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Incidence, timing and variation in unplanned readmissions within 30-days following isolated coronary artery bypass grafting

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ABSTRACT

Background: Coronary Artery Bypass Grafting (CABG) is the most common cardiac surgery, yet little is known about unplanned readmissions after CABG despite increasing clinical and policy focus on reducing readmissions. We assessed the incidence, timing, and reasons for unplanned readmission within 30 days of CABG and evaluated for variation in readmission rates across hospitals in Australia and New Zealand (ANZ).
Method: We identified isolated CABG procedures from 2013 to 2017 across all public and most private hospitals in ANZ. The primary outcome was unplanned (acute) readmissions within 30-days of discharge. Hospital specific risk standardised readmission rates (RSRRs) and 95% CI were estimated using a hierarchical generalized linear model accounting for differences in patient characteristics.
Results: 52,104 patients (mean age 66.1 ± 9.9 years, 17.6 % female, 30.7 % acute) were included. The 30-day unplanned readmission rate was 12.7 % (n = 6,613) and was higher following urgent surgery (16.2 %, n = 2,595). Readmission rates peaked on days 2–4 with a median time to readmission of 9 (IQR: 4–17) days. Procedural complications and chest pain were the most common diagnoses on readmission. Risk adjustment model demonstrated satisfactory performance (C-statistic = 0.62). The median RSRR was 12.8 % (range: 6.1–20.3 %) across 37 hospitals. Only one hospital had its RSRR estimate lower than average and no hospitals had higher than average RSRR.
Conclusion: One-in-8 patients undergoing CABG experienced an unplanned readmission within 30-day, rising to one-in-6 following urgent CABG. There was little statistically significant institutional variation in RSRR. Nevertheless, many readmissions are likely related to care quality and potentially preventable, highlighting scope for clinical and policy interventions to reduce readmissions.

1. Introduction

Isolated Coronary artery bypass grafting (CABG) is the most routinely performed and extensively studied cardiac surgery [1]. This is largely attributed to high prevalence of coronary artery disease in developed countries and the substantial morbidity and mortality of the disease [2]. Thirty-day post-operative mortality has historically been the primary measure of CABG care quality [1] and mortality is known to vary among hospitals even after risk adjustment implying potential difference in care quality [6]. Nevertheless, improvements in surgical and after-care practices means that the average 30-day mortality post-CABG is now less than 2 % [3–5]. In an effort to develop quality measures that are more widely applicable to patients, increasing focus has centered on 30-day unplanned hospital readmissions following CABG [2].

Unplanned readmissions are a useful quality measure because these are a key marker of patient morbidity, quality of hospital care, and effectiveness of care transition from hospital to the community. Despite the interest in unplanned readmissions, only a few contemporary studies have published readmission data with rate of 9.4–9.8 % reported [3–5]. Nevertheless, the available literature suggests the majority of readmissions are procedure related, and are commonly attributed to potentially preventable reasons such as wound site infections or sepsis, congestive heart failure, arrhythmias, pleural effusion, and angina [7,8]. Moreover, readmitted CABG patients are four times more likely to die within 30 days than those who are not [9]. Even fewer have studied

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variation in readmission rates among hospitals in contemporary practice with existing studies limited to the United States (US) healthcare setting, typically reporting data from a single region [7,9–11] or the US Medicare beneficiaries, [12] a sicker group of older adults > 65 years eligible for federal health insurance.

In this study, using national data from all public and most private hospitals in Australia and New Zealand (ANZ), we examined rates, timing and causes of 30-day unplanned readmissions following CABG. We also assessed variation in readmission rates among hospitals after adjusting for differences in patient characteristics to determine if there were meaningful differences in readmission rates among hospitals that may suggest variation in care quality.

2. Methods

2.1. Data Source

Hospitalization data were sourced from each Australian state and territory's Admitted Patient Collection and the equivalent New Zealand National Minimum Dataset (Hospital Events). The data contain a standardized set of variables routinely collected by all public and most (80 %) private hospitals which include, patient demographic characteristics, hospitalization status (elective or acute), admission and discharge dates, primary and secondary diagnoses, all procedures, and patient status at discharge. Data were not available from private hospitals in the Australian states of South Australia, Tasmania, and Northern Territory (collectively < 10 % of the Australian population) and from New Zealand. In both countries, diagnoses and procedures are coded as per the International Classification of Diseases, 10th Revision, Australian Modification (ICD10-AM) and the Australian Classification of Health Interventions (ACHI), respectively. Validation studies have reported the coding accuracy of this data to be > 85 % for cardiovascular diagnoses or procedures, and 100 % for CABG [17].

