Unplanned early hospital readmissions in a vascular surgery population

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Background: Patients who undergo vascular surgery are burdened by high early readmission rates. We examined the frequency and cause of early readmissions after elective and emergent admission to the vascular surgery service at our institution to identify modifiable targets for quality improvement.

Methods: Over a 5-year period, all patients admitted and readmitted to the vascular surgery service were identified. Medical records were then individually reviewed to identify baseline characteristics from the index admission and the most responsible diagnosis for readmission within 28 days of discharge.

Results: Of a total of 3324 patients, 421 (12.7%) were readmitted to our institution within 28 days of discharge. Forty-seven were found to have more than 1 readmission following their index admission. The readmission rate ranged from 11.8% to 14.1% over the 5-year study period, resulting in an average readmission rate of 12.7%. There were similar rates for men (12.9%) and women (12.3%). Of the readmitted cases, 236 (63.1%) were unplanned readmissions. The most common diagnoses for unplanned readmissions were worsening of peripheral arterial disease status including complications related to peripheral bypass graft (30.9%), surgical site infections (15.3%) and nonsurgical infections (14.8%).

Conclusion: To reduce readmission rates effectively, institutions must identify high-risk patients. In our study cohort, the most frequent pathology resulting in readmission was peripheral arterial disease. The most frequent preventable reason for readmission was surgical site infection. Interventions focused on early assessment of clinical status and wounds in addition to avoidance of infectious complications could help reduce readmission rates. Preventive resources can be efficiently targeted by focusing on subgroups at risk for readmission.

Contexte : Les patients soumis à une chirurgie vasculaire présentent malheureusement un taux élevé de réadmission précoce. Nous avons analysé la fréquence et les causes de réadmission précoce après une admission urgente ou non urgente au service de chirurgie vasculaire afin d'identifier les facteurs modifiables en vue d'améliorer la qualité des soins.

Méthodes : Sur une période de 5 ans, tous les patients admis, puis réadmis au service de chirurgie vasculaire ont été identifiés. On a ensuite passé en revue individuellement les dossiers médicaux pour relever les caractéristiques de base à l'admission initiale et le diagnostic ayant le plus probablement justifié la réadmission dans les 28 jours suivant le congé.

Résultats : Sur un total de 3324 patients, 421 (12,7 %) ont été réadmis à notre établissement dans les 28 jours suivant leur congé. Quarante-sept ont été réadmis plus d'une fois après leur hospitalisation initiale. Le taux de réadmission a varié de 11,8 % à 14,1 % pendant la période de 5 ans de l'étude, le taux moyen de réadmission étant de 12,7 %. Les taux étaient similaires chez les hommes (12,9 %) et les femmes (12,3 %). Parmi les cas réadmis, 236 (63,1 %) étaient imprévus. Les diagnostics ayant le plus souvent justifié une réadmission imprévue étaient aggravation de la maladie artérielle périphérique (y compris complications au niveau de pontages artériels périphériques) (30,9 %), infection du site opératoire (15,3 %) et infections non chirurgicales (14,8 %).

Conclusion : Pour réduire efficacement les taux de réadmission, les établissements doivent identifier les patients à haut risque. Dans notre cohorte, la pathologie ayant le plus souvent mené à une réadmission était la maladie artérielle périphérique. La raison évitable la plus fréquente était l'infection du site opératoire. Les interventions axées sur une évaluation rapide de l'état clinique et de l'état des plaies, ainsi que la prévention des complications infectieuses pourraient contribuer à réduire les taux de réadmission. Des mesures préventives pourraient cibler judicieusement les groupes à risque de réadmission.

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Hospital readmission has become a focus of quality improvement initiatives because of the associated burden on patients and the health care system. Many studies have found that unplanned readmissions are common,[1–4] costly[2,5] and potentially avoidable.[6,7] According to a 2012 study by the Canadian Institute for Health Information, readmission within 30 days costs the Canadian health care system $1.8 billion per year.[8] Readmitted patients suffer complications and comorbidities and may have increased mortality.[9]

There are several reasons why readmissions need to be examined specifically for patients who have undergone vascular surgery. First, the literature shows that patients who undergo vascular surgery have high readmission rates, as high as 24.9% in the Medicare population.[2] Second, there are few studies in the vascular surgery literature documenting rates of planned and unplanned readmissions and examining factors affecting readmission and strategies to reduce readmissions.[10]

The main outcome of interest for this study was the occurrence of an unplanned inpatient readmission within 28 days following discharge after an index elective or emergent hospital admission. We investigated the rate of vascular readmission to a single quaternary care vascular centre over a 5-year period and reviewed the factors associated with the readmission, to discuss strategies to prevent readmission among vascular patients.

