

Readmission to a non-index hospital following total joint replacement

prevalence and association with mortality in 394,248 Australian patients

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Aims

It is unclear whether mortality outcomes differ for patients undergoing total hip arthroplasty (THA) or total knee arthroplasty (TKA) surgery who are readmitted to the index hospital where their surgery was performed, or to another hospital.

Methods

We analyzed linked hospital and death records for residents of New South Wales, Australia, aged ≥ 18 years who had an emergency readmission within 90 days following THA or TKA surgery between 2003 and 2022. Multivariable modelling was used to identify factors associated with non-index readmission and to evaluate associations of readmission destination (non-index vs index) with 90-day and one-year mortality.

Results

Of 394,248 joint arthroplasty patients (THA = 149,456; TKA = 244,792), 9.5% ($n = 37,431$) were readmitted within 90 days, and 53.7% of these were admitted to a non-index hospital. Non-index readmission was more prevalent among patients who underwent surgery in private hospitals (60%). Patients who were readmitted for non-orthopaedic conditions (62.8%), were more likely to return to a non-index hospital compared to those readmitted for orthopaedic complications (39.5%). Factors associated with non-index readmission included older age, higher socioeconomic status, private health insurance, and residence in a rural or remote area. Non-index readmission was significantly associated with 90 day (adjusted odds ratio (aOR) 1.69; 95% confidence interval (CI) 1.39 to 2.05) and one-year mortality (aOR 1.31; 95% CI 1.16 to 1.47). Associations between non-index readmission and mortality were similar for patients readmitted with orthopaedic and non-orthopaedic complications (90-day mortality aOR 1.61; 95% CI 0.98 to 2.64, and aOR 1.67; 95% CI 1.35 to 2.06, respectively).

Conclusion

Non-index readmission was associated with increased mortality, irrespective of whether the readmission was for orthopaedic complications or other conditions.

Take home message

- Nearly one in ten patient undergoing total joint replacement are readmitted within 90 days of discharge and more

than half of them return to a hospital other than the operating hospital.

- Non-index hospital readmissions post-total joint replacement are predominantly due to non-orthopaedic

conditions and are linked with higher 90-day and one-year all-cause mortality rates, highlighting the need for comprehensive postoperative care.

Introduction

Consistent with trends observed in other developed countries,^{1,3} Australia has seen a significant surge in the incidence of total hip arthroplasty (THA) and total knee arthroplasty (TKA) over the past decade.⁴ Although joint arthroplasty surgeries are considered cost-effective, their high-volume and high-cost nature lead to a significant economic burden on healthcare resources. The annual direct hospital cost for such procedures is estimated to exceed \$1 billion Australian dollars.⁵ A major portion of these expenses is related to the primary procedure. However, postoperative complications that require readmission also significantly increase the overall cost.⁵ Moreover, readmissions following joint replacement are associated with poorer patient outcomes including mortality.⁶

Despite the potentially critical role of readmissions in managing complications resulting from complex surgical procedures like THA and TKA, factors that drive poor outcomes in readmitted patients remain insufficiently studied. Previous studies have found that readmission to a hospital different from the one where the initial procedure was performed — known as non-index readmission—is linked to a significantly increased risk of mortality following major surgeries.⁷⁻⁹ It is hypothesized that lack of continuity of care during the post-discharge period following surgery might increase the risk of mortality because treating clinicians are unfamiliar with the patient and the details of their procedure.⁷ Only a single study of USA Medicare beneficiaries has specifically investigated this issue in joint arthroplasty patients, reporting a significant increase in risk of 90-day mortality for THA or TKA arthroplasty patients who were readmitted to non-index hospitals.⁷ There is very limited knowledge from other settings about the frequency of non-index readmissions among joint arthroplasty patients and the associated clinical ramifications.

Australia's healthcare system caters to a geographically diverse population, and both public and private hospitals provide specialized services,¹⁰ potentially accounting for high rates of non-index readmission. Given this context, our study seeks to explore the incidence and mortality outcomes of non-index compared to index readmissions among Australian patients who have undergone THA or TKA. Additionally, we explore whether this association varies according to reason for readmission (orthopaedic vs other conditions).

Methods

Setting and data source

New South Wales (NSW) is Australia's most populous state, with approximately eight million residents, and spans a geographical area of more than 800,000 km². We used person-level linked hospital (NSW Admitted Patient Collections Dataset (APDC)) and mortality data (NSW Register of Births, Deaths and Marriages, RBDM) for NSW residents. Ethical approval for the study was granted by the NSW Population and Health Services Research Ethics Committee (Ref: 2019/ETH00436). The NSW Centre for Health Record Linkage

conducted the data linkage using a probabilistic method,¹¹ with an estimated false positive rate of 0.5% (5 per 1,000).¹²

Index joint arthroplasty procedure

We included patients aged 18 years or over who were admitted to any public or private hospital between 2003 and 2022 with an Australian Classification of Health Interventions (ACHI) procedure code for THA and TKA recorded.¹³ We excluded admissions where recorded diagnoses and procedures indicated that the joint arthroplasty procedure was not a primary and elective procedure (see Supplementary table i). Multiple acute, contiguous hospital episodes were considered as a single, acute period of care. The index hospital was defined as the hospital where the joint arthroplasty procedure was performed.

