Incidence and causes of early unplanned readmission after hospitalisation with peripheral arterial disease in Australia and New Zealand

Vanessa Woelk[1], Peter Speck[2], Billingsley Kaambwa[2], Robert A Fitridge[3,4], Isuru Ranasinghe[5,6]

The known: Clinical outcomes for people hospitalised with peripheral arterial disease (PAD) are often poor and patients may require early unplanned readmission. Their frequency and the reasons for these readmissions are relatively unexplored.

The new: About one in ten PAD-related hospitalisations in Australia and New Zealand were followed within 30 days of discharge by unplanned readmissions. The likelihood of readmission was influenced by several patient and hospitalisation factors, including potentially preventable procedural complications, cardiovascular events, and infections.

The implications: Reducing the unplanned readmission rate is important, both to minimise healthcare costs and to improve clinical outcomes for people with PAD.

Abstract

Objective: To evaluate the characteristics and predictors of unplanned readmission within 30 days of hospitalisation for the treatment of peripheral arterial disease (PAD) in Australia and New Zealand.

Design: Analysis of hospitalisations data in the Admitted Patient Collection for each Australian state and territory and the New Zealand National Minimum Dataset (Hospital Events).

Setting: All public and 80% of private hospitals in Australia and New Zealand.

Participants: Adults (18 years or older) hospitalised with a primary or conditional secondary diagnosis of PAD during 1 January 2010 – 31 December 2015.

Main outcome measure: Rate of unplanned readmission (any cause) within 30 days of hospitalisation with PAD.

Results: Of 104 979 admissions included in our analysis (mean patient age, 73.7 years; SD, 12.4 years), 9765 were followed by at least one unplanned readmission within 30 days of discharge (9.3%): 3395 within one week (34.8%) and 7828 within three weeks (80.2%). The most frequent readmission primary diagnoses were atherosclerosis (1477, 15.3%), type 2 diabetes (1057, 10.8%), and "complications of procedures not elsewhere classified" (963, 9.9%). Readmission was more frequent after acute (4830 of 26 304, 18.4%) than elective PAD hospitalisations (4935 of 78 675, 6.3%), but the readmission characteristics were similar. Factors associated with greater likelihood of readmission included acute PAD hospitalisations (odds ratio [OR], 2.04; 95% CI, 1.96–2.17), surgical intervention during the PAD hospitalisation (OR, 1.74; 95% CI, 1.64–1.84), and chronic limb-threatening ischaemia (OR, 1.55; 95% CI, 1.47–1.63).

Conclusion: Unplanned readmissions within 30 days of hospitalisation for PAD are often for potentially preventable reasons. Their number should be reduced to improve clinical outcomes for people with PAD.

More than 200 million people around the world have peripheral arterial disease (PAD), including more than 12% of people over 60 years of age.[1,2] Early symptoms include limb pain during movement (claudication), and progression of atherosclerosis can lead to chronic limb-threatening ischaemia — manifested as rest pain, ischaemia with ulceration, gangrene, and infection — that often necessitates limb amputation.[3,4] People with PAD typically have poor clinical outcomes, including substantial loss of mobility[1,5] and elevated risks of stroke, myocardial infarction, and death.[3,4,6] In particular, the 10-year risks of major coronary events and death (cardiovascular and all-cause) are twice as high for people with PAD.[3,4,6]

Patients hospitalised with PAD are at high risk of post-discharge complications, but few population studies have examined the frequency or causes of associated hospital re-admissions.[7] Unplanned readmission rates after vascular surgery are among the highest for any surgery type.[8] Arterial occlusions often require endovascular or surgical revascularisation, and the risks of complications are high.[9,10] In a recent American study, about one in six people hospitalised with PAD were readmitted within 30 days of discharge; procedural complications, sepsis, and diabetes were the most frequent primary readmission diagnoses.[9]

The 30-day unplanned readmission rate is increasingly regarded as a measure of hospital quality of care.[11,12] As little is known about the characteristics of unplanned readmissions after hospitalisation with PAD outside the United States, we investigated the characteristics of all unplanned readmissions within 30 days of hospitalisation with PAD in Australia and New Zealand, and compared these characteristics for readmissions after acute and elective PAD hospitalisations. We also assessed the patient and hospitalisation factors associated with early readmission.

