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Original Research

Rehabilitation Trends After Lower Extremity Amputations in Canada

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Abstract

Background: The heterogeneity of medical complications that lead to amputation has resulted in a diverse patient population with differing rehabilitation needs; however, the rehabilitation trends for patients with lower extremity amputations across Canada have not been studied previously.
Objective: To describe trends in rehabilitation after lower extremity amputations and the factors affecting rehabilitation length of stay in Canada.
Design: Retrospective cohort analysis.
Setting: Canadian inpatient rehabilitation facilities that received persons with lower extremity amputations discharged from academic or community hospitals.
Participants: Patients underwent lower extremity amputations between 2006 and 2009 for nontraumatic indications and were then discharged to a rehabilitation facility. Patients were identified from the Canadian Institute for Health Information's Discharge Abstract Database that includes hospital admissions across Canada except Quebec.
Interventions: Inpatient rehabilitation after lower extremity amputations.
Main Outcome Measures: Length of stay, discharge destination, and change in total and motor function scores.
Results: The analysis included 5342 persons who underwent lower extremity amputations, 1904 of whom were transferred to a rehabilitation facility (36%). Patients most commonly underwent single below-knee (74%) and above-knee (17%) amputations. The duration of rehabilitation varied by whether the amputation was performed by a vascular (median = 36 days), orthopedic (median = 38 days), or general surgeon (median = 35 days). The overall median length of stay was 36 days. Most patients (72%) subsequently were discharged home and 9% were readmitted to hospital. Predictors of longer rehabilitation included amputation by an orthopedic surgeon (beta = 5.0, $P \leq .01$), older age (beta = 0.2, $P \leq .01$), and a history of ischemic heart disease (beta = 3.8, $P = .03$) or congestive heart failure (beta = 5, $P = .04$). Patients who spent <7 days in hospital were significantly more likely to have a shorter rehabilitation stay (beta = −4, $P = .03$). Advanced patient age was the only predictor for hospital readmission (odds ratio = 1.03, $P \leq .01$).
Conclusions: Rehabilitation length of stay in Canada after lower extremity amputation varies by the type of surgeon performing the amputation. Advanced age, undergoing surgery in the province of Manitoba, and having a history of ischemic heart disease or congestive heart failure predict a longer rehabilitation stay. A shorter perioperative hospitalization period (<7 days) predicts a shorter rehabilitation duration. Future studies are needed to explore these issues and to optimize the delivery of rehabilitation services to Canadians after lower extremity amputation.
Level of Evidence: II

Introduction

Lower extremity amputations most commonly affect patients with diabetes and peripheral vascular disease [1]. Although great strides have been made in the medical treatment of the cardiovascular risk factors for amputation, almost 1 in 190 Americans currently is living with the loss of a limb, and that number may double by 2050 [2]. The overall incidence and prevalence of lower extremity amputations is not known, but

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we have previously shown that 81% of nontraumatic amputations in Canada were carried out as the result of diabetic complications [3].

The heterogeneity of medical complications that lead to amputation has resulted in a diverse patient population with differing rehabilitation requirements. Clearly, the rehabilitation needs of a young, otherwise-healthy person with amputation after bone cancer or trauma are different from those of an elderly, diabetic patient with multiple comorbidities.

Among the many methods for evaluating patient performance in rehabilitation, the Functional Independence Measure (FIM) score has been validated as a reliable method for assessing patient progress and response to rehabilitation and is used widely by rehabilitation professionals [4]. In Canada, the National Rehabilitation Reporting System, which collects data from participating Canadian adult inpatient rehabilitation facilities, requires the collection of FIM scores for patients on admission and discharge from a rehabilitation facility.

Although several previous studies have characterized the impact of inpatient rehabilitation after lower extremity amputation, published Canadian data have been limited [5-7]. The aim of this study was to describe trends in rehabilitation after lower extremity amputations and the factors affecting rehabilitation length of stay in Canada. A better understanding of such trends is integral to measuring the variation in the delivery of rehabilitation services across the country and identifying avenues for improving the quality of care of persons with amputations.

Methods

The Canadian Institute for Health Information (CIHI) Discharge Abstract Database for the years 2006 to 2009 was analyzed to identify all lower extremity amputations.

