Unplanned hospital readmissions within 30 days of discharge

Andrea Gruneir, PhD[1, 3, 5]

Irfan Dhalla, MD, MSc[2, 4, 5]

Carl van Walraven[3, 6, 7]

Hadas D. Fischer, MD, MSc[3]

Ximena Camacho, MMath[3]

Paula A. Rochon, MD, MPH[1, 3, 4, 5]

Geoffrey M. Anderson, MD, PhD[1, 3, 5]

Affiliations

1. Women's College Research Institute, Women's College Hospital, Toronto, Ontario, Canada

2. Keenan Research Centre, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada

3. Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada

4. Department of Medicine, University of Toronto, Toronto, Ontario, Canada

5. Department of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada

6. Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada

7. Ottawa Health Research Institute, Ottawa, Ontario

Corresponding author (and study guarantor):

Andrea Gruneir

790 Bay St., 7th floor

Toronto, Ontario

M5G 1N8

Phone: (416)351-3732 ext. 2745

Fax: (416)351-3746

E-mail: andrea.gruneir@wchospital.ca (e-mail address can be published)

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Author names and affiliations

Dr. Gruneir (andrea.gruneir@wchospital.ca) is a scientist at the Women's College Research Institute, an adjunct scientist at the Institute for Clinical Evaluative Sciences (ICES) and assistant professor in the Department of Health Policy, Management and Evaluation (HPME) at the University of Toronto. Dr. Dhalla (dhalli@smh.ca) is a scientist at the Keenan Research Centre of the Li Ka Shing Knowledge Institute at St. Michael's Hospital and staff physician in the Departments of Medicine and HPME at the University of Toronto. Dr. Van Walraven (cvanwalraven@ohri.ca) is a senior scientist in Clinical Epidemiology at the Ottawa Hospital Research Institute, adjunct scientist at the ICES, and associate professor in the Department of Medicine at the University of Ottawa. Dr. Fischer (hadas.fischer@ices.on.ca) is an epidemiologist at ICES. Ms. Camacho (ximena.camacho@ices.on.ca) is an analyst at ICES. Dr. Rochon (paula.rochon@wchospital.ca) is a senior scientist at the Women's College Research Institute, Vice President of Research at the Women's College Hospital, professor in the Departments of Medicine and HPME at the University of Toronto, and a scientist at ICES. Dr. Anderson (geoff.anderson@utoronto.ca) is a professor in the Department of HPME at the University of Toronto, scientist at ICES, and adjunct scientist at the Women's College Research Institute.

Contributor statement

Andrea Gruneir contributed substantially to study conception and design, data analysis and interpretation, wrote the first draft of the manuscript and oversaw subsequent revisions. Dr. Gruneir is the study guarantor and takes responsibility for the manuscript from study inception forward. Irfan Dhalla contributed substantially to study conception and design, data analysis and interpretation, and revised the manuscript critically for important intellectual content. Carl van Walraven contributed to data analysis and interpretation and revised the manuscript critically for important intellectual content. Hadas Fischer contributed to study design, data analysis and interpretation, and revised the manuscript critically for important intellectual content. Ximena Camacho conducted the data analysis, contributed to the writing of the methods section, and reviewed drafts of the manuscript. Paula Rochon was responsible for acquisition of funding, general supervision of the research group, study conception, data analysis and interpretation, and revised the manuscript critically for intellectual content. Geoff Anderson was responsible for acquisition of funding, general supervision of the research group, study conception and design, data analysis and interpretation, and revised the manuscript for intellectual content. All authors gave final approval of the version submitted for publication.

Competing Interests

None of the authors have any competing interest or conflicts of interest to declare.

Abstract

Background: Unplanned hospital readmissions are common, expensive, and often preventable. Strategies designed to reduce readmissions should target patients at those at high risk. The purpose of this study was to describe medical patients identified at high-risk using a recently published and validated algorithm (the LACE index) and examine hospital readmission rates.

Methods: We used population-based administrative data to identify adult medical patients discharged alive from six hospitals in Toronto, Canada during 2007. A LACE index score of 10 or higher was used to identify patients at high-risk for readmission. We described patient and hospitalization characteristics among both the high-risk and low-risk groups as well as the 30- and 90-day readmission rates.

