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Original Article

Causes of and risk factors for unplanned readmission in a large cohort of patients undergoing major surgery: a retrospective cohort study

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Summary

Introduction Unplanned hospital readmissions after surgery are substantial drivers of expenditure and bed occupancy within the healthcare system. As a result, any targeted interventions that reduce readmission in this population can have a significant impact on patient well-being and the health budget.

Methods We performed a large retrospective cohort study analysing data from patients from our institution who underwent major surgery between 1 May 2011 and 1 February 2022. We aimed primarily to study the epidemiology of patients who were readmitted within 90 days of discharge following an index procedure, as well as the reason(s) and risk factors for readmission. These complex, non-linear relationships were modelled with restricted cubic splines.

Results We identified 22,143 patients undergoing major surgery within the defined study period, of whom 1801 (12%) had an unplanned readmission. The most common reason for unplanned readmission across the entire cohort was wound complication, which was the primary cause identified in 232 (11%) readmissions. Ileus or small bowel obstruction was the primary cause of readmission identified following abdominal surgery, compared with pneumonia following thoracic surgery, mechanical injury following orthopaedic surgery and wound complication following cardiac surgery. A discharge haemoglobin concentration of < 100 g.l^{-1} ($p < 0.001$), duration of hospital stay of 14–30 days ($p < 0.001$) and Charlson comorbidity index score ≥ 2 ($p < 0.001$) were associated with increased odds of unplanned readmission. No association was found with patient age or duration of surgery.

Discussion Our study identified the causes of readmission after major surgery from a range of surgical specialties. An improved understanding of the causes of and risk factors for unplanned readmissions will enable the development of targeted interventions that can minimise the burden of unplanned readmissions after major surgery on patients and the larger healthcare system.

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Introduction

Unplanned hospital readmissions consume a significant proportion of healthcare resources. In Australia, the average hospital admission costs £1690–3070 (€2030–3700, US $2145–3900) [1]. With surgical readmissions estimated to account for over 2500 individual episodes annually, this is a significant cost to the healthcare system [2]. A recent study found that 7.4% of hospital discharges resulted in an unplanned readmission within 1 month [3]. The patient group that had the second highest rate of unplanned readmission was the adult surgical population, with a readmission rate of 5.9%. With just under 3 million surgical procedures performed in Australia between 2022 and 2023, interventions that reduce readmissions in the acute surgical population can have a significant impact on patient well-being and the health budget [4]. Surgical readmissions often differ from medical readmissions in that they are usually a consequence of postoperative complications [5]. Therefore, they need to be analysed separately to develop targeted initiatives that are effective for this specific cohort.

To target readmission rates, we first must understand why they occur. Currently, most literature that examines the reasons for hospital readmissions after surgery focuses on a single operation or speciality. While this is of value, it limits how the findings can be translated to the broader healthcare system. There are a small number of studies that include multiple surgical specialities in their analysis [5–8]. However, given the large cohort size and reliance on a national database, the accuracy and detail in which they can report on the causes and risk factors for readmission is limited. Having access to detailed information on readmissions following surgery from an array of specialities would allow for the development of large clinical trials that can have a significant impact. Moreover, these relationships are often complex and non-linear and to be truly understood require advanced statistical analysis with tools designed specifically for this purpose.

To address these research questions, we designed a retrospective observational study to analyse a large database of patients undergoing major surgery from a variety of surgical specialties. We assessed each patient encounter individually to determine the primary reason for readmission accurately. In addition, we explored the risk factors for readmission and modelled these complex, non-linear relationships using restricted cubic splines.

Methods

We analysed surgical readmission data from a university-affiliated tertiary hospital in Melbourne, Australia, that performs approximately 28,000 surgical procedures annually in all subspecialties except obstetrics. The data, which were obtained from the electronic medical record (Cerner Millennium, Oracle Corporation, Austin, TX, USA), spanned a 10-year period (1 May 2011 to 1 February 2022). Ethical approval was granted with a waiver of informed consent from the Austin Health Human Research Ethics Committee. The study is reported in accordance with the STROBE statement [9].

