787 (1.203-2.654)
Septicemia (PMC 5004)	2.092 (1.672-2.617)
Myocardial infarction (PMCs 0301-0308)	3.278 (2.308-4.655)
Respiratory insufficiency/failure (PMC 5006)	3.647 (2.445-5.440)
Shock (PMC 5011)	9.679 (3.811-24.58)

affiliated VAMCs, versus the remaining types), patient age, and whether the patient had guillotine amputation, gangrene, or acute lower extremity ischemia (i.e., were assigned to PMC 4113).

The model revealed that guillotine amputation was associated with a markedly reduced likelihood of AKA (Table II). Only 16% (16/98) of those undergoing guillotine amputation underwent AKA. Being treated in region 4 was independently associated with a lower risk of AKA (relative to BKA), as was being treated in RAM group 5 hospitals. Patients in RAM group 5 VAMCs, which were the flagship hospitals in the VA, were less likely to undergo AKA, despite greater illness severity and complexity, than patients in the remaining hospital types. Patients presenting with gangrene were less likely to undergo AKA, whereas those presenting with acute arterial thromboembolism (PMC 4113) were more likely to have AKA. Increasing age and increasing illness severity were associated with a greater likelihood for AKA. Further analysis revealed that those admitted from nursing homes had an AKA ratio of 0.72 vs. 0.53 for remaining patients not admitted to VAMCs from nursing homes ($p <$ 0.001).

A separate logistic regression model (Table III) indicated that the likelihood of death was lower in amputees who were admitted from nursing homes. Those admitted with peripheral vascular occlusive disease (PVOD) and managed electively (PMCs 4101 and 4106) had lower mortality than those with gangrene who were used as the reference population in the model. Increasing age and increasing patient complexity (PMC count) were associated with greater likelihood of in-hospital mortality. Those admitted with acute thromboembolic lower extremity ischemia were more likely to die. As expected, increasing illness severity was associated with a greater chance of death. Above-knee amputation was associated, per se, with greater odds of death. Surgical complications of the respiratory system (ICD-9-CM 997.30) and heart (ICD-9-CM 997.10); myocardial infarction (PMCs 0301-0308); septicemia (PMC 5004); respiratory insufficiency or failure (PMC 5006); and shock (PMC 5011) were each associated with greater odds of death after major lower extremity amputation.

DISCUSSION

Though complication rates were comparable, mortality rates after AKA were higher than those after BKA. Veterans with both BKA and AKA had mortality rates similar to those with AKA alone but were more likely to experience complications and longer hospital stay. It was clear from this study that major lower extremity amputation was associated with considerable morbidity and mortality. The mortality rates expected after above-knee and below-knee amputations done for disorders of the circulatory system were indeed higher than those reported by others, but the patient populations in the other studies were much smaller than in the present study.[7,8,11] In many cases, these smaller series were reported by those with a focused interest in outcomes after amputation.[4,7] In the present study, a postoperative mortality rate of 9.4% was present after uncomplicated BKA and a 16.1% mortality rate after uncomplicated AKA in all VAMCs during 4 fiscal years (1991-1994). Similar mortality rates have previously been reported.[1-3,5-6] It is clear that the range of outcomes following major limb amputation is broad, but the low mortality rates reported from some centers are not being duplicated across the country.

The mortality rates described in this study were inconsistent with those previously reported in a review of lower extremity amputation which described a 2% mortality rate after BKA and 9% mortality rate after AKA.[11] The latter review, however, collected only 1200 patients undergoing BKA and 609 patients undergoing AKA. The smaller number of patients in that review would possibly skew the results, particularly since some of the studies chosen for inclusion in the review were published by surgeons with a great interest in amputation outcomes. The present study included more than four times the number of patients collected in the aforementioned review, and evaluated patients treated throughout the United States in a variety of VAMCs. An argument could be made that outcomes in patients treated in VAMCs may be biased since veterans are predominantly males and tend to be more infirm than patients in nonfederal hospitals.[14] Despite similar biases, outcomes after abdominal aortic aneurysm repair, arterial bypass, and carotid endarterectomy in veterans have been comparable to, if not better than, those reported for patients treated in the private sector in this and other countries.[12] Surgeons practicing in VAMCs have substantial experience with management of patients with peripheral vascular disease, again with outcomes comparable to, or better than, those found in the private sector.[15] The volume of amputations performed in VAMCs is massive.[2,4,15] There are numerous Veterans Affairs medical centers throughout the country with varying size, varying degrees of affiliation with medical schools, and a variety of clinical practitioners. Because of the large number of patients treated and the heterogeneity of VAMC treatment settings, it is likely that the results of the present study may be more representative of the true but unknown overall mortality rates experienced in this country after BKA and AKA for diseases of the circulatory system than those of previously published studies.