Results: Of 26,045 patients, 12.6% were readmitted to hospital within 30 days and 20.9% were readmitted within 90 days of discharge. High-risk patients accounted for 34.0% of the sample and 51.7% of patients who were readmitted within 30 days. High-risk patients were readmitted with twice the frequency as other patients, had longer lengths of stay and were more likely to die during the readmission.

Interpretation: Using a LACE index score of 10, we identified patients with a high rate of readmission who may benefit from improved post-discharge care. Our findings suggest that the LACE index is potentially a useful tool for decision-makers interested in identifying appropriate patients for post-discharge interventions.

Background

Unplanned hospital readmissions have long been considered a marker of poor health system performance [1]. A recent study reported a 30-day hospital readmission rate of 19.6% among Medicare fee-for-service enrollees at an estimated cost of approximately US$17.4 billion [2].

Several observations suggest that readmissions are not inevitable and some may be avoided. Such observations includes significant variability in readmission rates between centres [3], concerns about inadequate follow-up and risk of readmission [4], patient complaints of inadequate preparation for discharge [5], and poor doctor-to-doctor communication at the time of discharge [6]. In recognition of this, reductions in hospital readmissions have been targeted for cost-containment and quality of care initiatives largely because many readmissions are viewed as being preventable [7]. While the extent to which readmissions can be reduced is still unclear, some well-designed interventions have reported reductions in the range of 25-45% [8-10].

Despite the success of a few interventions, the majority have not demonstrated meaningful reductions in the frequency of readmission or other adverse post-discharge outcomes [11]. One explanation is the recruitment of heterogeneous patient populations (e.g., medical, surgical and psychiatric patients) whose needs are too diverse to be met by a single program or intervention. This may be compounded by a mixture of patients at different levels of risk for readmission since the presence of low risk patients may result in an inability to observe the beneficial effects of a given intervention. Future efforts may be better served by efforts to focus on a restricted subset of patients with similar problems (e.g., medical patients) deemed to be at high-risk for readmission.

A recently published index identifies patients at high-risk of unplanned readmission [12]. The "LACE index" uses four relatively simple factors to gauge the risk of 30-day death or unplanned readmission: length of stay in days of index hospitalization ("L"), acuity on admission for index hospitalization ("A"), Charlson co-morbidity score ("C"); and number of emergency department visits in the six months prior to index hospitalization ("E"). The LACE index was derived using clinical data collected on hospital inpatients and validated extensively using both a split-sample method and administrative hospital records. The original intent of the index was to identify patients who may benefit from additional post-discharge care. However, patients deemed to be at high-risk for poor post-discharge outcomes by the index have not been described.

Our objectives were to describe medical patients deemed at high-risk for hospital readmission according to the LACE index, quantify the occurrence of 30-day and 90- day readmissions, and compare these outcomes to patients not identified at high-risk for readmission.

Methods

Setting

We used data from six hospitals that care for acutely ill adults in Toronto, Ontario, Canada. Toronto is the largest urban centre in Canada with a population of nearly 3 million. All Ontario residents are insured for physician services and inpatient hospital care by the Ontario Health Insurance Plan (OHIP), a universal, single-payer system. Four of the six hospital included in our study are academic health science centres.

Data

We used population-based administrative data to identify all patients discharged from the six study hospitals and to identify any post-discharge hospital use including emergency department visits and readmissions. Information on all hospitalizations was obtained using the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD)The CIHI-DAD includes demographic, clinical, and administrative data on all inpatient hospital stays that are abstracted by trained medical reviewers from patient charts.

Using unique encrypted identifiers, we linked CIHI-DAD records to other administrative databases. The Ontario Drug Benefit database and the OHIP claims database were used to identify patients who resided in nursing homes (using unique flags on records). The Registered Persons Database was used to identify deaths during the study period. The National Ambulatory Care Reporting System was used to identify all emergency department visits.

Study Population

We included all adults, aged 18 to 105, who were discharged alive after a medical hospitalization during the 2007 calendar year. For each patient we selected the first hospital discharge during the study period and designated it as the index hospitalization (n=32,165). We defined medical hospitalizations using the 2003 version of the Case Mix Groups (CMG) classification system devised by CIHI. The CMG classification system is comparable to the Diagnostic Related Groups (DRGs) used in the United States but adapted for the Canadian context and the International Classification of Disease, version 10 (ICD-10). We included all CMGs within the medical grouping as well as CMGs within the psychiatric grouping that correspond to diseases which are usually treated on general medical wards (e.g., alcohol withdrawal and delirium).

