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# BMJ Open

## 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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3 1 **Understanding Factors affecting 30-day Unplanned Readmissions for Patients**  
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5 2 **undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to**  
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7 3 **Home Orthopaedics Survey**  
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10 4 **Running title:** Unplanned readmissions following knee arthroplasty  
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12

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45 16 Paul Smith<sup>b,c</sup>: survey development, significant contributions to final manuscript,  
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49  
50 18 analysis, significant contributions to final manuscript.  
51

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## 32 **Abstract**

### 33 **Objectives**

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

### 38 **Design, setting and participants**

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

### 43 **Results**

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

### 52 **Conclusion**

1  
2  
3 53 Difference in unplanned readmission rates for public versus private patients may be due to  
4  
5 54 discrepancies in surgical waiting times. Strategies to reduce public hospital waiting times and  
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7 55 to mitigate against increasing disablement while waiting for a surgical procedure should be  
8  
9 56 explored. Reasons for non-attendance to post-surgical rehabilitation programs need to be  
10  
11 57 explored and strategies to foster increased participation developed.  
12  
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15 58 **Keywords:** knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care,  
16  
17 59 hospital performance.  
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## 22 61 **Article summary**

### 23 62 **Strengths and limitations of this study**

- 24 63 • This study is the first to use patient-reported responses to quantify the effect of  
25 64 hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions.
  - 26 65 • We were able to identify which patients attended or did not attend rehabilitation  
27 66 following total knee arthroplasty.
  - 28 67 • A limitation of this study is that results were based on self-reports with no capacity  
29 68 to link them to hospital records for confirmation.
  - 30 69 • As the Australian Capital Territory has a high socioeconomic demographic the  
31 70 findings may not apply to other less affluent areas.
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## 71 **Introduction**

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

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

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

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



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3 95 that this acquired transient state might be due to patients' experiences of pain, sleep  
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5 96 deprivation, and poor nutrition during their hospital stay [12]. This hypothesis is supported by  
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7 97 evidence that increasing patient capacity for self-care is effective at reducing 30-day  
8  
9 98 readmissions [11].  
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13 99 Research examining unplanned 30-day readmissions describes associations between patients'  
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15 100 clinical and demographic characteristics [13, 14], a lack of access to, continuity and  
16  
17 101 regularity of primary care [15-17], and deficits in hospital discharge planning, which often  
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19 102 focus on knowledge provision rather than patients' capacity to implement this knowledge  
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21 103 [11].  
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25 104 The patient-enablement instrument is a tool used to measure a person's knowledge and  
26  
27 105 understanding of their health condition; confidence to manage their condition, health, and life  
28  
29 106 [18]; and their ability to source appropriate healthcare for their individual needs. While this  
30  
31 107 measure has largely been examined in primary-care settings, its role in preventing unplanned  
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33 108 hospital readmissions has not yet been explored.  
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37 109 The purpose of this study was to investigate factors associated with unplanned 30-day  
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39 110 readmissions following a TKA, including aspects of hospital experiences, patient enablement,  
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41 111 and transition from hospital to home.  
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## 45 112 **Methods**

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### 48 49 114 **Study population**

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55 116 Consecutive patients over the age of 16 years, attending a six-week follow-up appointment  
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57 117 after undergoing total knee arthroplasty at one of four private and public clinical services  
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59 118 between 1 February 2018 and 31 January 2019.  
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3 **119 Study design**  
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6 **120**

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8 **121** A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1  
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10 **122** February 2018 and 31 January 2019 at all private and public sites delivering lower limb joint  
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12 **123** replacement services. The responses for patients having undergone TKA are presented in this  
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14 **124** paper.  
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18 **125**

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21 **126 Patient and public involvement**  
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24 **127** Orthopaedic patients (n=5) who had previously had surgery were emailed the survey and  
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26 **128** asked to complete it and provide feedback about its readability, length, and meaningfulness.  
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30 **129**

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32 **130 Instrument**  
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35 **131**

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37 **132** Researchers at the Australian National University, Canberra Hospital, Academic Unit of  
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39 **133** General Practice ACT Health, Health Care Consumer Association, and Capital Health  
40  
41 **134** Network developed *The ACT Transition from Hospital to Home Survey*. The 50-item survey  
42  
43 **135** was designed to measure patients' experiences in hospital and transition to home across six  
44  
45 **136** domains: 1. Patient demographic characteristics and co-morbidities; 2. Post-hospital  
46  
47 **137** syndrome; 3. Medication enablement; 4. Patient enablement; 5. Transition to general practice;  
48  
49 **138** and 6. Pre- and post-hospital information and pre-/post-surgical rehabilitation  
50  
51  
52 **139** Co-morbidities: Morbidity was assessed with the 18-item Functional Comorbidity Index  
53  
54  
55 **140** which is used to predict functional status rather than mortality [19].  
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3 141 Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of  
4  
5 142 sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.

7  
8 143 Medication enablement: Three items measured medication enablement in terms of patients'  
9  
10 144 knowledge and ability to manage their medications following discussions with health care  
11  
12 145 providers derived from a previous study in general practice nurse consultations [20].

13  
14  
15 146 Patient enablement: This is the internationally validated six-item Patient Enablement  
16  
17 147 Instrument [21] used internationally in primary-care research.

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20 148 Transition to general practice: 10-items assessing patients' relationships with their general  
21  
22 149 practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning,  
23  
24 150 patients' understanding of when to see their GP following discharge, and access to care.

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26 151 Interaction with the recommended rehabilitation program: Referral and attendance to  
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28 152 physiotherapy rehabilitation post-discharge was examined with one item.

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36 154 **Data collection**

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43 156 The paper surveys were distributed by reception staff at patients' six-week post-operative  
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45 157 consultation. Staff were given a protocol and suggested wording to use when providing the  
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47 158 survey. An information sheet about the study was provided to patients and anonymity  
48  
49 159 guaranteed. This ensured that patients understood that participation or non-participation did  
50  
51 160 not affect the care they received and that completed surveys were confidential to clinic staff.  
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53 161 Surveys were deposited in a sealed box in the waiting room and collected by the researcher at  
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55 162 regular intervals.  
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3 **164 Data analysis**  
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8 **166** Completed survey data was collated and descriptive and inferential statistics used. Variables  
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10 **167** were described using summary statistics and frequencies. Some variables were grouped to  
11  
12 **168** create new variables and others, for example, BMI, were converted to categorical variables  
13  
14 **169** for analysis. The primary outcome of interest was self-reported 30-day readmission to  
15  
16 **170** hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living  
17  
18 **171** situation, country of origin, education, self-rated health, comorbidities, post-hospital  
19  
20 **172** syndrome (experiences of sleep, diet and pain), experiences of family practice (access,  
21  
22 **173** continuity, planning, regularity), medication enablement, and patient enablement were  
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24 **174** separate independent variables.  
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30 **175** An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to  
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32 **176** explore the relationship between variables which described post hospital syndrome. The  
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34 **177** modes/themes which had an eigenvalue of  $>1$  were retained and the internal consistency of  
35  
36 **178** the modes which emerged was examined using Cronbach's alpha. The suitability of the data  
37  
38 **179** for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.  
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42 **180** Prior to analysis, variable independence was established. Ordinal variables were examined  
43  
44 **181** using Spearman's correlation coefficient and categorical variables using the chi squared ( $\chi^2$ )  
45  
46 **182** test and odds ratio. If a strong correlation ( $> 0.6$ ) or a significant association ( $p \leq 0.2$ ) existed  
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48 **183** between two eligible variables, only one of these was retained for inclusion in the final  
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50 **184** analysis.  
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54 **185** Univariate logistic regression analysis was conducted for each independent variable and the  
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56 **186** dependent variable (unplanned 30-day readmission). Variables with  $p$ -values  $\leq 0.25$  were  
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3 187 included in the multiple logistic regression analyses. Univariate logistic regression was  
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5 188 conducted on each individual comorbidity item, and then for the total comorbidity score.  
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8 189 Cronbach's alpha was used to determine the internal reliability of each scale. A value greater  
9  
10 190 than 0.5 was considered as a good indicator of internal consistency.  
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13 191 To further eliminate potential confounding, two multiple logistic regression models were run  
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15 192 - one including eligible individual variables from within the Functional Comorbidity Index,  
16  
17 193 Medication Enablement questions and the Patient Enablement Instrument; and a second  
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19 194 including total scores.  
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22  
23 195 The full multiple regression model included eight variables. These were public or private  
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25 196 hospital; stroke or transient ischemic attack (TIA); upper gastrointestinal disease; self-rated  
26  
27 197 health; given an information package or checklist before surgery; usual waiting time to see  
28  
29 198 GP; attendance at recommended rehabilitation or physiotherapy; and living status. The  
30  
31 199 reduced model included 'public or private hospital' and 'attendance at recommended  
32  
33 200 rehabilitation or physiotherapy'. Both the models were adjusted for age and sex.  
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37 201 Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit  
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39 202 of the final model. The Receiver Operator Curve (ROC) was plotted to check the specificity  
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41 203 and sensitivity of the predicted model.  
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45 204 Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].  
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## 51 206 **Missing data**

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3 208 The criteria used for acceptability of non-response to survey questions was 10% or lower [23-  
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5 209 25]. Missing data for individual variables within the medication and patient enablement  
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7 210 scales were imputed to equal the median value of non-missing data [26-29].  
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## 10 211 **Ethical approval**

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16 213 Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare  
17  
18 214 Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics  
19  
20 215 Committees.  
21  
22

