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Understanding Factors affecting 30-day Unplanned Readmissions for Patients undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to Home Orthopaedics Survey

Running title: Unplanned readmissions following knee arthroplasty

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Abstract

Objectives

Unplanned readmissions following total knee arthroplasty (TKA) place financial and logistical strain on the Australian healthcare system. The aim of this study was to examine associations between unplanned 30-day readmissions following TKA and patients' experiences in hospital and in transition to general practice and home.

Design, setting and participants

A cross-sectional survey of public and private patients attending a six-week follow-up appointment after TKA at one of four clinical services in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019. Multiple logistic regression analyses were used to estimate the risk of 30-day readmissions.

Results

Of the 380 participants who completed the survey (n=380, 54% of TKAs undertaken over the study period), 4% (n=13) were readmitted within 30 days of discharge. After controlling for age and sex, public patients were significantly more likely to be readmitted within 30 days than private patients (OR=6.87, 95% CI: 1.71-27.54, p=0.007). Compared with patients who did not attend rehabilitation, patients who attended were significantly less likely to have been readmitted within 30 days (OR=0.17, 95%CI: 0.05-0.59, p=0.006). There were no associations between post-hospital syndrome or patient enablement and 30-day readmissions in this study.

Conclusion

Difference in unplanned readmission rates for public versus private patients may be due to discrepancies in surgical waiting times. Strategies to reduce public hospital waiting times and to mitigate against increasing disablement while waiting for a surgical procedure should be explored. Reasons for non-attendance to post-surgical rehabilitation programs need to be explored and strategies to foster increased participation developed.

Keywords: knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care, hospital performance.

Article summary

Strengths and limitations of this study

- This study is the first to use patient-reported responses to quantify the effect of hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions.
- We were able to identify which patients attended or did not attend rehabilitation following total knee arthroplasty.
- A limitation of this study is that results were based on self-reports with no capacity to link them to hospital records for confirmation.
- As the Australian Capital Territory has a high socioeconomic demographic the findings may not apply to other less affluent areas.

Introduction

Unplanned readmission rates are an indicator of health system performance [1, 2]. The rate of unplanned 30-day readmission for total knee arthroplasty (TKA) in Australian public hospitals was 2.6% in 2017-18 [3]. In the United States, readmission rates have been used as an incentive to reduce readmission and drive improved practice [4]. While there is no such program in Australia, the economic burden of unplanned readmissions makes it a policy priority [3, 5, 6].

TKAs are conducted in both private and public sectors in Australia with 69% of knee arthroplasties being conducted in the private sector. The rate of knee replacement surgery has more than doubled over the past 15 years both in Australia and internationally [7] with the highest rate of increase seen in the private sector [3, 5, 8]. This growing demand has placed increased logistical and financial strain on the healthcare system [5]. This increase is not entirely explained by the ageing populations and a higher prevalence of obesity [7]. It is suggested that the growth in utilization is due to expansion of the eligibility criteria for knee replacement surgery [9], and injury patterns among younger people [7].

The most common condition-related causes of unplanned readmission following a total knee arthroplasty (TKA) are surgical-site infection, arthrofibrosis, cellulitis, concomitant co-morbidities, and fluid and electrolyte imbalance [10]. Other factors such as old age, revision procedure and increased length of hospital stay also increase the risk of unplanned 30-day readmissions [10]. However, factors related to the hospital stay itself have also been identified as important modifiable influences on post-admission outcomes [11].

Krumholz [12] describes post-hospital syndrome as a period of vulnerability after discharge from the hospital which leaves a patient at increased risk of re-hospitalization from conditions which are often unrelated to the original reason for of admission. It is proposed

that this acquired transient state might be due to patients' experiences of pain, sleep deprivation, and poor nutrition during their hospital stay [12]. This hypothesis is supported by evidence that increasing patient capacity for self-care is effective at reducing 30-day readmissions [11].

Research examining unplanned 30-day readmissions describes associations between patients' clinical and demographic characteristics [13, 14], a lack of access to, continuity and regularity of primary care [15-17], and deficits in hospital discharge planning, which often focus on knowledge provision rather than patients' capacity to implement this knowledge [11].

The patient-enablement instrument is a tool used to measure a person's knowledge and understanding of their health condition; confidence to manage their condition, health, and life [18]; and their ability to source appropriate healthcare for their individual needs. While this measure has largely been examined in primary-care settings, its role in preventing unplanned hospital readmissions has not yet been explored.

The purpose of this study was to investigate factors associated with unplanned 30-day readmissions following a TKA, including aspects of hospital experiences, patient enablement, and transition from hospital to home.

Methods

Study population

Consecutive patients over the age of 16 years, attending a six-week follow-up appointment after undergoing total knee arthroplasty at one of four private and public clinical services between 1 February 2018 and 31 January 2019.

Study design

A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019 at all private and public sites delivering lower limb joint replacement services. The responses for patients having undergone TKA are presented in this paper.

Patient and public involvement

Orthopaedic patients (n=5) who had previously had surgery were emailed the survey and asked to complete it and provide feedback about its readability, length, and meaningfulness.

Instrument

Researchers at the Australian National University, Canberra Hospital, Academic Unit of General Practice ACT Health, Health Care Consumer Association, and Capital Health Network developed *The ACT Transition from Hospital to Home Survey*. The 50-item survey was designed to measure patients' experiences in hospital and transition to home across six domains: 1. Patient demographic characteristics and co-morbidities; 2. Post-hospital syndrome; 3. Medication enablement; 4. Patient enablement; 5. Transition to general practice; and 6. Pre- and post-hospital information and pre-/post-surgical rehabilitation

Co-morbidities: Morbidity was assessed with the 18-item Functional Comorbidity Index which is used to predict functional status rather than mortality [19].

Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.

Medication enablement: Three items measured medication enablement in terms of patients' knowledge and ability to manage their medications following discussions with health care providers derived from a previous study in general practice nurse consultations [20].

Patient enablement: This is the internationally validated six-item Patient Enablement Instrument [21] used internationally in primary-care research.

Transition to general practice: 10-items assessing patients' relationships with their general practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning, patients' understanding of when to see their GP following discharge, and access to care.

Interaction with the recommended rehabilitation program: Referral and attendance to physiotherapy rehabilitation post-discharge was examined with one item.

Data collection

The paper surveys were distributed by reception staff at patients' six-week post-operative consultation. Staff were given a protocol and suggested wording to use when providing the survey. An information sheet about the study was provided to patients and anonymity guaranteed. This ensured that patients understood that participation or non-participation did not affect the care they received and that completed surveys were confidential to clinic staff. Surveys were deposited in a sealed box in the waiting room and collected by the researcher at regular intervals.

Data analysis

Completed survey data was collated and descriptive and inferential statistics used. Variables were described using summary statistics and frequencies. Some variables were grouped to create new variables and others, for example, BMI, were converted to categorical variables for analysis. The primary outcome of interest was self-reported 30-day readmission to hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living situation, country of origin, education, self-rated health, comorbidities, post-hospital syndrome (experiences of sleep, diet and pain), experiences of family practice (access, continuity, planning, regularity), medication enablement, and patient enablement were separate independent variables.

An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to explore the relationship between variables which described post hospital syndrome. The modes/themes which had an eigenvalue of >1 were retained and the internal consistency of the modes which emerged was examined using Cronbach's alpha. The suitability of the data for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.

Prior to analysis, variable independence was established. Ordinal variables were examined using Spearman's correlation coefficient and categorical variables using the chi squared (χ^2) test and odds ratio. If a strong correlation (> 0.6) or a significant association ($p \leq 0.2$) existed between two eligible variables, only one of these was retained for inclusion in the final analysis.

Univariate logistic regression analysis was conducted for each independent variable and the dependent variable (unplanned 30-day readmission). Variables with p-values ≤0.25 were

included in the multiple logistic regression analyses. Univariate logistic regression was conducted on each individual comorbidity item, and then for the total comorbidity score.

Cronbach's alpha was used to determine the internal reliability of each scale. A value greater than 0.5 was considered as a good indicator of internal consistency.

To further eliminate potential confounding, two multiple logistic regression models were run - one including eligible individual variables from within the Functional Comorbidity Index, Medication Enablement questions and the Patient Enablement Instrument; and a second including total scores.

The full multiple regression model included eight variables. These were public or private hospital; stroke or transient ischemic attack (TIA); upper gastrointestinal disease; self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance at recommended rehabilitation or physiotherapy; and living status. The reduced model included 'public or private hospital' and 'attendance at recommended rehabilitation or physiotherapy'. Both the models were adjusted for age and sex.

Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit of the final model. The Receiver Operator Curve (ROC) was plotted to check the specificity and sensitivity of the predicted model.

Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].

Missing data

The criteria used for acceptability of non-response to survey questions was 10% or lower [23-25]. Missing data for individual variables within the medication and patient enablement scales were imputed to equal the median value of non-missing data [26-29].

Ethical approval

Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics Committees.

Results

Of the 1069 people invited to participate, 827 (77%) completed the survey.

Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within 30 days. Participant demographics are presented in Table 1. Private patients accounted for 65% of the total population (247 private patients, 133 public patients). This represented 44% of all private patients and 96% of all public patients who had a TKA during the study period which represents 54% of all TKAs. 57% of those who underwent knee surgery were females. The mean age was 67.4 ± 0.5 years (age range 44.8 to 91.0 years). Mean BMI was 31.5 kg/m^2 with most having a BMI of >30 (58%). Most participants were non-indigenous (99%). There were three people of Aboriginal and/or Torres Strait Islander origin, none of whom was readmitted. There were proportionally more private patients aged 65-84 years (63%) compared to public (53%), whereas proportionally more public patients were in the 45-64 age group (44% compared to 35%). The proportion of females within the public cohort was greater than private (67% compared to 57%). A higher proportion of public patients lived alone (31% compared to 23%).

Post-hospital syndrome exploratory factor analysis (EFA)

Three modes/themes with acceptable internal consistency emerged. First, diet, which was described by responses to two questions: "Did you feel your dietary requirements were met in hospital?" and "Overall, how would you rate the quality of the food in hospital?" The second theme was pain, which was also explained by two questions: "How would you describe the general level of pain you experienced?" and "When you left hospital, how would you rate your pain out of 10?" The third was sleep which was explained by "Did you feel well rested when you left the hospital?" and "How would you rate the quality of sleep in the hospital?"