Each hospitalization was linked to subsequent hospitalizations within each region to track readmission to any hospital within 30-days and to each region's Registry of Deaths to track out-of-hospital deaths. Australian records were linked by specialized data linkage units within each region using probabilistic matching with multiple patient identifiers, with a reported accuracy > 99 % [18]. In New Zealand, hospitalizations are linked nationally using a unique National Health Index Number, with all deaths recorded in the National Health Index sociodemographic profile [19].

2.2. Study cohort

We included adults ≥ 18 years who underwent an elective or urgent CABG procedure from 2013 to 2017, inclusively. We excluded patients who: (1) underwent concomitant valve procedures; (2) discharged against medical advice, as readmissions in this context may not reflect quality of care; (3) died during the index hospitalization; (4) were transferred out to another hospital; (4) had CABG at hospitals with < 25 CABGs recorded during the entire study period; (5) lacked the 30-day follow-up data to adequately assess readmission; or (6) had a prior CABG within 30 days. For patients having multiple CABG procedures during the study period, if the admissions were more than 30 days apart, they were included as separate index cases. ACHI codes used to define CABGs are outlined in Supplemental Material Table S1.

2.3. Study outcomes

The primary outcome was all-cause unplanned (acute) 30-day readmissions following discharge from the hospitalization for CABG surgery. For patients who had multiple unplanned readmissions within 30-days of index hospitalization, only the first unplanned readmission was counted. Secondary outcomes included all-cause (planned or unplanned) 30-day readmission rates; rate of planned (elective) readmissions; and out-of-hospital deaths.

2.4. Statistical analysis

Continuous variables are reported as means ± SD or median (IQR), and categorical variables as frequencies and percentages. Chi-squared test, *t*-test and the Wilcoxon rank-sum test were used to compare patient characteristics as appropriate. Timing of readmissions were estimated by assessing the daily incidence of readmissions over the 30-days following discharge. The primary diagnosis associated with the readmission was used to determine the reasons for readmission and ranked in the order of frequency to determine the most frequent causes.

We estimated hospital-specific risk-standardized readmission rates using an approach published previously [6]. Briefly, we first developed a risk-adjustment model. Independent predictors of unplanned readmissions were identified using multivariable logistical regression model. Candidate variables considered for the model were those that could be reliably extracted from the datasets and reported in the literature as having an established or plausible relationship with 30-day readmission [13–16]. Candidate variables included age, sex, elective index procedure, PCI during admission and patient comorbidities. Comorbidities were defined using the Condition Categories classification, which groups ICD10-AM diagnoses from selected secondary diagnoses of the index admission and all primary and secondary diagnoses from hospitalizations in the preceding 12 months into 180 clinically meaningful conditions [17]. Variables in the final multivariable model were selected using backwards stepwise regression with only those with $p < 0.05$ retained. Variables that may have impacted care quality, including length of stay, public vs private status of the hospital, location (state/territory), socio-economic status, and race, were intentionally omitted. Risk-adjustment model performance was assessed using model discrimination and calibration statistics.

A hierarchical generalized linear model was then used to estimate a random point intercept equation reflecting the hospital-specific contribution to the risk of unplanned readmission based on its observed readmission rate, the performance of other hospitals with similar case-mix, and the hospital's sample size [6]. The risk-standardized readmission rate (RSRR) is the ratio of predicted readmission rate divided by the expected readmission rate multiplied by the cohort average readmission rate. The predicted readmission rate was derived from each hospital's case mix and estimated hospital-specific intercept term, while the expected readmission rate was calculated using each hospital's case mix and the cohort average intercept. We used bootstrapping with 1000 replications to empirically construct the 95 % confidence limits for each hospital's RSRR estimates using the percentile method. Hospitals were deemed significantly different from the average if the hospital's RSRR and associated 95 % confidence interval estimate was above or below the cohort average readmission rate.

All hospital-level estimates were limited to facilities that treated at least 25 patients to enable a robust estimate of the outcome rate. While data from private hospitals were provided for these analyses in most states in Australia, individual facility identifiers were not released in Queensland, Victoria and New South Wales and thus estimation of hospital-level RSRRs were limited to subset of cohort where patients could be localized to a unique facility. However, private hospital data were included in developing the risk adjustment models to avoid bias and to ensure the cohort average values included all patients undergoing CABG in the population.