We included patients aged > 18 y who underwent major elective or emergency surgery with a postoperative hospital stay of > 24 h. The surgical specialties included were orthopaedic; cardiac; abdominal (incorporating general surgery and urology); and thoracic. Eligible procedures were determined a priori (online Supporting Information Table S1). Patients undergoing less invasive surgical procedures (laparoscopic cholecystectomy, endoscopic procedure, interventional radiology procedures, etc.) or solid organ transplant were not studied. As postoperative haemoglobin concentration was a risk factor of interest, patients without this parameter available were not included in the dataset. Patients who died during their index readmission were also not studied as they were not eligible for readmission. No specific sample size was targeted beyond all patients that met the specified inclusion criteria within the defined study period.

We aimed primarily to study the epidemiology of the patients who were readmitted within 90 days of discharge following an index procedure as well as the reason(s) for the admission within each of the surgical specialties. These included patient characteristics for the entire cohort, as well as specialty-specific cohorts. Each readmission was then adjudicated to determine whether it was `planned´ or `unplanned´ and to ascertain the primary reason for readmission. The primary reason for readmission was considered individually and categorised by organ system as: infectious; cardiovascular; respiratory; gastrointestinal; musculoskeletal; genito-urinary (including renal); pain; neurological; oncological; symptoms with no cause identified; and `not otherwise classified´ (online Supporting Information Table S2). `Planned´ readmissions were episodes which were an expected continuation of care related to the index procedure (i.e. adjuvant chemotherapy) or an elective admission not related to the index surgery. `Unplanned´ readmissions were those episodes which were not elective in nature and were identified by the assessor as a possible complication or consequence of the index procedure. Secondarily, we aimed to identify the association between specific variables and the likelihood of a hospital readmission across the entire cohort. These were age; sex; duration of index hospital stay; surgery duration;