Floor and ceiling effects were observed for patient enablement due to a large number of participants reporting being either fully enabled or not enabled at all. To address this, the variable was dichotomised around the mean where 'less enabled' was ≤6.5 and 'more enabled' was >6.5 in line with previous studies using this instrument [28, 30]. Sixty percent of participants (n=212/357) reported that they were less enabled to manage their health after their stay in the hospital.

Multiple logistic regression analysis

Nine variables were eligible for inclusion in the multiple logistic regression analysis. Of these, 'public /private status' and 'rehabilitation attendance' were retained for the reduced model as they were the only variables to retain significance after stepwise removal of the other variables in the full model.

After controlling for age and sex, public patients were significantly more likely to be readmitted within 30 days compared to private patients (OR=6.87, 95% CI:1.71-27.54,

p=0.007), and patients who did not attend rehabilitation were significantly less likely to be readmitted within 30 days of discharge than those who did (OR=0.17, 95% CI: 0.05-0.59, p=0.006).

Discussion

The aim of this study was to investigate factors impacting unplanned 30-day readmission in TKA patients. Of the 4% of patients who had an unplanned readmission, those who attended public hospitals and those who did not attend a rehabilitation program were more likely to be readmitted to hospital within 30 days of discharge.

While the United States also has a similar 4% readmission rate following TKA [10, 31-33], this is higher than that reported by the Australian Institute of Health and Welfare (AIHW) [3]. However, our results may reflect the true readmission rate more accurately as the AIHW only reports public hospital data and the majority of TKAs in Australia are performed in the private sector.

In our study, public patients were more likely to be readmitted within 30 days as compared to private patients. The majority of respondents (65%) had their TKA in the private sector, consistent with the higher proportion (80%) of TKA procedures performed in the private sector in the ACT [34]. Our study has almost complete ascertainment from the public sector, and reasonable ascertainment from the private sector, supporting the robustness of our findings. The increased likelihood of readmission for public patients might be explained by several contributing factors such as socioeconomic status, longer waiting times and increased disease complexity [35-40]. The median waiting time for a TKA in 2018-19 in the ACT public hospital system was 62 days with 8.2% of patients waiting more than 365 days [35].

On the other hand, the median waiting time for Australian private patients was just 67 days during the same period [2, 41]. Therefore, waiting time may be an important mediating factor.

Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions for elective surgical procedures in Australia [42]. TKA patients who waited longer than six months have been described as having significantly worse function and quality of life scores, as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and depression [43]. It is important to understand that surgical waiting times are only part of the waiting journey for patients in the public system. The mean waiting times recorded for Australian patients do not take into account the lengthy process of referral, specialist assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical exercise and education programs are increasingly being implemented and the evidence for efficacy is strong [45, 46].

In our study, patients who attended rehabilitation were less likely to be readmitted within 30 days than those who did not. Previous research indicates that private patients are more likely to attend rehabilitation than public patients [47] and that rehabilitation is associated with better physical function after TKA [45]. However, we found no significant relationship between being a public or private patient and attendance at rehabilitation. Both groups in our sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after six weeks indicating that private/public status was not a mediating factor for this finding.

This study showed no significant associations between general practice (GP) factors and unplanned 30-day readmissions. A recent study reported that timely and regular GP contact during the two years following transition from hospital to community care lowered the risk of emergency readmission to hospital in patients with cardiovascular disease [48]. However, our

results might reflect the nature of the health condition. This cohort included people having TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other diseases in that the treatment is potentially definitive and is followed up by the surgeon.

Although more than half of the patients who were readmitted had high scores for post-hospital syndrome, there was no significant association with 30-day readmission. The hypothesis of post-hospital syndrome describes a transient state resulting in consequences, including a higher risk of readmission [12]. Brownlee et al. [49] found that post-hospital syndrome was an independent predictor of readmission within 30 days of discharge in a large cohort of surgical patients. While other studies have attempted to determine the impact of post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to use patient-reported responses to quantify the effect of hospital experience (of pain, sleep, and nutrition) on unplanned 30-day readmissions.

There are limitations to this study. The main limitation was that there were fewer readmissions than anticipated and the study may have been insufficiently powered for detecting the associations being tested. The results were based on anonymous self-reports; hence there was no capacity to link them to hospital data to establish actual readmission time frames, length of hospital stay, reasons for readmission or previous admission history. However, our primary endpoint was 30-day readmission and we believe that the self-reported data was accurate. The response rate is only an estimation based on joint replacement activity in the ACT. It assumes that all patients returning for their six-week follow-up appointment were invited to participate. We do not know whether the reception staff invited all patients, or only some. Also, as the ACT has a relatively high socioeconomic demographic the findings from this study may not apply to other less affluent areas.

Our data do not allow us to understand why rehabilitation was not accessed. It is possible that patients who were frailer did not feel able to participate and perhaps they were the patients who were readmitted. However, a range of patient and provider-based factors have been recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as insurance provider and hospital business model [51]. This association needs clarification.

It is not known if the rate of readmission can be reduced given the significant comorbidities of the TKA patient sample.

Conclusion

This study was undertaken to explore the factors impacting unplanned 30-day readmission after TKA. These results have implications for policy and for practice. An over-representation of public patients in the readmitted cohort is important. It is probable that the extended periods of delay to surgery among patients on the public waiting list may be an important factor. Therefore, it is essential to shorten waiting times and prioritize medical need when dealing with public patients. Clinicians should also place emphasis on the importance of attending rehabilitation after a TKA as an effective way to reduce 30-day readmission. Further investigation of how the pre-surgical patient journey can be better optimised to reduce readmission rates is warranted.

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Tables

Table 1. Characteristics of all patients and those with an unplanned 30-day readmission (knee arthroplasty only).

		Public	Private	TOTAL	
		N=133	N=247	N=380*	Readmission N=13**
Age	45-64	55	79	134	2
	65- 84	66	145	211	10
	>85 years	4	5	9	0
Gender	Male	42	97	139	3
	Female	86	129	215	10
	Other	0	2	2	0
Language	Other than English at home	21	28	49	2
	Only speak English	108	212	320	11
Living Status	Live alone	40	55	95	2
	Live with someone	90	189	273	11

*Missing values for age: 26, Gender:24, Language: 11, Living status: 12.

**Missing value for readmission for age: 1

12

	Total observations (n=380)		Unplanned 30-day readmission (n=13)	
Demographic factors	No.	% (of total)	No.	% (of variable)
BMI Calculations				
BMI (Mean)	31.5			
18.5-24.4	31	8.2	1	7.7
24.5-30	129	34.0	2	15.4
>30	220	57.9	10	76.9
Missing	6	1.6	-	-
Indigenous status				
Aboriginal	1	0.3	0	0
Torres Strait Islander	2	0.5	0	0
Both	0	0	0	0
Neither	315	82.9	13	100.0
Missing	62	16.3	-	-
Education				
No school certificate or other qualifications	22	5.8	0	0
School or intermediate certificate	87	22.9	6	46.2
Year 12 or leaving certificate	54	14.2	2	15.4
Trade/ apprenticeship	30	7.9	1	7.7
Certificate/ diploma	76	20.0	2	15.4
University degree or higher	95	25.0	2	15.4
Missing	16	4.2	-	-

2

Public/Private				
Public	134	35.3	9	69.2
Private	246	64.7	4	30.8

Table 2. Exploratory Factor Analysis (EFA) and emerging variables.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	2.53	0.85	0.18	0.18
Factor 2	1.69	0.42	0.12	0.30
Factor 3	1.27	0.12	0.09	0.39
Bartlett test of sphericity p=0.000				
Kaiser-Meyer-Olkin (KMO)= 0.62				

Variable	Factor 1	Factor 2	Factor 3
Did you feel your dietary requirements were met in hospital?	**0.88**	0.01	0.10
Overall, how would you rate the quality of the food in hospital?	**0.86**	0.01	0.09
How would you describe the general level of pain you experienced?	-0.02	**0.83**	0.10
When you left hospital, how would you rate your pain out of 10?	0.04	**0.75**	0.09
Did you feel well rested when you left the hospital?	0.20	0.18	**0.75**
How would you rate the quality of sleep in the hospital? (Poor)	0.30	0.18	**0.67**

Table 3. Results of multiple logistic regression analysis examining the association between patient, hospital and transition to general practice factors associated with unplanned 30-day readmission to hospital.

	*Full model**			*Reduced model***		
Relevant Variables	*OR*	*95% CI*	*p-Value*	*OR*	*95% CI*	*p-Value*
Public or Private	3.788	0.47-30.293	0.211	6.879	1.71-27.54	0.007
Co-morbidity						
Stroke	23.92	0.495-1165.54	0.1091	-	-	-
Upper gastrointestinal disease	0.12	0.00-3.374	0.210	-	-	-
Living status						
I live with my children	2.8	0.5-59.7	0.5	-	-	-
Self-Rated Health						
Fair	0.90	0.02-40.981.0	0.961.0	-	-	-
Good	1.61	0.31-19.326	0.71	-	-	-
Information Package	-	-	-	-	-	-
Attended info session	0.82	0.091-7.071	0.859	-	-	-
Waiting time to see GP	0.61	0.114-2.687	0.51	-	-	-
Attendance to rehabilitation	1.92	0.51-7.23	0.33	0.172	0.051-0.596	0.006

Note. *Full model included public or private hospital; stroke or transient ischemic attack (TIA); upper gastrointestinal disease; Self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance to recommended rehabilitation or physiotherapy; and living status. **Reduced model included variables public or private hospital and attendance to recommended rehabilitation or physiotherapy. Both the models were run when adjusting for age and sex.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7,8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8
Bias	9	Describe any efforts to address potential sources of bias	*9*
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8,9,10
		(*b*) Describe any methods used to examine subgroups and interactions	8,9,10
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	Not available
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 1-3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12
		(*b*) Report category boundaries when continuous variables were categorized	11,12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11,12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13,14,15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15,16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Understanding Factors affecting 30-day Unplanned Readmissions for Patients undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to Home Orthopaedics Survey

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Understanding Factors affecting 30-day Unplanned Readmissions for Patients undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to Home Orthopaedics Survey

Running title: Unplanned readmissions following knee arthroplasty

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All authors have read and approve the manuscript below

Abstract

Objectives

The aim of this study was to investigate factors associated with unplanned 30-day readmissions following a TKA, including association with post-hospital syndrome, patient enablement, and transition from hospital to home.

Design, setting and participants

A cross-sectional written survey of public and private patients attending a six-week follow-up appointment after TKA at one of four clinical services in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019. Multiple logistic regression analyses were used to measure associations between patient, hospital and transitional care factors with unplanned 30-day readmissions, whilst controlling for known confounders.