## 23 216 **Results**

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25 217 Of the 1069 people invited to participate, 827 (77%) completed the survey.  
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29 218 Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within  
30  
31 219 30 days. Participant demographics are presented in Table 1. Private patients accounted for  
32  
33 220 65% of the total population (247 private patients, 133 public patients). This represented 44%  
34  
35 221 of all private patients and 96% of all public patients who had a TKA during the study period  
36  
37 222 which represents 54% of all TKAs. 57% of those who underwent knee surgery were females.  
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39 223 The mean age was  $67.4 \pm 0.5$  years (age range 44.8 to 91.0 years). Mean BMI was  $31.5 \text{ kg/m}^2$   
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41 224 with most having a BMI of  $>30$  (58%). Most participants were non-indigenous (99%). There  
42  
43 225 were three people of Aboriginal and/or Torres Strait Islander origin, none of whom was  
44  
45 226 readmitted. There were proportionally more private patients aged 65-84 years (63%)  
46  
47 227 compared to public (53%), whereas proportionally more public patients were in the 45-64 age  
48  
49 228 group (44% compared to 35%). The proportion of females within the public cohort was  
50  
51 229 greater than private (67% compared to 57%). A higher proportion of public patients lived  
52  
53 230 alone (31% compared to 23%).  
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### 232 **Post-hospital syndrome exploratory factor analysis (EFA)**

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

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

247

### 248 **Multiple logistic regression analysis**

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

254 After controlling for age and sex, public patients were significantly more likely to be  
255 readmitted within 30 days compared to private patients (OR=6.87, 95% CI:1.71-27.54,  
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3 256 p=0.007), and patients who did not attend rehabilitation were significantly less likely to be  
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5 257 readmitted within 30 days of discharge than those who did (OR=0.17, 95% CI: 0.05-0.59,  
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7 258 p=0.006).  
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## 13 260 **Discussion**

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19 262 The aim of this study was to investigate factors impacting unplanned 30-day readmission in  
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21 263 TKA patients. Of the 4% of patients who had an unplanned readmission, those who attended  
22  
23 264 public hospitals and those who did not attend a rehabilitation program were more likely to be  
24  
25 265 readmitted to hospital within 30 days of discharge.

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29 266 While the United States also has a similar 4% readmission rate following TKA [10, 31-33],  
30  
31 267 this is higher than that reported by the Australian Institute of Health and Welfare (AIHW) [3].  
32  
33 268 However, our results may reflect the true readmission rate more accurately as the AIHW only  
34  
35 269 reports public hospital data and the majority of TKAs in Australia are performed in the  
36  
37 270 private sector.

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41 271 In our study, public patients were more likely to be readmitted within 30 days as compared to  
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43 272 private patients. The majority of respondents (65%) had their TKA in the private sector,  
44  
45 273 consistent with the higher proportion (80%) of TKA procedures performed in the private  
46  
47 274 sector in the ACT [34]. Our study has almost complete ascertainment from the public sector,  
48  
49 275 and reasonable ascertainment from the private sector, supporting the robustness of our  
50  
51 276 findings. The increased likelihood of readmission for public patients might be explained by  
52  
53 277 several contributing factors such as socioeconomic status, longer waiting times and increased  
54  
55 278 disease complexity [35-40]. The median waiting time for a TKA in 2018-19 in the ACT  
56  
57 279 public hospital system was 62 days with 8.2% of patients waiting more than 365 days [35].  
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3 280 On the other hand, the median waiting time for Australian private patients was just 67 days  
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5 281 during the same period [2, 41]. Therefore, waiting time may be an important mediating  
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7 282 factor.

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11 283 Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions  
12  
13 284 for elective surgical procedures in Australia [42]. TKA patients who waited longer than six  
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15 285 months have been described as having significantly worse function and quality of life scores,  
16  
17 286 as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and  
18  
19 287 depression [43]. It is important to understand that surgical waiting times are only part of the  
20  
21 288 waiting journey for patients in the public system. The mean waiting times recorded for  
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23 289 Australian patients do not take into account the lengthy process of referral, specialist  
24  
25 290 assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical  
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27 291 exercise and education programs are increasingly being implemented and the evidence for  
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29 292 efficacy is strong [45, 46].

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35 293 In our study, patients who attended rehabilitation were less likely to be readmitted within 30  
36  
37 294 days than those who did not. Previous research indicates that private patients are more likely  
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39 295 to attend rehabilitation than public patients [47] and that rehabilitation is associated with  
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41 296 better physical function after TKA [45]. However, we found no significant relationship  
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43 297 between being a public or private patient and attendance at rehabilitation. Both groups in our  
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45 298 sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after  
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47 299 six weeks indicating that private/public status was not a mediating factor for this finding.

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51 300 This study showed no significant associations between general practice (GP) factors and  
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53 301 unplanned 30-day readmissions. A recent study reported that timely and regular GP contact  
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55 302 during the two years following transition from hospital to community care lowered the risk of  
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57 303 emergency readmission to hospital in patients with cardiovascular disease [48]. However, our  
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3 304 results might reflect the nature of the health condition. This cohort included people having  
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5 305 TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other  
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7 306 diseases in that the treatment is potentially definitive and is followed up by the surgeon.  
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10 307 Although more than half of the patients who were readmitted had high scores for post-  
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12 308 hospital syndrome, there was no significant association with 30-day readmission. The  
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14 309 hypothesis of post-hospital syndrome describes a transient state resulting in consequences,  
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16 310 including a higher risk of readmission [12]. Brownlee et al. [49] found that post-hospital  
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18 311 syndrome was an independent predictor of readmission within 30 days of discharge in a large  
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20 312 cohort of surgical patients. While other studies have attempted to determine the impact of  
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22 313 post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to  
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24 314 use patient-reported responses to quantify the effect of hospital experience (of pain, sleep,  
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26 315 and nutrition) on unplanned 30-day readmissions.  
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29 316 There are limitations to this study. The main limitation was that there were fewer  
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31 317 readmissions than anticipated and the study may have been insufficiently powered for  
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33 318 detecting the associations being tested. The results were based on anonymous self-reports;  
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35 319 hence there was no capacity to link them to hospital data to establish actual readmission time  
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37 320 frames, length of hospital stay, reasons for readmission or previous admission history.  
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39 321 However, our primary endpoint was 30-day readmission and we believe that the self-reported  
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41 322 data was accurate. The response rate is only an estimation based on joint replacement activity  
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43 323 in the ACT. It assumes that all patients returning for their six-week follow-up appointment  
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45 324 were invited to participate. We do not know whether the reception staff invited all patients, or  
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47 325 only some. Also, as the ACT has a relatively high socioeconomic demographic the findings  
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49 326 from this study may not apply to other less affluent areas.  
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3 327 Our data do not allow us to understand why rehabilitation was not accessed. It is possible that  
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5 328 patients who were frailer did not feel able to participate and perhaps they were the patients  
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7 329 who were readmitted. However, a range of patient and provider-based factors have been  
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10 330 recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative  
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12 331 preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as  
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14 332 insurance provider and hospital business model [51]. This association needs clarification.

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17 333 It is not known if the rate of readmission can be reduced given the significant comorbidities  
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19 334 of the TKA patient sample.

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## 24 25 26 336 **Conclusion**

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31 338 This study was undertaken to explore the factors impacting unplanned 30-day readmission  
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33 339 after TKA. These results have implications for policy and for practice. An over-  
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35 340 representation of public patients in the readmitted cohort is important. It is probable that the  
36  
37 341 extended periods of delay to surgery among patients on the public waiting list may be an  
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39 342 important factor. Therefore, it is essential to shorten waiting times and prioritize medical  
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41 343 need when dealing with public patients. Clinicians should also place emphasis on the  
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43 344 importance of attending rehabilitation after a TKA as an effective way to reduce 30-day  
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45 345 readmission. Further investigation of how the pre-surgical patient journey can be better  
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47 346 optimised to reduce readmission rates is warranted.

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5  
6 349 We wish to thank Orthopaedics ACT and Dr Michael Gross from Canberra Hip and Knee  
7

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1 **Tables**

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4 Table 1. Characteristics of all patients and those with an unplanned 30-day readmission (knee  
5 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 e 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

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

7 \*\*Missing value for readmission for age: 1

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	Total observations (n=380)		Unplanned 30-day readmission (n=13)	
Demographic factors	No.	% (of total)	No.	% (of variable)
<i>BMI Calculations</i>				
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	-	-
<i>Indigenous status</i>				
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	-	-
<i>Education</i>				
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	-	-

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*Public/Private*

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Public	134	35.3	9	69.2
Private	246	64.7	4	30.8

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15 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

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

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

<i>Relevant Variables</i>	<i>Full model*</i>			<i>Reduced model**</i>		
	<i>OR</i>	<i>95% CI</i>	<i>p-Value</i>	<i>OR</i>	<i>95% CI</i>	<i>p-Value</i>
<i>Public or Private</i>	3.788	0.47-30.293	0.211	6.879	1.71-27.54	0.007
<i>Co-morbidity</i>						
Stroke	23.92	0.495-1165.54	0.1091	-	-	-
Upper gastrointestinal disease	0.12	0.00-3.374	0.210	-	-	-
<i>Living status</i>						
I live with my children	2.8	0.5-59.7	0.5	-	-	-
<i>Self-Rated Health</i>						
Fair	0.90	0.02-40.981.0	0.961.0	-	-	-
Good	1.61	0.31-19.326	0.71	-	-	-
<i>Information Package</i>						
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

23 Note. \*Full model included public or private hospital; stroke or transient ischemic attack (TIA); upper  
 24 gastrointestinal disease; Self-rated health; given an information package or checklist before surgery; usual  
 25 waiting time to see GP; attendance to recommended rehabilitation or physiotherapy; and living status.