Detailed description of the RSRR calculation and bootstrapping algorithm are provided in the Supplemental Material. All analyses were performed using SAS ver 9.2 (Carey, NC).

2.5. Ethical approval

The Human Research Ethics Committee of each Australian state and territory provided ethical approval to undertake the study as outlined in the Supplemental Material. Deidentified data from New Zealand were obtained under a data use agreement with the New Zealand Ministry of Health. A waiver of informed consent was granted for use of de-identified patient data.

3. Results

We identified 52,104 hospitalizations for CABG surgery that met our inclusion and exclusion criteria (Fig. 1). The most common reasons for exclusion were concomitant valve surgery (n = 12,269), lacking 30-day follow-up (n = 1,408) and death in-hospital (n = 1,163).

3.1. Cohort characteristics

The mean age of patients was 66.1 ± 9.9 years, and 17.61 % were female (Table 1). Most (69.3 %) procedures were elective, and the median length of initial hospitalization was 10 (IQR:7–14) days. The most common cardiac comorbidities were ischemic heart disease (88.4 %), hypertension (60.5 %), and acute coronary syndrome (37.1 %). The most common non-cardiac comorbidities were diabetes (36.9 %), anemia (23.2 %), and cancers and tumors (6.66 %). 2,558 (4.91 %) patients had a PCI in the preceding 12 months and 721 (1.38 %) had a PCI during the index admission.

Patients with unplanned readmissions were of comparable age (66.6 ± 10.4y vs. 66.0 ± 9.9y, $p < 0.001$) but were more likely to be female (22.1 % vs. 17.0 %, $p < 0.001$). Readmitted patients were also more likely to have acute coronary syndrome and congestive heart failure and were more likely to suffer from non-cardiac comorbidities such as diabetes, anemia, and dialysis or renal failure (all $p < 0.001$).

3.2. Incidence and timing of 30-Day unplanned readmissions

Of the cohort, 7,891 (15.1 %) had at least one readmission within 30 days of discharge, among which 6,613 (12.7 %) were unplanned (Table 2). The risk of unplanned readmission was higher after urgent procedures than for elective CABG (16.2 % vs 11.1 %). The median time to readmission was 9 (IQR 4–17) days after discharge with the peak daily risk of unplanned readmissions occurring on days 2–4 post discharge (Fig. 2).

3.3. Diagnoses associated with unplanned readmissions

Table 3 outlines the top 20 most common diagnoses associated with the 30-day unplanned readmissions. These diagnoses constitute 69.5 % of all unplanned readmissions. The most common diagnoses were complications of procedure (15.4 %), pain in throat and chest (8.8 %), heart failure (5.8 %), atrial fibrillation and flutter (5.6 %), and pleural effusion (5.6 %).

3.4. Risk adjustment model

Age, female sex, and 18 patient level variables were independently associated with risk of readmission (Table S2). Chronic lung disease, psychiatric disorders, seizures, and chronic ulcers were most strongly associated with readmissions. Elective surgery status and prior cardiac catheterization were inversely related to risk of readmission. Model performance demonstrated satisfactory discrimination (c-statistic = 0.62) and predicted patient risk of 8.10 % to 32.35 % across deciles, which closely approximated to the observed readmission rate (Hosmer and Lemeshow Goodness-of-Fit test p-value > 0.05) (Supplemental Figure S1).

3.5. Variation in Risk-Standardized readmission rates (RSRR) among hospitals

For 36,324 (70 %) of the cohort, patient's CABG procedure could be localized to a unique hospital. The median 30-day RSRR was 12.8 % (range: 6.1 % to 20.3 %) across 37 hospitals, equating to a 3.3-fold institutional variation (Fig. 3). One hospital had its entire 95 % confidence interval (CI) below the average indicating lower than average unplanned readmission rates. No hospitals had their 95 % confidence interval above the average, suggesting statistically higher than average readmission rates. When the 30-day RSRR estimates were plotted against each institute's total CABG cases, no correlation was identified between a hospital's case volume and RSRR ($R^2 = 0.0058$) (Fig. 4).