Methods

We conducted a retrospective cohort study of all patients with an index admission under vascular surgery who were readmitted to our institution within 28 days of discharge over a 5-year period between 2007 and 2012. This cohort included patients who underwent surgery or endovascular therapy or who were treated with medical management. The cohort consisted of patients 18 years of age and older who were discharged from the vascular surgery service after an index inpatient admission of at least 24 hours; patients undergoing same-day surgery were not included in the study cohort. Readmissions were defined as any subsequent inpatient stay following discharge identified using the hospital's Planning and Performance Measurement database. The Office of Planning and Performance Measurement (OPPM) provides an infrastructure for indicator development and conducts analysis to support management decision-making across our hospital network (the University Health Network). A list of patients who were readmitted within 28 days was compiled by this department. Charts were individually hand screened to identify and classify the readmission as planned versus unplanned. Charts were also screened to categorize index and readmission diagnosis, procedures performed and baseline comorbidities. We attempted to identify characteristics that may have contributed to readmission, such as elective versus emergent entry, most responsible diagnosis, comorbidities, complications and scheduled clinic follow-up visit. All analyses were undertaken using SPSS version 2.0 (IBM). Continuous variables were reported by mean and standard deviation (SD) and categorical variables by count or percentage. We used χ^2 analyses to compare proportion(s) of count variables, and we used *t* tests to compare continuous variables. Ethics approval was obtained from University Health Network Research Ethics Board.

Results

During the period of study, 3324 patients were admitted to the vascular surgery service. The majority of the discharges (2903) neither arose from nor resulted in any 28-day readmission. There were 421 readmissions to any service at our hospital within 28 days of discharge. Of these patients, 47 were found to have more than 1 readmission following the initial stay. A total of 374 charts remained for individual hand screening. Our readmission rate ranged from 11.8% to 14.1% over the 5 years, resulting in an average readmission rate of 12.7% (Fig. 1). Planned 28-day readmissions (surgery cancellations and preoperative workups) comprised a significant fraction (36.9%, n = 138) of the readmissions. Excluding planned early readmissions, the unplanned 28-day readmission rate was 71 cases per 1000.

The mode of admission (elective or emergent) and the admission diagnoses for the index admission and first readmission for patients included in this study can be found in Table 1. Table 2 documents the procedures performed. In addition, we identified 45 patients (12% of readmissions) who had a cancelled operation date requiring a planned readmission at a later date. The reasons for cancellation were lack of a bed in the intensive care unit (n = 10), change in medical status (n = 8) and more urgent case (n = 27). Data from the Planning and Performance Measurement database showed there were similar rates of readmission for men (12.9%) and women (12.3%). Rates of readmission were

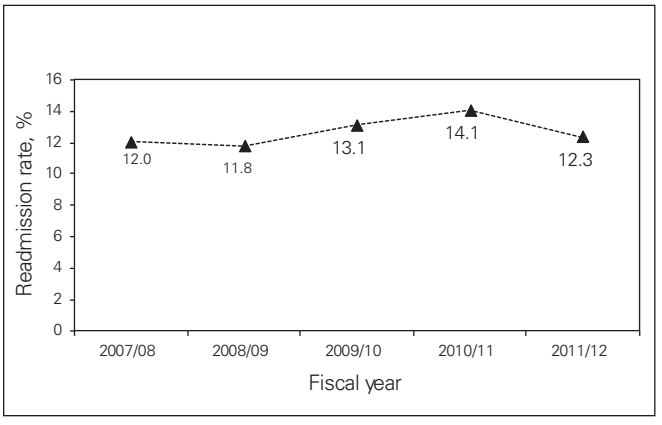

Fig. 1. Readmission rate by year.

similar across age groups: 18–44 years, 12.6%; 45–64 years, 12.8%; and 65 years and older, 12.6%. In our χ^2 analysis, we found no difference in readmission rates on the basis of age ($\chi^2 = 0.02$, degrees of freedom [df] = 2, $p = 0.99$) or sex ($\chi^2 = 0.09$, df = 1, $p = 0.77$).