26 \*\*Reduced model included variables public or private hospital and attendance to recommended rehabilitation or  
 27 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 #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

## 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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3 1 **Understanding Factors affecting 30-day Unplanned Readmissions for Patients**  
4  
5 2 **undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to**  
6  
7 3 **Home Orthopaedics Survey**  
8  
9

10 4 **Running title:** Unplanned readmissions following knee arthroplasty  
11  
12

13 5 **Authors:**  
14

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30 11 Christine Phillips<sup>c</sup>: survey development, significant contributions to final manuscript  
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49  
50 18 analysis, significant contributions to final manuscript.  
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31 31 **All authors have read and approve the manuscript below**  
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## 32 Abstract

### 33 Objectives

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

### 37 Design, setting and participants

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

### 43 Results

44 Of the 380 participants who completed the survey (n=380, 54% of TKAs undertaken over the  
45 study period), 4% (n=13) were subsequently readmitted within 30 days of discharge after a  
46 primary hospitalization. After controlling for age and sex, public patients were significantly  
47 more likely to be readmitted within 30 days than private patients (OR=6.31, 95% CI:1.59-  
48 25.14, p=0.009), and patients who attended rehabilitation were significantly less likely to  
49 have been readmitted within 30 days than those who did not (OR=0.16, 95% CI: 0.04-0.57,  
50 p=0.005). There were no associations between post-hospital syndrome or patient enablement  
51 and 30-day readmissions in this study.

### 52 Conclusion

1  
2  
3 53 Reasons underlying the difference in unplanned readmission rates for public versus private  
4  
5 54 patients need to be explored, including differences in surgical waiting times. Strategies to  
6  
7 55 foster increased participation post-surgical rehabilitation programs need to be developed as  
8  
9  
10 56 an avenue to mitigate the burden of unplanned 30-day readmissions on individuals and health  
11  
12 57 systems.

13  
14  
15 58 **Keywords:** knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care,  
16  
17 59 hospital performance.

20  
21 60 **ARTICLE SUMMARY**

- 22  
23  
24 61 • A survey, co-designed with clinicians and patients, examined associations between  
25  
26 62 patient, hospital and transitional care factors and unplanned 30-day readmission  
27  
28 63 following total knee arthroplasty in both public and private hospital settings.  
29  
30  
31 64 • This study is the first to use patient-reported responses to quantify the effect of  
32  
33 65 hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions  
34  
35 66 following total knee arthroplasty.  
36  
37  
38 67 • A limitation of this study is that results were based on self-reported patient outcomes  
39  
40 68 with no capacity to link them to hospital records for confirmation as well as the lack  
41  
42 69 of information from those who declined the survey.  
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## 71 **Introduction**

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

78 The rate of knee replacement surgery has more than doubled over the past 15 years both in  
79 Australia and internationally [7] with the highest rate of increase seen in the private sector [3,  
80 5, 8]. This growing demand has placed increased logistical and financial strain on the  
81 healthcare system, including associated unplanned 30-day readmissions [5]. The most  
82 common condition-related causes of unplanned readmission following a total knee  
83 arthroplasty (TKA) are surgical-site infection, arthrofibrosis, cellulitis, concomitant co-  
84 morbidities, and fluid and electrolyte imbalance [9]. Other factors such as old age, revision  
85 procedure and acute length of hospital stay also increase the risk of unplanned 30-day  
86 readmissions [9]. Beyond the complications as a cause of the readmission, there are patient  
87 factors related to the hospital stay that increase risk of readmission [10].

88 Krumholz [11] describes post-hospital syndrome as a period of vulnerability after discharge  
89 from the hospital which leaves a patient at increased risk of re-hospitalization from  
90 conditions which are often unrelated to the original reason for of admission. It is proposed  
91 that this acquired transient state might be due to patients' experiences of pain, sleep  
92 deprivation, and poor nutrition during their hospital stay [11]. While this hypothesis is  
93 supported by evidence that increasing patient capacity for self-care is effective at reducing  
94 30-day readmissions [10], , as far as we are aware, post-hospital syndrome has not been

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2  
3 95 quantified or measured as an independent variable in association with unplanned 30-day  
4  
5 96 readmission.

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7  
8 97 Research examining unplanned 30-day readmissions has described a number of associated  
9  
10 98 factors. These factors include: clinical and demographic characteristics [12, 13]; a lack of  
11  
12 99 access to primary care; the continuity and regularity of primary care [14-16]; and deficits in  
13  
14 100 hospital discharge planning, which often focus on knowledge provision rather than patients'  
15  
16 101 capacity to implement this knowledge [10].

17  
18  
19  
20 102 The patient-enablement instrument is a tool used to measure a person's knowledge and  
21  
22 103 understanding of their health condition; confidence to manage their condition, health, and life  
23  
24 104 [17]; and their ability to source appropriate healthcare for their individual needs. While this  
25  
26 105 measure has largely been examined in primary-care settings, its role in preventing unplanned  
27  
28 106 hospital readmissions has not yet been explored.

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31  
32 107 The purpose of this study was to investigate factors associated with unplanned 30-day  
33  
34 108 readmissions following a TKA, including aspects of hospital experiences, patient enablement,  
35  
36 109 and transition from hospital to home.

## 40 110 **Methods**

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### 43 112 **Study population**

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45  
46 113 Consecutive patients over the age of 16 years, attending a six-week follow-up appointment  
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48 114 after undergoing total knee arthroplasty at one of four private and public clinical services  
49  
50 115 between 1 February 2018 and 31 January 2019.

### 51 116 **Study design**

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2  
3 118 A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1  
4  
5 119 February 2018 and 31 January 2019 at all private and public sites undertaking lower limb  
6  
7 120 joint replacement services. Data was collected retrospectively at the six-week follow-up  
8  
9 121 appointment post-surgery for both total knee and hip replacement (THA). The responses for  
10  
11 122 patients having undergone elective TKA are presented in this paper.  
12  
13  
14

### 15 123 **Instrument**

16 124  
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18  
19  
20 125 The *ACT Transition from Hospital to Home Survey* was developed and piloted by researchers  
21  
22 126 at the Australian National University, Canberra Hospital, Academic Unit of General Practice  
23  
24 127 ACT Health, Capital Health Network, Health Care Consumer Association ACT, and people  
25  
26 128 who had previously experienced either TKA or THA [18]. The 50-item survey was designed  
27  
28 129 to measure patients' experiences in hospital and transition to home across six domains: 1.  
29  
30 130 Patient demographic characteristics and co-morbidities; 2. Post-hospital syndrome; 3.  
31  
32 131 Medication enablement; 4. Patient enablement; 5. Transition to general practice; and 6. Pre-  
33  
34 132 and post-hospital information and pre-/post-surgical rehabilitation  
35  
36  
37 133 Co-morbidities: Morbidity was assessed with the validated 18-item Functional Comorbidity  
38  
39 134 Index which is used to predict functional status rather than mortality [19].  
40  
41  
42 135 Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of  
43  
44 136 sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.  
45  
46  
47 137 Medication enablement: Three items measured medication enablement in terms of patients'  
48  
49 138 knowledge and ability to manage their medications following discussions with health care  
50  
51 139 providers derived from a previous study in general practice nurse consultations [20]. The  
52  
53 140 internal consistency of this scale was established ( $\alpha = 0.80$ ) in the pilot study (unpublished  
54  
55 141 results).  
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3 142 Patient enablement: This is the internationally validated six-item Patient Enablement

4  
5 143 Instrument [21] used primarily in primary-care research.

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7  
8 144 Transition to general practice: 10-items assessing patients' relationships with their general

9  
10 145 practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning,

11  
12 146 patients' understanding of when to see their GP following discharge, and access to care.

13  
14 147 These questions were refined as a result of the pilot study to eliminate covariance and

15  
16 148 repetition.

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19  
20 149 Interaction with the recommended rehabilitation program: Referral and attendance to

21  
22 150 outpatient physiotherapy rehabilitation post-discharge was examined with one item.

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26 151 **Data collection**

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29 152 The paper surveys were distributed by reception staff at patients' six-week post-operative

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31 153 consultation. Staff were given a protocol and suggested wording to use when providing the

32  
33 154 survey. An information sheet about the study was provided to patients and anonymity

34  
35 155 guaranteed. Patients were not required to include their name or identifying information on the

36  
37 156 survey. This ensured that patients understood that participation or non-participation did not

38  
39 157 affect the care they received and that completed surveys were confidential to clinic staff.

40  
41  
42 158 Completion of the survey implied written consent, and this was agreed and approved by the

43  
44 159 local ethics committee. Surveys were deposited in a sealed box in the waiting room and

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46 160 collected by the researcher at regular intervals.

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53 162 **Data analysis**

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3 164 Completed survey data was collated and descriptive and inferential statistics used. Variables  
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5 165 were described using summary statistics and frequencies. Some variables were grouped to  
6  
7 166 create new variables and others, for example, BMI, were converted to categorical variables  
8  
9  
10 167 for analysis. The primary outcome of interest was self-reported 30-day readmission to  
11  
12 168 hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living  
13  
14 169 situation, country of origin, education, self-rated health, comorbidities, post-hospital  
15  
16 170 syndrome (experiences of sleep, diet and pain), experiences of family practice (access,  
17  
18 171 continuity, planning, regularity), medication enablement, and patient enablement were  
19  
20 172 separate independent variables.  
21  
22