Inclusion and Exclusion Criteria

The analysis included acute inpatient records of adult patients (18 years or older) who underwent an above- or below-knee amputation for ischemia, neuropathy, or malignancy in a Canadian hospital (excluding the province of Quebec, which does not participate in the CIHI database). Patients who were discharged to an inpatient rehabilitation facility also were identified. Only the index admission at which a patient's first amputation was performed was included in the analysis. The analysis excluded pediatric and trauma patients and outpatient encounters as they were not captured in our database.

Patient Identification

To identify the patients, the CIHI database was queried for the Canadian Classification of Health Interventions codes 1.VC.93 (femoral amputations, which include all above-knee amputations) or 1.VQ.93 (tibial and fibular amputations, which include all below-knee as well as foot and toe amputations) in any position within the intervention fields, and the *International Statistical 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. The dataset obtained from CIHI did not have any missing data. Only patients undergoing an index amputation were analyzed.

Statistical Analysis

Descriptive statistics were generated for continuous and categorical variables (means, medians). Where appropriate, the analysis was stratified by the type of surgeon who performed the initial amputation: vascular, orthopedic, general, or "other" surgeon. The "other" category included other surgical specialties, most frequently plastic surgeons.

A multivariable linear regression model was developed to identify factors associated with a prolonged inpatient rehabilitation length of stay after discharge from hospital. To address potential sources of bias and confounding, we controlled for the type of surgeon who performed the initial amputation (reference category: vascular surgeon), female gender, the type of hospital (academic versus community), age, province (reference category: province of Ontario), type of amputation (reference category: below-knee amputation), diabetes mellitus, hypertension, ischemic heart disease (IHD), congestive heart failure (CHF), hyperlipidemia, and whether the patient had had a short ($<$7 day) length of stay in hospital before transfer to the rehabilitation center.

A multivariable logistic regression model also was developed to identify factors associated with readmission to hospital from the rehabilitation center. The model controlled for the same variables outlined previously.

Because of their relatively small numbers, patients from the Yukon, Northwest, and Nunavut territories were analyzed as part of a single "Northern Territories" category. Significance was determined at the $P = .05$ level.

All analyses were carried out with the statistical software package SAS 9.3 (SAS Institute Inc, 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.

Results

Between 2006 and 2009, 5342 patients underwent index lower extremity amputations in Canada (1382

Table 1
Baseline patient characteristics of persons with amputations admitted to rehabilitation facilities, stratified by the type of surgeon who performed the amputation

Patient Characteristic	Type of Surgeon				
	VS (n = 625)	OS (n = 827)	GS (n = 405)	Other (n = 47)	Total (n = 1904)
Age, y ± SD	66 ± 12	63 ± 12	66 ± 12	62 ± 14	65 ± 12
Gender (% male)	74	72	73	83	73
Diabetes, n (%)	615 (98)	787 (95)	401 (99)	44 (94)	1847 (97)
Hypertension, n (%)	209 (33)	289 (35)	109 (27)	15 (32)	622 (33)
Ischemic heart disease, n (%)	98 (16)	126 (15)	81 (20)	12 (25)	317 (17)
Congestive heart failure, n (%)	44 (7)	61 (7)	40 (10)	6 (13)	151 (8)
Hyperlipidemia, n (%)	43 (7)	55 (7)	17 (4)	3 (6)	118 (6)
Teaching hospital, n (%)	432 (69)	374 (45)	53 (13)	15 (32)	874 (46)
Type of amputation, n (%)					
Above-knee	143 (23)	89 (11)	79 (20)	14 (30)	325 (17)
Below-knee	466 (75)	724 (88)	319 (79)	32 (68)	1541 (81)
Ankle	2 (0.3)	0	0	0	2 (0.1)
Foot	13 (2)	10 (1)	5 (1)	0	28 (1)
Toe	1 (0.2)	4 (0.5)	2 (0.5)	0	7 (0.4)

VS = vascular surgeon; OS = orthopedic surgeon; GS = general surgeon; Other = other type of surgeon; SD = standard deviation.

amputations in 2006, 1382 in 2007, 1288 in 2008, and 1290 in 2009). Patients were treated at 207 different hospitals and discharged to 83 inpatient rehabilitation facilities across Canada. Most amputations (53%) took place in Ontario, followed by British Columbia (12%) and Alberta (10%).