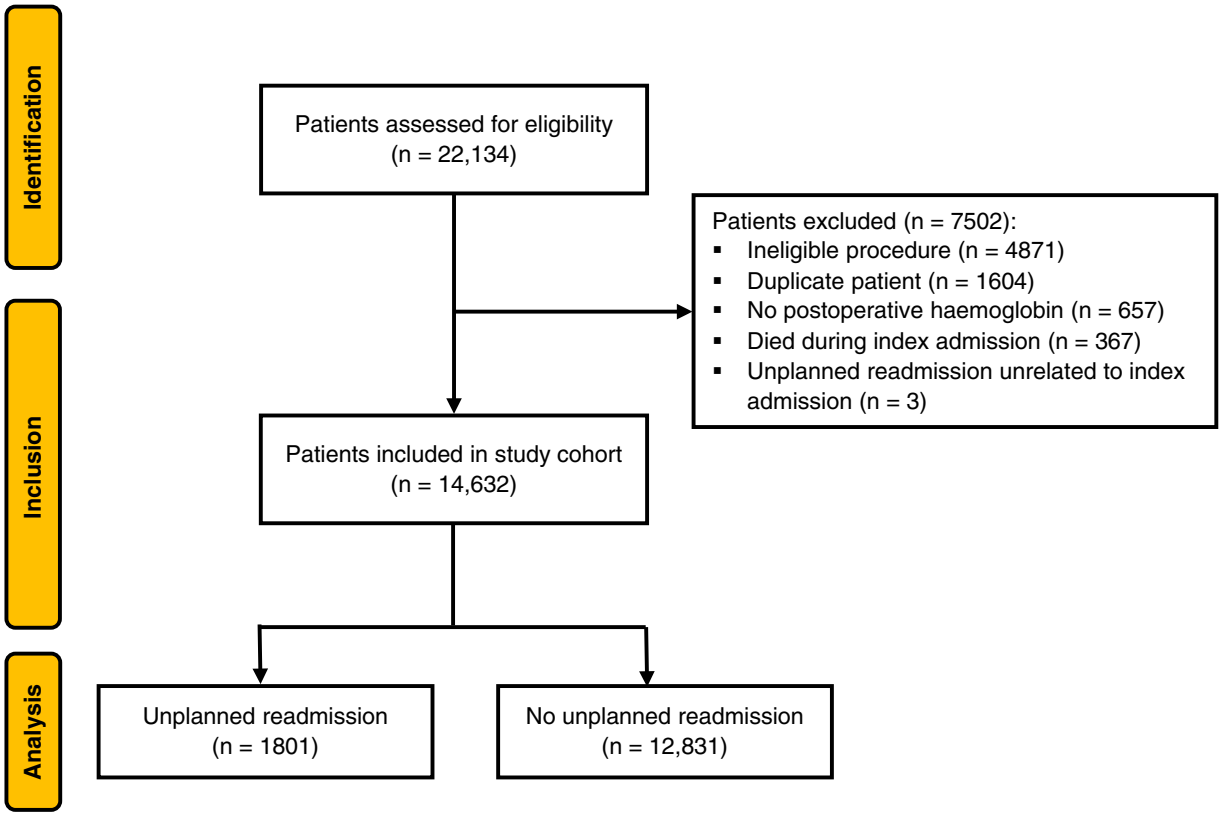

Figure 1 Study flowchart.

surgical specialty; Charlson comorbidity index score (excluding age); units of red cells transfused; emergency admission; and inpatient complications. These variables were determined a priori by the study team. All data were collected as part of routine care.

Data were described for the cohort, for each individual surgical specialty and for elective and emergency surgical procedures. A multivariable binary logistic regression model was used to estimate odds ratio (95%CI) for unplanned readmission within 90 days of discharge across the whole cohort. Restricted cubic splines were used to model relationships between significant continuous covariates and unplanned readmission where possible. The number of knots was selected between 3 and 6 using an iterative process to minimise Akaike information criterion of the final model. All analyses were performed using R (v4.4.0; R Core Team 2024, Vienna, Austria) and p values < 0.05 were considered significant.

Results

We identified 22,143 patients undergoing surgery within the defined study period. After applying the exclusion criteria, 15,002 patients remained. Within this cohort, 367 (2%) died during their index admission and were not included in the readmission analysis. A further three patients were excluded after assessment determined their readmission episode(s) were a consequence of adjuvant therapy rather than the index surgery (Fig. 1).

Of the 14,632 patients included in the primary analysis, 1802 (12%) required an unplanned readmission (Table 1). Mean (SD) age of the overall cohort was 66 (16.2) y and 7079 (48%) were female. Median (IQR [range]) duration of index hospital stay was 7 (5–15 [1–721]) days for the entire cohort and 10 (6–19 [1–221]) days for those who had an unplanned readmission. Overall, 9694 (66%) patients had elective surgery and 4938 (34%) had emergency surgery. Orthopaedic surgery was performed in 6085 (42%) patients, cardiac surgery in 2939 (20%), abdominal surgery in 4417 (30%) and thoracic surgery in 1191 (8%).

The most common reason for unplanned readmission across the entire cohort was wound complication (including wound breakdown, dehiscence or infection), which was the primary cause of 232 (11%) readmissions (Table 2 and online Supporting Information Table S2). The next four most common causes of readmission were falls or other mechanical injuries (150, 7%); pneumonia (140, 7%); ileus or

Table 1 Patient characteristics. Values are number (proportion), mean (SD) and median (IQR [range]).

	Overall n = 14,632	**No unplanned readmission n = 12,831**	**Unplanned readmission n = 1801**
Sex; male	7553 (52%)	6612 (52%)	941 (52%)
Age; y	66 (16.2)	66 (16.2)	68 (15.8)
Discharge haemoglobin concentration; $g.l^{-1}$	109 (17.5)	110 (17.5)	106 (16.8)
Duration of hospital stay; days	7 (5–15 [1–721])	7 (5–14 [1–721])	10 (6–19 [1–221])
Allogeneic red blood cell transfusion	1956 (13%)	1604 (13%)	352 (20%)
Emergency index admission	4938 (34%)	4219 (33%)	719 (40%)
Postoperative complication*	6171 (42%)	5229 (41%)	942 (52%)
Charlson comorbidity index	4 (2–5 [0–16])	3 (2–5 [0–16])	5 (3–7 [0–15])
Surgery duration; min	194 (136–305 [32–1084])	192 (136–300 [32–1084])	214 (137–336 [32–911])
Surgical specialty			
Orthopaedic	6085 (42%)	5507 (43%)	578 (32%)
Cardiac	2939 (20%)	2554 (20%)	385 (21%)
Abdominal	4417 (30%)	3749 (29%)	668 (37%)
Thoracic	1191 (8%)	1021 (8%)	170 (9%)

*During index admission.

bowel obstruction (114, 6%); and heart failure/pulmonary oedema (107, 5%). Median (IQR [range]) duration of unplanned readmission across the entire cohort was 7 (3–16 [1–231]) days.