23  
24 173 An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to  
25  
26 174 explore the relationship between variables which described post hospital syndrome. The  
27  
28 175 modes/themes which had an eigenvalue of  $>1$  were retained and the internal consistency of  
29  
30 176 the modes which emerged was examined using Cronbach's alpha. The suitability of the data  
31  
32 177 for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.  
33  
34  
35 178 Prior to analysis, variable independence was established. Ordinal variables were examined  
36  
37 179 using Spearman's correlation coefficient and categorical variables using the chi squared ( $\chi^2$ )  
38  
39 180 test and odds ratio. If a strong correlation ( $> 0.6$ ) or a significant association ( $p \leq 0.2$ ) existed  
40  
41 181 between two eligible variables, only one of these was retained for inclusion in the final  
42  
43 182 analysis.  
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47  
48 183 Univariate logistic regression analysis was conducted for each independent variable and the  
49  
50 184 dependent variable (unplanned 30-day readmission). Univariate logistic regression was  
51  
52 185 conducted on each individual comorbidity item, and then for the total comorbidity score.  
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54  
55 186 To further eliminate potential confounding, two multiple logistic regression models were run  
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57 187 - one including eligible individual variables from within the Functional Comorbidity Index,  
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3 188 Medication Enablement questions and the Patient Enablement Instrument; and a second  
4  
5 189 including total scores.  
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8 190 The full multiple regression model included eight variables. These were public or private  
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10 191 hospital; upper gastrointestinal disease; self-rated health; given an information package or  
11  
12 192 checklist before surgery; usual waiting time to see GP; attendance at recommended  
13  
14 193 rehabilitation or physiotherapy; and living status. The reduced model included 'public or  
15  
16 194 private hospital' and 'attendance at recommended rehabilitation or physiotherapy'. Only risk  
17  
18 195 factors with  $p$ -values  $\leq 0.25$  were included in the multiple logistic regression analyses.  
19  
20 196 Logistic regression with backward stepwise selection was used to choose risk factors for the  
21  
22 197 multivariable model. A significance level of 0.25 was required to allow a risk factor into the  
23  
24 198 model, and a significance level of 0.25 was required for a risk factor to stay in the model.  
25  
26 199 Additionally, risk factor selection for the model may be driven by available knowledge and  
27  
28 200 biological plausibility of potential confounders, taking into consideration the hypothesis of  
29  
30 201 interest. The adjusted odds ratio and its 95% confidence interval were calculated for each risk  
31  
32 202 factor in the presence of others in the final model. Both the models were adjusted for age and  
33  
34 203 sex.  
35  
36 204 Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit  
37  
38 205 of the final model. The Receiver Operator Characteristic Curve (ROC) was plotted to check  
39  
40 206 the specificity and sensitivity of the predicted model.  
41  
42 207 Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].  
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## 51 208 **Missing data**

52 209 The criteria used for acceptability of non-response to all survey questions was 10% or lower  
53  
54 210 including for medication and patient enablement scale [23-25]. Missing data for individual  
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1  
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3 211 variables within the medication and patient enablement scales were imputed to equal the  
4  
5 212 median value of non-missing data [26-29].  
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7

### 8 213 **Ethical approval**

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11  
12  
13 215 Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare  
14 216 Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics  
15  
16  
17  
18 217 Committees. All participants provided written informed consent to participate in this study.  
19  
20

### 21 218 **Results**

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23 219 Of the 1069 people invited to participate, 827 (77%) completed the overall survey.  
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25

26 220 Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within  
27  
28 221 30 days. Participant demographics are presented in Table 1. Private patients accounted for  
29  
30 222 65% of the total population (247 private patients, 133 public patients). This represented 44%  
31  
32 223 of all private patients and 96% of all public patients who had a TKA during the study period  
33  
34 224 which represents 54% of all TKAs. 57% of those who underwent knee surgery were females.  
35  
36

37 225 The mean age was 67.4 with a standard deviation 0.5 years (age range 44.8 to 91.0 years).  
38  
39

40 226 Mean BMI was 31.5 kg/m<sup>2</sup> with most having a BMI of >30 (58%). Most participants were  
41  
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43 227 non-indigenous (99%). There were three people of Aboriginal and/or Torres Strait Islander  
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45

46 228 origin, none of whom was readmitted. There were proportionally more private patients aged  
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48

49 229 65-84 years (63%) compared to public (53%), whereas proportionally more public patients  
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51

52 230 were in the 45-64 age group (44% compared to 35%). The proportion of females within the  
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55 231 public cohort was greater than private (67% compared to 57%). A higher proportion of  
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58 232 public patients lived alone (31% compared to 23%).  
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234 Table 1. Characteristics of all TKA patients and those with an unplanned 30-day  
 235 readmission.

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Variable	Public	Private	Total
	N=133	N=247	N=13/380 (%)*
	n/N	n/N	
<b>Age</b>			
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
<b>Gender</b>			
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
<b>Language</b>			
Other than English at home	0/21	2/28	2/49 (4.1%)
Only speak English	9/108	2/212	11/320 (3.4%)
<b>Living Status</b>			
Live alone	7/40	0/55	2/95 (2.1%)
Live with someone	2/90	4/189	11/273 (4%)
<b>BMI Calculations</b>			
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%)
<b>Indigenous status</b>			
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%)
<b>Education</b>	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%)
<b>Public/Private</b>	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

### 241 Post-hospital syndrome exploratory factor analysis (EFA)

242 The results of the exploratory factor analysis are reported in Table 2. Three modes/themes  
243 with acceptable internal consistency emerged. First, diet, which was described by responses  
244 to two questions: “Did you feel your dietary requirements were met in hospital?” and  
245 “Overall, how would you rate the quality of the food in hospital?” The second theme was  
246 pain, which was also explained by two questions: “How would you describe the general level  
247 of pain you experienced?” and “When you left hospital, how would you rate your pain out of  
248 10?” The third was sleep which was explained by “Did you feel well rested when you left the  
249 hospital?” and “How would you rate the quality of sleep in the hospital?”

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

256 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?	<b>0.88</b>	0.01	0.10	
Overall, how would you rate the quality of the food in hospital?	<b>0.86</b>	0.01	0.09	
How would you describe the general level of pain you experienced?	-0.02	<b>0.83</b>	0.10	
When you left hospital, how would you rate your pain out of 10?	0.04	<b>0.75</b>	0.09	
Did you feel well rested when you left the hospital?	0.20	0.18	<b>0.75</b>	
How would you rate the quality of sleep in the hospital? (Poor)	0.30	0.18	<b>0.67</b>	

259

## 260 Multiple logistic regression analysis

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

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

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

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

15

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

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3 297 consistent with the higher proportion (80%) of TKA procedures performed in the private  
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5 298 sector in the ACT [34]. Our study has almost complete ascertainment from the public sector,  
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7 299 and reasonable ascertainment from the private sector, supporting the robustness of our  
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10 300 findings. The increased likelihood of readmission for public patients might be explained by  
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12 301 several contributing factors such as socioeconomic status, longer waiting times and increased  
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14 302 disease complexity [35-40]. The median waiting time for a TKA in 2018-19 in the ACT  
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16 303 public hospital system was 62 days with 8.2% of patients waiting more than 365 days [35].  
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18 304 On the other hand, the median waiting time for Australian private patients was just 67 days  
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20 305 during the same period [2, 41]. Therefore, waiting time may be an important mediating factor  
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22 306 however association between the two may only be inferred and no causation can be implied.  
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27 307 Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions  
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29 308 for elective surgical procedures in Australia [42]. TKA patients who waited longer than six  
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31 309 months have been described as having significantly worse function and quality of life scores,  
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33 310 as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and  
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35 311 depression [43]. It is important to understand that surgical waiting times are only part of the  
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37 312 waiting journey for patients in the public system. The mean waiting times recorded for  
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39 313 Australian patients do not take into account the lengthy process of referral, specialist  
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41 314 assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical  
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43 315 exercise and education programs are increasingly being implemented and the evidence for  
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45 316 efficacy is strong [45, 46].  
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51 317 In our study, patients who attended rehabilitation were less likely to be readmitted within 30  
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53 318 days than those who did not. Previous research indicates that private patients are more likely  
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55 319 to attend rehabilitation than public patients [47] and that rehabilitation is associated with  
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57 320 better physical function after TKA [45]. However, we found no significant relationship  
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3 321 between being a public or private patient and attendance at rehabilitation. Both groups in our  
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5 322 sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after  
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7 323 six weeks indicating that private/public status was not a mediating factor for this finding.  
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10 324 This study showed no significant associations between general practice (GP) factors and  
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12 325 unplanned 30-day readmissions. A recent study reported that timely and regular GP contact  
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14 326 during the two years following transition from hospital to community care lowered the risk of  
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16 327 emergency readmission to hospital in patients with cardiovascular disease [48]. However, our  
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18 328 results might reflect the nature of the health condition. This cohort included people having  
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20 329 TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other  
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22 330 diseases in that the treatment is potentially definitive and is followed up by the surgeon.  
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27 331 Although more than half of the patients who were readmitted had high scores for post-  
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29 332 hospital syndrome, there was no significant association with 30-day readmission. The  
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31 333 hypothesis of post-hospital syndrome describes a transient state resulting in consequences,  
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33 334 including a higher risk of readmission [11]. Brownlee et al. [49] found that post-hospital  
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35 335 syndrome was an independent predictor of readmission within 30 days of discharge in a large  
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37 336 cohort of surgical patients. While other studies have attempted to determine the impact of  
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39 337 post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to  
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41 338 use patient-reported responses to quantify the effect of hospital experience (of pain, sleep,  
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43 339 and nutrition) on unplanned 30-day readmissions.  
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49 340 There are limitations to this study. The main limitation was that there were fewer  
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51 341 readmissions than anticipated and the study may have been insufficiently powered for  
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53 342 detecting the associations being tested. The results were based on anonymous self-reports;  
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55 343 hence there was no capacity to link them to hospital data to establish actual readmission time  
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57 344 frames, length of hospital stay, reasons for readmission or previous admission history.  
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3 345 However, our primary endpoint was 30-day readmission and we believe that the self-reported  
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5 346 data was accurate. The response rate is only an estimation based on joint replacement activity  
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7 347 in the ACT. It assumes that all patients returning for their six-week follow-up appointment  
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9 348 were invited to participate. We do not know whether the reception staff invited all patients, or  
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11 349 only some. The lack of information about non-responders is another limitation of this study.  
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13 350 More non-responders may have been readmitted and it is possible that they may have been  
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15 351 sicker than responders, which would also influence the readmission rate. Also, as the ACT  
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17 352 has a relatively high socioeconomic demographic the findings from this study may not apply  
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19 353 to other less affluent areas.  
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24 354 Our data do not allow us to understand why rehabilitation was not accessed. It is possible that  
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26 355 patients who were frailer did not feel able to participate and perhaps they were the patients  
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28 356 who were readmitted. However, a range of patient and provider-based factors have been  
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30 357 recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative  
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32 358 preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as  
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34 359 insurance provider and hospital business model [51]. This association needs clarification.  
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39 360 It is not known if the rate of readmission can be reduced given the significant comorbidities  
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41 361 of the TKA patient sample.  
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## 47 363 **Conclusion**