Results

Of the 380 participants who completed the survey (n=380, 54% of TKAs undertaken over the study period), 4% (n=13) were subsequently readmitted within 30 days of discharge after a primary hospitalization. After controlling for age and sex, public patients were significantly more likely to be readmitted within 30 days than private patients (OR=6.31, 95% CI:1.59-25.14, p=0.009), and patients who attended rehabilitation were significantly less likely to have been readmitted within 30 days than those who did not (OR=0.16, 95% CI: 0.04-0.57, p=0.005). There were no associations between post-hospital syndrome or patient enablement and 30-day readmissions in this study.

Conclusion

Reasons underlying the difference in unplanned readmission rates for public versus private patients need to be explored, including differences in surgical waiting times. Strategies to foster increased participation post-surgical rehabilitation programs need to be developed as an avenue to mitigate the burden of unplanned 30-day readmissions on individuals and health systems.

Keywords: knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care, hospital performance.

ARTICLE SUMMARY

- A survey, co-designed with clinicians and patients, examined associations between patient, hospital and transitional care factors and unplanned 30-day readmission following total knee arthroplasty in both public and private hospital settings.
- This study is the first to use patient-reported responses to quantify the effect of hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions following total knee arthroplasty.
- A limitation of this study is that results were based on self-reported patient outcomes with no capacity to link them to hospital records for confirmation as well as the lack of information from those who declined the survey.

Introduction

Unplanned readmission rates are an indicator of health system performance [1, 2]. The rate of unplanned 30-day readmission for total knee arthroplasty (TKA) in Australian public hospitals was 2.6% in 2017-18 [3]. In the United States, readmission rates have been used as an incentive to reduce readmission and drive improved practice [4]. While there is no such program in Australia, the economic burden of unplanned readmissions makes it a policy priority [3, 5, 6].

The rate of knee replacement surgery has more than doubled over the past 15 years both in Australia and internationally [7] with the highest rate of increase seen in the private sector [3, 5, 8]. This growing demand has placed increased logistical and financial strain on the healthcare system, including associated unplanned 30-day readmissions [5]. The most common condition-related causes of unplanned readmission following a total knee arthroplasty (TKA) are surgical-site infection, arthrofibrosis, cellulitis, concomitant co-morbidities, and fluid and electrolyte imbalance [9]. Other factors such as old age, revision procedure and acute length of hospital stay also increase the risk of unplanned 30-day readmissions [9]. Beyond the complications as a cause of the readmission, there are patient factors related to the hospital stay that increase risk of readmission [10].

Krumholz [11] describes post-hospital syndrome as a period of vulnerability after discharge from the hospital which leaves a patient at increased risk of re-hospitalization from conditions which are often unrelated to the original reason for of admission. It is proposed that this acquired transient state might be due to patients' experiences of pain, sleep deprivation, and poor nutrition during their hospital stay [11]. While this hypothesis is supported by evidence that increasing patient capacity for self-care is effective at reducing 30-day readmissions [10], , as far as we are aware, post-hospital syndrome has not been

quantified or measured as an independent variable in association with unplanned 30-day readmission.

Research examining unplanned 30-day readmissions has described a number of associated factors. These factors include: clinical and demographic characteristics [12, 13]; a lack of access to primary care; the continuity and regularity of primary care [14-16]; and deficits in hospital discharge planning, which often focus on knowledge provision rather than patients' capacity to implement this knowledge [10].

The patient-enablement instrument is a tool used to measure a person's knowledge and understanding of their health condition; confidence to manage their condition, health, and life [17]; and their ability to source appropriate healthcare for their individual needs. While this measure has largely been examined in primary-care settings, its role in preventing unplanned hospital readmissions has not yet been explored.

The purpose of this study was to investigate factors associated with unplanned 30-day readmissions following a TKA, including aspects of hospital experiences, patient enablement, and transition from hospital to home.

Methods

Study population

Consecutive patients over the age of 16 years, attending a six-week follow-up appointment after undergoing total knee arthroplasty at one of four private and public clinical services between 1 February 2018 and 31 January 2019.

Study design

A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019 at all private and public sites undertaking lower limb joint replacement services. Data was collected retrospectively at the six-week follow-up appointment post-surgery for both total knee and hip replacement (THA). The responses for patients having undergone elective TKA are presented in this paper.

Instrument

The *ACT Transition from Hospital to Home Survey* was developed and piloted by researchers at the Australian National University, Canberra Hospital, Academic Unit of General Practice ACT Health, Capital Health Network, Health Care Consumer Association ACT, and people who had previously experienced either TKA or THA [18]. The 50-item survey was designed to measure patients' experiences in hospital and transition to home across six domains: 1. Patient demographic characteristics and co-morbidities; 2. Post-hospital syndrome; 3. Medication enablement; 4. Patient enablement; 5. Transition to general practice; and 6. Pre- and post-hospital information and pre-/post-surgical rehabilitation

Co-morbidities: Morbidity was assessed with the validated 18-item Functional Comorbidity Index which is used to predict functional status rather than mortality [19].

Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.

Medication enablement: Three items measured medication enablement in terms of patients' knowledge and ability to manage their medications following discussions with health care providers derived from a previous study in general practice nurse consultations [20]. The internal consistency of this scale was established ($\alpha = 0.80$) in the pilot study (unpublished results).

Patient enablement: This is the internationally validated six-item Patient Enablement Instrument [21] used primarily in primary-care research.

Transition to general practice: 10-items assessing patients' relationships with their general practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning, patients' understanding of when to see their GP following discharge, and access to care. These questions were refined as a result of the pilot study to eliminate covariance and repetition.

Interaction with the recommended rehabilitation program: Referral and attendance to outpatient physiotherapy rehabilitation post-discharge was examined with one item.

Data collection

The paper surveys were distributed by reception staff at patients' six-week post-operative consultation. Staff were given a protocol and suggested wording to use when providing the survey. An information sheet about the study was provided to patients and anonymity guaranteed. Patients were not required to include their name or identifying information on the survey. This ensured that patients understood that participation or non-participation did not affect the care they received and that completed surveys were confidential to clinic staff. Completion of the survey implied written consent, and this was agreed and approved by the local ethics committee. Surveys were deposited in a sealed box in the waiting room and collected by the researcher at regular intervals.

Data analysis

Completed survey data was collated and descriptive and inferential statistics used. Variables were described using summary statistics and frequencies. Some variables were grouped to create new variables and others, for example, BMI, were converted to categorical variables for analysis. The primary outcome of interest was self-reported 30-day readmission to hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living situation, country of origin, education, self-rated health, comorbidities, post-hospital syndrome (experiences of sleep, diet and pain), experiences of family practice (access, continuity, planning, regularity), medication enablement, and patient enablement were separate independent variables.

An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to explore the relationship between variables which described post hospital syndrome. The modes/themes which had an eigenvalue of >1 were retained and the internal consistency of the modes which emerged was examined using Cronbach's alpha. The suitability of the data for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.

Prior to analysis, variable independence was established. Ordinal variables were examined using Spearman's correlation coefficient and categorical variables using the chi squared (χ^2) test and odds ratio. If a strong correlation (> 0.6) or a significant association ($p \leq 0.2$) existed between two eligible variables, only one of these was retained for inclusion in the final analysis.

Univariate logistic regression analysis was conducted for each independent variable and the dependent variable (unplanned 30-day readmission). Univariate logistic regression was conducted on each individual comorbidity item, and then for the total comorbidity score.

To further eliminate potential confounding, two multiple logistic regression models were run - one including eligible individual variables from within the Functional Comorbidity Index,

Medication Enablement questions and the Patient Enablement Instrument; and a second including total scores.

The full multiple regression model included eight variables. These were public or private hospital; upper gastrointestinal disease; self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance at recommended rehabilitation or physiotherapy; and living status. The reduced model included 'public or private hospital' and 'attendance at recommended rehabilitation or physiotherapy'. Only risk factors with *p*-values ≤0.25 were included in the multiple logistic regression analyses. Logistic regression with backward stepwise selection was used to choose risk factors for the multivariable model. A significance level of 0.25 was required to allow a risk factor into the model, and a significance level of 0.25 was required for a risk factor to stay in the model. Additionally, risk factor selection for the model may be driven by available knowledge and biological plausibility of potential confounders, taking into consideration the hypothesis of interest. The adjusted odds ratio and its 95% confidence interval were calculated for each risk factor in the presence of others in the final model. Both the models were adjusted for age and sex.

Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit of the final model. The Receiver Operator Characteristic Curve (ROC) was plotted to check the specificity and sensitivity of the predicted model.

Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].

Missing data

The criteria used for acceptability of non-response to all survey questions was 10% or lower including for medication and patient enablement scale [23-25]. Missing data for individual

variables within the medication and patient enablement scales were imputed to equal the median value of non-missing data [26-29].

Ethical approval

Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics Committees. All participants provided written informed consent to participate in this study.

Results

Of the 1069 people invited to participate, 827 (77%) completed the overall survey.

Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within 30 days. Participant demographics are presented in Table 1. Private patients accounted for 65% of the total population (247 private patients, 133 public patients). This represented 44% of all private patients and 96% of all public patients who had a TKA during the study period which represents 54% of all TKAs. 57% of those who underwent knee surgery were females. The mean age was 67.4 with a standard deviation 0.5 years (age range 44.8 to 91.0 years). Mean BMI was 31.5 kg/m^2 with most having a BMI of >30 (58%). Most participants were non-indigenous (99%). There were three people of Aboriginal and/or Torres Strait Islander origin, none of whom was readmitted. There were proportionally more private patients aged 65-84 years (63%) compared to public (53%), whereas proportionally more public patients were in the 45-64 age group (44% compared to 35%). The proportion of females within the public cohort was greater than private (67% compared to 57%). A higher proportion of public patients lived alone (31% compared to 23%).

Table 1. Characteristics of all TKA patients and those with an unplanned 30-day readmission.