Methods

We analysed hospitalisations data in the Admitted Patient Collection for each Australian state and territory and the New Zealand National Minimum Dataset (Hospital Events). These datasets include data collected by all public and most private hospitals (80%) for a standard set of variables, including hospitalisation type (elective, acute), admission and discharge dates, primary and secondary diagnoses, procedures, and patient status at discharge. In both countries, diagnoses and procedures are coded according to the International Classification of Diseases, tenth revision, Australian modification (ICD-10-AM) and the Australian Classification of Health Interventions (ACHI).[13] An audit of discharge medical records found that accuracy of ICD-10 coding in Australia exceeded 85%.[14]

[1] International Centre for Point-of-Care Testing, Flinders University, Adelaide, SA. [2] Flinders University, Adelaide, SA. [3] Royal Adelaide Hospital, Adelaide, SA. [4] University of Adelaide, Adelaide, SA. [5] The University of Queensland, Brisbane, QLD. [6] The Prince Charles Hospital, Brisbane, QLD. vanessa.woelk@flinders.edu.au
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Study population

We included hospitalisations of adults (18 years or older) during the period 1 January 2010 – 31 December 2015 for which the primary diagnosis was PAD, or the secondary diagnosis was PAD and the primary diagnosis was diabetes with vascular complications, other peripheral vessel disease, arterial embolism and thrombosis, or ulcers. These criteria have been used previously to identify PAD-related hospitalisations.[15] Diagnoses were defined by ICD-10-AM codes (Supporting Information, table 1). Hospitalisations were excluded if the patients had discharged themselves against medical advice (as readmission may not reflect quality of care) or died during the hospitalisation, or had been transferred to another hospital, hospitalised with PAD during the final 30 days of the study period, or hospitalised with PAD within 30 days of an earlier hospitalisation (to ensure that the hospitalisation with PAD was not itself a readmission).

Study outcomes

The primary outcome was unplanned readmission for any reason within 30 days of hospitalisation with PAD. Secondary outcomes were the rates of all-cause (planned and unplanned) readmissions, planned readmissions, and out-of-hospital deaths. Readmissions to any hospital and death within 30 days of discharge were identified by linking hospitalisations data with data for subsequent hospitalisations and deaths registry data. In Australia, records were linked by state-specific data linkage units applying probabilistic matching (reported accuracy greater than 99%[16]); in New Zealand, all hospitalisations and deaths are recorded and linked by unique, person-specific National Health Index numbers.

Statistical analysis

We summarised data for continuous variables as means with standard deviations (SDs) or medians with interquartile ranges (IQRs), and categorical variables as counts and proportions. We assessed the statistical significance of differences between patient group characteristics in χ^2, *t*, and Wilcoxon rank-sum tests. We identified predictors of unplanned readmission using logistic regression. Candidate variables included age, sex, hospital status (private or public), acute PAD hospitalisation, region, presentation with chronic limb-threatening ischaemia, PAD-related interventions (endovascular or surgical revascularisation, or hybrid procedure), and comorbid conditions. Comorbid conditions were grouped according to the hierarchical condition category model;[17] we combined the ICD-10-AM diagnosis codes for selected secondary diagnoses during the PAD hospitalisation and the primary and secondary diagnoses for all hospitalisations during the preceding 12 months into 180 clinically meaningful categories. Variables in the final multivariable model were selected by backward stepwise regression ($P < 0.05$). Goodness of model fit was quantified with the concordance statistic (*C*-statistic). Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for each variable. Statistical analyses were conducted in Stata SE 13.