4. Discussion

In this population-wide study of isolated CABG surgery in ANZ, we

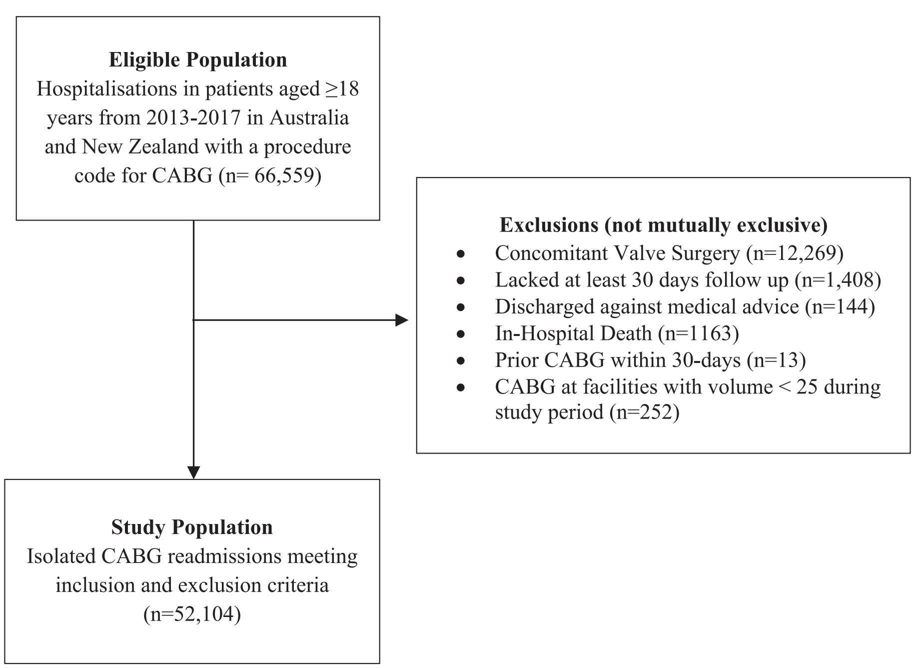

Fig. 1. Flowchart of Patient Selection Abbreviation: CABG = Coronary Artery Bypass Grafting.

Table 1
Baseline Patient Characteristics.

Baseline characteristics	**Overall**		**Unplanned Readmissions**		**No Readmission**		**p value**
	n = 52,104		**n = 6,613**		**n = 45,491**		
	n	**%**	**n**	**%**	**n**	**%**	
Age (mean ± SD), y	66.1 ± 9.9		66.6 ± 10.4		66.0 ± 9.9		<0.001
18–54	7,202	13.8	919	13.9	6,283	13.8	<0.001
55–64	14,474	27.8	1,679	25.4	12,795	28.1	
65–74	19,790	38.0	2,461	37.2	17,329	38.1	
75–84	9,943	19.1	1,441	21.8	8,502	18.7	
85+	695	1.33	113	1.71	582	1.28	
Female	9,177	17.6	1,461	22.1	7,716	17.0	<0.001
Presenting Region							
−NSW/ACT	15,816	30.4	1,976	29.9	13,840	30.4	<0.001
−VIC	12,865	24.7	1,418	21.4	11,447	25.2	
−QLD	9,460	18.2	1,415	21.4	8,045	17.7	
−SA/NT	2,289	4.39	298	4.51	1,991	4.38	
−TAS	811	1.56	77	1.16	734	1.61	
−WA	4,126	7.92	405	6.12	3,721	8.18	
−NZ	6,737	12.9	1,024	15.5	5,713	12.6	
Presentation Characteristics							
Presentation to PVT Hospitals	17,808	34.2	1,466	22.2	16,342	35.9	<0.001
Median LOS (IQR)	10 (7-14)		11 (8-16)		10 (7-14)		<0.001
Elective	36,124	69.3	4,018	60.8	32,106	70.6	<0.001
PCI During Admission	721	1.38	98	1.48	623	1.37	0.465
Cardiovascular Comorbidities							
Acute Coronary Syndrome	19,303	37.05	2,912	44.03	16,391	36.03	<0.001
Ischemic Heart Disease	46,044	88.37	5,895	89.14	40,149	88.26	0.036
Hypertension	31,542	60.54	4,207	63.62	27,335	60.09	<0.001
Congestive Heart Failure	5,986	11.49	1,130	17.09	4,856	10.67	<0.001
Heart Infection/Inflammation excluding Rheumatic Heart Disease	54	0.10	9	0.14	45	0.10	0.38
Valvular and Rheumatic Heart Disease	2,998	5.75	455	6.88	2,543	5.59	<0.001
Arrythmia or Conduction System Disorder	4,999	9.59	874	13.22	4,125	9.07	<0.001
Stroke and Cerebrovascular Diseases	1,027	1.97	192	2.90	835	1.84	<0.001
Vascular Disease	1,848	3.55	329	4.98	1,519	3.34	<0.001
PCI in the preceding year	2,558	4.91	358	5.41	2,200	4.84	0.042
CABG in preceding year	14	0.03	4	0.06	10	0.02	0.074
Other Comorbidities							
Diabetes	19,225	36.9	2,865	43.32	16,360	35.96	<0.001
Major and Metastatic Cancer	559	1.07	100	1.51	459	1.01	<0.001
Other Cancers & Tumours	2,911	5.59	389	5.88	2,522	5.54	0.263
COPD	2,087	4.01	448	6.77	1,639	3.6	<0.001
Lung Fibrosis and Other Chronic Lung Disorders	418	0.80	86	1.30	332	0.73	<0.001
Pneumonia	3,045	5.84	550	8.32	2,495	5.48	<0.001
Dialysis or Renal Failure	3,547	6.81	744	11.25	2,803	6.16	<0.001
Anaemias and Blood Disease	12,088	23.2	1,918	29	10,170	22.36	<0.001
Chronic Liver Disease & Cirrhosis	1,514	2.91	267	4.04	1,247	2.74	<0.001
Dementia	198	0.38	36	0.54	162	0.36	0.02
Psychiatric Disorders	2,471	4.74	478	7.23	1,993	4.38	<0.001
Hemiplegia, Paraplegia, Paralysis and Functional Disability	782	1.5	157	2.37	625	1.37	<0.001
Protein Caloric Malnutrition	2,136	4.1	402	6.08	1,734	3.81	<0.001
Disorder of fluid and electrolytes	2,977	5.71	643	9.72	2,334	5.13	<0.001
Seizure and convulsion	253	0.49	56	0.85	197	0.43	<0.001