Table 1. Admission types and admission diagnoses for the index admission and first readmission for the 374 patients included in this study

Characteristic	No. (%) of participants	
	Index admission	First readmission
Admission type		
Emergent	224 (59.9)	236 (63.1)
Elective	150 (40.1)	138 (36.9)
Admission diagnosis		
PAD	183 (48.9)	81 (21.7)
PAD graft complication		47 (12.6)
AAA/TAAA	79 (21.2)	42 (11.3)
Carotid stenosis	34 (9.1)	21 (5.6)
Acute embolus	18 (4.8)	10 (2.7)
Nonaortic aneurysm	15 (4.0)	9 (2.4)
Nonvascular	15 (4.0)	40 (10.7)
Rupture aneurysm	11 (2.9)	3 (0.8)
AV fistula	15 (4.0)	
Aortic dissection	3 (0.8)	
Renal hypertension	1 (0.3)	
Respiratory failure		14 (3.7)
Bleeding		15 (4.0)
Cardiac event		5 (1.3)
CVA/TIA/syncope		11 (2.9)
Infection (nonsurgical)		36 (9.6)
Pain		2 (0.5)

AAA = abdominal aortic aneurysm; AV = arteriovenous; CVA = cerobrovascular accident; PAD = peripheral arterial disease; TAAA = thoracoabdominal aortic aneurysm; TIA = transient ischemic attack.

Table 2. Management of patients on index admission and on first readmission for the 374 patients included in this study

Procedure	No. (%) of patients	
	Index admission	First readmission
Percutaneous intervention (peripheral)	66 (17.7)	18 (4.8)
Leg bypass	34 (9.1)	58 (15.5)
EVAR/TEVAR	30 (8.1)	33 (8.8)
Open AAA/TAA	8 (2.2)	6 (1.6)
Toe/foot amputation	5 (1.3)	13 (3.5)
Below- or above-knee amputation	11 (2.9)	31 (8.3)
Carotid endarterectomy	14 (3.7)	17 (4.5)
Femoral repair	27 (7.2)	19 (5.1)
EVAR + bypass	8 (2.1)	4 (1.1)
Nonvascular procedure	6 (1.6)	23 (6.1)
Multiprocedure surgery	25 (6.7)	13 (3.5)
AV fistula	14 (3.7)	5 (1.3)
None (surgery cancelled, not a surgical candidate, medical management, preoperative workup, palliative)	126 (33.7)	134 (35.9)

AAA = abdominal aortic aneurysm; AV= arteriovenous; EVAR = endovascular aneurysm repair; TAAA= thoracoabdominal aortic aneurysm; TEVAR = thoracic endovascular aneurysm repair.

Readmitted patients were found to have multiple comorbidities: 151 patients (40.4%) had 5 or more comorbidities. Readmitted patients had an average of 3.4 comorbidities (SD 1.817). The list of comorbidities in our patient cohort is displayed in Table 3, with hypertension (72.5%) and peripheral arterial disease (PAD) (63.4%) being the most frequent followed by coronary artery disease (51.9%) and hyperlipidemia (41.7%). A total of 36.6% of readmitted patients had diabetes. Our hand screening of charts revealed that PAD was not consistently documented as a comorbidity and therefore the rates of PAD may actually be higher.

The majority of the patients who were readmitted were admitted emergently on index admission (63.1%, $n = 236$). Of these readmitted cases, the patients who were emergent admits on index admission were significantly more likely to be readmitted on an emergent rather than an elective basis ($\chi^2 = 7.7$, df = 1, $p = 0.004$). Our data showed that patients who were admitted on an emergent basis at the time of initial admission were 68.8% more likely to be admitted emergently on readmission. Of all readmitted patients, 59.9% ($n = 224$) did not experience a complication in the inpatient setting.