Ethics approval

Our study was approved by the NSW Population and Health Services Research Ethics Committee (2015/06/591), the ACT Health Department Human Research Ethics Committee (HREC) (ETH.7.15.143), the ACT Calvary Hospital HREC (20-2015), the South Australian Department of Health and Ageing HREC (HREC/15/SAH/102), the Western Australian Department of Health HREC (2016/47), the Tasmanian Department of Health HREC (H0016011), the Northern Territory Department of Health and Menzies School of Health Research HREC (2017-2944), and Queensland Health (*Public Health Act* approval, RD008025). Queensland Health and the Victorian Department of Health accepted the NSW Population and Health Services Research Ethics Committee approval. New Zealand data were analysed under a data user agreement with the Ministry of Health. A waiver of individual informed consent by patients was granted for our analysis of de-identified data.

Results

After assessing the eligibility of 140 820 hospitalisations with PAD for our analysis, we included data for 104 979 admissions: 26 304 acute (25.1%) and 78 675 elective (scheduled) hospitalisations (74.9%). The reasons for excluding hospitalisations (multiple reasons possible) were prior hospitalisation within 30 days of index hospitalisation (23 563 hospitalisations), transfer to another hospital (11 838), in-hospital death (2278), 30-day follow-up data not available (1757), and discharge against medical advice (777).

Patient and hospitalisation characteristics

The mean age of patients was higher for PAD admissions followed by unplanned readmissions (73.7 years; SD, 12.4 years) than for those that were not (73.0 years; SD, 11.7 years); the proportions of women in the two groups were similar (about 36%). The median length of stay was longer for hospitalisations followed by unplanned readmissions (5 days; IQR, 1–12 days *v* 1 day; IQR, 1–6 days), a smaller proportion were admissions to private hospitals (19.7% *v* 39.3%), and larger proportions had been of patients who presented with chronic limb-threatening ischaemia (61.4% *v* 36.8%), or who had undergone surgical (18.3% *v* 12.5%) or hybrid procedures (5.4% *v* 3.5%). All examined comorbid conditions were more frequent for PAD admissions followed by unplanned readmissions (Box 1).

The median hospital length of stay was longer for acute than elective PAD hospitalisations, and the proportions involving patients with most comorbid conditions (including chronic limb-threatening ischaemia and heart failure) larger, both for hospitalisations followed by unplanned readmissions and those that were not (Box 1).

Primary outcome

A total of 9765 hospitalisations (9.3%) were followed by at least one unplanned readmission within 30 days. Early readmissions were more frequent after acute than elective PAD hospitalisations (18.4% *v* 6.3%) (Box 2).

Secondary outcomes

A total of 21 193 hospitalisations (20.2%) were followed by at least one planned or unplanned readmission within 30 days; readmissions were more frequent after acute than elective PAD hospitalisations (28.3% *v* 17.5%). Of these readmissions, 11 428 were elective (10.9% of all hospitalisations); elective readmissions were less frequent after acute than elective PAD hospitalisations (9.9% *v* 11.2%). Out-of-hospital death within 30 days (without readmission) followed 1190 hospitalisations (1.1%); deaths were more frequent after acute than elective PAD hospitalisations (3.5% *v* 0.3%) (Box 2).

Time to unplanned readmission

Of 9765 unplanned readmissions within 30 days, 3395 were within one week (34.8%) and 7828 within three weeks of

1 Baseline characteristics of 104 979 admissions in Australia and New Zealand with peripheral arterial disease (PAD), by hospitalisation type and 30-day unplanned readmission status