Variable		Public	Private	Total
		N=133 n/N	N=247 n/N	N=13/380 (%)*
Age	45-64	1/55	1/79	2/134 (1.5%)
	65- 84	8/66	2/145	10/211(4.7%)
	>85 years	0/4	0/5	0/9
Gender	Male	2/42	1/97	3/139 (2.2%)
	Female	7/86	3/129	10/215 (4.6%)
	Other	0/0	0/2	0/2
Language	Other than English at home	0/21	2/28	2/49 (4.1%)
	Only speak English	9/108	2/212	11/320 (3.4%)
Living Status	Live alone	7/40	0/55	2/95 (2.1%)
	Live with someone	2/90	4/189	11/273 (4%)
BMI Calculations	BMI (Mean)	31.5		
	18.5-24.4	1/7	0/22	1/31 (3.2%)
	24.5-30	1/34	2/86	2/129 (1.6%)
	>30	7/74	3/109	10/220 (4.5%)
Indigenous status	Aboriginal	0/1	0/0	0/1
	Torres Strait Islander	0/1	0/1	0/2

	Both			0/0
	Neither	9/104	4/198	13/315 (4.1%)
Education	No school certificate or other qualifications	0/9	0/11	0/22
	School or intermediate certificate	5/40	1/40	6/87 (6.9%)
	Year 12 or leaving certificate	1/17	1/32	2/54 (3.7%)
	Trade/ apprenticeship	0/10	1/17	1/30 (3.3%)
	Certificate/ diploma	2/23	0/50	2/76 (2.6%)
	University degree or higher	1/17	1/68	2/95 (2.1%)
Public/Private	Public	-	-	9/134 (6.7%)
	Private	-	-	4/246 (1.6%)

*Missing values for age: 26, Gender: 24, Language: 11, Living status: 6, BMI: 36, Indigenous status: 62 , Education: 16.

**Missing value for readmission for age: 1

Post-hospital syndrome exploratory factor analysis (EFA)

The results of the exploratory factor analysis are reported in Table 2. Three modes/themes with acceptable internal consistency emerged. First, diet, which was described by responses to two questions: "Did you feel your dietary requirements were met in hospital?" and "Overall, how would you rate the quality of the food in hospital?" The second theme was pain, which was also explained by two questions: "How would you describe the general level of pain you experienced?" and "When you left hospital, how would you rate your pain out of 10?" The third was sleep which was explained by "Did you feel well rested when you left the hospital?" and "How would you rate the quality of sleep in the hospital?"

Floor and ceiling effects were observed for patient enablement due to a large number of participants reporting being either fully enabled or not enabled at all. To address this, the variable was dichotomised around the mean where 'less enabled' was ≤6.5 and 'more enabled' was >6.5 in line with previous studies using this instrument [28, 30]. Sixty percent of participants (n=212/357) reported that they were less enabled to manage their health after their stay in the hospital.

Table 2. Exploratory Factor Analysis (EFA) and emerging variables.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	2.53	0.85	0.18	0.18
Factor 2	1.69	0.42	0.12	0.30
Factor 3	1.27	0.12	0.09	0.39
Bartlett test of sphericity p=0.000				
Kaiser-Meyer-Olkin (KMO)= 0.62				

Variable	Factor 1	Factor 2	Factor 3
Did you feel your dietary requirements were met in hospital?	**0.88**	0.01	0.10
Overall, how would you rate the quality of the food in hospital?	**0.86**	0.01	0.09
How would you describe the general level of pain you experienced?	-0.02	**0.83**	0.10
When you left hospital, how would you rate your pain out of 10?	0.04	**0.75**	0.09
Did you feel well rested when you left the hospital?	0.20	0.18	**0.75**
How would you rate the quality of sleep in the hospital? (Poor)	0.30	0.18	**0.67**

Multiple logistic regression analysis

The results of univariate analysis are presented in Supplementary table 1. The Area Under the Curve (AUC) was 0.79 indicating high overall accuracy of the logistic model (79%) (Figure 1). Eight variables were eligible for inclusion in the multiple logistic regression analysis. Due to the wide confidence interval for stroke, this variable was eliminated from the full model. Of these, 'public /private status' and 'rehabilitation attendance' were retained for the reduced model as they were the only variables to retain significance after stepwise removal of the other variables in the full model. The results of the multiple regression analysis are reported in Table 3.

The final multiple regression model included a sample size of 328 observations and the following factors remained significant. After controlling for age and sex, public patients were significantly more likely to be readmitted within 30 days compared to private patients (OR=6.31, 95% CI:1.59-25.14, p=0.009), and patients attended rehabilitation were significantly less likely to be readmitted within 30 days of discharge than those who did not (OR=0.16, 95% CI: 0.04-0.57, p=0.005).

Table 3. Results of multiple logistic regression analysis examining the association between patient, hospital and transition to general practice factors associated with unplanned 30-day readmission to hospital.

	*Full model**			*Reduced model** (n=328)*		
Relevant Variables	*OR*	*95% CI*	*p-Value*	*OR*	*95% CI*	*p-Value*
Public or Private	3.44	0.70-16.89	0.12	6.31	1.59-25.14	0.009
Co-morbidity						

Upper gastrointestinal disease	0.43	0.06-2.96	0.39	-	-	-
Living status	0.27	0.03-2.45	0.25	-	-	-
Self-Rated Health	0.39	0.14-1.13	0.08	-	-	-
Information Package	0.56	0.05-4.04	0.65	-	-	-
Attended info session	0.80	0.16-7.071	0.79	-	-	-
Waiting time to see GP	0.60	0.23-1.58	0.30	-	-	-
Attendance to rehabilitation	0.21	0.05-0.96	0.04	0.16	0.04-0.57	0.005

Note. *Full model included public or private hospital; upper gastrointestinal disease; Self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance to recommended rehabilitation or physiotherapy; and living status. **Reduced model included variables public or private hospital and attendance to recommended rehabilitation or physiotherapy. Both the models were run when adjusting for age and sex.

Discussion

The aim of this study was to investigate factors associated with unplanned 30-day readmission in TKA patients. Of the 4% of patients who had an unplanned readmission, those who attended public hospitals and those who did not attend an outpatient rehabilitation program were more likely to be readmitted to hospital within 30 days of discharge.

While the United States also has a similar 4% readmission rate following TKA [9, 31-33], this is higher than that reported by the Australian Institute of Health and Welfare (AIHW) [3]. However, our results may reflect the true readmission rate more accurately as the AIHW only reports public hospital data and the majority of TKAs in Australia are performed in the private sector.

In our study, public patients were more likely to be readmitted within 30 days as compared to private patients. The majority of respondents (65%) had their TKA in the private sector,

consistent with the higher proportion (80%) of TKA procedures performed in the private sector in the ACT [34]. Our study has almost complete ascertainment from the public sector, and reasonable ascertainment from the private sector, supporting the robustness of our findings. The increased likelihood of readmission for public patients might be explained by several contributing factors such as socioeconomic status, longer waiting times and increased disease complexity [35-40]. The median waiting time for a TKA in 2018-19 in the ACT public hospital system was 62 days with 8.2% of patients waiting more than 365 days [35]. On the other hand, the median waiting time for Australian private patients was just 67 days during the same period [2, 41]. Therefore, waiting time may be an important mediating factor however association between the two may only be inferred and no causation can be implied.

Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions for elective surgical procedures in Australia [42]. TKA patients who waited longer than six months have been described as having significantly worse function and quality of life scores, as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and depression [43]. It is important to understand that surgical waiting times are only part of the waiting journey for patients in the public system. The mean waiting times recorded for Australian patients do not take into account the lengthy process of referral, specialist assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical exercise and education programs are increasingly being implemented and the evidence for efficacy is strong [45, 46].

In our study, patients who attended rehabilitation were less likely to be readmitted within 30 days than those who did not. Previous research indicates that private patients are more likely to attend rehabilitation than public patients [47] and that rehabilitation is associated with better physical function after TKA [45]. However, we found no significant relationship

between being a public or private patient and attendance at rehabilitation. Both groups in our sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after six weeks indicating that private/public status was not a mediating factor for this finding.

This study showed no significant associations between general practice (GP) factors and unplanned 30-day readmissions. A recent study reported that timely and regular GP contact during the two years following transition from hospital to community care lowered the risk of emergency readmission to hospital in patients with cardiovascular disease [48]. However, our results might reflect the nature of the health condition. This cohort included people having TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other diseases in that the treatment is potentially definitive and is followed up by the surgeon.

Although more than half of the patients who were readmitted had high scores for post-hospital syndrome, there was no significant association with 30-day readmission. The hypothesis of post-hospital syndrome describes a transient state resulting in consequences, including a higher risk of readmission [11]. Brownlee et al. [49] found that post-hospital syndrome was an independent predictor of readmission within 30 days of discharge in a large cohort of surgical patients. While other studies have attempted to determine the impact of post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to use patient-reported responses to quantify the effect of hospital experience (of pain, sleep, and nutrition) on unplanned 30-day readmissions.

There are limitations to this study. The main limitation was that there were fewer readmissions than anticipated and the study may have been insufficiently powered for detecting the associations being tested. The results were based on anonymous self-reports; hence there was no capacity to link them to hospital data to establish actual readmission time frames, length of hospital stay, reasons for readmission or previous admission history.

However, our primary endpoint was 30-day readmission and we believe that the self-reported data was accurate. The response rate is only an estimation based on joint replacement activity in the ACT. It assumes that all patients returning for their six-week follow-up appointment were invited to participate. We do not know whether the reception staff invited all patients, or only some. The lack of information about non-responders is another limitation of this study. More non-responders may have been readmitted and it is possible that they may have been sicker than responders, which would also influence the readmission rate. Also, as the ACT has a relatively high socioeconomic demographic the findings from this study may not apply to other less affluent areas.

Our data do not allow us to understand why rehabilitation was not accessed. It is possible that patients who were frailer did not feel able to participate and perhaps they were the patients who were readmitted. However, a range of patient and provider-based factors have been recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as insurance provider and hospital business model [51]. This association needs clarification.

It is not known if the rate of readmission can be reduced given the significant comorbidities of the TKA patient sample.

Conclusion

This study was undertaken to explore the factors impacting unplanned 30-day readmission after TKA. These results have implications for policy and for practice. An over-representation of public patients in the readmitted cohort is important. It is possible that the extended periods of delay to surgery among patients on the public waiting list may be an

important factor. Therefore, it is essential to shorten waiting times and prioritize medical need when dealing with public patients. Clinicians should also place emphasis on the importance of attending rehabilitation after a TKA as an effective way to reduce 30-day readmission. Further investigation of how the pre-surgical patient journey can be better optimised to reduce readmission rates is warranted.

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Competing interests

None declared.

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Data sharing statement

Survey data and statistical analysis plans are available from Dr Desborough (ORCID ID: 0000-0003-1406-4593) upon reasonable request.