Following orthopaedic surgery, there were 653 unplanned readmission events affecting 578 (32%) patients. The most common primary cause of readmission in this subgroup was fall or other mechanical injury (127, 19%). The next four most common primary causes of readmission in descending order of frequency were wound complications (55, 8%); pneumonia (49, 8%); pain related to surgery (38, 6%); and heart failure/pulmonary oedema (30, 5%). Median (IQR [range]) duration of unplanned readmission in the orthopaedic surgery subgroup was 7 (3–16 [1–188]) days.

Following cardiac surgery, there were 428 unplanned readmission events affecting 385 (21%) patients. The most common primary cause of unplanned readmission in this subgroup was wound complication (76, 18%). The next four most common primary causes of readmission in descending order of frequency were heart failure/pulmonary oedema (57, 3%); arrhythmia (including atrial fibrillation, atrial flutter or malignant arrhythmia unrelated to ischaemia) (46, 11%); pleural effusion not related to heart failure (39, 9%); and pneumonia (22, 5%). Median (IQR [range]) duration of unplanned readmission in the cardiac surgery subgroup was 5 (3–12 [1–132]) days.

Following abdominal surgery, there were 766 readmission events affecting 668 (15%) patients. The most common primary cause of unplanned readmission in this subgroup was ileus or bowel obstruction with (104, 14%). The next four most common primary causes of readmission in descending order of frequency were wound complication (89, 12%); postoperative pain (50, 7%); reason not otherwise specified (47, 6%); and deep surgical site infection (collection/abscess) (45, 6%). Median (IQR [range]) duration of unplanned readmission in the abdominal surgery subgroup was 9 (4–19 [1–231]) days.

Following thoracic surgery, there were 201 unplanned readmission events affecting 170 (9%) patients. The most common primary cause of unplanned readmission in this subgroup was pneumonia (36, 18%). The next four most common primary causes of readmission in descending order of frequency were pleural effusion not related to heart failure (35, 17%); progression of cancer (21, 10%); wound complication (12, 6%); and thromboembolism (9, 4%). Median (IQR [range]) duration of unplanned readmission in the thoracic surgery subgroup was 7 (4–17 [1–91]) days.

Patients who had an emergency admission during their index hospital admission were more likely to have an unplanned readmission (OR 1.33, 95%CI 1.16–1.51, $p < 0.001$). Similarly, allogeneic red blood cell transfusion, which occurred in 1956 (13%) patients, was associated with a greater risk of readmission (OR 1.04, 95%CI 1.01–1.08, $p = 0.013$). Patients who had abdominal surgery had increased risk of readmission compared with those who underwent orthopaedic surgery (OR 1.39, 95%CI 1.21–1.61,

Table 2 System-specific reasons (by organ system) for readmission, categorised by surgical specialty. Values are number (proportion).

	Overall n = 2048	Orthopaedic n = 653	Cardiac n = 428	Abdominal n = 766	Thoracic n = 201
Infectious	352 (17%)	84 (13%)	91 (21%)	153 (20%)	24 (12%)
Cardiovascular	300 (15%)	79 (12%)	148 (35%)	45 (6%)	28 (14%)
Respiratory	242 (12%)	62 (9%)	64 (15%)	44 (6%)	72 (36%)
Gastrointestinal	288 (14%)	32 (5%)	19 (4%)	230 (30%)	7 (3%)
Musculoskeletal	206 (10%)	166 (25%)	12 (3%)	24 (3%)	4 (2%)
Genito-urinary/renal	140 (7%)	59 (9%)	20 (5%)	57 (7%)	4 (2%)
Pain	133 (6%)	51 (8%)	17 (4%)	55 (7%)	10 (5%)
Symptoms without cause identified	125 (6%)	27 (4%)	21 (5%)	60 (8%)	17 (8%)
Neurological	79 (4%)	36 (6%)	15 (4%)	23 (3%)	5 (2%)
Oncological	72 (4%)	24 (4%)	1 (0%)	23 (3%)	24 (12%)
Other	111 (5%)	33 (5%)	20 (5%)	52 (7%)	6 (3%)

Table 3 Risk of readmission for categorical model variables and continuous variables not amenable to analysis with restricted cubic splines.

