From the Society for Vascular Surgery

Predictors of hospital readmissions after lower extremity amputations in Canada

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Objective: **To describe the factors associated with early (≤30 days) and late (31-365 days) hospital readmissions after lower extremity amputations in Canada.**

Methods: **A retrospective cohort study was carried out for all Canadian adults who underwent elective lower extremity amputations in the years 2006 to 2008 for nontraumatic indications. Patients were identified from the Canadian Institute for Health Information's Discharge Abstract Database, which includes all hospital admissions across Canada, with the exception of the Province of Quebec.**

Results: **During the study period, 3823 patients underwent lower limb amputations (major amputations = 95%) and 2116 were readmitted at least once (55.4%). Of those patients, 1112 (29.1%) were readmitted within 30 days (mean = 5.0 ± 8.3 days after discharge) and 1004 (26.3%) were readmitted between 31 and 365 days (mean = 151.4 ± 95.9 days after discharge). Stump complications accounted for 13% and 10% of early and late readmissions, respectively. Stump revision surgery was performed in 301 readmitted patients (7.9%). Predictors of early readmission included amputation by a vascular surgeon (odds ratio, 1.6; 95% confidence interval, 1.3-1.9), female sex (odds ratio, 1.2; 95% confidence interval, 1.1-1.5), and a short (<7 day) admission (odds ratio, 1.7; 95% confidence interval, 1.4-2.1). Predictors of late readmission included a longer (≥7 days) admission (odds ratio, 1.5; 95% confidence interval, 1.2-1.8), discharge to a long-term care facility (odds ratio, 3.3; 95% confidence interval, 2.7-3.9), and home discharge with community support (odds ratio, 2.3; 95% confidence interval, 1.8-2.9).**

Conclusions: **Half of patients who underwent lower extremity amputations were readmitted to the hospital within 1 year. Markers of patient dependence (long hospitalization, discharge to long-term care facility) predict late readmission. (J Vasc Surg 2016;63:688-95.)**

Hospital readmissions are associated with poor patient outcomes and result in significant health care expenditures. In an effort to incentivize hospitals to reduce readmissions and save costs, the Hospital Readmission Reduction Program was established in the United States in 2012 to financially penalize hospitals that demonstrated "higher than expected" 30-day readmission rates.[1] In Canada, where no similar program currently exists, an estimated 8.5% of patients are readmitted to the hospital within 30 days at an annual cost of 1.8 billion Canadian dollars.[2]

For many patients, undergoing lower extremity amputation predicts poor clinical outcomes. The 5-year mortality rate for this vulnerable patient population is >50%,[3] and their resource use after amputation increases significantly.[4] A recent study reported the 30-day hospital readmission rate among lower extremity amputees in the United States as 18%, and identified chronic nursing home residence, nonelective surgery, and previous revascularization or amputation as independent risk factors for readmission.[5]

There are currently no published Canadian studies on readmission after lower extremity amputations, and as such the clinical implications of readmissions in Canada have not been previously described. The aim of this study was thus to describe the factors associated with early (≤30 days) and late (31-365 days) hospital readmissions after lower extremity amputation in Canada.

METHODS

A retrospective cohort study was carried out on readmissions after lower extremity amputations in Canada using the Canadian Institute for Health Information (CIHI) Discharge Abstract Database for the years 2006, 2007, 2008, and 2009.

Inclusion and exclusion criteria. All inpatient records of acute patients 18 years of age or older who had above- or below-knee amputations for ischemia or malignancy (bone, soft tissues, or metastatic disease) in Canada (excluding the province of Quebec) and readmitted to hospital after discharge were included. In addition, all subsequent hospitalizations of patients identified in this cohort were included for the same period. Pediatric and

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Table I. Baseline characteristics of readmitted patients stratified according to the type of readmission: early (≤30 days), late (31-365 days), or no readmission

Characteristic	*Early readmission, No. (%)*	*Late readmission, No. (%)*	*No readmission, No. (%)*	P
Age ± SD, years	67 ± 13	67 ± 13	68 ± 13	<.01
Sex, % male	65	70	68	.02
Diabetes	990 (89)	913 (91)	1622 (95)	<.01
Hypertension	282 (25)	299 (30)	533 (31)	<.01
Ischemic heart disease	160 (14)	177 (18)	332 (19)	<.01
Congestive heart failure	92 (8)	136 (14)	181 (11)	<.01
Hyperlipidemia	33 (3)	37 (4)	77 (4)	.12
Type of amputation				
Above-knee	329 (30)	273 (27)	524 (31)	.17
Below-knee	761 (69)	713 (71)	1084 (63)	<.01
Ankle	0	0	15 (1)	<.01
Foot	14 (1)	16 (2)	67 (4)	<.01
Toe	3 (0.3)	2 (0.2)	23 (1)	<.01