PAD was the most responsible pathology for both initial admission and readmission. On initial presentation, 48.9% ($n = 183$) of patients had an admitting diagnosis of PAD defined as limb ischemia or complications related to peripheral bypass graft (infection, occlusion, false aneurysm). For patients who had an emergent unplanned readmission, the most responsible diagnosis again was PAD or graft-related limb complications (30.9%, $n = 73$) (Table 4). The most frequent preventable reason for readmission was surgical site infection.

Among the patients with PAD as the initial cause of admission, there was a higher than expected number of emergent admissions compared with among patients without PAD on initial presentation ($\chi^2 = 15.7$, $p < 0.001$). Those with PAD as their initial cause of admission were found to have a significantly higher than expected emergent

Table 3. Comorbidities of the 374 readmitted patients in this study

Comorbidity	No. (%) of patients
Hypertension	271 (72.5)
Peripheral arterial disease	237 (63.4)
Coronary artery disease	194 (51.9)
Hyperlipidemia	156 (41.7)
Diabetes	137 (36.6)
Chronic kidney disease	101 (26.7)
Cerebral vascular disease	72 (19.5)
Chronic obstructive pulmonary disease	62 (16.6)
Congestive heart failure	52 (13.9)

Table 4. Readmission diagnosis (elective/emergent) for the 374 patients included in this study

Admission type; readmission diagnosis	No. (%) of patients
Elective	
PAD	42 (30.4)
AAA/TAAA	44 (31.9)
Carotid stenosis	22 (15.9)
PAD graft complication	14 (10.2)
Nonaortic aneurysm	8 (5.8)
Nonvascular	5 (3.6)
Wound problem	2 (1.5)
Cardiac event (procedure)	1 (0.7)
Total	138 (100)
Emergent	
PAD	39 (16.5)
Surgical site infection	36 (15.3)
Infection (nonsurgical)	35 (14.8)
Nonvascular	35 (14.8)
PAD graft complication	34 (14.4)
Bleeding	15 (6.4)
Respiratory failure	14 (5.9)
CVA/TIA/syncope	10 (4.2)
Acute embolus	9 (3.8)
Cardiac event	4 (1.7)
Pain	2 (0.9)
AAA/TAAA	2 (0.9)
Nonaortic aneurysm	1 (0.4)
Total	236 (100)

AAA = abdominal aortic aneurysm; CVA = cerobrovascular accident; PAD = peripheral arterial disease; TAAA = thoracoabdominal aortic aneurysm; TIA = transient ischemic attack.

(as opposed to elective) readmission rate (n = 102, 72.9%) compared with those without PAD as their initial cause of readmission (n = 38, 27.1%, χ^2 = 6.7, p = 0.006).

On further review of the PAD group, we examined patient management on initial admission and readmission. The most common management strategies were conservative management at 32.1% (n = 45) and percutaneous intervention (e.g., angioplasty/stent, thrombolysis) at 27.9% (n = 39). On readmission, 35.7% of patients (n = 50) did not have a procedure, but leg bypass was the most commonly performed surgical procedure (21.4%, n = 30) in patients who underwent a surgical procedure. From these data it appears that PAD limb ischemia was treated more often with percutaneous intervention on initial admission and leg bypass on readmission.

We found that one-third of all patients had no procedure during their initial or readmission stay (Table 2). The reasons for not having a procedure on initial admission varied: 37.8% underwent preoperative workup and were readmitted for surgery scheduled for a later date, 35.4% had been scheduled for an operation that was cancelled, 23.6% received medical management such as intravenous antibiotics or anticoagulation and 3.2% received palliative care.

We also examined whether patients had an outpatient visit set up on discharge within the 28 days of readmission. In our cohort, 75.1% (n = 281) did not have a vascular clinic visit confirmed within the 28 days before readmission. Of these 281 cases, 59.1% (n = 166) were unplanned readmissions within 28 days from initial admission. The remaining cases without a clinic visit were planned for readmission and treatment. Of the 18.8% of patients (n = 70) with a clinic visit scheduled, 57.1% (n = 40) had a regular visit, 31.4% (n = 22) were readmitted from clinic and 11.4% (n = 8) had a clinic booked but did not show. A remaining 32.9% (n = 23) presented to the emergency department within the 28 days of readmission and bypassed clinic scheduling or visit.