Characteristic	All admissions			Acute admissions			Elective admissions		
	Unplanned readmission	No readmission	*P*	Unplanned readmission	No readmission	*P*	Unplanned readmission	No readmission	*P*
Number of admissions	9765	95 214		4830	21 474		4935	73 740	
Age (years), mean (SD)	73.7 (12.4)	73.0 (11.7)	< 0.001	73.5 (13.1)	73.8 (13.4)	0.13	74 (11.7)	72.8 (11.2)	< 0.001
Sex (women)	3531 (36.2%)	33 750 (35.5%)	0.16	1734 (35.9%)	8044 (37.5%)	0.043	1797 (36.4%)	25 706 (34.9%)	0.027
Length of stay (days), median (IQR)	5 (1–12)	1 (1–6)	< 0.001	8 (4–15)	8 (3–15)	0.001	2 (1–7)	1 (1–3)	< 0.001
Hospital type (private)	1919 (19.7%)	37 458 (39.3%)	< 0.001	360 (7.4%)	2666 (12.4%)	< 0.001	1559 (31.6%)	34 792 (47.2%)	< 0.001
Presentation characteristics									
Region			< 0.001			< 0.001			< 0.001
New South Wales/Australian Capital Territory	2693 (27.6%)	29 526 (31.0%)		1361 (28.2%)	7257 (33.8%)		1332 (27.0%)	22 269 (30.2%)	
Western Australia	1071 (11%)	11 855 (12.5%)		463 (9.6%)	1755 (8.2%)		608 (12.3%)	10 100 (13.7%)	
South Australia/Northern Territory	616 (6.3%)	4219 (4.4%)		351 (7.3%)	1658 (7.7%)		265 (5.4%)	2561 (3.5%)	
Queensland	1478 (15.1%)	13 858 (14.6%)		754 (15.6%)	3170 (14.8%)		724 (14.7%)	10 688 (14.5%)	
Victoria	1986 (20.3%)	23 809 (25.0%)		860 (17.8%)	4055 (18.9%)		1126 (22.8%)	19 754 (26.8%)	
Tasmania	119 (1.2%)	962 (1.0%)		67 (1.4%)	297 (1.4%)		52 (1.0%)	665 (0.9%)	
New Zealand	1802 (18.5%)	10 985 (11.5%)		974 (20.2%)	3 282 (15.3%)		828 (16.8%)	7703 (10.5%)	
Chronic limb-threatening ischaemia	5991 (61.4%)	35 000 (36.8%)	< 0.001	3630 (75.2%)	14 822 (69.0%)	< 0.001	2361 (47.8%)	20 178 (27.4%)	< 0.001
Intervention									
Surgery	1787 (18.3%)	11 871 (12.5%)	< 0.001	552 (11.4%)	2199 (10.2%)	0.015	1235 (25.0%)	9672 (13.1%)	< 0.001
Endovascular	4064 (41.6%)	52 647 (55.3%)	< 0.001	1498 (31.0%)	7600 (35.4%)	< 0.001	2566 (52.0%)	45 047 (61.1%)	< 0.001
Hybrid	531 (5.4%)	3306 (3.5%)	< 0.001	242 (5.0%)	984 (4.6%)	0.20	289 (5.9%)	2322 (3.2%)	< 0.001
PAD intervention in preceding year	2459 (25.2%)	23 937 (25.1%)	0.93	970 (20.1%)	4163 (19.4%)	0.27	1489 (30.2%)	19 774 (26.8%)	< 0.001
Cardiac disease history									
Acute coronary syndrome	834 (8.5%)	4648 (4.9%)	< 0.001	436 (9.0%)	1424 (6.6%)	< 0.001	398 (8.1%)	3224 (4.4%)	< 0.001
Ischaemic heart disease	1189 (12.2%)	8541 (9.0%)	< 0.001	597 (12.4%)	2118 (9.9%)	< 0.001	592 (12.0%)	6423 (8.7%)	< 0.001
Heart failure	1705 (17.5%)	7337 (7.7%)	< 0.001	1042 (21.6%)	3278 (15.3%)	< 0.001	663 (13.4%)	4059 (5.5%)	< 0.001
Valvular/rheumatic heart disease	351 (3.6%)	1952 (2.0%)	< 0.001	181 (3.8%)	648 (3.0%)	< 0.001	170 (3.4%)	1304 (1.8%)	< 0.001
Hypertension	4025 (41.2%)	25 874 (27.2%)	< 0.001	2187 (45.3%)	8239 (38.4%)	< 0.001	1838 (37.2%)	17 635 (23.9%)	< 0.001
Arrhythmia, conduction disorders	1432 (14.7%)	8220 (8.6%)	< 0.001	765 (15.8%)	2 781 (13%)	< 0.001	667 (13.5%)	5439 (7.4%)	< 0.001
Stroke, transient ischaemic attack, cerebral haemorrhage	426 (4.4%)	2845 (3.0%)	< 0.001	213 (4.4%)	827 (3.8%)	0.07	213 (4.3%)	2018 (2.7%)	< 0.001
Vascular disease	4152 (42.5%)	34 670 (36.4%)	< 0.001	1875 (38.8%)	7467 (34.8%)	< 0.001	2277 (46.1%)	27 203 (36.9%)	< 0.001