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52 365 This study was undertaken to explore the factors impacting unplanned 30-day readmission  
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54 366 after TKA. These results have implications for policy and for practice. An over-  
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56 367 representation of public patients in the readmitted cohort is important. It is possible that the  
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58 368 extended periods of delay to surgery among patients on the public waiting list may be an  
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3 369 important factor. Therefore, it is essential to shorten waiting times and prioritize medical  
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5 370 need when dealing with public patients. Clinicians should also place emphasis on the  
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7 371 importance of attending rehabilitation after a TKA as an effective way to reduce 30-day  
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9 372 readmission. Further investigation of how the pre-surgical patient journey can be better  
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11 373 optimised to reduce readmission rates is warranted.  
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For peer review only



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37

38 **388** 0000-0003-1406-4593) upon reasonable request.  
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40  
41 **389**  
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43  
44 **390 Figures**  
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47 **391** 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

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<i>Odds Ratio</i>			
<i>Variables</i>	<i>OR</i>	<i>95% CI</i>	<i>p-value</i>
<i>Public vs Private</i>	4.2	1.2-14.2	0.02
<i>Comorbidities</i>			
Arthritis <sup>#</sup>	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
<i>Morbidity scale</i>	1.4	0.7-2.8	0.40
0	-	-	-

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1	0.6	0.1-2.9	0.56
2	0.4	0.1-2.3	0.32
3 or more	-	-	-
<i>Self-Rated Health</i>			
<i>Before you went to hospital</i>			
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	-	-	-
<i>Pain</i>			
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
<i>Sleep</i>			
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

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4	Feel rested when leaving	1.5	0.5-4.5	0.50
5	hospital			
6				
7	Dietary requirement met	0.4	0.1-3.3	0.41
8				
9	Water in reach	3.5	0.7-17.1	0.12
10				
11	Quality of food in	0.5	0.1-4.0	0.52
12	hospital(average)			
13				
14				
15	<i>Discussion of medications</i>	0.5	0.1-2.1	0.38
16	<i>with health care provider</i>			
17	<i>Patient medication</i>			
18	<i>enablement</i>			
19				
20	Better understand use of	0.4	0.1-3.6	0.44
21	medication			
22				
23	Feel more confident about	0.7	0.1-6.2	0.80
24	taking medications			
25				
26	Take your medications	0.5	0.1-4.0	0.48
27				
28	<i>Total medication</i>	0.9	0.6-1.4	0.59
29	<i>enablement (medication</i>			
30	<i>scale)</i>			
31	<i>Patient enablement</i>			
32				
33	Able to cope with life	0.7	0.3-1.6	0.46
34				
35	Able to understand your	0.9	0.4-1.2	0.81
36	condition			
37				
38	Able to cope with your	0.8	0.3-1.7	0.50
39	condition			
40				
41	Able to keep yourself	1.2	0.5-2.6	0.65
42	healthy			
43				
44	Confident about your health	0.6	0.3-1.4	0.25
45				
46	Able to help yourself	1.3	0.6-2.8	0.54
47				
48	<i>Total enablement score (less</i>	1.0	0.3-3.3	0.96
49	<i>enabled)</i>			
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4 *When you got home from*

5 *hospital*

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7 Recall being given 0.8 0.2-3.8 0.79

8 information about who to

9 contact

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11  
12 *Who were you instructed to* 0.8 0.6-1.0 0.05

13 *contact?*

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16 *Go to ED within 30 days of* 42.5 10.9-164.8 0.00

17 *discharge*

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20 *Readmitted within 30 days* - - -

21 *of discharge*

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24 *General Practice Questions*

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26 *Regular GP practice* - - -

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28 *See the same doctor* 0.3 0.0-3.0 0.33

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30 *Regular appointments with* 1.2 0.4-3.7 0.76

31 *GP*

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34 *Discussion of plan with GP* 0.7 0.2-2.2 0.50

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36 *When were you advised to* 1.9 0.2-14.7 0.56

37 *see GP next*

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40 *Usual waiting time to see* 0.9 0.4-1.8 0.80

41 *GP*

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43  
44 *How soon after surgery did* 0.9 0.4-1.8 0.80

45 *you see GP*

46  
47 *Attendance to rehab* 0.1 0.0-0.4 0.001

48 *program*

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51 *Attendance to rehab within* 2.2 0.8-5.5 0.11

52 *5 days*

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54  
55 *Length of attendance to* 0.9 0.5-1.5 0.60

56 *rehab*

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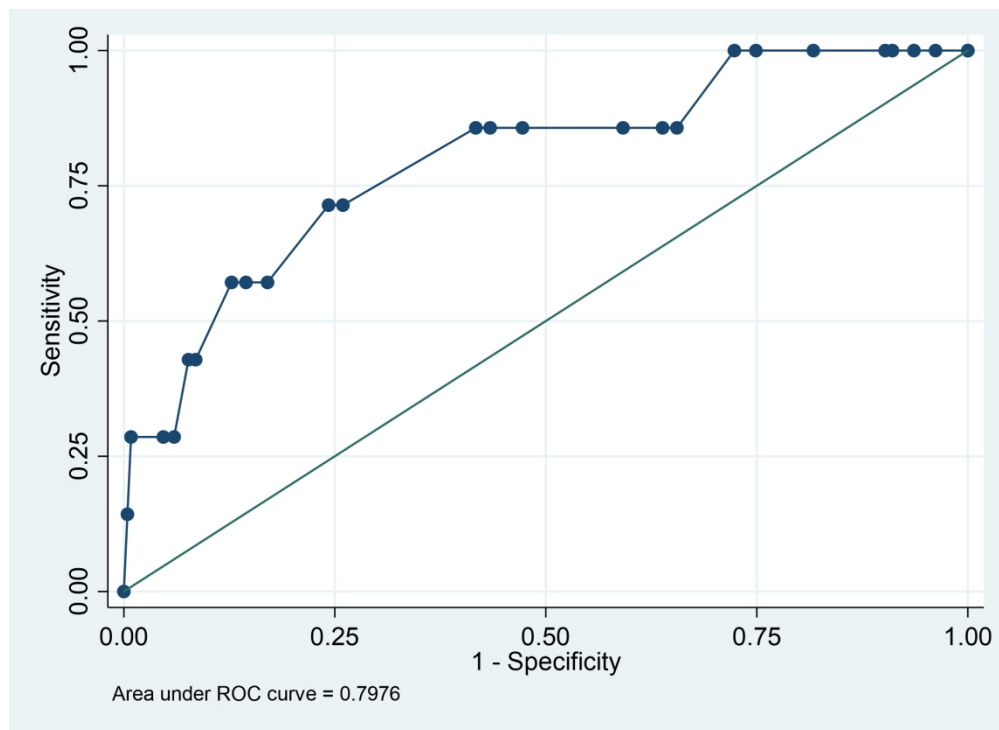


Figure 1. Receiver Operator Curve

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

<i>Variables</i>	<i>Odds Ratio</i>		
	<i>OR</i>	<i>95% CI</i>	<i>p-value</i>
<i>Public vs Private</i>	4.2	1.2-14.2	0.02
<i>Comorbidities</i>			
Arthritis <sup>#</sup>	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
<i>Morbidity scale</i>	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	-	-	-
<i>Self-Rated Health</i>	0.5	0.2-1.0	0.04
<i>Before you went to hospital</i>			
<i>Invited to attend session by surgeon</i>	0.5	0.1-1.5	0.21
<i>Attended information session</i>	1.0	0.3-3.2	0.99
<i>Usefulness of pre-surgery information session</i>	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	-	-	-
<i>Pain</i>	-	-	-
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
<i>Medication for pain control</i>	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
<i>Sleep</i>			
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
<i>Discussion of medications with health care provider</i>	0.5	0.1-2.1	0.38
<i>Patient medication enablement</i>			
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
<i>Total medication enablement (medication scale)</i>	0.9	0.6-1.4	0.59
<i>Patient enablement</i>			
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
<i>Total enablement score (less enabled)</i>	1.0	0.3-3.3	0.96
<i>When you got home from hospital</i>			
Recall being given information about who to contact	0.8	0.2-3.8	0.79
<i>Who were you instructed to contact?</i>	0.8	0.6-1.0	0.05
<i>Go to ED within 30 days of discharge</i>	42.5	10.9-164.8	0.00
<i>Readmitted within 30 days of discharge</i>	-	-	-
<i>General Practice Questions</i>			
Regular GP practice	-	-	-
<i>See the same doctor</i>	0.3	0.0-3.0	0.33
<i>Regular appointments with GP</i>	1.2	0.4-3.7	0.76
<i>Discussion of plan with GP</i>	0.7	0.2-2.2	0.50
<i>When were you advised to see GP next</i>	1.9	0.2-14.7	0.56
<i>Usual waiting time to see GP</i>	0.9	0.4-1.8	0.80
<i>How soon after surgery did you see GP</i>	0.9	0.4-1.8	0.80

1				
2				
3				
4	<i>Attendance to rehab</i>	0.1	0.0-0.4	0.001
5	<i>program</i>			
6				
7	<i>Attendance to rehab within</i>	2.2	0.8-5.5	0.11
8	<i>5 days</i>			
9				
10				
11	<i>Length of attendance to</i>	0.9	0.5-1.5	0.60
12	<i>rehab</i>			
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For peer review only

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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

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

Journal:	<i>BMJ Open</i>
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Complete List of Authors:	Chhabra, Madhur; Australian National University, Department of Health Services and Research Perriman, Diana; ACT Health, Trauma & Orthopaedic Research Unit; Australian National University Medical School Phillips, Christine; Australian National University Medical School Parkinson, Anne; Australian National University, Health Services Research and Policy Glasgow, Nicholas; Australian National University Medical School Douglas, Kirsty; Australian National University Medical School Cox, Darlene; Health Care Consumers Association, ACT Smith, Paul; ACT Health, Trauma and Orthopaedic Unit; Australian National University Medical School Desborough, Jane; Australian National University, Health Services Research and Policy
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Surgery
Keywords:	Knee < ORTHOPAEDIC & TRAUMA SURGERY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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1                   **Understanding Factors affecting 30-day Unplanned Readmissions for Patients**  
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4                   **undergoing Total Knee Arthroplasty (TKA): The ACT Transition from Hospital to**  
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6                   **Home Orthopaedics Survey**  
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10           **Running title:** Unplanned readmissions following knee arthroplasty  
11  
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47

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50           analysis, significant contributions to final manuscript.  
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## 32 Abstract

### 33 Objectives

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

### 37 Design, setting and participants

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

### 43 Results

44 Of the 380 participants who completed the survey (n=380, 54% of TKAs undertaken over the  
45 study period), 3.4% (n=13; 95% confidence interval; 1.8 – 5.8) were subsequently readmitted  
46 within 30 days of discharge after a primary hospitalization. Public patients were significantly  
47 more likely to be readmitted within 30 days compared to private patients (adjusted OR=6.31,  
48 95% CI:1.59-25.14, p=0.009), and patients who attended rehabilitation were significantly less  
49 likely to be readmitted within 30 days of discharge than those who did not (adjusted  
50 OR=0.16, 95% CI: 0.04-0.57, p=0.005). There were no associations between post-hospital  
51 syndrome or patient enablement and 30-day readmissions in this study.