In order to focus on a medical population, we excluded index admissions to psychiatry (n=77), obstetrics (n ≤5), or gynecology (n=214) services, or if the most responsible diagnosis indicated admission for chemotherapy, radiotherapy or a cancelled surgery (n=3,530). We further excluded index hospitalizations with discharge to rehabilitation or continuing care facilities because these facilities are intended to provide post-acute care services (n=1,966). We also excluded individuals who were not residents of Ontario because their readmissions would likely occur in another jurisdiction (n=309) as well as admissions where there was evidence of data quality problems (n=23).

Risk of Readmission – The LACE Index

Once eligible index hospitalizations were identified (n=26,045), we used the empirically derived and validated LACE index to distinguish between patients at high and low risk of unplanned readmission or death within the 30 days following discharge [12]. The LACE index

consists of four primary components which are: **L**ength of stay for the complete index hospitalization; **A**cuity on admission to the index hospitalization (emergent or urgent status on admission); **C**o-morbidity at time of the index hospitalization as measured on the Charlson score with updated disease category weights;[13] and number of **E**mergency department visits in the six months prior to the index hospitalization (see Table 1). The LACE index has been shown to have moderate discriminate abilities, and can range in value from 0 to 19. Patients with a LACE score of 10 or higher at the time of discharge from their index hospitalization were defined as being high-risk for readmission; patients with a LACE score of less than 10 were defined as being low-risk for readmission. A score of 10 corresponded to an expected probability of 12.2% for 30-day readmission or death in the original validation study.

Analyses

We used descriptive statistics to characterize our sample by age, gender, and location prior to index hospitalization. We followed each eligible patient after discharge from the index hospitalization and counted the frequency of emergency department visits in the following 30 days and non-elective readmissions in each the following 30 and 90 days. We described both the index and readmission hospitalizations according to length of stay, most common discharge diagnoses, and whether any of the stay had been designated as "alternative level of care" (ALC). ALC days refer to inpatient days during which patients are no longer considered to require acute level care but cannot be discharged due to lack of appropriate alternative options. We also looked at proportion of readmissions to the same hospital as the index hospitalization and the proportion to those at other hospitals within the same health region and outside of the health region.

We repeated all analyses on each the high-risk and low-risk for readmission patient groups. The occurrence of short-term adverse outcomes (emergency department visit,

readmission, and death) between the high-risk and low-risk groups was compared using unadjusted relative risks and 95% confidence intervals.

All analyses were completed using SAS 9.1 (SAS Institute Inc., Cary, NC).

This study was approved by the research ethics board of Sunnybrook Health Sciences Centre. The study sponsor did not play a role in any aspect of study conception, design, analysis, or interpretation.

Results

Our study cohort consisted of 26,045 medical patients discharged from one of the six study hospitals. Patients had a median age of 65 (interquartile range 48-79). The majority of patients (94%) resided in the community prior to the index hospitalization. The most commonly reported CMGs included heart failure, pneumonia, and gastrointestinal disorders (Table 2).

Patients at high-risk for readmission, defined by a LACE score greater than or equal to 10, accounted for 34.0% of the cohort. High-risk patients had a median age of 71 (IQR 55-82) and 8% had been in a long-term care facility prior to the index hospitalization. Among low-risk patients, the median age was 61 (IQR45-77) and only 4.1% had been in a long-term care facility prior to the index hospitalization. The high-risk and low-risk patient groups had a similar distribution of CMGs.

30-day and 90-day readmissions

From the full cohort, 3,286 (12.6%) patients visited an ED and 3,270 (12.6%) were readmitted to hospital within the 30 days following discharge. By the 90th day after discharge, 5,439 (20.9%) had been readmitted to hospital (Table 3).

Among high-risk patients, 1,299 (14.7%) made an ED visit and 1,690 (19.1%) were readmitted to hospital in the 30 days after discharge while among low-risk patients, 1,987

(11.6%) made an ED visit and 1,580 (9.2%) were readmitted within the same time. The risk of readmission was twice as high for high-risk as it was for low-risk patients (relative risk (RR) 2.1, 95% confidence interval (CI) 1.9-2.2). Similarly, the risk of readmission within 90 days of discharge was twice as high for high-risk as for low-risk patients (high-risk: 31.7%; low-risk 15.3%; RR 2.1, 95% CI 2.0-2.2).