SD, Standard deviation.
Data are expressed as number (%) unless otherwise indicated. Percentages are expressed as part of the total readmissions for each type of readmission.

trauma amputations, and outpatient visits, were excluded. Amputations from Quebec were excluded because data from that province are coded differently, and as such is not encompassed within the CIHI database.

Patient identification. Patients were identified using Canadian Classification of Health Interventions codes "1.VC.93" (femoral amputation, which includes all above-knee amputations) or "1.VQ.93" (tibial and fibular amputation, which includes all below-knee and foot and toe amputations) in any position within the intervention fields, and International Classification of Diseases and Related Health Problems, 10th Canadian Revision codes "E10-E14" (diabetes mellitus) or "C00-C97" (malignant neoplasms) in any position within the diagnosis fields.

Statistical analysis. Descriptive statistics (means, medians) were generated for continuous and categorical variables. Differences between groups were assessed using an analysis of variance with a Bonferroni post hoc test for continuous variables, and a χ^2 test for categorical variables. Where appropriate, the analysis was stratified according to the type of surgeon who performed the initial amputation: vascular, orthopedic, general, or "other" type of surgeon, or according to the type of readmission (early, late, or not readmitted). The "other" category included plastic surgeons and podiatrists, among other physicians. Time to readmission was calculated from the day that a patient was discharged from the hospital regardless of the length of stay on the initial admission.

A multivariable logistic regression model was developed to assess the variables associated with early (≤30 days) and late (31-365 days) hospital readmissions controlling for the type of surgeon who performed the initial amputation (reference category: orthopedic surgeon), female sex, the type of hospital where the initial amputation was performed (academic vs community), age, province (reference category: province of Ontario), type of amputation (reference category: below-knee amputation), diabetes mellitus, hypertension, ischemic heart disease, congestive heart failure, hyperlipidemia, whether the patient's length of stay after the initial amputation was >7 days, and whether the patient was transferred to a long-term care facility or home with support after the initial amputation. Because of their relatively small number, patients from the Yukon, Northwest Territories, and Nunavut territories were analyzed as part of a single "northern territories" category. All of the patients in the data set (early, late, and not readmitted) were included in the analysis. Significance was determined at the $P = .05$ level.

Data analysis was carried out using the statistical suite SAS version 9.3 (Cary, NC). Approval for this study was obtained from CIHI's Privacy, Confidentiality and Security Committee and the research ethics board of the University of Toronto's University Health Network. The research was conducted using an anonymized database of thousands of amputees and so obtaining consent from individual patients was not deemed necessary.

RESULTS

Of 3823 patients included in the analysis, 29% were readmitted within 30 days (average time to early readmission: 5 ± 8 days) and 55% were readmitted at least once within 1 year (average time to late readmission: 151 ± 96 days). The characteristics of the readmitted patients are outlined in Table I. Most readmitted patients (95%) had undergone major (above the foot) amputations before readmission, with below-knee amputation being the most common procedure.

There was a significant difference in baseline characteristics between nonreadmitted and readmitted patients in the early and late postdischarge period. Nonreadmitted patients were significantly older than those readmitted within 30 days, although the difference was approximately 1 year of age. Patients with late readmissions were more likely to be male compared with patients with early readmissions. Nonreadmitted patients tended to have a greater prevalence of diabetes, hypertension, ischemic heart disease, and congestive heart failure compared with patients with early readmissions. Although there was no difference in the proportion of readmitted groups who underwent an above-knee amputation, more below-knee amputees were readmitted in the early and late phase compared with those who were not readmitted.

Most early readmissions were secondary to impaired physical function after discharge from hospital (Table II). Conversely, most late readmissions were secondary to diabetic complications. Amputation stump complications accounted for 13% of early and 10% of late readmissions. Ischemic heart disease was the cause of early and late readmissions in 1% and 4% of patients, respectively.

Further amputations were required in 8% of readmitted patients. The types of amputations that patients underwent are illustrated in the Fig. Most patients with early readmissions underwent above-knee amputations, and those with late readmissions were more likely to undergo