### 52 Conclusion

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3 53 Reasons underlying the difference in unplanned readmission rates for public versus private  
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5 54 patients need to be explored, including differences in surgical waiting times and the  
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7 55 consequences for impairment and disease complexity. Strategies to foster increased  
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10 56 participation post-surgical rehabilitation programs need to be developed as an avenue to  
11  
12 57 mitigate the burden of unplanned 30-day readmissions on individuals and health systems.  
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15  
16 58 **Keywords:** knee arthroplasty, 30-day readmission, post-hospital syndrome, transitional care,  
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18 59 hospital performance.  
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21 60 **ARTICLE SUMMARY**  
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- 23  
24 61 • A survey, co-designed with clinicians and patients, examined associations between  
25  
26 62 patient, hospital and transitional care factors and unplanned 30-day readmission  
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28 63 following total knee arthroplasty in both public and private hospital settings.  
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31 64 • This study is the first to use patient-reported responses to quantify the effect of  
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33 65 hospital experience of pain, sleep, and nutrition in unplanned 30-day readmissions  
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35 66 following total knee arthroplasty.  
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38 67 • A limitation of this study is that results were based on self-reported patient outcomes  
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40 68 with no capacity to link them to hospital records for confirmation as well as the lack  
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42 69 of information from those who declined the survey.  
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## 71 **Introduction**

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

78 The rate of knee replacement surgery has more than doubled over the past 15 years both in  
79 Australia and internationally [7] with the highest rate of increase seen in the private sector [3,  
80 5, 8]. This growing demand has placed increased logistical and financial strain on the  
81 healthcare system, including associated unplanned 30-day readmissions [5]. The most  
82 common condition-related causes of unplanned readmission following a total knee  
83 arthroplasty (TKA) are surgical-site infection, arthrofibrosis, cellulitis, concomitant co-  
84 morbidities, and fluid and electrolyte imbalance [9]. Other factors such as old age, revision  
85 procedure and acute length of hospital stay also increase the risk of unplanned 30-day  
86 readmissions [9]. Beyond the complications as a cause of the readmission, there are patient  
87 factors related to the hospital stay that increase risk of readmission [10].

88 Krumholz [11] describes post-hospital syndrome as a period of vulnerability after discharge  
89 from the hospital which leaves a patient at increased risk of re-hospitalization from  
90 conditions which are often unrelated to the original reason for of admission. It is proposed  
91 that this acquired transient state might be due to patients' experiences of pain, sleep  
92 deprivation, and poor nutrition during their hospital stay [11]. While this hypothesis is  
93 supported by evidence that increasing patient capacity for self-care is effective at reducing  
94 30-day readmissions [10], as far as we are aware, post-hospital syndrome has not been

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3 95 quantified or measured as an independent variable in association with unplanned 30-day  
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5 96 readmission.

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8 97 Research examining unplanned 30-day readmissions has described a number of associated  
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10 98 factors. These factors include: clinical and demographic characteristics [12, 13]; a lack of  
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12 99 access to primary care; the continuity and regularity of primary care [14-16]; and deficits in  
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14 100 hospital discharge planning, which often focus on knowledge provision rather than patients'  
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16 101 capacity to implement this knowledge [10].

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20 102 The patient-enablement instrument is a tool used to measure a person's knowledge and  
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22 103 understanding of their health condition; confidence to manage their condition, health, and life  
23  
24 104 [17]; and their ability to source appropriate healthcare for their individual needs. While this  
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26 105 measure has largely been examined in primary-care settings, its role in preventing unplanned  
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28 106 hospital readmissions has not yet been explored.

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32 107 The purpose of this study was to investigate factors associated with unplanned 30-day  
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34 108 readmissions following a TKA, including aspects of hospital experiences, patient enablement,  
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36 109 and transition from hospital to home.

## 40 110 **Methods**

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### 43 112 **Study population**

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46 113 Consecutive patients over the age of 16 years, attending a six-week follow-up appointment  
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48 114 after undergoing total knee arthroplasty at one of four private and public clinical services  
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50 115 between 1 February 2018 and 31 January 2019.

### 51 116 **Patient and public involvement**

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3 118 Five people who had previously had an arthroplasty with a surgeon from one of the  
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5 119 participating clinics completed the survey and provided feedback regarding its  
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8 120 meaningfulness in relation to their experiences, and the length and readability of the survey.  
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## 10 121 **Study design**

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15 123 A cross-sectional survey was conducted in the Australian Capital Territory (ACT) between 1  
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17 124 February 2018 and 31 January 2019 at all private and public sites undertaking lower limb  
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19 125 joint replacement services. Data was collected retrospectively at the six-week follow-up  
20  
21 126 appointment post-surgery for both total knee and hip replacement (THA). The responses for  
22  
23 127 patients having undergone elective TKA are presented in this paper.  
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## 27 128 **Instrument**

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33 130 The *ACT Transition from Hospital to Home Survey* was developed and piloted by researchers  
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35 131 at the Australian National University, Canberra Hospital, Academic Unit of General Practice  
36  
37 132 ACT Health, Capital Health Network, Health Care Consumer Association ACT, and people  
38  
39 133 who had previously experienced either TKA or THA [18]. The 50-item survey was designed  
40  
41 134 to measure patients' experiences in hospital and transition to home across six domains: 1.  
42  
43 135 Patient demographic characteristics and co-morbidities; 2. Post-hospital syndrome; 3.  
44  
45 136 Medication enablement; 4. Patient enablement; 5. Transition to general practice; and 6. Pre-  
46  
47 137 and post-hospital information and pre-/post-surgical rehabilitation  
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49  
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51 138 Co-morbidities: Morbidity was assessed with the validated 18-item Functional Comorbidity  
52  
53 139 Index which is used to predict functional status rather than mortality [19].  
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57 140 Post-hospital syndrome: Fifteen items within three domains covering patients' experiences of  
58  
59 141 sleep, pain, and diet in hospital were designed to measure post-hospital syndrome.  
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3 142 Medication enablement: Three items measured medication enablement in terms of patients'  
4  
5 143 knowledge and ability to manage their medications following discussions with health care  
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7 144 providers derived from a previous study in general practice nurse consultations [20]. The  
8  
9 145 internal consistency of this scale was established ( $\alpha = 0.80$ ) in the pilot study (unpublished  
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11 146 results).

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15 147 Patient enablement: This is the internationally validated six-item Patient Enablement  
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17 148 Instrument [21] used primarily in primary-care research.

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20 149 Transition to general practice: 10-items assessing patients' relationships with their general  
21  
22 150 practitioner (GP) in terms of continuity of care, regularity of care, healthcare planning,  
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24 151 patients' understanding of when to see their GP following discharge, and access to care.  
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26 152 These questions were refined as a result of the pilot study to eliminate covariance and  
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28 153 repetition.

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32 154 Interaction with the recommended rehabilitation program: Referral and attendance to  
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34 155 outpatient physiotherapy rehabilitation post-discharge was examined with one item.

### 35 36 37 38 156 **Data collection**

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41 157 The paper surveys were distributed by reception staff at patients' six-week post-operative  
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43 158 consultation. Staff were given a protocol and suggested wording to use when providing the  
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45 159 survey. An information sheet about the study was provided to patients and anonymity  
46  
47 160 guaranteed. Patients were not required to include their name or identifying information on the  
48  
49 161 survey. This ensured that patients understood that participation or non-participation did not  
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51 162 affect the care they received and that completed surveys were confidential to clinic staff.  
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53 163 completion of the survey implied written consent and this was agreed and approved by the  
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55 164 local ethics committee. Surveys were deposited in a sealed box in the waiting room and  
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57 165 collected by the researcher at regular intervals.

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6 167 **Data analysis**7  
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11 169 Completed survey data was collated and descriptive and inferential statistics used. Variables  
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13 170 were described using summary statistics and frequencies. Some variables were grouped to  
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15 171 create new variables and others, for example, BMI, were converted to categorical variables  
16  
17 172 for analysis. The primary outcome of interest was self-reported 30-day readmission to  
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19 173 hospital following discharge, categorized as a binary variable (yes/no). Age, sex, living  
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21 174 situation, country of origin, education, self-rated health, comorbidities, post-hospital  
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23 175 syndrome (experiences of sleep, diet and pain), experiences of family practice (access,  
24  
25 176 continuity, planning, regularity), medication enablement, and patient enablement were  
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27 177 separate independent variables.