Continues

1 Continued

Characteristic	All admissions			Acute admissions			Elective admissions		
	Unplanned readmission	No readmission	*P*	Unplanned readmission	No readmission	*P*	Unplanned readmission	No readmission	*P*
Comorbid conditions									
Chronic lung disease	852 (8.7%)	4194 (4.4%)	< 0.001	478 (9.9%)	1535 (7.2%)	< 0.001	374 (7.6%)	2659 (3.6%)	< 0.001
Pneumonia	876 (9.0%)	4240 (4.4%)	< 0.001	497 (10.3%)	1809 (8.4%)	< 0.001	379 (7.7%)	2431 (3.3%)	< 0.001
Diabetes mellitus	4008 (41.0%)	26 344 (27.7%)	< 0.001	2251 (46.6%)	8353 (38.9%)	< 0.001	1757 (35.6%)	17 991 (24.4%)	< 0.001
Major and metastatic cancer	264 (2.7%)	1470 (1.5%)	< 0.001	162 (3.4%)	578 (2.7%)	0.012	102 (2.1%)	892 (1.2%)	< 0.001
Other cancer	790 (8.1%)	6892 (7.2%)	0.002	385 (8.0%)	1503 (7.0%)	0.018	405 (8.2%)	5389 (7.3%)	0.019
Renal failure or dialysis	2275 (23.3%)	10 515 (11.0%)	< 0.001	1309 (27.1%)	4138 (19.3%)	< 0.001	966 (19.6%)	6377 (8.6%)	< 0.001
Chronic liver disease	99 (1.0%)	399 (0.4%)	< 0.001	67 (1.4%)	196 (0.9%)	0.003	32 (0.6%)	203 (0.3%)	< 0.001
Anaemia, other haematological disorders	2457 (25.2%)	12 830 (13.5%)	< 0.001	1391 (28.8%)	5046 (23.5%)	< 0.001	1066 (21.6%)	7784 (10.6%)	< 0.001
Psychiatric disorders	513 (5.2%)	2445 (2.6%)	< 0.001	328 (6.8%)	1127 (5.2%)	< 0.001	185 (3.8%)	1318 (1.8%)	< 0.001
Hemiplegia, paraplegia, paralysis, functional disability	1888 (19.3%)	9294 (9.8%)	< 0.001	1214 (25.1%)	4470 (20.8%)	< 0.001	674 (13.7%)	4824 (6.5%)	< 0.001
Dementia and senility	499 (5.1%)	2698 (2.8%)	< 0.001	370 (7.7%)	1610 (7.5%)	0.70	129 (2.6%)	1088 (1.5%)	< 0.001
Protein-calorie malnutrition	878 (9.0%)	4443 (4.7%)	< 0.001	562 (11.6%)	2251 (10.5%)	0.019	316 (6.4%)	2192 (3.0%)	< 0.001

IQR = interquartile range; SD = standard deviation. ◆

2 Primary and secondary study outcomes, by peripheral arterial disease hospitalisation type

	All hospitalisations	Acute hospitalisation	Elective hospitalisation	*P**
Hospitalisations	104 979	26 304	78 675	
Thirty-day outcomes				
Primary outcome				
Unplanned readmission	9765 (9.3%)	4830 (18.4%)	4935 (6.3%)	< 0.001
Secondary outcomes				
All-cause readmission	21 193 (20.2%)	7438 (28.3%)	13 755 (17.5%)	< 0.001
Elective readmission	11 428 (10.9%)	2608 (9.9%)	8820 (11.2%)	< 0.001
Out-of-hospital death (no readmission)	1190 (1.1%)	931 (3.5%)	259 (0.3%)	< 0.001

* Acute *v* elective hospitalisations. ◆

discharge (80.2%). The temporal distribution after acute and elective PAD hospitalisations was similar (Box 3).