Hospitalization Characteristics

In Table 4, we present features of each the index hospitalization and readmission among patients who had been readmitted in the 30 days following discharge. Among the full sample of readmitted patients, the median length of the index hospitalization was 5 days (IQR: 2-10 days) and 6 days (IQR: 3-12 days) during the readmission. An ALC designation was twice as common during the readmission as during the index admission. Fourteen percent of patients died during the readmission.

Approximately half (51.7%) of patients readmitted within 30 days were high-risk. Among the high-risk group, both the index hospitalization and readmission were slightly longer (median lengths of stay were 9 days (IQR: 5-15 days) and 7 days (IQR: 3-14 days) respectively) than for the low-risk patients and there was a higher frequency of ALC designations. The frequency of death during readmission was approximately double among the high-risk as compared to the low-risk patients (18% vs. 9.5%). In all patient groups, approximately two-thirds were readmitted to the same hospital as at index; of those readmitted to another hospital, over half were readmitted to a hospital outside of the study health region. There was no variation in readmission rates among study hospitals (not shown).

Although only 51.7% of all readmissions were by patients identified as high-risk, they accounted for the majority of index hospitalizations and readmissions that had been designated

ALC (94.7% and 65.2%, respectively). They also accounted for the majority of deaths during

readmission (67.5%).

Interpretation

We found that hospital readmission rates for medical patients in a large urban area were very high. Within 30 days of discharge, 12.6% of medical patients had been readmitted to hospital and by 90 days of discharge, 20.9% had been readmitted. The most common reasons for readmission were heart failure, gastrointestinal disorders, and pneumonia, which was consistent with other reports. We further found that readmissions were slightly longer than index hospitalizations and that 14% of patients died suggesting that readmissions were both resource intensive and serious. The readmission rates reported here are somewhat lower than those reported among Medicare enrollees [2, 14] but this may, at least in part, be explained by differences in hospital reimbursement policies between the United States and Ontario.

Our data showed that nearly 30% of all readmissions were to a different hospital, and that of these, over half were to a hospital outside of the study region. This discontinuity of hospital admissions for individual patients is striking and leads to questions regarding the extent of duplication and inappropriate resource utilization that result. We also found, but did not report here, that there was no variation between study hospitals in overall readmission rate or readmission location. These findings suggest that high rates of readmission are a system-level issue and are not limited to a small number of "problem" hospitals. Although various models of post-discharge care have proven successful in research studies and at individual institutions, system-level solutions that integrate primary, hospital-based, and post-acute home care services remain elusive.

We found that approximately 34% of all discharged medical patients would be identified at high-risk of readmission using the recently published LACE index with a cut-off of 10.

Among these high-risk patients, 19% were readmitted within 30 days and 32% were readmitted within 90 days, approximately double the risk of readmission seen for all other patients.

The LACE index enabled us to identify a subset of patients who clearly had different needs than other medical inpatients. Patients deemed at high-risk for readmission were older and more likely to come from long-term care. Further, they accounted for nearly all index hospitalizations with ALC designations and for the majority of deaths during readmission. The ALC designation is given to a patient who is not considered to require hospital-level services but has no appropriate discharge destination (i.e. long-term care or rehabilitation bed). Our findings suggest that, at the very least, any patient labeled as ALC should be given high priority for intensive post-discharge follow-up. They may also require frequent assessment during the hospital stay to ensure that that ALC designation is still appropriate.

We also found that despite the ability of the LACE index to identify a group with greater post-discharge complications, we identified only half of all discharged patients who were readmitted within 30 days. This could, in part, be due to the LACE cut-off that we chose; a lower LACE index score would have identified a higher proportion of those who were readmitted as high-risk but the trade-off would have been a much larger high-risk subgroup. This could have important implications for any discharge planning program or post-acute care intervention that uses the LACE index or similar algorithms to identify suitable participants. The LACE's predictive ability is likely also influenced by its variable composition. The LACE was derived from a list of over 40 patient and hospitalization variables with the intention of developing a clinical algorithm for physicians to use at the bedside to identify patients at high-risk for complications. Its authors purposefully did not include macro- or system-level factors that may not be easily accessible to care providers. It may be that the strongest predictive algorithms

require both patient- and system-level factors and that clinical tools, such as the LACE, may require some "tweaking" in different contexts. Future research is required to understand how other patient characteristics and access to post-acute care services, such as home care or on-demand primary care, influence the risk of readmission or other complications both among high-risk patients and others.