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32 178 An exploratory factor analysis (EFA) with orthogonal varimax rotation was undertaken to  
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34 179 explore the relationship between variables which described post hospital syndrome. The  
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36 180 modes/themes which had an eigenvalue of  $>1$  were retained and the internal consistency of  
37  
38 181 the modes which emerged was examined using Cronbach's alpha. The suitability of the data  
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40 182 for an EFA was confirmed with a Kaiser-Meyer-Olkin (KMO) criteria and Bartlett test.  
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44 183 Prior to analysis, variable independence was established. Ordinal variables were examined  
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46 184 using Spearman's correlation coefficient and categorical variables using the chi squared ( $\chi^2$ )  
47  
48 185 test and odds ratio. If a strong correlation ( $> 0.6$ ) or a significant association ( $p \leq 0.2$ ) existed  
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50 186 between two eligible variables, only one of these was retained for inclusion in the final  
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52 187 analysis.  
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3 188 Univariate logistic regression analysis was conducted for each independent variable and the  
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5 189 dependent variable (unplanned 30-day readmission). Univariate logistic regression was  
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7 190 conducted on each individual comorbidity item, and then for the total comorbidity score.  
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10 191 To further eliminate potential confounding, two multiple logistic regression models were run  
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12 192 - one including eligible individual variables from within the Functional Comorbidity Index,  
13  
14 193 Medication Enablement questions and the Patient Enablement Instrument; and a second  
15  
16 194 including total scores.  
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19 195 The full multiple logistic regression model included eight variables. These were public or  
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21 196 private hospital; upper gastrointestinal disease; self-rated health; given an information  
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23 197 package or checklist before surgery; usual waiting time to see GP; attendance at  
24  
25 198 recommended rehabilitation or physiotherapy; and living status. The reduced model included  
26  
27 199 'public or private hospital' and 'attendance at recommended rehabilitation or physiotherapy'.  
28  
29 200 Only risk factors with  $p$ -values  $\leq 0.25$  were included in the multiple logistic regression  
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31 201 analyses. Logistic regression with backward stepwise selection was used to choose risk  
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33 202 factors for the multivariable model. A significance level of 0.25 was required to allow a risk  
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35 203 factor into the model, and a significance level of 0.25 was required for a risk factor to stay in  
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37 204 the model. The adjusted odds ratio and its 95% confidence interval were calculated for each  
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39 205 risk factor in the presence of others in the final model. Both the models were adjusted for age  
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41 206 and sex.  
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44 207 Likelihood ratio tests and Hosmer Lemeshow goodness of fit test were used to check the fit  
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46 208 of the final model. The Receiver Operator Characteristic Curve (ROC) was plotted to check  
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48 209 the specificity and sensitivity of the predicted model.  
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51 210 Stata/IC 15.1 (StataCorp LLC, Texas, USA) was used to perform all statistical analyses [22].  
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## 211 **Missing data**

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

## 216 **Ethical approval**

217  
218 Ethical approval was obtained from the ACT Health (ETHLR.17.207), Calvary Healthcare  
219 Bruce (45-2017) and the Australian National University (2017/798) Human Research Ethics  
220 Committees. All participants provided written informed consent to participate in this study.

## 221 **Results**

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

223 Of all surgeries, 380 received a total knee arthroplasty and of these 13 were readmitted within  
224 30 days. Participant demographics are presented in Table 1. Private patients accounted for  
225 65% of the total population (247 private patients, 133 public patients). This represented 44%  
226 of all private patients and 96% of all public patients who had a TKA during the study period  
227 which represents 54% of all TKAs. 57% of those who underwent knee surgery were females.

228 The mean age was 67.4 with a standard deviation 0.5 years (age range 44.8 to 91.0 years).

229 Mean BMI was 31.5 kg/m<sup>2</sup> with most having a BMI of >30 (58%). Most participants were

230 non-indigenous (99%). There were three people of Aboriginal and/or Torres Strait Islander

231 origin, none of whom was readmitted. There were proportionally more private patients aged

232 65-84 years (63%) compared to public (53%), whereas proportionally more public patients

233 were in the 45-64 age group (44% compared to 35%). The proportion of females within the

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234 public cohort was greater than private (67% compared to 57%). A higher proportion of

235 public patients lived alone (31% compared to 23%).

236

For peer review only

237 Table 1. Characteristics of TKA participants with an unplanned 30-day readmission (n) as a  
 238 proportion of all participants (N).  
 239

Variable	Public n/N	Private n/N	Total N=13/380 (%)*	
<b>Age</b>	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
<b>Gender</b>	Male	1/21	1/97	3/139 (2%)
	Female	7/86	3/129	2/55 (5%)
	Other	0/0	0/2	0/2
<b>Language</b>	Other than English at home	0/21	1/14	2/49 (4%)
	Only speak English	1/12	1/106	11/320 (3%)
<b>Living Status</b>	Live alone	7/40	0/55	2/95 (2%)
	Live with someone	1/45	4/189	11/273 (4%)
<b>BMI Calculations</b>	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%)
<b>Indigenous status</b>	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%)
<b>Education</b>	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

### 244 **Post-hospital syndrome exploratory factor analysis (EFA)**

245 The results of the exploratory factor analysis are reported in Table 2. Three modes/themes  
246 with acceptable internal consistency emerged. First, diet, which was described by responses  
247 to two questions: “Did you feel your dietary requirements were met in hospital?” and  
248 “Overall, how would you rate the quality of the food in hospital?” The second theme was  
249 pain, which was also explained by two questions: “How would you describe the general level  
250 of pain you experienced?” and “When you left hospital, how would you rate your pain out of  
251 10?” The third was sleep which was explained by “Did you feel well rested when you left the  
252 hospital?” and “How would you rate the quality of sleep in the hospital?”

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

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

259 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?	<b>0.88</b>	0.01	0.10	
Overall, how would you rate the quality of the food in hospital?	<b>0.86</b>	0.01	0.09	
How would you describe the general level of pain you experienced?	-0.02	<b>0.83</b>	0.10	
When you left hospital, how would you rate your pain out of 10?	0.04	<b>0.75</b>	0.09	
Did you feel well rested when you left the hospital?	0.20	0.18	<b>0.75</b>	
How would you rate the quality of sleep in the hospital? (Poor)	0.30	0.18	<b>0.67</b>	

## 263 **Multiple logistic regression analysis**

264 The results of univariate analysis are presented in Supplementary table 1. The Area Under the  
265 Curve (AUC) was 0.80 (95% CI: 0.66, 0.94) indicating high overall accuracy of the logistic  
266 model (80%) (Figure 1). The area under the ROC curve is interpreted as the probability that a  
267 subject with unplanned 30-day readmission is given a higher probability of the outcome by  
268 the logistic model than a randomly chosen subject without unplanned 30-day readmission. An  
269 AUC value of 0.50 indicates that the model has no discriminatory ability (the diagonal line  
270 corresponds to random change). The Pearson chi-sq GOF test statistic is 11.64 and since  $p =$   
271 0.7682, we conclude that there is no evidence against the model fitting the data well.

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

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

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

289

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

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

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

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## 299 Discussion

300 The aim of this study was to investigate factors associated with unplanned 30-day  
 301 readmission in TKA patients. Of the 4% of patients who had an unplanned readmission, those  
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3 302 who attended public hospitals and those who did not attend an outpatient rehabilitation

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5 303 program were more likely to be readmitted to hospital within 30 days of discharge.

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8 304 While the United States also has a similar 4% readmission rate following TKA [9, 31-33],

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10 305 this is higher than that reported by the Australian Institute of Health and Welfare (AIHW) [3].

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12 306 However, our results may reflect the true readmission rate more accurately as the AIHW only

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14 307 reports public hospital data and the majority of TKAs in Australia are performed in the

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16 308 private sector.

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20 309 In our study, public patients were more likely to be readmitted within 30 days as compared to

21  
22 310 private patients. The majority of respondents (65%) had their TKA in the private sector,

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24 311 consistent with the higher proportion (80%) of TKA procedures performed in the private

25  
26 312 sector in the ACT [34]. Our study has almost complete ascertainment from the public sector,

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28 313 and reasonable ascertainment from the private sector, supporting the robustness of our

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30 314 findings. The increased likelihood of readmission for public patients might be explained by

31  
32 315 several contributing factors such as socioeconomic status, longer waiting times resulting in

33  
34 316 increased impairment and disease complexity [35-40]. The median waiting time for a TKA in

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36 317 2018-19 in the ACT public hospital system was 209 days with 8.2% of patients waiting more

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38 318 than 365 days [35]. On the other hand, the median waiting time for Australian private patients

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40 319 was just 67 days during the same period [2, 41]. Therefore, waiting time may be an important

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42 320 mediating factor however association between the two may only be inferred and no causation

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44 321 can be implied.

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48 322 Patients who have had to wait longer constitute 1.2% of all unplanned 30-day readmissions

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50 323 for elective surgical procedures in Australia [42]. TKA patients who waited longer than six

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52 324 months have been described as having significantly worse function and quality of life scores,

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54 325 as well as dissatisfaction rates which were mainly influenced by pre-operative anxiety and



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3 326 depression [43]. It is important to understand that surgical waiting times are only part of the  
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5 327 waiting journey for patients in the public system. The mean waiting times recorded for  
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7 328 Australian patients do not take into account the lengthy process of referral, specialist  
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9 329 assessment and investigation [44]. Addressing long waiting lists by utilising non-surgical  
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11 330 exercise and education programs are increasingly being implemented and the evidence for  
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13 331 efficacy is strong [45, 46].  
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18 332 In our study, patients who attended rehabilitation were less likely to be readmitted within 30  
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20 333 days than those who did not. Previous research indicates that private patients are more likely  
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22 334 to attend rehabilitation than public patients [47] and that rehabilitation is associated with  
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24 335 better physical function after TKA [45]. However, we found no significant relationship  
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26 336 between being a public or private patient and attendance at rehabilitation. Both groups in our  
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28 337 sample had similar rehabilitation opportunities, except for the provision of hydrotherapy after  
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30 338 six weeks indicating that private/public status was not a mediating factor for this finding.  
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35 339 This study showed no significant associations between general practice (GP) factors and  
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37 340 unplanned 30-day readmissions. A recent study reported that timely and regular GP contact  
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39 341 during the two years following transition from hospital to community care lowered the risk of  
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41 342 emergency readmission to hospital in patients with cardiovascular disease [48]. However, our  
42  
43 343 results might reflect the nature of the health condition. This cohort included people having  
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45 344 TKA as a treatment for severe pain for arthritis of the knee, which is quite different to other  
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47 345 diseases in that the treatment is potentially definitive and is followed up by the surgeon.  
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51 346 Although more than half of the patients who were readmitted had high scores for post-  
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53 347 hospital syndrome, there was no significant association with 30-day readmission. The  
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55 348 hypothesis of post-hospital syndrome describes a transient state resulting in consequences,  
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57 349 including a higher risk of readmission [11]. Brownlee et al. [49] found that post-hospital  
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3 350 syndrome was an independent predictor of readmission within 30 days of discharge in a large  
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5 351 cohort of surgical patients. While other studies have attempted to determine the impact of  
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7 352 post-hospital syndrome through linked hospital records data, [49, 50] this study is the first to  
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10 353 use patient-reported responses to quantify the effect of hospital experience (of pain, sleep,  
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12 354 and nutrition) on unplanned 30-day readmissions.