Discussion

Unplanned readmissions represent a major burden to both patients and the health care system.[1–4] Significant morbidity and costs are associated with 30-day readmissions.[2,5] Although many readmissions may be necessary, others may be avoidable and perhaps predictable.[6] Consequently, preventing readmission is a target of health care reform.

Unplanned hospital readmissions have been a focus of health service researchers and policy and decision-makers since the early 1970s.[5] Growing attention has been given to this issue because of the burden of unplanned readmissions on patients and their family members and on the health care system. Hospital readmissions are considered to be an indicator of suboptimal care and are the focus of efforts by the health authorities to reduce health care costs and improve quality. In Ontario, the Ministry of Health and Long-Term Care introduced quality-based procedures (QBPs) in 2012 as a potential funding model. QBPs define episodes of care for patients with related diagnoses and allocate funding accordingly. Although QBP indicators are not currently tied to funding, these indicator results help to examine the causes of gaps in care.[11] For instance, in vascular surgery, QBP indicators were total length of stay and 30-day all-cause readmission rates for elective repair of lower extremity occlusive disease and elective aortic aneurysm repair.

Jencks and colleagues[2] found that 7 conditions account for more than 30% of preventable readmissions; among them, vascular pathologies are the most costly. The readmission rate for patients who undergo vascular surgery is 23.9% among Medicare beneficiaries, far higher than the overall surgical readmission rate of 15.6%.[2]

The overall early readmission rate of 12.7% in our study is substantially lower than that previously reported from large data sets in the literature[2] but consistent with the data from other single centre studies.[12] Excluding planned early readmissions, the unplanned 28-day readmission rate was 71 cases per 1000 in our study. Planned 28-day readmissions (surgery cancellations and preoperative workups)

comprised a significant fraction (36.9%, n = 138) of readmissions in our cohort. Jencks and colleagues[2] estimated that 10% of readmissions in their study were planned. The current results suggest that this may be an underestimate in patients who undergo vascular surgery in our heath care system, as 36.9% of 28-day readmission events in our study were planned. Distinguishing between planned and unplanned early readmissions would therefore appear to be an important factor in coding to prevent erroneous readmission rates being reported, with potential funding effects.

Of all readmitted patients, 59.9% (n = 224) did not experience a complication in the inpatient setting; however, readmitted patients were found to have on average 3.4 comorbidities (SD 1.817), and 40.4% (n = 151) of patients had 5 or more comorbidities, highlighting the fact that this is a highly morbid cohort.

Patients with the diagnosis of PAD (defined as limb ischemia) and patients with initial emergent admissions had the highest rates of unplanned 28-day readmission. Strategies to reduce surgical readmissions may be most effective if applied prospectively to patients who are at increased risk for readmission. Hospitals do not currently have the means to identify surgical patients who are at high risk for unplanned readmission. Our study identifies PAD as a predictor of readmission, consistent with other studies.[12] Interestingly, from this analysis it appears PAD limb ischemia was treated more often with percutaneous intervention on initial admission and leg bypass on readmission. Endovascular interventions have significantly evolved over the past decades. Since the initial application of plain balloon or percutaneous transluminal angioplasty, several novel endovascular approaches and devices have been released on the market. These devices have usually been studied in relatively small and selected patient populations, often not including patients with critical limb ischemia (CLI).[13] The BASIL trial is still the only randomized controlled trial to have compared a "bypass surgery first" with a "plain balloon angioplasty first" strategy for the management of chronic limb-threatening ischemia. In patients who were likely to survive for 2 years and had a suitable vein, primary bypass was associated with better clinical outcomes. Despite this, in many centres endovascular revascularization is the favoured approach to CLI and PAD, because it is associated with lower morbidity and mortality than open surgery.[14] Between 1996 and 2006 in the United States, endovascular interventions increased more than 3-fold (from 138 to 455 per 100 000; risk ratio [RR] 3.30, 95% confidence interval [CI] 2.9–3.7) while bypass surgery decreased by 42% (from 219 to 126 per 100 000; RR 0.58, 95% CI 0.5–0.7) and the rate of major lower extremity amputation declined significantly (from 263 to 188 per 100 000; RR 0.71, 95% CI 0.6–0.8).[2] However, this change does not come without a cost.