A total of 1904 patients (36%) were admitted to an inpatient rehabilitation facility from hospital after undergoing lower extremity amputation. This did not include patients who underwent rehabilitation as inpatients in the same hospital or were transferred to another hospital that was not specifically a rehabilitation facility after undergoing amputation. Baseline patient characteristics are outlined in Table 1. Most patients were male and 65 years of age or older. Most (97%) were diabetic and most (81%) underwent a below-the-knee amputation.

The reasons for admission to an inpatient rehabilitation facility are outlined in Table 2. Single below-knee amputation was the most frequent reason for admission to a rehabilitation facility (74%), followed by single above-knee amputation (17%). Of the patients admitted to a rehabilitation facility in our study population, 98% had an admission diagnosis of amputation. The other patients had admission diagnoses that included cardiovascular diseases and medical complications after undergoing a lower extremity amputation in hospital. The "Other" category of admission diagnoses comprised medical conditions such as failure to thrive, stroke, and CHF.

The mean locomotion FIM domain scores on admission to and discharge from an inpatient rehabilitation facility are outlined Figure 1. There was a statistically significant gain of 4.3 points in the locomotion FIM domain score in patients discharged from rehabilitation compared with the initial score on admission ($P < .001$).

Nearly half of the patients were discharged home with services (48%). Those services included home physiotherapy, wound care, and personal support with activities of daily living. Conversely, 24% were discharged home without services (Table 3). Approximately 9% required readmission to hospital, and 5 patients (0.3%) died in the rehabilitation facility.

The median length of stay in rehabilitation was different according to the type of surgeon who performed the procedure. Vascular surgery patients were admitted for a median of 36 days (range 1-177), orthopedic patients 38 days (range 1-560), general surgery patients 35 days (range 2-246), and other patients 35 days (range 7-121). The overall median length of stay was 36 days (range 1-560).

Factors associated with a prolonged rehabilitation facility length of stay are listed in Table 4. Being older, undergoing amputation by an orthopedic surgeon, undergoing surgery in the province of Manitoba, and having a history of IHD or CHF all predicted a longer hospital stay. Admission to hospital for fewer than 7 days before transfer to a rehabilitation facility was protective against a prolonged rehabilitation length of stay.

The analytical results of predictors of readmission to hospital from a rehabilitation facility are outlined in Table 5. Only being older was predictive of readmission to hospital.

Discussion

Our study has shown that approximately one-third of persons with nontraumatic lower extremity amputations in Canada are admitted directly to an inpatient rehabilitation facility after being discharged from hospital and that most of those patients will continue to require medical resources in the community after they are discharged home.

Table 2
Inpatient rehabilitation facility admitting diagnosis stratified by the type of surgeon who performed the amputation

Admitting Diagnosis, n (%)	Type of Surgeon				
	VS	OS	GS	Other	Total
Single below-knee amputation	425 (68)	661 (80)	295 (73)	31 (66)	1412 (74)
Single above-knee amputation	126 (20)	99 (12)	77 (19)	13 (28)	315 (17)
Double below-knee amputation	30 (5)	29 (4)	16 (4)	1 (2)	76 (4)
Double above-knee amputation	12 (2)	2 (0.2)	1 (0.3)	0	15 (1)
Double above and below-knee amputation	5 (1)	5 (1)	2 (0.5)	1 (2)	13 (1)
Other amputation	3 (0.5)	4 (0.5)	4 (1)	0	11 (1)
Other	23 (4)	26 (3)	10 (2)	1 (2)	60 (3)

VS = vascular surgeon; OS = orthopedic surgeon; GS = general surgeon; Other = other type of surgeon.

Reason for Inpatient Rehabilitation

Previous studies have reported that 37%-55% of persons with amputations required inpatient rehabilitation postdischarge from hospital [8,9]. Dillingham et al [9] found that persons with amputations were more likely to be discharged home from hospital instead of transferred to an inpatient rehabilitation facility if they were younger, married, had no history of nursing home residence, and had fewer perioperative complications. We have shown previously that general surgery patients with amputations were more likely to be discharged home than to a rehabilitation facility compared with patients who received an amputation by a vascular or orthopedic surgeon and hypothesized that those patients had a greater burden of disease and required transfer to a rehabilitation facility to recover from surgery [3].