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14  
15 355 There are limitations to this study. The main limitation was that there were fewer  
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17 356 readmissions than anticipated and the study may have been insufficiently powered for  
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19 357 detecting the associations being tested. The results were based on anonymous self-reports;  
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21 358 hence there was no capacity to link them to hospital data to establish actual readmission time  
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23 359 frames, length of hospital stay, reasons for readmission or previous admission history.  
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25 360 However, our primary endpoint was 30-day readmission and we believe that the self-reported  
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27 361 data was accurate. The response rate is only an estimation based on joint replacement activity  
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29 362 in the ACT. It assumes that all patients returning for their six-week follow-up appointment  
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31 363 were invited to participate. We do not know whether the reception staff invited all patients, or  
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33 364 only some. The lack of information about non-responders is another limitation of this study.  
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36 365 More non-responders may have been readmitted and it is possible that they may have been  
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38 366 sicker than responders, which would also influence the readmission rate. Also, as the ACT  
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40 367 has a relatively high socioeconomic demographic the findings from this study may not apply  
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42 368 to other less affluent areas.

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45 369 Our data do not allow us to understand why rehabilitation was not accessed. It is possible that  
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47 370 patients who were frailer did not feel able to participate and perhaps they were the patients  
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49 371 who were readmitted. However, a range of patient and provider-based factors have been  
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51 372 recognized as affecting the rehabilitation pathway chosen by patients, such as pre-operative  
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53 373 preferences, previous experiences, perceived benefits, clinical status post-surgery, as well as  
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55 374 insurance provider and hospital business model [51]. This association needs clarification.

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3 375 It is not known if the rate of readmission can be reduced given the significant comorbidities  
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5 376 of the TKA patient sample.  
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11 378 **Conclusion**  
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16 380 This study was undertaken to explore the factors impacting unplanned 30-day readmission  
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18 381 after TKA. These results have implications for policy and for practice. An over-  
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20 382 representation of public patients in the readmitted cohort is important. It is possible that the  
21  
22 383 consequences of extended periods of delay to surgery among patients on the public waiting  
23  
24 384 list may be an important factor. Therefore, it is essential to shorten waiting times and  
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26 385 prioritize medical need when dealing with public patients. Clinicians should also place  
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28 386 emphasis on the importance of attending rehabilitation after a TKA as an effective way to  
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30 387 reduce 30-day readmission. Further investigation of how the pre-surgical patient journey can  
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32 388 be better optimised to reduce readmission rates is warranted.  
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35 **402 Data sharing statement**  
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39 **403** Survey data and statistical analysis plans are available from Dr Desborough (ORCID ID:  
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41 **404** 0000-0003-1406-4593) upon reasonable request.  
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44 **405**  
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47 **406 Figures**  
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50 **407** Figure 1. Receiver Operator Curve  
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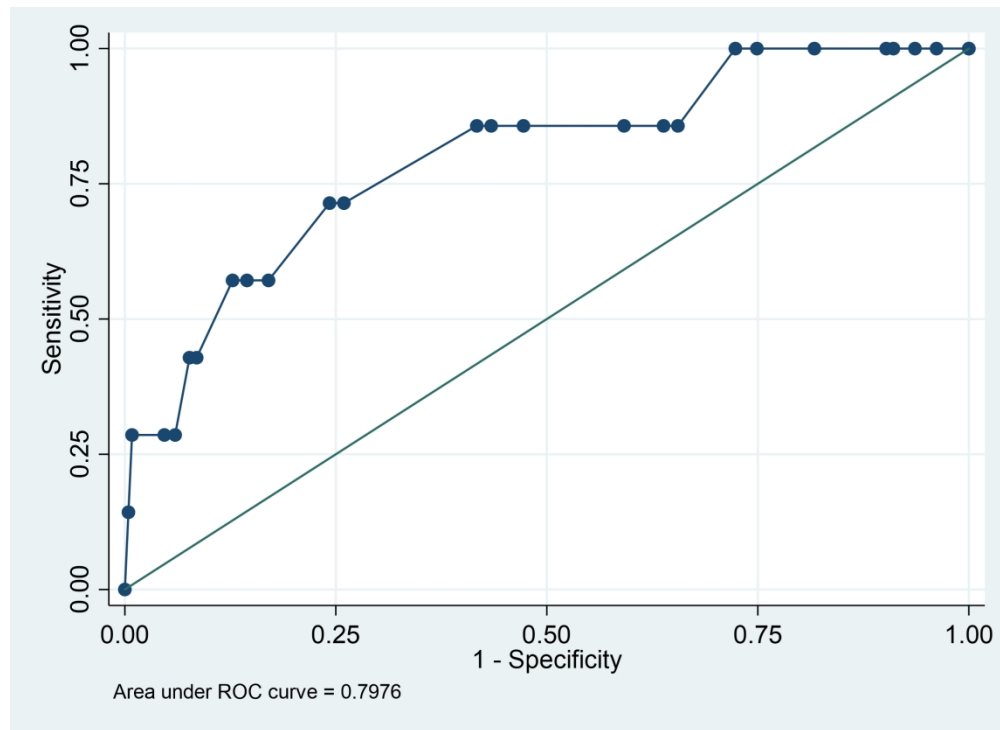


Figure 1 Receiver Operator Curve. The area under the ROC curve is 0.80 (95% CI: 0.66, 0.94). The area under the ROC curve is interpreted as the probability that a subject with unplanned 30-day readmission is given a higher probability of the outcome by the logistic model than a randomly chosen subject 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

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

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<i>Excellent</i>	-	-	-
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**Before you went to hospital**

Invited to attend session by surgeon	0.5	0.1-1.5	0.21
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Attended information session	1.0	0.3-3.2	0.99
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Usefulness of pre-surgery information session	0.7	0.3-1.9	0.53
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<i>Not very useful</i>	-	-	-
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<i>Moderately useful</i>	0.1	0.0-1.8	0.13
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<i>Very useful</i>	0.3	0.0-1.8	0.21
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Given information package or checklist	-	-	-
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Use of information package or checklist	-	-	-
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**Pain**

Worst pain (more than six score)	1.5	0.4-5.7	0.51
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Pain experienced during hospital stay (general pain)	4.7	1.0-21.6	0.05
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Pain on discharge (less than 6)	5.0	1.3-18.4	0.016
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Medication for pain control	0.4	0.1-1.7	0.20
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Pain management with ice	0.9	0.2-4.2	0.90
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Breathing exercise	1.9	0.6-6.2	0.30
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**Sleep**

Single/shared room (single)	1.4	0.4-4.8	0.55
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Quality of sleep (Poor)	1.2	0.4-4.0	0.80
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Medication for sleep	1.2	0.4-3.9	0.71
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Feel rested when leaving hospital	1.5	0.5-4.5	0.50
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**Diet**

Dietary requirement met	0.4	0.1-3.3	0.41
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Water in reach	3.5	0.7-17.1	0.12
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Quality of food in hospital(average)	0.5	0.1-4.0	0.52
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Discussion of medications with health care provider	0.5	0.1-2.1	0.38
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<i>Pharmacist</i>	3.3	0.2-57.9	0.40
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<i>Doctor</i>	-	-	-
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<i>Nurse</i>	1.2	0.1-13.3	0.90
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<i>Physiotherapist</i>	-	-	-
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<i>Other</i>	-	-	-	Total enablement score (less enabled)	1.0	0.3-3.3	0.96
<i>Don't know</i>	-	-	-				
<i>More than one</i>	1.8	0.0-0.2	0.60				
<b>Patient medication enablement</b>				<b>When you got home from hospital</b>			
Better understand use of medication	0.4	0.1-3.6	0.44	Recall being given information about who to contact	0.8	0.2-3.8	0.79
Feel more confident about taking medications	0.7	0.1-6.2	0.80	Who were you instructed to contact?	0.8	0.6-1.0	0.05
Take your medications	0.5	0.1-4.0	0.48	<i>surgeon</i>	-	-	-
Total medication enablement (medication scale)	0.9	0.6-1.4	0.59	<i>nurse at hospital</i>	0.3	0.0-2.7	0.32
<b>Patient enablement</b>				<i>GP</i>	0.5	0.1-2.0	0.28
Able to cope with life	0.7	0.3-1.6	0.46	<i>emergency department</i>	0.3	0.1-2.0	0.27
Able to understand your condition	0.9	0.4-1.2	0.81	<i>other</i>	-	-	-
Able to cope with your condition	0.8	0.3-1.7	0.50	Go to ED within 30 days of discharge	42.5	10.9-164.8	0.00
Able to keep yourself healthy	1.2	0.5-2.6	0.65	<b>General Practice Questions</b>			
Confident about your health	0.6	0.3-1.4	0.25	Regular GP practice	-	-	-
Able to help yourself	1.3	0.6-2.8	0.54	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

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



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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).