Limitations

There are limitations to this study. We only included hospitals within a single, densely-populated urban area. Based on this, we cannot speculate on the risks for readmission among people discharged from hospitals in smaller or more remote communities. Future research is required to document readmissions among more diverse populations and to identify differences by community type. However, by restricting our analysis to a single urban area, we controlled for variations in policy and resources that otherwise could obscure important differences between urban and rural populations. Second, we did not incorporate any other measures of health services use post-discharge, such as home health care or follow-up physician visits. Since our objective was solely to document overall readmissions, we were not specifically interested in describing these as a function of post-discharge care. Future work is required to better understand how different types of post-discharge care are used, whether they are used by those patients identified at highest risk for readmission, and the extent to which they reduce post-discharge complications.

Summary

We found that within 30 days of hospital discharge, nearly 13% of medical patients were readmitted to hospital. Using the LACE index, we identified a high-risk group of medical patients who had twice the occurrence of readmission and more resource intensive hospital stays

than other patients. The high-risk group accounted for over half of all readmissions. These findings suggest that the LACE is a useful tool to aid in the identification of appropriate candidates for post-discharge interventions. However, that only half of all readmitted patients were *a priori* identified as high-risk suggests that additional research may be helpful in optimizing strategies to identify patients for resource intensive post-discharge intervention.

Table 1: LACE Index[1] Components

Length of hospital stay	Number of days between admission to and discharge from acute care hospital for the index hospital stay
Acuity on admission	Need for care on admission to index hospitalization rated as emergent or urgent
Comorbidity	Number of co-existing medical conditions at the time of admission for the index hospitalization as measured by Charlson score with updated disease category weights
Emergency department visits	Number of unique emergency department visits made in the 6 months prior to admission for the index hospitalization

Table 2: Characteristics of patients discharged alive from a medical hospitalization during calendar year 2007.

	Discharged Patients		
	All	High-Risk for Readmission[2]	Low-Risk for Readmission[3]
	N = 26,045	N = 8,854	N = 17,191
Age			
Median	65	71	61
(IQR)	(48-79)	(55-82)	(45-77)
<55	9,010 (34.6%)	2,089 (23.6%)	6,921 (40.3%)
55-64	3,923 (15.1%)	1,304 (14.7%)	2,619 (15.2%)
65-74	4,315 (16.6%)	1,644 (18.6%)	2,671 (15.5%)
75-84	5,463 (21.0%)	2,285 (25.8%)	3,178 (18.5%)
85+	3,334 (12.8%)	1,532 (17.3%)	1,802 (10.5%)
Male, n (%)	13,062 (50%)	4,363 (49%)	8,698 (50.6%)
Location prior to index admission, n (%)			
Home/community	24,468 (94%)	8,061 (91%)	16,407 (95.4%)
Long-term care facility	1,411 (5%)	707 (8%)	704 (4.1%)
Rehabilitation or continuing care facility	166 (1%)	86 (1%)	80 (0.5%)
LACE Index, n (%)			
<10	17,191 (66%)	-	17,191 (100%)
10	4,759 (18%)	4,759 (54%)	-

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[1] van Walraven C, Dhalla IA, Bell C, Etchells E, Stiell IG, Zarnke K, Austin PC, Forster AJ. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *Can Med Assoc J* 182(6): 551-557.

[2] Patients were identified as high-risk for readmission if they had a score of 10 or higher on the LACE index which is based on length of index hospital stay, acuity on admission to index hospital stay, comorbidities, and number of emergency department visits in the six months preceding the index hospital stay.

[3] Patients were identified as low-risk for readmission if they had a score of less than 10 on the LACE index.

	≥11	4,095 (16%)	4,095 (46%)	-
Five Most Common Case-Mix Groups[4]	Esophagitis, Gastroenteritis and Miscellaneous Digestive Disease	Heart failure		Esophagitis, Gastroenteritis and Miscellaneous Digestive Disease
	Simple pneumonia and pleurisy	Simple pneumonia and pleurisy		Arrhythmia
	Heart failure	Esophagitis, Gastroenteritis and Miscellaneous Digestive Disease		Simple pneumonia and pleurisy
	Arrhythmia	Lower urinary tract infection		G.I.[5] Hemorrhage
	G.I.Error: Reference source not found Hemorrhage	Specific cerebrovascular disorders except TIA[6]		Other G.I.Error: Reference source not found Diagnoses

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[4] Case-Mix Groups are based on diagnoses at index hospitalization.