Characteristics	Odds ratio (95%CI)	p value
Sex; male	0.93 (0.83–1.03)	0.165
Allogeneic red blood cell transfusion	1.04 (1.01–1.08)	0.013
Emergency admission	1.33 (1.16–1.51)	< 0.001
Surgical specialty		
Orthopaedic	..	..
Cardiac	1.14 (0.95–1.37)	0.151
Abdominal	1.39 (1.21–1.61)	< 0.001
Thoracic	1.20 (0.97–1.48)	0.091
Postoperative complication*	1.05 (0.94–1.19)	0.369

*During index admission.

$p < 0.001$) whereas cardiac and thoracic surgery were not associated with a change in the likelihood of readmission (Table 3). No relationship was identified between postoperative complication during index admission and a subsequent unplanned readmission (Table 3).

Our analysis showed that a higher haemoglobin concentration on discharge was associated with a reduced risk of unplanned readmission (Fig. 2). Specifically, a haemoglobin concentration > 130 $g.l^{-1}$ had lower odds of an unplanned readmission and a haemoglobin concentration < 100 $g.l^{-1}$ had higher odds. A concentration of 100–130 $g.l^{-1}$ showed essentially no change in the risk of readmission. The effect of discharge haemoglobin concentration on odds of readmission was significant ($p < 0.001$) and was best modelled by a restricted cubic spline with four knots.

When analysing the impact of index admission duration of hospital stay on readmission rate, we found that a duration of hospital stay < 7 days had a reduced risk of unplanned readmission (Fig. 2). In contrast, a duration of hospital stay of 14–30 days had a higher risk of readmission. As the duration of hospital stay went beyond 30 days, the impact on odds of readmission plateaued; that is, the odds of readmission for a 60-day stay were similar to that of 150-day stay. A restrictive cubic spline with five knots best represented the relationship between duration of hospital stay and unplanned readmission. The result was significant ($p < 0.001$).

The relationship between Charlson comorbidity index score (excluding age) and unplanned readmission was also significant ($p < 0.001$) (Fig. 2). The Charlson comorbidity index score at which patients were more likely to have an unplanned readmission was ≥ 2. The impact of the Charlson comorbidity index score on odds of readmission was greatest between a score of 0 and 3. Beyond this point, the association between Charlson comorbidity index score and unplanned readmission began to plateau, but did not reach an asymptote. A Charlson comorbidity index score of 0 was the only score with reduced odds of readmission. This association was best modelled by a restrictive cubic spline with three knots.

Age did not have a significant effect on the odds of unplanned readmissions within 90 days of discharge ($p = 0.054$) (Fig. 2). Similarly, duration of surgery did not impact the risk of readmission, with no significant change in odds as surgical time increased ($p = 0.478$) (Fig. 2). No