In the present study, the AKA ratio was 0.55 compared to 0.58 for patients undergoing amputation in selected VAMCs in 1967.[2] It appears that mortality rates in veterans after AKA and BKA have also remained stable over the last 30 years.[2] A study of amputations done in selected Veterans Affairs hospitals in 1967 revealed an 8.5% mortality rate after BKA and a 13% mortality rate after AKA.[2] The latter study reported that mortality was not greater in amputees who had prior vascular reconstruction. The present study not only showed that mortality was higher after AKA than BKA but that severity of illness, patient complexity, and anticipated resource utilization were likewise greater for those undergoing AKA.

The decisions to perform lower extremity amputation and determine amputation level are complex.[16] The decision to perform an amputation must first be made. In some patients, decisions to reconstruct versus amputate limbs may be very difficult, even controversial.[17-23] Such decisions may vary from patient to patient and clinician to clinician. Amputations after failed arterial reconstructions may have different outcomes than those after primary amputations.[24-29] The mortality rate and likelihood of AKA did not, however, appear to be different in those who underwent lower extremity arterial reconstruction and major lower extremity amputation during the same hospitalization in the present study. Those undergoing urgent vascular reconstruction, however, had a significantly higher likelihood of AKA and death. Those presenting with gangrene in PMC 4141 who underwent vascular reconstruction and amputation had a statistically greater chance of not having AKA. Others have previously advocated vascular reconstruction to lower amputation levels.[21] Further clarification of the complex effects of vascular reconstruction on amputation level is necessary.

The present study showed that outcomes after amputation were affected by the mode of patient presentation. Acute limb ischemia was associated with a higher likelihood of AKA and death, regardless of whether a reconstructive vascular procedure was also performed during the same hospital admission. In addition, the source of admission had an impact on choice of amputation level. Those admitted to VAMCs from nursing homes were more likely to have above-knee amputations than patients admitted from other sources. Clinical practices also affected amputation level. In this study, patients managed by guillotine amputation had a very low likelihood of undergoing AKA.[30]

Once a decision is made to perform major limb amputation, clinical and noninvasive assessment may help define the most distal amputation level that will likely heal. One must determine whether salvage of the knee joint is feasible or necessary. If a patient cannot use the leg to ambulate or transfer, or if there is a fixed, severe flexion contracture of the knee, there may be little benefit from attempted salvage of the knee joint, and AKA would then be warranted. Such factors may, in part, have been responsible for the finding that AKA were more commonly performed in those patients admitted to VAMCs from nursing homes. If the patient is ambulatory, BKA might be chosen even when there is less certainty about the ability to heal an amputation at the BKA level, because of the importance of the knee joint in successful rehabilitation.[6] If a center or physician continued to aggressively attempt to salvage knee joints, however, a higher amputation revision rate and longer length of stay could be anticipated.[31] Though contrary to current vascular surgical thinking, some have questioned the wisdom of aggressive attempts at salvage of the knee joint since such an approach can result in a high incidence of stump healing problems.[31] Rehabilitation outcomes are poor for those with nonhealing BKAs.[32]

Patients with lower extremity ischemia, whether treated by arterial reconstruction or amputation, are in a declining state of health.[33] There are patient factors, such as age and clinical status, as well as individual physician factors that may influence decisions about major limb amputation.[20] Additional subtle factors may also influence amputation practices. Tunis et al. reported that age greater than 74 years, African-American race, diabetes mellitus, and having Medicaid or no insurance were independently associated with a significantly greater likelihood of having an amputation instead of revascularization.[22] In VAMCs the choice to perform amputation versus revascularization may be less likely to depend on patient-based economic issues.

The current study revealed that choices leading to the performance of AKA versus BKA did not appear to be randomly distributed across hospitals in the entire VA health care system or within the four regions of the country. The AKA ratio in the western region (region 4) was much lower than the remaining three regions. This difference could not be explained by differences in disease severity and requires further evaluation. The largest and most highly affiliated hospitals had the lowest rate of AKA among the various hospital types.

The present study has described outcomes after major lower limb amputations done for disorders of the circulatory system. Mortality rates as well as complication rates remain high after major lower extremity amputation, even in modern surgical practice. Given the observed differences in outcomes after above-knee and below-knee amputations, differences in amputation practice patterns (AKA versus BKA) and the complicated impact of revascularization attempts on amputation levels warrant continued study.

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