Approximately three-fourths of the patients in our study who were admitted to a rehabilitation facility had undergone a single below-knee amputation. Previous reports have similarly found that about two-thirds of admitted rehabilitation patients after amputation are below-knee persons with amputations [10-12]. Interestingly, Fletcher et al [12] described a growing trend towards more below- compared with above-knee amputations over the 50 years captured in their study. They attributed this trend to changes in surgical practice, advances in revascularization techniques, improved management of diabetes, and better foot care.

There is a slight discrepancy between the type of amputations listed in Table 1 and the admitting rehabilitation diagnoses in Table 2. This discrepancy is attributed to database limitations, because only the index amputation during initial admission to hospital was captured. For example, a patient who initially underwent a below-knee amputation but subsequently required revision to an above-knee amputation would thus have still have been counted as a below-knee person with an amputation in Table 1.

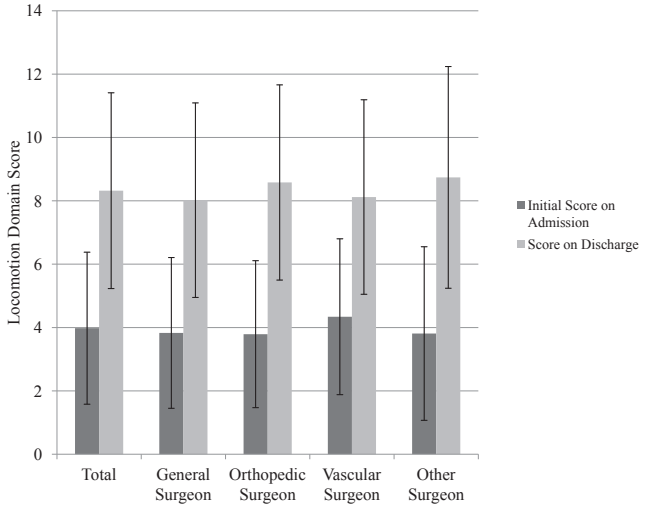

Figure 1. Mean locomotion domain scores (motor FIM) on admission to a rehabilitation facility and on discharge after rehabilitation, stratified by the type of surgeon who performed the amputation. FIM = Functional Independence Measure.

FIM Scores

We found an improvement in total FIM and locomotion scores (motor FIM) in patients after undergoing a course of inpatient rehabilitation. The FIM score is the most commonly used instrument in Canadian rehabilitation centers [13]. It has been shown to have acceptable reliability across a wide variety of rehabilitation patients with different physical limitations [14]; however, Leung et al [15] demonstrated that total FIM scores were not useful in predicting successful prosthetic rehabilitation in persons with lower extremity amputations and that only the locomotion domains have some evidence to support their use in this patient population. Furthermore, there is considerable interrater variability and lack of responsiveness when using this score in clinical practice [16], which further highlights the need for the use of validated rehabilitation outcomes measurement score for persons with amputations.

Length of Stay

We have not been able to identify any recent published studies that reported rehabilitation length of stay

Table 3
Postrehabilitation discharge destination of persons with amputations stratified by the type of surgeon who performed the amputation

	Type of Surgeon				
Discharge Destination, n (%)	VS	OS	GS	Other	Total
Home with services	293 (47)	384 (46)	206 (51)	22 (47)	905 (48)
Home without services	150 (24)	214 (26)	82 (20)	18 (38)	464 (24)
Acute care facility	61 (10)	77 (9)	39 (10)	2 (4)	179 (9)
Long-term care facility	59 (9)	66 (8)	38 (9)	2 (4)	165 (9)
Short-term care facility	25 (4)	48 (6)	21 (5)	2 (4)	96 (5)
Not discharged	35 (6)	38 (5)	16 (4)	1 (2)	90 (5)
Death	2 (0.3)	0	3 (1)	0	5 (0.3)

VS = vascular surgeon; OS = orthopedic surgeon; GS = general surgeon; Other = other type of surgeon.

after lower extremity amputation with which to compare our results; however, a report by Malone et al [17] published in 1981 reported an average rehabilitation time of 31 days in patients who were ambulating before amputation.