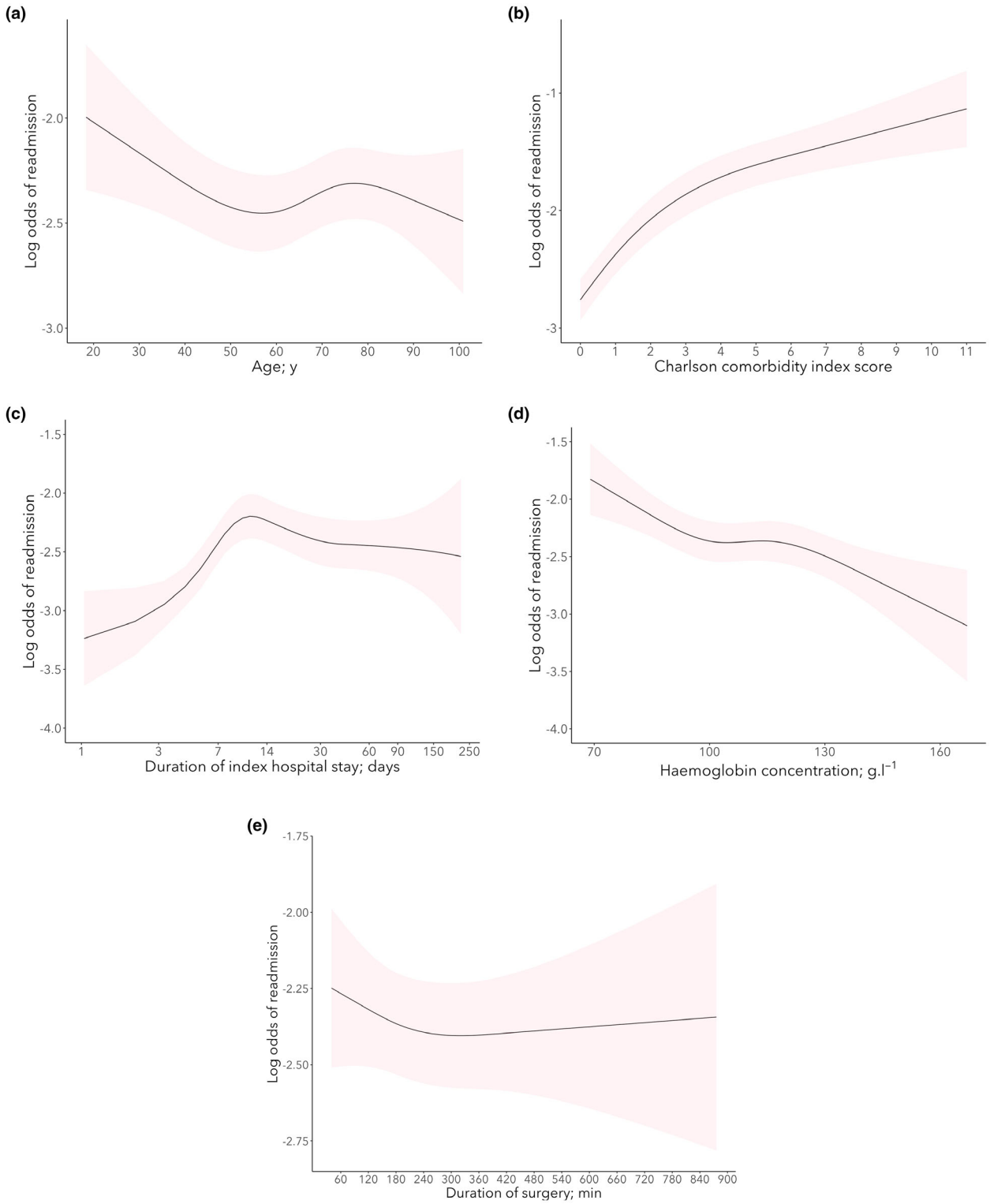

Figure 2 Restricted cubic spline curves for continuous model variables amenable to analysis: (a) age; (b) Charlson comorbidity index scores (excluding age); (c) duration of index hospital stay; (d) haemoglobin concentration at time of discharge; (e) duration of surgery. Red shading represents 95%CI.

analysis could be performed on the number of units of allogeneic red blood cells administered as the points were too discrete to fit a spline appropriately.

Discussion

In this single-centre, retrospective cohort study, we screened 22,143 patients to identify the causes of readmission following major elective or emergency surgery. We found that the most common reason for readmission within 90 days of discharge after the index admission was surgical wound complications, accounting for 232 (11%) readmissions. Ileus or small bowel obstruction was the primary cause of admission following abdominal surgery, compared with pneumonia following thoracic surgery, mechanical injury (i.e. falls) following orthopaedic surgery and wound complication following cardiac surgery. In addition, we studied the risk factors for readmission using a multivariable binary logistic regression model. A discharge haemoglobin concentration of < 100 g.l^{-1}, a duration of hospital stay of 14–30 days and a Charlson comorbidity index score ≥ 2 were associated with increased odds of unplanned readmission. No association was found with patient age or duration of surgery.