Diagnoses associated with 30-day unplanned readmissions

The 9765 unplanned readmissions were associated with more than 450 primary diagnoses, of which the twenty most frequent accounted for 6369 readmissions (65.2%). The leading primary diagnoses were atherosclerosis (1477 unplanned readmissions, 15.3%), type 2 diabetes (1057, 10.8%) and "complications of procedures not elsewhere classified" (963, 9.9%); less frequent were other procedural complications (569, 5.8%) and infections such as cellulitis (302, 3.1%), pneumonia (204, 2.1%), and sepsis (177, 1.8%) (Box 4). Readmission diagnoses following acute and elective PAD hospitalisations were similar (Supporting Information, tables 2 and 3).

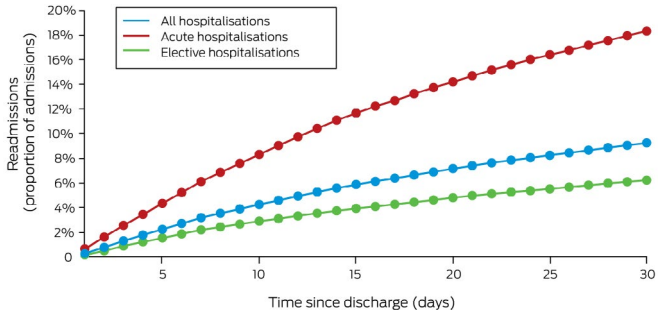
Predictors of unplanned readmission

Thirty-three patient and hospitalisation characteristics were independently associated with the risk of unplanned readmission (*C*-statistic, 0.727). Acute PAD hospitalisation (OR, 2.04; 95% CI, 1.96–2.17), surgical intervention during PAD hospitalisation (OR, 1.74; 95% CI, 1.64–1.84), and chronic limb-threatening ischaemia (OR, 1.55; 95% CI, 1.47–1.63) were associated with increased likelihood of readmission; treatment in a private hospital was associated with reduced likelihood (OR, 0.63; 95% CI, 0.59–0.66) (Box 5).

Cardiovascular conditions, including congestive heart failure (OR, 1.33; 95% CI, 1.24–1.43), arrhythmias and conduction disorders (OR, 1.10; 95% CI, 1.02–1.17), acute coronary syndrome (OR, 1.09; 95% CI, 1.00–1.19), and hypertension (OR, 1.09; 95% CI, 1.03–1.14), were each associated with increased likelihood of readmission. Other conditions associated with greater likelihood of readmission included drug/alcohol psychosis (OR, 1.28; 95% CI, 1.05–1.57), drug/alcohol misuse without dependence (OR, 1.22; 95% CI, 1.10–1.35), major eye infections and inflammations (OR, 1.99; 95% CI, 1.04–3.80), and rheumatoid arthritis and inflammatory connective tissue disease (OR, 1.51; 95% CI, 1.31–1.74) (Box 5).

Predictors of readmission were similar for acute and elective PAD hospitalisations, except that the influence of chronic