Figures

Figure 1. Receiver Operator Curve

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564 Supplementary table 1. Results of univariate logistic regression analyses of variables
565 associated with unplanned 30-day readmission in patients who received total knee
566 arthroplasty

567

	Odds Ratio		
Variables	*OR*	*95% CI*	*p-value*
Public vs Private	4.2	1.2-14.2	0.02
Comorbidities			
Arthritis[#]	1.6	0.2-12.7	0.66
Osteoporosis	1.4	0.3-5.6	0.65
Asthma	0.8	0.2-3.8	0.78
COPD, ARDS, emphysema	2.2	0.3-19.1	0.47
Angina	-	-	-
Congestive heart failure (or heart disease)	1.9	0.2-16.4	0.56
Heart attack	-	-	-
Neurological disease	-	-	-
Stroke or TIA	5.2	0.9-29.6	0.06
Peripheral vascular disease	-	-	-
Diabetes type I and II	1.3	0.3-6.2	0.77
Upper GI disease	0.3	0.1-1.6	0.17
Depression	0.8	0.2-3.9	0.77
Anxiety or panic disorders	1.7	0.5-8.5	0.29
Visual impairment	1.0	0.3-3.7	0.98
Hearing impairment	1.3	0.3-6.0	0.80
Degenerative disc disease	1.6	0.5-5.4	0.44
Morbidity scale	1.4	0.7-2.8	0.40
0	-	-	-

1	0.6	0.1-2.9	0.56
2	0.4	0.1-2.3	0.32
3 or more	-	-	-
Self-Rated Health Before you went to hospital	0.5	0.2-1.0	0.04
Invited to attend session by surgeon	0.5	0.1-1.5	0.21
Attended information session	1.0	0.3-3.2	0.99
Usefulness of pre-surgery information session	0.7	0.3-1.9	0.53
Given information package or checklist	0.2	0.03-0.82	0.03
Use of information package or checklist	-	-	-
Pain	-	-	-
Worst pain (more than six score)	1.5	0.4-5.7	0.51
Pain experienced during hospital stay (general pain)	4.7	1.0-21.6	0.05
Pain on discharge (less than 6)	5.0	1.3-18.4	0.016
Medication for pain control	0.4	0.1-1.7	0.20
Pain management with ice	0.9	0.2-4.2	0.90
Breathing exercise	1.9	0.6-6.2	0.30
Sleep			
Single/shared room (single)	1.4	0.4-4.8	0.55
Quality of sleep (Poor)	1.2	0.4-4.0	0.80
Medication for sleep	1.2	0.4-3.9	0.71

Feel rested when leaving hospital	1.5	0.5-4.5	0.50
Dietary requirement met	0.4	0.1-3.3	0.41
Water in reach	3.5	0.7-17.1	0.12
Quality of food in hospital(average)	0.5	0.1-4.0	0.52
Discussion of medications with health care provider	0.5	0.1-2.1	0.38
Patient medication enablement			
Better understand use of medication	0.4	0.1-3.6	0.44
Feel more confident about taking medications	0.7	0.1-6.2	0.80
Take your medications	0.5	0.1-4.0	0.48
Total medication enablement (medication scale)	0.9	0.6-1.4	0.59
Patient enablement			
Able to cope with life	0.7	0.3-1.6	0.46
Able to understand your condition	0.9	0.4-1.2	0.81
Able to cope with your condition	0.8	0.3-1.7	0.50
Able to keep yourself healthy	1.2	0.5-2.6	0.65
Confident about your health	0.6	0.3-1.4	0.25
Able to help yourself	1.3	0.6-2.8	0.54
Total enablement score (less enabled)	1.0	0.3-3.3	0.96

When you got home from hospital			
Recall being given information about who to contact	0.8	0.2-3.8	0.79
Who were you instructed to contact?	0.8	0.6-1.0	0.05
Go to ED within 30 days of discharge	42.5	10.9-164.8	0.00
Readmitted within 30 days of discharge	-	-	-
General Practice Questions			
Regular GP practice	-	-	-
See the same doctor	0.3	0.0-3.0	0.33
Regular appointments with GP	1.2	0.4-3.7	0.76
Discussion of plan with GP	0.7	0.2-2.2	0.50
When were you advised to see GP next	1.9	0.2-14.7	0.56
Usual waiting time to see GP	0.9	0.4-1.8	0.80
How soon after surgery did you see GP	0.9	0.4-1.8	0.80
Attendance to rehab program	0.1	0.0-0.4	0.001
Attendance to rehab within 5 days	2.2	0.8-5.5	0.11
Length of attendance to rehab	0.9	0.5-1.5	0.60

568

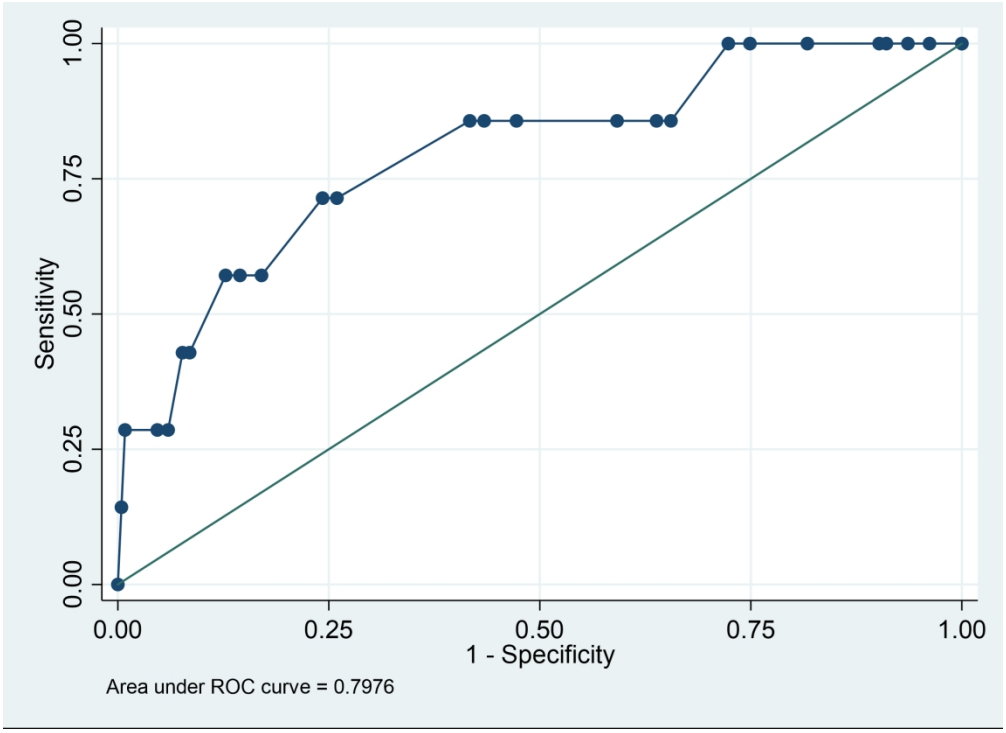

Figure 1. Receiver Operator Curve

272x198mm (236 x 236 DPI)

Supplementary table 1. Results of univariate logistic regression analyses of variables associated with unplanned 30-day readmission in patients who received total knee arthroplasty

	Odds Ratio		
Variables	*OR*	*95% CI*	*p-value*
Public vs Private	4.2	1.2-14.2	0.02
Comorbidities			
Arthritis[#]	1.6	0.2-12.7	0.66
Osteoporosis	1.4	0.3-5.6	0.65
Asthma	0.8	0.2-3.8	0.78
COPD, ARDS, emphysema	2.2	0.3-19.1	0.47
Angina	-	-	-
Congestive heart failure (or heart disease)	1.9	0.2-16.4	0.56
Heart attack	-	-	-
Neurological disease	-	-	-
Stroke or TIA	5.2	0.9-29.6	0.06
Peripheral vascular disease	-	-	-
Diabetes type I and II	1.3	0.3-6.2	0.77
Upper GI disease	0.3	0.1-1.6	0.17
Depression	0.8	0.2-3.9	0.77
Anxiety or panic disorders	1.7	0.5-8.5	0.29
Visual impairment	1.0	0.3-3.7	0.98
Hearing impairment	1.3	0.3-6.0	0.80
Degenerative disc disease	1.6	0.5-5.4	0.44
Morbidity scale	1.4	0.7-2.8	0.40

0	-	-	-
1	0.6	0.1-2.9	0.56
2	0.4	0.1-2.3	0.32
3 or more	-	-	-
Self-Rated Health	0.5	0.2-1.0	0.04
Before you went to hospital			
Invited to attend session by surgeon	0.5	0.1-1.5	0.21
Attended information session	1.0	0.3-3.2	0.99
Usefulness of pre-surgery information session	0.7	0.3-1.9	0.53
Given information package or checklist	0.2	0.03-0.82	0.03
Use of information package or checklist	-	-	-
Pain	-	-	-
Worst pain (more than six score)	1.5	0.4-5.7	0.51
Pain experienced during hospital stay (general pain)	4.7	1.0-21.6	0.05
Pain on discharge (less than 6)	5.0	1.3-18.4	0.016
Medication for pain control	0.4	0.1-1.7	0.20
Pain management with ice	0.9	0.2-4.2	0.90
Breathing exercise	1.9	0.6-6.2	0.30
Sleep			
Single/shared room (single)	1.4	0.4-4.8	0.55

Quality of sleep (Poor)	1.2	0.4-4.0	0.80
Medication for sleep	1.2	0.4-3.9	0.71
Feel rested when leaving hospital	1.5	0.5-4.5	0.50
Dietary requirement met	0.4	0.1-3.3	0.41
Water in reach	3.5	0.7-17.1	0.12
Quality of food in hospital(average)	0.5	0.1-4.0	0.52
Discussion of medications with health care provider	0.5	0.1-2.1	0.38
Patient medication enablement			
Better understand use of medication	0.4	0.1-3.6	0.44
Feel more confident about taking medications	0.7	0.1-6.2	0.80
Take your medications	0.5	0.1-4.0	0.48
Total medication enablement (medication scale)	0.9	0.6-1.4	0.59
Patient enablement			
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7,8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8
Bias	9	Describe any efforts to address potential sources of bias	*9*
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8,9,10
		(*b*) Describe any methods used to examine subgroups and interactions	8,9,10
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	Not available
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 1-3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12
		(*b*) Report category boundaries when continuous variables were categorized	11,12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11,12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13,14,15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15,16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Understanding Factors affecting 30-day Unplanned Readmissions for Patients undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to Home Orthopaedics Survey

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Understanding Factors affecting 30-day Unplanned Readmissions for Patients undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to Home Orthopaedics Survey

Running title: Unplanned readmissions following knee arthroplasty

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Christine Phillips[c]: survey development, significant contributions to final manuscript

Anne Parkinson[a]: data collection, significant contributions to final manuscript,

Nicholas Glasgow[c]: survey development, significant contributions to final manuscript;

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Darlene Cox[d]: survey development, contributions to final manuscript;

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All authors have read and approve the manuscript below

Abstract

Objectives

The aim of this study was to investigate factors associated with unplanned 30-day readmissions following a TKA, including association with post-hospital syndrome, patient enablement, and transition from hospital to home.