We have found that orthopedic surgery patients are likely to spend up to 5 more days in rehabilitation compared with vascular surgery patients. This difference likely is attributable to patient factors rather than technical differences in the operative approach to amputation. Vascular surgery persons with amputations, who generally have advanced peripheral arterial disease that necessitates a longer postoperative length of stay in hospital, may require less time at an inpatient rehabilitation facility secondary to initiation of rehabilitation before discharge from hospital. Indeed, we have reported previously that vascular surgery persons with amputations have a longer acute inpatient hospital stay compared with other persons with amputations [3,18]. Unfortunately, we are unable to further explain this postamputation rehabilitation trend with the current dataset.

Interestingly, we found that persons with amputations who spent fewer than 7 days in hospital also needed less inpatient rehabilitation time. Although patient comorbidity information in our dataset is limited, we hypothesize that patients fit enough to be discharged from hospital in less than a week will also perform better in rehabilitation compared with other patients.

Older patients were at a greater risk of a longer rehabilitation stay with every increased year of age. This finding is likely due to the increased burden of disease among older patients that hinders their participation in rehabilitation activities. Esquenazi [19] described 9 phases of amputation patient rehabilitation that require, among other things, adequate wound healing, muscle strength, and active participation in physical and daily living activities. One could thus appreciate why older patients might experience greater difficulty in some of these domains if they suffer from more comorbidities compared with younger patients.

Table 4
Predictors of prolonged inpatient rehabilitation after an index amputation

Characteristic	Regression Coefficient	Standard Error	*P* Value
Type of surgeon			
Vascular surgeon		Reference category	
Orthopedic surgeon	5.0	1.6	<.001
General surgeon	1.7	2.0	.39
Other surgeon	−0.4	4.0	.92
Female (vs male)	2.7	1.4	.06
Community (vs teaching) hospital	−2.0	1.5	.17
Age	0.2	0.1	<.001
Province or territory			
Ontario		Reference category	
Newfoundland	10.3	5.5	.060
Prince Edward Island	−5.6	19.7	.78
Nova Scotia	2.9	2.8	.31
New Brunswick	4.3	16.1	.79
Manitoba	15.6	3.0	<.001
Saskatchewan	−2.9	4.3	.49
Alberta	3.5	2.5	.15
British Columbia	−3.7	2.9	.21
Type of amputation			
Below-knee		Reference category	
Above-knee	2.7	1.80	.13
Ankle	0.04	5.78	.99
Foot	−2.2	3.3	.51
Toes	8.2	5.9	.16
Cardiovascular risk factors			
Diabetes	5.9	3.9	.13
Hypertension	1.5	1.5	.32
Ischemic heart disease	3.8	1.8	.030
Congestive heart failure	5.0	2.4	.040
Hyperlipidemia	−3.6	2.8	.20
Prerehabilitation hospital stay <7 d	−4.0	1.8	.030

Regional Variation

We have identified variability in rehabilitation facility length of stay between 2 regions in Canada. We are not aware of any previous reports that have similarly characterized the use of Canadian rehabilitation facilities after lower-extremity amputation.

Compared with Ontario, Canada's most populous province, patients in Manitoba were likely to spend 2 more weeks in rehabilitation. Because the provision of health care is a provincial jurisdiction in Canada, these results might be explained by differences in health care

Table 5
Predictors of readmission to hospital from a rehabilitation facility after an index amputation

Characteristic	OR	95% CI	*P* Value
Type of surgeon			
Vascular surgeon		Reference category	
Orthopedic surgeon	1.1	0.7-1.6	.61
General surgeon	1.1	0.7-1.8	.68
Other surgeon	0.4	0.1-1.9	.27
Female (vs male)	1.2	0.8-1.6	.40
Community (vs teaching) hospital	0.8	0.6-1.2	.25
Age	1.03	1.01-1.04	<.001
Province or territory			
Ontario		Reference category	
Newfoundland	0.3	0.04-2.4	.27
Nova Scotia	0.5	0.2-1.2	.14
New Brunswick	8	0.7-93.7	.10
Manitoba	1	0.5-2.0	.93
Saskatchewan	0.9	0.3-2.6	.81
Alberta	0.9	0.5-1.7	.79
British Columbia	0.9	0.4-1.8	.70
Type of amputation			
Below-knee		Reference category	
Above-knee	1.2	0.8-1.8	.34
Ankle	2.3	0.7-7.1	.15
Foot	0.3	0.1-1.2	.080
Toes	0.5	0.1-3.6	.48
Cardiovascular risk factors			
Diabetes	2.1	0.6-7.2	.22
Hypertension	1.1	0.8-1.6	.51
Ischemic heart disease	1.4	0.9-2.0	.13
Congestive heart failure	1.3	0.8-2.2	.34
Hyperlipidemia	1.0	0.5-1.8	.91
Prerehabilitation hospital stay <7 d	0.7	0.4-1.2	.23

OR = odds ratio; 95% CI = 95% confidence interval.

systems and the availability of community support services. Differences in socioeconomic factors also may help explain this trend, because Manitoba has a relatively larger proportion of First Nations communities with a greater prevalence of diabetes and renal failure compared with the general Canadian population [20-22].