Footnote: NSW = New South Wales. ACT = Australian Capital Territory. VIC = Victoria. QLD = Queensland. SA = South Australia. NT = Northern Territory. TAS = Tasmania. WA = Western Australia. NZ = New Zealand. LOS = Length of Stay. PCI = Percutaneous Coronary Intervention. CABG = Coronary Artery Bypass Grafting. COPD = Chronic Obstructive Pulmonary Disease. SD = Standard deviation. LOS = Length of stay. IQR = Interquartile range.

found that one in 8 patients discharged alive experienced at least one unplanned readmission within 30-days, with the incidence rising to 1 in 6 for patient undergoing urgent (acute) CABG. Many unplanned readmissions occurred for potentially preventable reasons such as procedural complications, hospital-acquired complications, and cardiovascular sequalae with the majority occurring within the first 10 days post-discharge. We also observed a 3.3-fold difference in median risk-adjusted readmission rates (range:6.1–20.3 %) among hospitals, although none of the hospitals had a higher RSRR compared with the cohort average. These findings suggest significant scope for concerted clinical and policy-based interventions to reduce unplanned readmissions and support the broader use of unplanned 30-day readmissions as a key performance measure of CABG surgery alongside early mortality [6].

We extend the literature by capturing outcomes from most public and private CABG-performing centers. Our observed *unplanned* readmission incidence rate was considerably higher than the 10.0 % all-cause (*planned and unplanned*) readmission rates observed by the Australia and New Zealand Society of Cardiothoracic Surgeons (ANZSCTS) registry in 2016–19 and the 9.4–9.8 % *all-cause* readmission rates reported outside ANZ [3–5]. Around a third of the patients following CABG are readmitted to a different hospital than the one that

Table 2
Study Outcomes.