Hospital readmissions after surgery are responsible for a significant proportion of bed occupancy and bed days within the healthcare system. They are estimated to account for 2500 individual episodes annually, with an average cost of £1690–3070 (€2030–3700, US$ 2145–3900) per readmission [1, 2]. In a recent retrospective cohort study examining unplanned readmission in major Australian health services, the rate of readmission within 28 days of discharge was 7.4% [3]. When analysing adult patients undergoing surgery specifically, the rate was 5.9%. This was significantly less than two large cohort studies that reported 30-day readmission rates of 11.1% and 12.3% following surgery [5, 6]. Moreover, 50% of unplanned readmissions occur within the first 8–9 days following discharge [3, 6]. We report an unplanned readmission rate of 12.3%, although it should be noted that our methodology included all readmission episodes within 90 days of discharge. This reflects findings from the National Emergency Laparotomy Audit, suggesting there is an ongoing readmission burden related to the index procedure that continues beyond the traditional 30-day follow-up period [10].

Most current research on readmissions after surgery focuses on a single surgical speciality or operation. One speciality that has been well studied is orthopaedic surgery. Following joint arthroplasty, the most widely reported reason for readmission is infection, including wound, soft tissue and joint infections [11–13]. However, there are some discrepancies across the literature as other large cohort studies found dislocation to be the most common cause [14]. Similarly, the literature on abdominal surgery reports an array of reasons for readmission. Bowel obstruction was one of the more common reasons following colorectal surgery whereas infection was found to be the leading cause of readmission following emergency general surgery [15–19]. In comparison, there was greater consistency in the literature when examining readmissions following thoracic surgery. A systematic review that focused on lung resections found that the most frequent cause of readmission was respiratory in origin (pneumonia, pneumothorax, dyspnoea, etc.) [20]. This was further supported by studies which examined readmissions following lung transplant [21, 22]. Lastly, when assessing the literature in patients undergoing cardiac surgery, heart failure was one of the most reported reasons for readmission [23–25]. However, there were numerous large cohort studies that determined `infection´ to be the primary cause [26–28]; clearly, even within one surgical speciality, there can be an array of readmission presentations. As a result, despite there being significant literature on the causes of readmission, there is limited ability to utilise these data to inform clinical trials that might target broader surgical populations, rather than specific procedures.

There are several studies that include multiple surgical specialities in their analysis [5–8, 29, 30]. Across these, infection was the most common reason for readmission, including `sepsis´; `surgical site infection´; and `infection not otherwise specified´ [5, 8, 29, 30]. Broader categories such as these were used commonly to group together multiple reasons for readmission, reducing the number of diagnoses included in the readmission analysis. These diagnoses were often obtained from a large national database, where a diagnosis code is determined by local administrators at the time of data entry [5–8]. While this allows for many patients to be included in the study with minimal additional effort on the part of the investigators, it introduces the potential for error when the primary reason for readmission is determined without independent clinician review.

Identifying the risk factors for readmissions can provide valuable information when trying to devise strategies to reduce readmission rates. However, this is only of use if the risk factors are modifiable. One such risk factor that we studied recently was postoperative anaemia, with an increased odds of readmission when the discharge haemoglobin concentration is < 100 g.l^{-1} [31]. The rest of the literature reports predominantly on non-modifiable factors, which accounts for approximately 82% of the variability in 30-day readmissions at the patient level [32]

and which is reflected by our results. This includes age, which Rossi et al. found to be a significant risk factor for readmission, as well as comorbidities and functional status which were reported as significant variables in several other studies [6, 15, 30, 32]. The significance of these relationships was determined largely using multivariate logistic regression models. This approach assumes a linear relationship between these factors and outcomes and does not account for the possibility of complex, polynomial relationships.

Our study aimed to address this shortcoming, while also examining multiple surgical specialties and procedures. Furthermore, we were able to delineate between similar presentations that other studies may have included as a single diagnosis by assessing each admission by hand. By determining the specific cause(s) of each readmission episode, we have highlighted potential interventional targets for future clinical trials. For example, wound complication (i.e. infection) was identified as one of the four leading drivers of unplanned readmission in each individual specialty and the most common reason for unplanned readmission in the overall cohort. Therefore, a possible intervention trial based on our findings might be undertaken in patients with or at risk of developing postoperative anaemia, using an intervention designed to treat the same (i.e. intravenous iron with or without erythropoietin) compared with a matched control, with unplanned readmission as a primary outcome and postoperative wound complication as a secondary outcome. This is not dissimilar to the POP-I study, which is recruiting currently [33]. We also included the primary reasons for readmission for each of the studied surgical specialties to highlight relevant differences, which in turn can help guide more targeted interventional trials.