Ischemic Heart Disease

Patients with a history of IHD or CHF were more likely to require additional time in rehabilitation compared with other patients. Initiation of cardiovascular conditioning in the early postoperative period is a cornerstone of successful rehabilitation after amputation [23]. As such, one would expect that patients challenged to commence cardiovascular training because of previous heart disease will likely need longer rehabilitation stays.

Community Services

Almost half of our patients were discharged home with community services, which include physiotherapy at home, wound care, and personal support with activities of daily living. Patients with amputation secondary to peripheral arterial disease have been shown to have increased problems with mobility, social isolation, lethargy, pain, sleep, and emotional disturbance compared with other persons with amputations, which may explain why so many require home supports [24].

Readmission

Approximately 9% of our patients required readmission to hospital. We did not identify any factors associated with an increased risk for readmission other than advanced age. A more thorough analysis that used detailed patient risk factors and comorbidity data would have been more informative but unfortunately not possible with our dataset.

Our finding that only 1 in 4 persons with amputations was eventually able to go home from a rehabilitation facility without requiring additional homecare services is a sobering reminder of the considerable social and economic needs of this patient population. Indeed, it has been shown previously that persons with amputations have high long-term resource use requirements that extend beyond the perioperative period [25]. Factors reportedly associated with successful rehabilitation after amputation include the ability to perform activities of daily living, a lower level of amputation, timely admission to a rehabilitation center, good social supports, and motivation. Conversely, phantom pain, advanced age, and multiple patient comorbidities have been shown to adversely impact the chances of successful rehabilitation [26].

Study Limitations

Our analysis was limited to adult persons with amputations. We did not capture traumatic or pediatric amputations, or patients from Quebec, which is Canada's second most populous province. Our dataset also lacked detailed patient comorbidity data or significant hospitalization, operative, or rehabilitation details that would have allowed us to carry out a more comprehensive analysis. Unfortunately, the models of care and variation in practices across different hospitals and regions likely confound our results. For example, in some hospitals the amputations might only be performed by a particular specialty, such as orthopedic surgery, regardless of the patient's presenting diagnosis or reason for amputation. Finally, our database is several years old and does not capture inpatient rehabilitation that may have taken place before a patient being discharged to a dedicated rehabilitation facility.

Nonetheless, ours is the first report on rehabilitation outcomes after lower extremity amputation that uses a national patient sample from across Canada. Our findings might help generate hypotheses and guide the development of more detailed studies aimed at

optimizing the provision of health care to lower extremity persons with amputations.

Future Directions

There are several challenges in optimizing the rehabilitation of persons with lower extremity amputations, including a lack of agreement on appropriate outcome measures to assess rehabilitation success [27]. Indeed, Deathe et al [13] surveyed the medical directors of Canadian amputation rehabilitation centers and reported a diverse selection of program- and patient-related outcome measures. Unfortunately, many of those measures are "home-made" and have not been validated. As such, some researchers have argued that rehabilitation success should be determined based on the patient's individual goals, rather than a pre-set change in standardized functional improvement scores [28]. Future work is thus needed to explore these issues and standardize the measurement and assessment of rehabilitation services across regions and health care providers in Canada.

Conclusions

Rehabilitation length of stay in Canada after lower extremity amputation varies by the type of surgeon performing the amputation. Advanced age, undergoing surgery in the province of Manitoba, and having a history of IHD or CHF all predicted a longer rehabilitation stay. A shorter perioperative hospitalization period (<7 days) predicts a shorter duration of rehabilitation. Differences between surgical specialties and provincial variations may be attributed to systemic issues. Future studies are needed to explore these issues and to optimize the delivery of rehabilitation services to Canadians following lower extremity amputation.

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Disclosure

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