3 Cumulative proportions of unplanned readmissions following 104 979 peripheral arterial disease hospitalisations

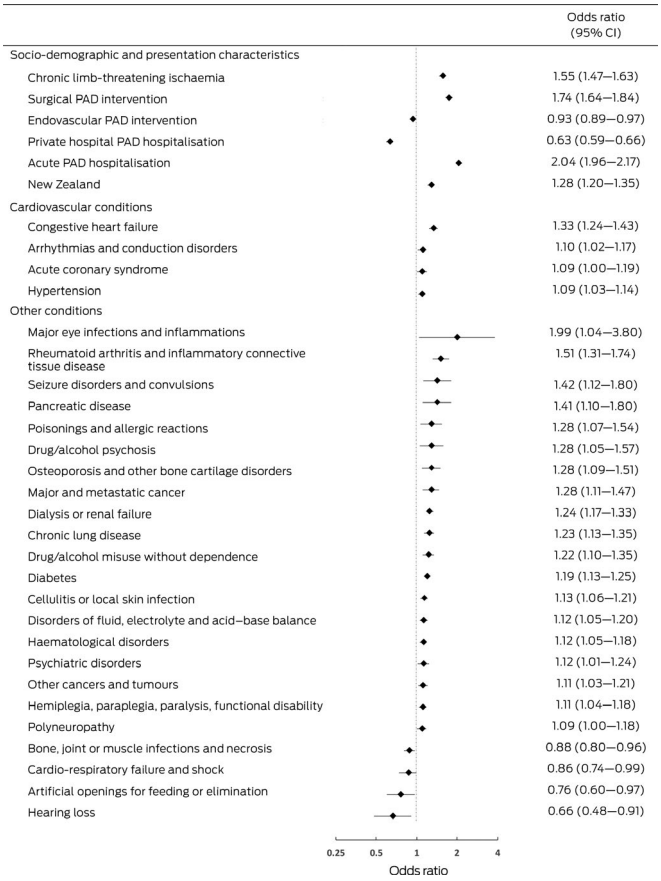


4 Twenty most frequent primary diagnoses for 9765 unplanned readmissions within 30 days of peripheral arterial disease hospitalisation

Readmission primary diagnosis (ICD-10-AM code)	Readmissions
Atherosclerosis (I70)	1477 (15.1%)
Type 2 diabetes mellitus (E11)	1057 (10.8%)
Complications of procedures, not elsewhere classified (T81)	963 (9.9%)
Complications of cardiac and vascular prosthetic devices, implants and grafts (T82)	407 (4.2%)
Heart failure (I50)	337 (3.4%)
Cellulitis (L03)	302 (3.1%)
Acute myocardial infarction (I21)	252 (2.6%)
Pneumonia, organism unspecified (J18)	204 (2.1%)
Other sepsis (A41)	177 (1.8%)
Complications peculiar to reattachment and amputation (T87)	162 (1.7%)
Osteomyelitis (M86)	155 (1.6%)
Other chronic obstructive pulmonary disease (J44)	137 (1.4%)
Ulcer of lower limb, not elsewhere classified (L97)	131 (1.3%)
Pain in throat and chest (R07)	118 (1.2%)
Angina pectoris (I20)	105 (1.1%)
Other disorders of urinary system (N39)	103 (1.0%)
Cerebral infarction (I63)	97 (1.0%)
Type 1 diabetes mellitus (E10)	95 (1.0%)
Arterial embolism and thrombosis (I74)	90 (0.9%)
Acute kidney failure (N17)	90 (0.9%)

ICD-10-AM = International Classification of Diseases, tenth revision, Australian modification. ◆

5 Patient and hospitalisation characteristics associated with unplanned readmission after hospitalisation with peripheral arterial disease (PAD): multivariable logistic regression*



CI = confidence interval. * Number of admissions for the treatment of PAD: 104 979; *C*-statistic, 0.727. ◆

limb-threatening ischaemia (OR, 1.69; 95% CI, 1.58–1.80 *v* OR, 1.19; 95% CI, 1.10–1.28) and surgical PAD intervention (OR, 2.20; 95% CI, 2.05–2.36 *v* OR, 1.22; 95% CI, 1.10–1.35) were each greater for elective than acute PAD hospitalisations (Supporting Information, figures 1 and 2).

Discussion

Our study is the first to assess unplanned readmissions within 30 days of hospitalisation for the treatment of PAD in Australia and New Zealand, and the most recent regarding such readmissions in any country. We found that 9.3% of hospitalisations for PAD during 2010–2015 were followed within 30 days by unplanned readmissions; four in five readmissions were within three weeks of discharge, and readmission was three times as frequent after acute than elective hospitalisations. Many readmissions were potentially avoidable, with reasons such as procedural complications, cardiovascular events, and infections.