Recently the authors of the BASIL trial published a comparison of clinical outcomes between primary bypass (PB) and secondary bypass (SB) after failed plain balloon angioplasty.[15] At a median of 7 years, primary bypass was associated with better amputation-free survival (PB 60% v. SB 40%; hazard ratio 1.58, p = 0.04), limb salvage (PB 85% v. SB 73%, p = 0.06) and overall survival (PB 68% v. 51%, p = 0.06). Freedom from revascularization was equivalent (PB 53% v. 53%, p = 0.3). Clinical outcomes following PB were significantly better than in patients undergoing SB after failed plain balloon angioplasty.

The initial choice of treatment in patients with CLI and PAD is not easily made, and it depends on patient- and procedure-specific factors, such as age and comorbidity, the severity of limb ischemia, the presence of a useable vein graft and the vascular anatomy, which influence the available options for bypass anastomosis and the potential success of endovascular interventions as well. Well-designed randomized controlled trials investigating novel devices and factors influencing treatment success in CLI would be very useful in determining which patients are eligible for an endovascular-first strategy.

Our data suggest that perhaps our centre favoured endovascular options as a first-line therapy when surgery was more appropriate in certain cases, but it is often chosen because of the frailty of the patients.

The most common unplanned readmission diagnoses were worsening PAD including complications related to peripheral bypass grafting (30.9%), surgical site infections (15.3%) and nonsurgical infections (14.8%), and this finding is comparable to other studies.[12] In addition, the lack of an early clinic follow-up date predicted unplanned 28-day readmission (59.1%). Early physician follow-up has been found to be effective in lowering hospital readmission rates.[16] In our study we found the absence of a confirmed postoperative visit date was associated with an early readmission.

Glebova and colleagues demonstrated a readmission rate of 9.3%, which is comparable to our rate of 12.7%.[17] Among the 86 000 patients in their study, readmissions were mainly driven by postoperative complications identified after discharge. This supports our argument for early reassessment postoperatively to identify modifiable complications. We identified infection as the most modifiable factor for unplanned readmissions. Once again this is in keeping with the published literature; Hicks and colleagues determined that infectious complications dominated the reasons for 30-day readmission in patients who underwent vascular surgery.[18] Both groups of authors used the American College of Surgeons National Surgical Quality Improvement Program database. Our findings were similar to the results of these big cohort papers.

The strengths of the study include the fact that we used a large data set of patients and that each chart was reviewed individually by hand. We gathered local Canadian data, which reflected real-life practice. In addition, our study adds to the sparse data in the vascular literature examining factors affecting readmission and strategies specific to the vascular population.

Preventable hospital readmissions have many causes, including fragmented and poorly coordinated care, unsafe transitions between inpatient and outpatient settings, and medical errors.[17,18] Specific interventions such as comprehensive discharge planning and early physician follow-up have been found to be effective in lowering hospital readmission rates.[16,19–22] Strategies to reduce surgical readmissions may be more effective if they are focused on the patients who face the highest risk of readmission. This requires an evidence-based method to identify surgical patients at elevated risk for readmission, as was performed in this study.

Limitations

One of the limitations of our study is its retrospective design. Documentation in electronic patient records has limitations with respect to some patient variables of interest. Complications and discharge disposition are not consistently documented. Furthermore, with our administrative database we had limited access to patient-related variables such as supports at home or socioeconomic status. Lastly, we were unable to capture data for patients who were readmitted to other hospitals in Ontario.

CONCLUSION

The most frequent pathology resulting in readmission in our study was PAD. The most frequent preventable reason for readmission was surgical site infection. Interventions focused on early assessment of clinical status and wounds in addition to avoidance of infectious complications could help reduce readmission rates. By focusing on subgroups at risk for readmission, preventive resources can be efficiently targeted.

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Competing interests: None declared.

Contributors: A. Papadopoulos, S. Devries and G. Roche-Nagle designed the study. A. Papadopoulos acquired and analyzed the data, which J. Montbriand, N. Eisenberg, C. de Mestral and G. Roche-Nagle also analyzed. A. Papadopoulos, S. Devries, N. Eisenberg and G. Roche-Nagle wrote the article, which all authors reviewed and approved for publication. All authors agreed to be accountable for all aspects of the work.

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