Outcome	All Cohort		Urgent CABG		Elective CABG	
	n 52,104	%	n 15,980	%	n 36,124	%
30-day all-cause Readmission	7,891	15.1	2,912	18.2	4,979	13.8
Unplanned Readmission (primary outcome)	**6,613**	**12.7**	**2,595**	**16.2**	**4,018**	**11.1**
Elective/Planned Readmission	1,278	2.45	317	1.98	961	2.66
Out-of-hospital death within 30 days of discharge	110	0.21	54	0.34	56	0.16

performed the surgery and are more likely to experience a longer length of stay, major complications, and in-hospital mortality [20,21]. Administrative dataset, such as one used in this study, can capture readmissions to any hospital which are unaccounted by medical records-based data, permitting a holistic evaluation of all relevant readmissions. Readmissions under a different care team (i.e. Cardiology or General Medicine) may also remain uncaptured by registry datasets. Moreover, readmissions peaked 2–4 days following discharge and the most common diagnoses observed (Table 3) were either procedure-related complications or common sequalae of cardiovascular disease and CABG. This suggests many readmissions are likely related to procedural or postoperative care quality, therefore potentially preventable. Ongoing evaluation with administrative datasets in addition to participation in clinical registries may be useful in monitoring and minimizing unplanned readmissions.

We also extend the literature by reporting variation in risk-adjusted unplanned readmission rates among hospitals. National level institution-specific crude and RSRRs are only reported from the US and Canada, consistently describing statistically significant institutional variation [3,4]. Readmission data from other regions are scarce, therefore institutional variation in RSRRs in other developed countries remain unknown. The ANZSCTS Registry confidentially reports all-cause 30-day readmission rates from volunteering hospitals without standardization for patient characteristics. [5] Moreover, it includes elective readmissions which are typically not associated with care quality. Previous ANZ research highlights considerable institution-specific disparities in 30-day risk-standardized mortality rates following CABG [6]. Despite a high average readmission rate, we found little variation in RSRRs among hospitals. Nevertheless, unplanned readmissions are almost 14-times more common than early mortality (1.1 %) following isolated CABG, [5] hence more relevant to a broader cohort of patients. Our findings support the use of 30-day readmission rates alongside early mortality a key metric of surgical care quality. High surgical volume is known to be associated with lower readmission rates [22] and an inverse relationship between CABG case volume and readmission rates has been postulated [15]. The 37 centers performed between 30 and 2364 cases over the five-year period, yet we did not identify a significant relationship between institutional CABG volume and RSRRs. CABG caseload is likely not a key factor contributing to institutional variation in readmissions in the ANZ context and low-volume centers likely maintain reasonable quality control in their care pathways.

Table 3
Top 20 Principal Diagnoses associated with 30-day Unplanned Readmissions.

Principal Diagnosis for Readmission	n	% of Total Unplanned Readmissions
Complications of procedures, not elsewhere classified	1,015	15.4
Pain in throat and chest	581	8.79
Heart failure	381	5.76
Atrial fibrillation and flutter	369	5.58
Pleural effusion, not elsewhere classified	368	5.57
Complications of cardiac and vascular prosthetic devices, implants and grafts	244	3.69
Postprocedural respiratory disorders, not elsewhere classified	235	3.55
Pneumonia, organism unspecified	224	3.39
Postprocedural disorders of circulatory system, not elsewhere classified	142	2.15
Pulmonary embolism	118	1.78
Syncope and collapse	114	1.72
Other surgical follow-up care	113	1.71
Acute myocardial infarction	106	1.60
Abnormalities of breathing	98	1.48
Hypotension	93	1.41
Other diseases of pericardium	89	1.35
Other disorders of fluid, electrolyte, and acid-base balance	82	1.24
Unspecified acute lower respiratory infection	76	1.15
Angina pectoris	73	1.10
Cellulitis	70	1.06