Previously reported 30-day readmission rates of 11.7–21.3% referred to patients with PAD who had undergone arterial revascularisation or had chronic limb-threatening ischaemia.[9,18-20] In contrast, we report the unplanned 30-day readmission rate for all patients hospitalised with PAD, regardless of disease severity and medical intervention. Population studies of predictors of readmission after hospitalisation with PAD outside Canada and the United States have not been reported. Procedural complications after PAD revascularisation are the most frequent causes of early unplanned readmission in the United States, followed by sepsis, gangrene, and complications of diabetes.[9] A 2018 Canadian study found that congestive heart failure, obstructive pulmonary disease, and diabetes mellitus were associated with early readmission and death after elective bypass surgery for PAD.[20] Our finding that hospitalisations for the treatment of PAD in Australia and New Zealand are often followed by readmissions linked with procedural complications, infections, and cardiovascular events complement these North American reports.

We found that almost three times as many acute as elective PAD hospitalisations are followed by early unplanned readmission. We also found that one-third of unplanned readmissions were within one week and about 80% within three weeks of discharge. An American study found that readmissions within seven days of discharge were often associated with premature discharge or incorrect decision making during the PAD hospitalisation, and that multidisciplinary follow-up and continuity of care were crucial for averting unplanned readmissions 8–30 days after discharge.[21] Despite the difference in readmission incidence, we found that time to and the reasons for unplanned readmission after acute and elective PAD hospitalisations were similar.

Many readmission diagnoses in our study were of potentially avoidable conditions. Type 2 diabetes was the primary diagnosis for 10.8% of readmissions, reflecting the large proportion of people with PAD who have diabetes and the adverse clinical outcomes associated with poor glycaemic control.[22] The primary diagnosis was "complications of procedures, not elsewhere classified" for 9.9% of readmissions and "complications of cardiac and vascular prosthetic devices, implants and grafts" for 4.2%. The incidence of these complications could be reduced by improving postoperative care;[9] for instance, routine early follow-up of discharged patients reduces the incidence of procedural complications in people treated for heart failure.[23] Infections such as cellulitis, pneumonia, and sepsis were also frequent readmission diagnoses, and targeted interventions could avert these potentially avoidable conditions.[24] For a large proportion of readmissions the major diagnoses were heart failure, acute myocardial infarction, angina, or stroke, reflecting the risk of cardiovascular events associated with PAD. Aggressive primary and secondary prevention of cardiovascular disease could improve outcomes for patients with PAD.

A broad range of patient and hospitalisation factors were associated with the risk of early unplanned readmission, several of which could be modified by lifestyle changes and improved health care. Surgical intervention during the PAD hospitalisation and chronic limb-threatening ischaemia were associated with increased risk of rehospitalisation, possibly reflecting high rates of infection, cardiovascular events, and need for debridement in patients who are urgently hospitalised.[3] Early multidisciplinary follow-up for patients with chronic limb-threatening ischaemia is needed to reduce the risks of unplanned readmission and poor clinical outcomes.[25] In contrast, endovascular revascularisation was associated with a lower readmission rate, suggesting fewer short term complications.[26] Cardiac conditions were associated with higher readmission risk, indicating that patients with PAD with cardiovascular disease require more intensive care during and after hospitalisation. Care at a private hospital was associated with lower readmission risk; differences in quality of care in public and private hospitals should be investigated. Finally, improving discharge and hospital-to-homecare transition practices,

supported by general practice liaison officers, has been reported to reduce readmission and emergency department visit rates by 30%, and accompanied by substantial cost savings.[27]

Limitations

Administrative data are less specific than data collected for research purposes, but were the only national data available for assessing our research question. Further, administrative data do not capture certain patient factors that may influence readmission rates, such as pharmacotherapy and socio-economic status. We did not account for the competing risk of out-of-hospital death, and may therefore have underestimated readmission risk. Clinical outcomes for people with PAD are influenced by patient factors, clinician experience, institutional care practices, and policy; further analyses are needed to fully assess the influence of these factors on clinical outcomes and the effectiveness of interventions for improving care.

Conclusion

In Australia and New Zealand, 9.3% of admissions for the treatment of PAD during 2010–2015, including 18.4% of acute admissions, were followed by unplanned readmissions within 30 days of discharge. The reasons for many readmissions were potentially preventable, including procedural complications, cardiovascular events, and infections. The number of unplanned readmissions should be reduced to improve clinical outcomes for people with PAD and to reduce health care costs.

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Supporting Information

Additional Supporting Information is included with the online version of this article.