[5] G.I. = gastrointestinal

[6] TIA = transient ischemic attacks

Table 3: Complications following hospital discharge.

	Discharged Patients			Relative Risk of Readmission (High- vs. Low-Risk) (95% CI[7])
	All N = 26,045	High-Risk for ReadmissionError: Reference source not found N = 8,854	Low-Risk for ReadmissionError: Reference source not found N = 17,191	
Events within 30 Days of Discharge				
Emergency department visit	3,286 (12.6%)	1,299 (14.7%)	1,987 (11.6%)	1.27 (1.19, 1.35)
Hospital readmission	3,270 (12.6%)	1,690 (19.1%)	1,580 (9.2%)	2.08 (1.95, 2.21)
Death without hospital use[8]	340 (1.3%)	215 (2.4%)	125 (0.7%)	3.34 (2.68, 4.16)
Events within 90 Days of Discharge				
Hospital readmission	5,439 (20.9%)	2,810 (31.7%)	2,629 (15.3%)	2.08 (1.98, 2.17)
Death without hospital useError: Reference source not found	603 (2.3%)	371 (4.2%)	232 (1.3%)	3.1 (2.64, 3.65)

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[7] CI = confidence interval
[8] Without either visit to the emergency department or inpatient admission.

Table 4: Characteristics of index and readmission hospitalization among patients readmitted to hospital within 30 days of discharge of a medical hospitalization.

	Discharged Patients		
	All N = 3,270	High-Risk for ReadmissionError: Reference source not found N = 1,690	Low-Risk for ReadmissionError: Reference source not found N = 1,580
Features of the Index Hospitalization			
Length of stay in days, median (IQR)	5 (2-10)	9 (5-15)	3 (1-5)
Number of emergency department visits in prior 6 months, median (IQR)	2 (1-3)	2 (1-3)	1 (1-2)
Any part of hospital stay designated as "alternative level of care", n (%)	172 (5%)	163 (10%)	9 (0.6%)
Five Most Common Case-Mix GroupsError: Reference source not found	Heart failure	Heart failure	Esophagitis, gastroenteritis, and miscellaneous digestive disease
	Esophagitis, gastroenteritis, and miscellaneous digestive disease	Esophagitis, gastroenteritis, and miscellaneous digestive disease	Heart failure
	Simple pneumonia and pleurisy	Simple pneumonia and pleurisy	Simple pneumonia and pleurisy
	Other G.I.Error: Reference source not found diagnoses	Renal failure without dialysis	Arrhythmia
	Arrhythmia	Pancreatic cancer or other malignancy of the hepatobiliary system	G.I.Error: Reference source not found Obstruction
Features of the Readmission			
Length of stay in days, median (IQR)	6 (3-12)	7 (3-14)	5 (3-10)
Any part of hospital stay designated as "alternative level of care", n (%)	345 (11%)	225 (13%)	120 (7.6%)
Death during readmission	461 (14%)	311 (18%)	150 (9.5%)

Five Most Common Case-Mix Groups,	Heart failure	Heart failure	Heart failure
	Esophagitis, gastroenteritis, and miscellaneous digestive disease	Esophagitis, gastroenteritis, and miscellaneous digestive disease	Esophagitis, gastroenteritis, and miscellaneous digestive disease
	Simple pneumonia and pleurisy	Simple pneumonia and pleurisy	Specific cerebrovascular disorders except TIA
	Specific cerebrovascular disorders except TIA	Respiratory infections and inflammations	Simple pneumonia and pleurisy
	Nutritional and miscellaneous metabolic disorders	Other specified aftercare	G.I.Error: Reference source not found Obstruction
Location of readmission, n (%)			
Same hospital as index	2,399 (73%)	1,232 (73%)	1,167 (73.9%)
Different hospital but same health region	351 (11%)	169 (10%)	182 (11.5%)
Outside of health region	521 (16%)	290 (17%)	231 (14.6%)

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