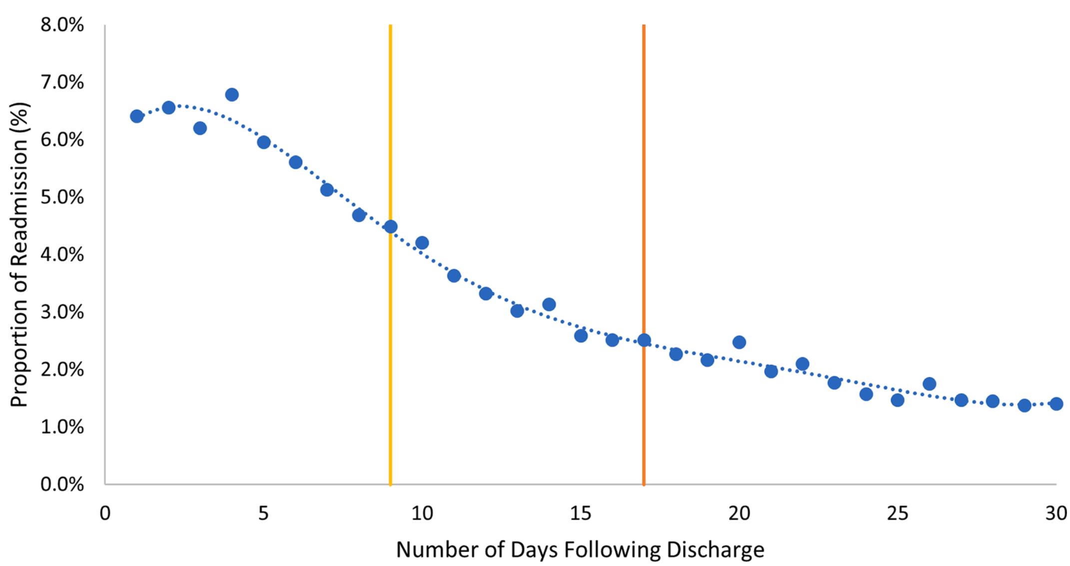

Fig. 2. Timing of Unplanned Readmissions The daily incidence of 30-day readmissions depicted against number of days from discharge to readmission. 50% and 75% of cumulative readmissions were reached on day 9 (yellow vertical line) and day 17 (orange vertical line), respectively.

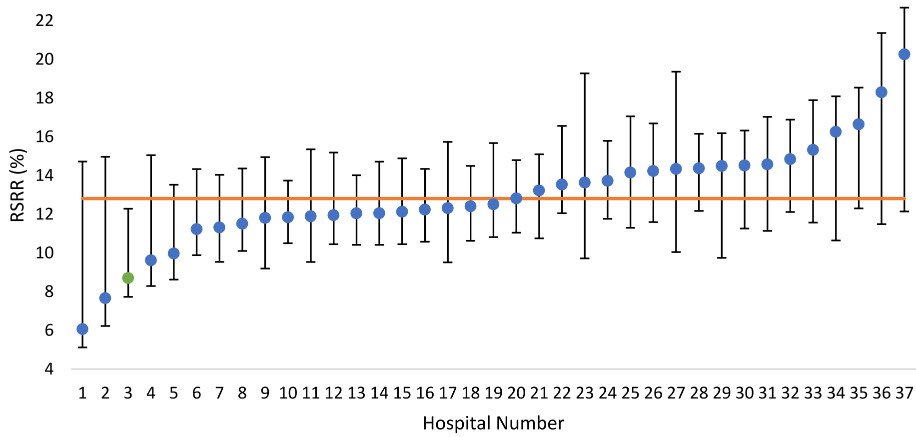

Fig. 3. Institutional Variation in 30-day RSRR The orange horizontal line shows the observed average mortality rate. Hospitals are ordered and labelled from left to right, in ascending order of RSRR point estimates (dot) and their 95 % CI (whiskers). The hospital with an entire 95 % CI below the national average (indicating better than average outcomes) is marked in green. Abbreviation: CI = confidence interval, RSRR = Risk standardized readmission rate.