Design, setting and participants

A cross-sectional written survey of public and private patients attending a six-week follow-up appointment after TKA at one of four clinical services in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019. Multiple logistic regression analyses were used to measure associations between patient, hospital and transitional care factors with unplanned 30-day readmissions, whilst controlling for known confounders.

Results

Of the 380 participants who completed the survey (n=380, 54% of TKAs undertaken over the study period), 3.4% (n=13; 95% confidence interval; 1.8 – 5.8) were subsequently readmitted within 30 days of discharge after a primary hospitalization. Public patients were significantly more likely to be readmitted within 30 days compared to private patients (adjusted OR=6.31, 95% CI:1.59-25.14, p=0.009), and patients who attended rehabilitation were significantly less likely to be readmitted within 30 days of discharge than those who did not (adjusted OR=0.16, 95% CI: 0.04-0.57, p=0.005). There were no associations between post-hospital syndrome or patient enablement and 30-day readmissions in this study.

Conclusion

Reasons underlying the difference in unplanned readmission rates for public versus private patients need to be explored, including differences in surgical waiting times and the consequences for impairment and disease complexity. Strategies to foster increased participation post-surgical rehabilitation programs need to be developed as an avenue to mitigate the burden of unplanned 30-day readmissions on individuals and health systems.

Keywords: knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care, hospital performance.

ARTICLE SUMMARY

- A survey, co-designed with clinicians and patients, examined associations between patient, hospital and transitional care factors and unplanned 30-day readmission following total knee arthroplasty in both public and private hospital settings.
- This study is the first to use patient-reported responses to quantify the effect of hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions following total knee arthroplasty.
- A limitation of this study is that results were based on self-reported patient outcomes with no capacity to link them to hospital records for confirmation as well as the lack of information from those who declined the survey.

Introduction

Unplanned readmission rates are an indicator of health system performance [1, 2]. The rate of unplanned 30-day readmission for total knee arthroplasty (TKA) in Australian public hospitals was 2.6% in 2017-18 [3]. In the United States, readmission rates have been used as an incentive to reduce readmission and drive improved practice [4]. While there is no such program in Australia, the economic burden of unplanned readmissions makes it a policy priority [3, 5, 6].

The rate of knee replacement surgery has more than doubled over the past 15 years both in Australia and internationally [7] with the highest rate of increase seen in the private sector [3, 5, 8]. This growing demand has placed increased logistical and financial strain on the healthcare system, including associated unplanned 30-day readmissions [5]. The most common condition-related causes of unplanned readmission following a total knee arthroplasty (TKA) are surgical-site infection, arthrofibrosis, cellulitis, concomitant co-morbidities, and fluid and electrolyte imbalance [9]. Other factors such as old age, revision procedure and acute length of hospital stay also increase the risk of unplanned 30-day readmissions [9]. Beyond the complications as a cause of the readmission, there are patient factors related to the hospital stay that increase risk of readmission [10].

Krumholz [11] describes post-hospital syndrome as a period of vulnerability after discharge from the hospital which leaves a patient at increased risk of re-hospitalization from conditions which are often unrelated to the original reason for of admission. It is proposed that this acquired transient state might be due to patients' experiences of pain, sleep deprivation, and poor nutrition during their hospital stay [11]. While this hypothesis is supported by evidence that increasing patient capacity for self-care is effective at reducing 30-day readmissions [10], as far as we are aware, post-hospital syndrome has not been

quantified or measured as an independent variable in association with unplanned 30-day readmission.

Research examining unplanned 30-day readmissions has described a number of associated factors. These factors include: clinical and demographic characteristics [12, 13]; a lack of access to primary care; the continuity and regularity of primary care [14-16]; and deficits in hospital discharge planning, which often focus on knowledge provision rather than patients' capacity to implement this knowledge [10].

The patient-enablement instrument is a tool used to measure a person's knowledge and understanding of their health condition; confidence to manage their condition, health, and life [17]; and their ability to source appropriate healthcare for their individual needs. While this measure has largely been examined in primary-care settings, its role in preventing unplanned hospital readmissions has not yet been explored.

The purpose of this study was to investigate factors associated with unplanned 30-day readmissions following a TKA, including aspects of hospital experiences, patient enablement, and transition from hospital to home.

Methods

Study population

Consecutive patients over the age of 16 years, attending a six-week follow-up appointment after undergoing total knee arthroplasty at one of four private and public clinical services between 1 February 2018 and 31 January 2019.

Patient and public involvement

Five people who had previously had an arthroplasty with a surgeon from one of the participating clinics completed the survey and provided feedback regarding its meaningfulness in relation to their experiences, and the length and readability of the survey.

Study design

A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1 February 2018 and 31 January 2019 at all private and public sites undertaking lower limb joint replacement services. Data was collected retrospectively at the six-week follow-up appointment post-surgery for both total knee and hip replacement (THA). The responses for patients having undergone elective TKA are presented in this paper.

Instrument

The *ACT Transition from Hospital to Home Survey* was developed and piloted by researchers at the Australian National University, Canberra Hospital, Academic Unit of General Practice ACT Health, Capital Health Network, Health Care Consumer Association ACT, and people who had previously experienced either TKA or THA [18]. The 50-item survey was designed to measure patients' experiences in hospital and transition to home across six domains: 1. Patient demographic characteristics and co-morbidities; 2. Post-hospital syndrome; 3. Medication enablement; 4. Patient enablement; 5. Transition to general practice; and 6. Pre- and post-hospital information and pre-/post-surgical rehabilitation

Co-morbidities: Morbidity was assessed with the validated 18-item Functional Comorbidity Index which is used to predict functional status rather than mortality [19].

Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.

Medication enablement: Three items measured medication enablement in terms of patients' knowledge and ability to manage their medications following discussions with health care providers derived from a previous study in general practice nurse consultations [20]. The internal consistency of this scale was established ($\alpha = 0.80$) in the pilot study (unpublished results).

Patient enablement: This is the internationally validated six-item Patient Enablement Instrument [21] used primarily in primary-care research.

Transition to general practice: 10-items assessing patients' relationships with their general practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning, patients' understanding of when to see their GP following discharge, and access to care. These questions were refined as a result of the pilot study to eliminate covariance and repetition.

Interaction with the recommended rehabilitation program: Referral and attendance to outpatient physiotherapy rehabilitation post-discharge was examined with one item.

Data collection

The paper surveys were distributed by reception staff at patients' six-week post-operative consultation. Staff were given a protocol and suggested wording to use when providing the survey. An information sheet about the study was provided to patients and anonymity guaranteed. Patients were not required to include their name or identifying information on the survey. This ensured that patients understood that participation or non-participation did not affect the care they received and that completed surveys were confidential to clinic staff. completion of the survey implied written consent and this was agreed and approved by the local ethics committee. Surveys were deposited in a sealed box in the waiting room and collected by the researcher at regular intervals.

Data analysis

Completed survey data was collated and descriptive and inferential statistics used. Variables were described using summary statistics and frequencies. Some variables were grouped to create new variables and others, for example, BMI, were converted to categorical variables for analysis. The primary outcome of interest was self-reported 30-day readmission to hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living situation, country of origin, education, self-rated health, comorbidities, post-hospital syndrome (experiences of sleep, diet and pain), experiences of family practice (access, continuity, planning, regularity), medication enablement, and patient enablement were separate independent variables.

An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to explore the relationship between variables which described post hospital syndrome. The modes/themes which had an eigenvalue of >1 were retained and the internal consistency of the modes which emerged was examined using Cronbach's alpha. The suitability of the data for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.

Prior to analysis, variable independence was established. Ordinal variables were examined using Spearman's correlation coefficient and categorical variables using the chi squared (χ^2) test and odds ratio. If a strong correlation (> 0.6) or a significant association ($p \leq 0.2$) existed between two eligible variables, only one of these was retained for inclusion in the final analysis.

Univariate logistic regression analysis was conducted for each independent variable and the dependent variable (unplanned 30-day readmission). Univariate logistic regression was conducted on each individual comorbidity item, and then for the total comorbidity score.

To further eliminate potential confounding, two multiple logistic regression models were run - one including eligible individual variables from within the Functional Comorbidity Index, Medication Enablement questions and the Patient Enablement Instrument; and a second including total scores.

The full multiple logistic regression model included eight variables. These were public or private hospital; upper gastrointestinal disease; self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance at recommended rehabilitation or physiotherapy; and living status. The reduced model included 'public or private hospital' and 'attendance at recommended rehabilitation or physiotherapy'. Only risk factors with *p*-values ≤0.25 were included in the multiple logistic regression analyses. Logistic regression with backward stepwise selection was used to choose risk factors for the multivariable model. A significance level of 0.25 was required to allow a risk factor into the model, and a significance level of 0.25 was required for a risk factor to stay in the model.. The adjusted odds ratio and its 95% confidence interval were calculated for each risk factor in the presence of others in the final model. Both the models were adjusted for age and sex.

Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit of the final model. The Receiver Operator Characteristic Curve (ROC) was plotted to check the specificity and sensitivity of the predicted model.

Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].

Missing data

The criteria used for acceptability of non-response to all survey questions was 10% or lower including for medication and patient enablement scale [23-25]. Missing data for individual variables within the medication and patient enablement scales were imputed to equal the median value of non-missing data [26-29].

Ethical approval

Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics Committees. All participants provided written informed consent to participate in this study.

Results

Of the 1069 people invited to participate, 827 (77%) completed the overall survey.

Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within 30 days. Participant demographics are presented in Table 1. Private patients accounted for 65% of the total population (247 private patients, 133 public patients). This represented 44% of all private patients and 96% of all public patients who had a TKA during the study period which represents 54% of all TKAs. 57% of those who underwent knee surgery were females. The mean age was 67.4 with a standard deviation 0.5 years (age range 44.8 to 91.0 years). Mean BMI was 31.5 kg/m^2 with most having a BMI of >30 (58%). Most participants were non-indigenous (99%). There were three people of Aboriginal and/or Torres Strait Islander origin, none of whom was readmitted. There were proportionally more private patients aged 65-84 years (63%) compared to public (53%), whereas proportionally more public patients were in the 45-64 age group (44% compared to 35%). The proportion of females within the

public cohort was greater than private (67% compared to 57%). A higher proportion of public patients lived alone (31% compared to 23%).