We also studied the relationship between several covariates and risk of readmission. We found that discharge haemoglobin concentration of < 100 g.l^{-1}, duration of hospital stay of 14–30 days and Charlson comorbidity index score ≥ 2 were all associated with increased odds of unplanned readmission. Restricted cubic splines were utilised to map these non-linear relationships. In doing so, we have been able to more accurately represent how each covariate impacts the risk of readmission. Using splines allows us to no longer be bound by the assumption of linearity when modelling relationships. Unlike the physical sciences, few parameters in medicine show linear relationships. There are multiple potential relationships that, if modelled linearly, would show no relationship or a relationship in the opposite direction of that seen when modelled by using splines. More specifically, we have been able to show at which point each variable begins to increase the odds of readmission, at what rate it does so and at what point the impact begins to plateau. This provides a potential range for which an intervention may be able to have a significant impact on readmission rates.

Our study has several strengths. We studied a large cohort across multiple surgical subspecialties enabling us to provide an accurate overview of the reasons and risk factors of readmission following major surgery. In addition, we hand-assessed every readmission to determine the reason for presentation. This allowed us to provide a comprehensive list of diagnosis with only 4% of readmissions not classified. While the study reported by Merkow et al. was larger (n = 498,875), between 31.7% and 41.9% of readmissions were uncategorised, depending on the surgical specialty, contrasting with < 10% in our study [30]. As a result, there is a significant proportion of data missing from the Merkow et al. study, which hinders the ability of the reader to determine the reasons for readmission accurately. Finally, using routinely collected patient data enabled us to have a complete dataset with minimal missing information. We could then use these data in a multivariable binary logistic regression model to accurately determine the risk factors of readmission across the whole cohort.

We acknowledge some limitations. First, despite all readmissions being hand-assessed, we cannot be certain that every readmission in the study was a direct consequence of the index surgery. For example, if a patient were to suffer a fall necessitating readmission after total hip arthroplasty, we cannot be completely certain that this event would not have occurred irrespective of surgery. However, given that our results are consistent with other studies which examine the reasons for readmission following surgery, it is likely that the readmissions that are not directly related to the index surgery are a substantial minority and have minimal impact on our overall results. Second, we cannot exclude the possibility that patients presented to another hospital for an unplanned readmission. Given that the electronic medical records are not centralised across the state or country in Australia, these data cannot be captured in our analysis. However, similar retrospective studies which had access to national data reported a similar readmission rate, suggesting that any effect is limited [5, 6]. Third, like all retrospective studies, only those variables that were collected as part of routine care were able to be included in our modelling. Notably, we were not able to include a direct assessment of frailty, and while frailty and Charleston comorbidity index scores are both broadly correlated with postoperative outcomes [34], frailty has

been found to be a stronger predictor in some surgical populations [35]. Frailty would ideally be assessed and recorded as part of pre-operative assessment; it is unfortunate that our centre has not yet embedded this important prognostic marker into routine practice. Fourth, the study cohort was collected over an 11-year period, with an unavoidable risk of unmeasured, temporal confounding due to practice changes during the study period. Finally, our study was performed in a single centre, and therefore, despite the large cohort size, our results may not be applicable in all settings.

To conclude, we have performed a large, retrospective cohort study to identify common causes of readmission across multiple surgical specialties. In addition, we found that discharge haemoglobin concentration of < 100 g.l^{-1}, duration of hospital stay of 14–30 days and Charlson comorbidity index score ≥ 2 were all associated with increased odds of unplanned readmission. Future studies could utilise this information to investigate whether targeted interventions can reduce readmissions after major surgery and minimise the burden that this patient cohort has on the healthcare system.

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Supporting Information

Additional supporting information may be found online via the journal website.

Table S1. Procedure counts.

Table S2. Individual reasons for unplanned readmission and counts across the entire cohort and surgical specialty subgroups.