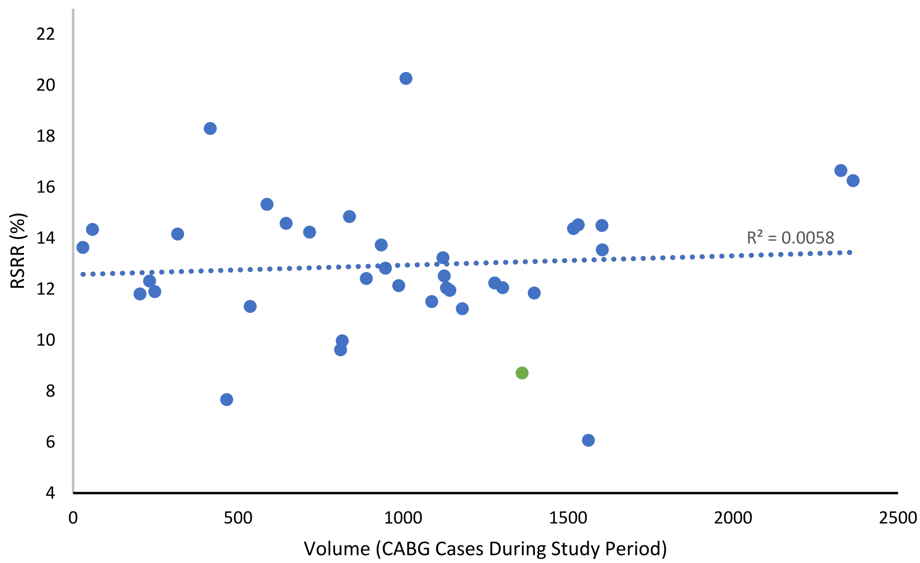

Fig. 4. Hospital Case Volume vs RSRR Relationship 30-day RSRR point estimates are plotted against the number of recorded CABG cases during the study period (hospital volume). The low outlier hospital identified in Fig. 3 is again depicted in green. The dotted line is a linear regression trendline with a R^2 = 0.0058. Abbreviation: RSRR = Risk standardized readmission rate, CABG = Coronary Artery Bypass Grafting.

Several interventions demonstrably reduce unplanned rehospitalizations. Effective postoperative drainage, proactive thoracocentesis, and early re-exploration for excessive bleeding may prevent postoperative intrathoracic effusions [23]. Conversely, anticoagulation for post-operative atrial fibrillation is associated with higher readmissions from bleeding without substantial stroke prevention [4]. Optimization of heart failure therapy is also associated with reduced readmissions [24]. Stringent perioperative glycemic control in diabetic patients have demonstrated substantial reduction in sternal and leg wound infections with improved readmission rates [25]. Appropriate discharge education, patient-specific discharge instructions, caregiver support, individualized rehabilitation programs, and early post-discharge clinic or telephone follow-up (collectively often referred to as transitional care interventions) have all demonstrated improved readmission rates [26]. Specifically, introduction of discharge nurse and transitional care pharmacist reduced readmissions by 30 % [27]. Telemonitoring vital signs of high-risk patients have also demonstrated a 23 % reduction in unplanned readmissions [28]. Implementation of pre- and post-operative checklists reduce readmissions following non-cardiac surgery, [29] and may also prevent readmissions following CABG. High-risk patients may be identified using predictive models [30] and discharge practices can be individualized for such patients. From a policy perspective, public reporting, and financial penalties for hospitals with higher-than-expected RSRRs, have been utilized to incentivize hospitals to reduce readmissions [31]. Although effective at reducing readmissions, [32] such policies has faced significant scrutiny and concerns about unintended harm [33] and needs careful consideration before implementation.

Our study has limitations. We used administrative data, which are less granular than data collected for research or used in clinical registries. Nevertheless, coded data in ANZ have a reasonable (>85 %) coding accuracy overall with reported 100 % accuracy for identifying CABG procedures [17]. We could not include data from all private hospitals although data from most private hospitals were included in estimating the average readmission rate and thus any resulting bias is likely to be modest. We could not estimate hospital-specific rates for most private hospitals as a hospital specific identifier is not released to researchers and approximately 10 hospitals from specific regions were excluded from the institutional analysis. However, all hospitals were standardized to a cohort average that included both public and private hospital data. Perioperative factors such as left ventricular dysfunction, prescribed medications, and surgeon experience may influence unplanned readmissions, which are not captured in the administrative data. These unmeasured confounders may impact the risk standardization model. However, our risk standardization model performed comparably to regression models in the literature [7,10–12].

5. Conclusion

One-in-8 patients undergoing isolated CABG surgery have at least one unplanned readmission within 30-days of discharge, with the incidence rising to one-in-6 for urgent CABG. These readmissions were often for procedure-related or hospital acquired complications and cardiovascular sequalae that may be potentially preventable. Nevertheless, we found little variation in readmission rates suggesting institutional heterogeneity in readmission rates is less of a concern among Australian and New Zealand centers performing CABG. Implementing evidence based clinical and policy-based interventions may provide significant opportunities to reduce avoidable hospitalizations and improve patient outcomes.

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Disclosures.

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CRediT authorship contribution statement

Aayush Patel: Writing – review & editing, Writing – original draft. **Sunnya Khawaja:** Formal analysis, Data curation. **Trang Dang:** Writing – review & editing, Methodology. **Isuru Ranasinghe:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [Isuru Ranasinghe reports financial support was provided by National Heart Foundation of Australia. Isuru Ranasinghe reports a relationship with National Heart Foundation of Australia that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper].

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2024.101552.

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