Table 1. Characteristics of TKA participants with an unplanned 30-day readmission (n) as a proportion of all participants (N).

Variable		**Public n/N**	**Private**	**Total**
		N=133 n/N	N=247 n/N	N=13/380 (%)*
Age	45-64	1/55	1/79	2/134 (2%)
	65- 84	4/33	2/145	10/211(5%)
	>85 years	0/4	0/5	0/9
Gender	Male	1/21	1/97	3/139 (2%)
	Female	7/86	3/129	2/55 (5%)
	Other	0/0	0/2	0/2
Language	Other than English at home	0/21	1/14	2/49 (4%)
	Only speak English	1/12	1/106	11/320 (3%)
Living Status	Live alone	7/40	0/55	2/95 (2%)
	Live with someone	1/45	4/189	11/273 (4%)
BMI Calculations	BMI (Mean)	31.5		
	18.5-24.4	1/7	0/22	1/31 (3%)
	24.5-30	1/34	1/43	2/129 (2%)
	>30	7/74	3/109	10/220 (5%)
Indigenous status	Aboriginal	0/1	0/0	0/1
	Torres Strait Islander	0/1	0/1	0/2
	Both			0/0

	Neither	9/104	2/99	13/315 (4%)
Education	No school certificate or other qualifications	0/9	0/11	0/22
	School or intermediate certificate	1/8	1/40	6/87 (7%)
	Year 12 or leaving certificate	1/17	1/32	1/27 (4%)
	Trade/ apprenticeship	0/10	1/17	1/30 (3%)
	Certificate/ diploma	2/23	0/50	1/38 (3%)
	University degree or higher	1/17	1/68	2/95 (2%)

*Missing values for age: 26, Gender: 24, Language: 11, Living status: 6, BMI: 36, Indigenous status: 62, Education: 16.

**Missing value for readmission for age: 1

Post-hospital syndrome exploratory factor analysis (EFA)

The results of the exploratory factor analysis are reported in Table 2. Three modes/themes with acceptable internal consistency emerged. First, diet, which was described by responses to two questions: "Did you feel your dietary requirements were met in hospital?" and "Overall, how would you rate the quality of the food in hospital?" The second theme was pain, which was also explained by two questions: "How would you describe the general level of pain you experienced?" and "When you left hospital, how would you rate your pain out of 10?" The third was sleep which was explained by "Did you feel well rested when you left the hospital?" and "How would you rate the quality of sleep in the hospital?"

Floor and ceiling effects were observed for patient enablement due to a large number of participants reporting being either fully enabled or not enabled at all. To address this, the

variable was dichotomised around the mean where 'less enabled' was ≤6.5 and 'more enabled' was >6.5 in line with previous studies using this instrument [28, 30]. Sixty percent of participants (n=212/357) reported that they were less enabled to manage their health after their stay in the hospital.

Table 2. Exploratory Factor Analysis (EFA) and emerging variables.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	2.53	0.85	0.18	0.18
Factor 2	1.69	0.42	0.12	0.30
Factor 3	1.27	0.12	0.09	0.39
Bartlett test of sphericity p=0.000				
Kaiser-Meyer-Olkin (KMO)= 0.62				

Variable	Factor 1	Factor 2	Factor 3
Did you feel your dietary requirements were met in hospital?	**0.88**	0.01	0.10
Overall, how would you rate the quality of the food in hospital?	**0.86**	0.01	0.09
How would you describe the general level of pain you experienced?	-0.02	**0.83**	0.10
When you left hospital, how would you rate your pain out of 10?	0.04	**0.75**	0.09
Did you feel well rested when you left the hospital?	0.20	0.18	**0.75**
How would you rate the quality of sleep in the hospital? (Poor)	0.30	0.18	**0.67**

Multiple logistic regression analysis

The results of univariate analysis are presented in Supplementary table 1. The Area Under the Curve (AUC) was 0.80 (95% CI: 0.66, 0.94) indicating high overall accuracy of the logistic model (80%) (Figure 1). The area under the ROC curve is interpreted as the probability that a subject with unplanned 30-day readmission is given a higher probability of the outcome by the logistic model than a randomly chosen subject without unplanned 30-day readmission. An AUC value of 0.50 indicates that the model has no discriminatory ability (the diagonal line corresponds to random change). The Pearson chi-sq GOF test statistic is 11.64 and since p = 0.7682, we conclude that there is no evidence against the model fitting the data well.

Eight variables were eligible for inclusion in the multiple logistic regression analysis. Due to the wide confidence interval for stroke, this variable was eliminated from the full model. Of these, 'public /private status' and 'rehabilitation attendance' were retained for the reduced model as they were the only variables to retain significance after stepwise removal of the other variables in the full model. The results of the multiple regression analysis are reported in Table 3.

The final multiple regression model included a sample size of 328 observations and the following factors remained significant. After controlling for age and sex, public patients were significantly more likely to be readmitted within 30 days compared to private patients (OR=6.31, 95% CI:1.59-25.14, p=0.009), and patients attended rehabilitation were significantly less likely to be readmitted within 30 days of discharge than those who did not (OR=0.16, 95% CI: 0.04-0.57, p=0.005) After attempting to adjust for age and sex in a four-covariate reduced model, public patients (9/134, 6.7%) were significantly more likely (adjusted OR=6.31, 95% CI:1.59-25.14, p=0.009) to be readmitted within 30 days compared to private patients (4/246, 1.6%) and patients attended rehabilitation (7/301, 2.3%) were

significantly less likely (adjusted OR=0.16, 95% CI: 0.04-0.57, p=0.005) to be readmitted within 30 days of discharge than those who did not (6/39,15.3 %).

Table 3. Results of multiple logistic regression analysis examining the association between patient, hospital and transition to general practice factors associated with unplanned 30-day readmission to hospital.

	*Full model**			*Reduced model** (n=328)*		
Relevant Variables	*OR*	*95% CI*	*p-Value*	*OR*	*95% CI*	*p-Value*
Public or Private	3.44	0.70-16.89	0.12	6.31	1.59-25.14	0.009
Co-morbidity						
Upper gastrointestinal disease	0.43	0.06-2.96	0.39	-	-	-
Living status	0.27	0.03-2.45	0.25	-	-	-
Self-Rated Health	0.39	0.14-1.13	0.08	-	-	-
Information Package	0.56	0.05-4.04	0.65	-	-	-
Attended info session	0.80	0.16-7.071	0.79	-	-	-
Waiting time to see GP	0.60	0.23-1.58	0.30	-	-	-
Attendance to rehabilitation	0.21	0.05-0.96	0.04	0.16	0.04-0.57	0.005

Note. *Full model included public or private hospital; upper gastrointestinal disease; Self-rated health; given an information package or checklist before surgery; usual waiting time to see GP; attendance to recommended rehabilitation or physiotherapy; and living status. **Reduced model included variables public or private hospital and attendance to recommended rehabilitation or physiotherapy. Both the models were run when adjusting for age and sex.

Discussion

The aim of this study was to investigate factors associated with unplanned 30-day readmission in TKA patients. Of the 4% of patients who had an unplanned readmission, those

who attended public hospitals and those who did not attend an outpatient rehabilitation program were more likely to be readmitted to hospital within 30 days of discharge.

While the United States also has a similar 4% readmission rate following TKA [9, 31-33], this is higher than that reported by the Australian Institute of Health and Welfare (AIHW) [3]. However, our results may reflect the true readmission rate more accurately as the AIHW only reports public hospital data and the majority of TKAs in Australia are performed in the private sector.

In our study, public patients were more likely to be readmitted within 30 days as compared to private patients. The majority of respondents (65%) had their TKA in the private sector, consistent with the higher proportion (80%) of TKA procedures performed in the private sector in the ACT [34]. Our study has almost complete ascertainment from the public sector, and reasonable ascertainment from the private sector, supporting the robustness of our findings. The increased likelihood of readmission for public patients might be explained by several contributing factors such as socioeconomic status, longer waiting times resulting in increased impairment and disease complexity [35-40]. The median waiting time for a TKA in 2018-19 in the ACT public hospital system was 209 days with 8.2% of patients waiting more than 365 days [35]. On the other hand, the median waiting time for Australian private patients was just 67 days during the same period [2, 41]. Therefore, waiting time may be an important mediating factor however association between the two may only be inferred and no causation can be implied.

Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions for elective surgical procedures in Australia [42]. TKA patients who waited longer than six months have been described as having significantly worse function and quality of life scores, as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and

depression [43]. It is important to understand that surgical waiting times are only part of the waiting journey for patients in the public system. The mean waiting times recorded for Australian patients do not take into account the lengthy process of referral, specialist assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical exercise and education programs are increasingly being implemented and the evidence for efficacy is strong [45, 46].

In our study, patients who attended rehabilitation were less likely to be readmitted within 30 days than those who did not. Previous research indicates that private patients are more likely to attend rehabilitation than public patients [47] and that rehabilitation is associated with better physical function after TKA [45]. However, we found no significant relationship between being a public or private patient and attendance at rehabilitation. Both groups in our sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after six weeks indicating that private/public status was not a mediating factor for this finding.

This study showed no significant associations between general practice (GP) factors and unplanned 30-day readmissions. A recent study reported that timely and regular GP contact during the two years following transition from hospital to community care lowered the risk of emergency readmission to hospital in patients with cardiovascular disease [48]. However, our results might reflect the nature of the health condition. This cohort included people having TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other diseases in that the treatment is potentially definitive and is followed up by the surgeon.

Although more than half of the patients who were readmitted had high scores for post-hospital syndrome, there was no significant association with 30-day readmission. The hypothesis of post-hospital syndrome describes a transient state resulting in consequences, including a higher risk of readmission [11]. Brownlee et al. [49] found that post-hospital

syndrome was an independent predictor of readmission within 30 days of discharge in a large cohort of surgical patients. While other studies have attempted to determine the impact of post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to use patient-reported responses to quantify the effect of hospital experience (of pain, sleep, and nutrition) on unplanned 30-day readmissions.

There are limitations to this study. The main limitation was that there were fewer readmissions than anticipated and the study may have been insufficiently powered for detecting the associations being tested. The results were based on anonymous self-reports; hence there was no capacity to link them to hospital data to establish actual readmission time frames, length of hospital stay, reasons for readmission or previous admission history. However, our primary endpoint was 30-day readmission and we believe that the self-reported data was accurate. The response rate is only an estimation based on joint replacement activity in the ACT. It assumes that all patients returning for their six-week follow-up appointment were invited to participate. We do not know whether the reception staff invited all patients, or only some. The lack of information about non-responders is another limitation of this study. More non-responders may have been readmitted and it is possible that they may have been sicker than responders, which would also influence the readmission rate. Also, as the ACT has a relatively high socioeconomic demographic the findings from this study may not apply to other less affluent areas.

Our data do not allow us to understand why rehabilitation was not accessed. It is possible that patients who were frailer did not feel able to participate and perhaps they were the patients who were readmitted. However, a range of patient and provider-based factors have been recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as insurance provider and hospital business model [51]. This association needs clarification.

It is not known if the rate of readmission can be reduced given the significant comorbidities of the TKA patient sample.

Conclusion

This study was undertaken to explore the factors impacting unplanned 30-day readmission after TKA. These results have implications for policy and for practice. An over-representation of public patients in the readmitted cohort is important. It is possible that the consequences of extended periods of delay to surgery among patients on the public waiting list may be an important factor. Therefore, it is essential to shorten waiting times and prioritize medical need when dealing with public patients. Clinicians should also place emphasis on the importance of attending rehabilitation after a TKA as an effective way to reduce 30-day readmission. Further investigation of how the pre-surgical patient journey can be better optimised to reduce readmission rates is warranted.

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Competing interests

None declared.

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Data sharing statement

Survey data and statistical analysis plans are available from Dr Desborough (ORCID ID: 0000-0003-1406-4593) upon reasonable request.

Figures

Figure 1. Receiver Operator Curve

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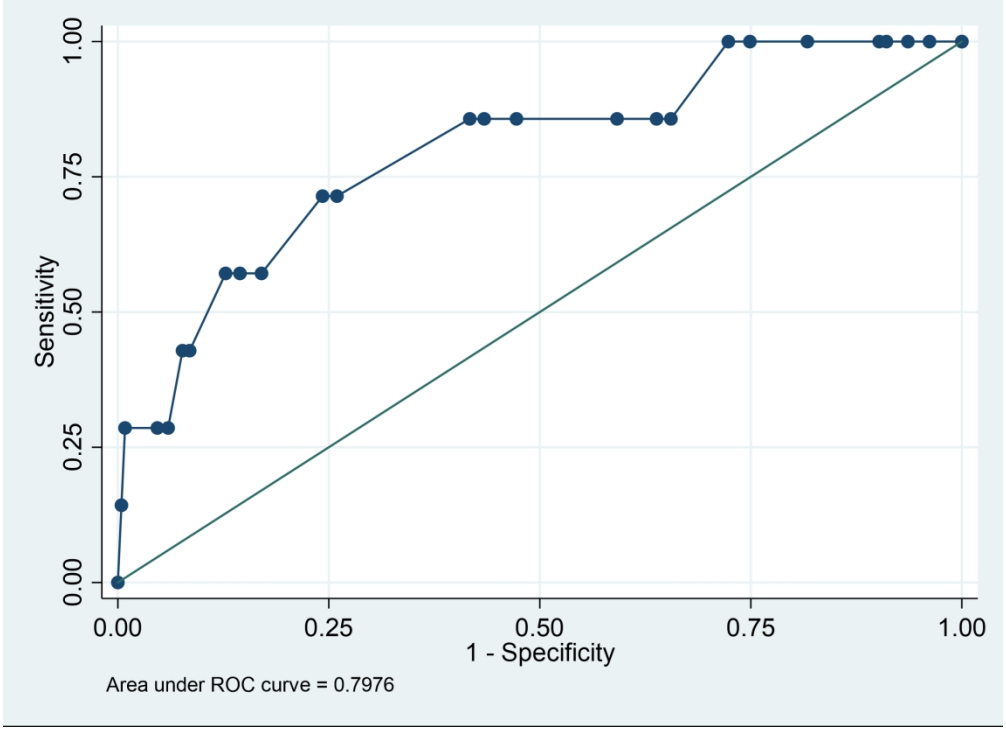

Figure 1Receiver Operator Curve. The area under the ROC curve is 0.80 (95% CI: 0.66, 0.94). The area under the ROC curve is interpreted as the probability that a subject with unplanned 30-day readmission is given a higher probability of the outcome by the logistic model than a randomly chosen subject without unplanned 30-day readmission. An AUC value of 0.50 indicates that the model has no discriminatory ability (the diagonal line corresponds to random change).

272x198mm (236 x 236 DPI)

Supplementary table 1. Results of univariate logistic regression analyses of variables associated with unplanned 30-day readmission in patients who received total knee arthroplasty

	Odds Ratio		
Variables	*OR*	*95% CI*	*p-value*
Public vs Private	4.2	1.2-14.2	0.02
Comorbidities			
Arthritis[#]	1.8	0.2-14.6	0.56
Osteoporosis	1.7	0.4-6.7	0.43
Asthma	0.8	0.2-3.8	0.80
COPD, ARDS, emphysema	1.8	0.2-14.9	0.58
Angina	-	-	-
Congestive heart failure (or heart disease)	1.9	0.2-16.2	0.53
Heart attack	-	-	-
Neurological disease	-	-	-
Stroke or TIA	3.6	0.7-18.2	0.11
Peripheral vascular disease	-	-	-
Diabetes type I and II	2.3	0.6-9.1	0.21
Upper GI disease	0.6	0.2-2.4	0.52
Depression	0.6	0.1-2.9	0.55
Anxiety or panic disorders	1.6	0.4-6.3	0.46
Visual impairment	1.0	0.3-3.7	0.98
Hearing impairment	1.3	0.3-6.0	0.80
Degenerative disc disease	1.6	0.5-5.4	0.44
Morbidity scale			
0	-	-	-
1	0.6	0.1-2.5	0.50
2	0.4	0.1-2.0	0.27
3 or more	-	-	-
Self-Rated Health			
Poor	-	-	-
Fair	0.3	0.0-3.0	0.3
Good	0.2	0.0-2.0	0.1
Very good	0.1	0.0-1.0	0.1

Excellent	-	-	-
Before you went to hospital			
Invited to attend session by surgeon	0.5	0.1-1.5	0.21
Attended information session	1.0	0.3-3.2	0.99
Usefulness of pre-surgery information session	0.7	0.3-1.9	0.53
Not very useful	-	-	-
Moderately useful	0.1	0.0-1.8	0.13
Very useful	0.3	0.0-1.8	0.21
Given information package or checklist	-	-	-
Use of information package or checklist	-	-	-
Pain			
Worst pain (more than six score)	1.5	0.4-5.7	0.51
Pain experienced during hospital stay (general pain)	4.7	1.0-21.6	0.05
Pain on discharge (less than 6)	5.0	1.3-18.4	0.016
Medication for pain control	0.4	0.1-1.7	0.20
Pain management with ice	0.9	0.2-4.2	0.90
Breathing exercise	1.9	0.6-6.2	0.30
Sleep			
Single/shared room (single)	1.4	0.4-4.8	0.55
Quality of sleep (Poor)	1.2	0.4-4.0	0.80
Medication for sleep	1.2	0.4-3.9	0.71
Feel rested when leaving hospital	1.5	0.5-4.5	0.50
Diet			
Dietary requirement met	0.4	0.1-3.3	0.41
Water in reach	3.5	0.7-17.1	0.12
Quality of food in hospital(average)	0.5	0.1-4.0	0.52
Discussion of medications with health care provider	0.5	0.1-2.1	0.38
Pharmacist	3.3	0.2-57.9	0.40
Doctor	-	-	-
Nurse	1.2	0.1-13.3	0.90
Physiotherapist	-	-	-

Other	-	-	-
Don't know	-	-	-
More than one	1.8	0.0-0.2	0.60
Patient medication enablement			
Better understand use of medication	0.4	0.1-3.6	0.44
Feel more confident about taking medications	0.7	0.1-6.2	0.80
Take your medications	0.5	0.1-4.0	0.48
Total medication enablement (medication scale)	0.9	0.6-1.4	0.59
Patient enablement			
Able to cope with life	0.7	0.3-1.6	0.46
Able to understand your condition	0.9	0.4-1.2	0.81
Able to cope with your condition	0.8	0.3-1.7	0.50
Able to keep yourself healthy	1.2	0.5-2.6	0.65
Confident about your health	0.6	0.3-1.4	0.25
Able to help yourself	1.3	0.6-2.8	0.54
Total enablement score (less enabled)	1.0	0.3-3.3	0.96
When you got home from hospital			
Recall being given information about who to contact	0.8	0.2-3.8	0.79
Who were you instructed to contact?	0.8	0.6-1.0	0.05
surgeon	-	-	-
nurse at hospital	0.3	0.0-2.7	0.32
GP	0.5	0.1-2.0	0.28
emergency department	0.3	0.1-2.0	0.27
other	-	-	-
Go to ED within 30 days of discharge	42.5	10.9-164.8	0.00
General Practice Questions			
Regular GP practice	-	-	-
See the same doctor	0.3	0.0-3.0	0.33
Regular appointments with GP	1.2	0.4-3.7	0.76
Discussion of plan with GP	0.7	0.2-2.2	0.50

When were you advised to see GP next			
1-6 weeks	1.9	0.2-14.7	0.56
Don't know	-	-	-
Usual waiting time to see GP			
same day	-	-	-
Within a couple of days	0.6	0.2-2.1	0.43
Within a week	0.2	0.0-2.1	0.19
1-2 weeks	0.4	0.0-4.2	0.48
>2 weeks	-	-	-
How soon after surgery did you see GP			
Within 1 week	-	-	-
2-3 weeks	0.5	0.1-1.9	0.33
4-6 weeks	0.7	0.1-6.1	0.78
Don't know	1.3	0.1-10.6	0.84
Did GP know you were in hospital	-	-	-
Rehabilitation			
Attendance to rehab program	0.1	0.0-0.4	0.00
Attendance to rehab within 5 days	2.2	0.8-5.5	0.11
Length of attendance to rehab			
One week	-	-	-
2 weeks	-	-	-
3 weeks	-	-	-
4 weeks	0.1	0.0-1.5	0.09
>4 weeks	0.4	0.0-2.0	0.25

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7,8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8
Bias	9	Describe any efforts to address potential sources of bias	*9*
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8,9,10
		(*b*) Describe any methods used to examine subgroups and interactions	8,9,10
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	Not available
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 1-3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12
		(*b*) Report category boundaries when continuous variables were categorized	11,12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11,12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13,14,15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15,16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.