90-day readmission

We identified all readmissions within 90 days of discharge following a THA or TKA procedure. A 90-day time frame was chosen because certain conditions, such as mechanical complications, infections, and inflammatory reactions, following joint arthroplasty are more likely to occur beyond the initial 30 days after discharge.¹⁴ We excluded hospitalizations for rehabilitation, haemodialysis, chemotherapy, radiotherapy, or cataract surgery. If multiple readmissions occurred within 90 days of the index discharge, only the first readmission was considered for analysis. The hospital where the patient first received care during the readmission was regarded as the location of the readmission. If a patient was readmitted to the hospital where the procedure was performed, we considered it an index readmission. Conversely, we considered a readmission as non-index if patients were readmitted to a hospital other than the one where the procedure was undertaken.

Based on prior works conducted by the Australian Institute for Health and Welfare (AIHW) and the NSW Bureau of Health Information (BHI),^{15,16} we categorized readmissions into orthopaedic complications and non-orthopaedic conditions, based on the principal diagnosis.

Outcomes and covariates

The primary outcomes of this study were 90-day mortality and one-year mortality, defined respectively as death within 90 days and one-year of the date of readmission, regardless of the cause. For the index joint arthroplasty procedure, we gathered information on the patient's age at the procedure, sex, type of procedure, remoteness of patients' residence, socioeconomic status (SES), pre-surgery hospital transfers, private health insurance status, length of stay, and hospital funding type (public or private). We assessed the presence of comorbidities using all diagnosis codes recorded for the index stay and any linked hospital records up to two years prior (see Supplementary table ii for the list of codes).

Statistical analysis

We estimated the proportion of patients readmitted to a non-index hospital among all patients who experienced a 90-day emergency readmission following a joint arthroplasty procedure. We evaluated differences in patient and hospital characteristics according to readmission destination (index vs non-index). To identify the factors associated with non-index

readmission, we built multiple logistic regression models with adjustment for age, sex, and comorbidities.

To assess the relationship between non-index readmission and mortality, we constructed multiple logistic regression models incorporating inverse probability weighting (IPW) to help minimize for potential confounding between the exposure (non-index vs index readmission) and the outcome of mortality. IPW is a type of propensity score analysis that estimates the probability of an exposure (in this case, non-index readmission) based on potential confounders (age at index procedure, sex, socioeconomic status, remoteness of residence, private insurance, procedure type, readmission reason, index hospital type, and comorbidities) and assigns weights to each patient inversely proportional to the estimated probabilities.¹⁷ We estimated the adjusted odds ratio (aOR) with 95% confidence intervals (CIs) for 30-day and one-year mortality using logistic regression models with and without IPW. We repeated these analyses stratified according to reason for readmission (orthopaedic complications vs non-orthopaedic conditions). Weights were calculated separately for readmissions for orthopaedic complications and other conditions. Supplementary figures a-c show the standardized differences in covariates before and after IPW for all readmitted patients, those with orthopaedic complications, and those with non-orthopaedic complications, respectively. For stratified analysis, heterogeneity was assessed by likelihood ratio tests comparing models with and without cross product interaction term for readmission cause.

Results

Between 2003 and 2022, a total of 394,248 joint arthroplasty surgeries were recorded, comprising 149,456 THA and 244,792 TKA (Table I). The mean age of these patients was 68.8 years (standard deviation (SD) 10.1), and a majority (55.4%) were female. Two-thirds of these patients were from major cities, and 57.5% (n = 226,668) had private health insurance. Most of the joint arthroplasty procedures (62.0%; n = 244,477) were performed in private hospitals. Compared to patients who underwent THA, those who underwent TKA were older (mean age 69.4 years vs 67.9 years) and more likely to be female (56.7% vs 53.2%) and to have certain comorbidities including diabetes, hypertension, chronic kidney disease, chronic pulmonary disease, and rheumatoid arthritis (Table I).

A total of 37,431 (9.5%) patients were readmitted within 90 days of total joint replacement. The 90-day readmission rate was higher among patients who had the procedure at a public hospital than those who had the procedure at a private hospital (12.0% vs 8.0%) (Figure 1). Among patients who were readmitted within 90 days, 14,594 (39%) had orthopaedic complications. Supplementary table c lists the top 15 ICD-10 codes for orthopaedic and other conditions categories. More than half (62.8%) of the readmissions for other conditions were to non-index hospitals, compared to 39.5% (n = 14,594) of readmissions due to orthopaedic complications. The rate of non-index readmissions varied according to the type of the hospital where the initial procedure took place, particularly for patients readmitted with other conditions. Among the latter patients, those who had their primary procedure at a private hospital had the highest rate (72.6%) of non-index readmission, whereas those who had their primary procedures at a public hospital had the

lowest rate (51.6%) of non-index readmission (Figure 1). Only a small proportion (3.8%) of those readmitted to a non-index hospital were transferred back to the index hospital during readmission. The median length of stay ranged from eight days (interquartile range (IQR) 6 to 14) in 2003 to four days (IQR 3 to 6) in 2022, whereas 90-day readmission rate ranged from 10.1% to 10.0% during the same period (Supplementary table iv).

Table II provides a comparison of the characteristics of patients who were readmitted to index and non-index hospitals. Compared to patients readmitted to the index hospital, those readmitted to a non-index hospital were older (mean age 71.5 years vs 70.0 years), more likely to live in major cities (61.9% vs 58.1%), and were more likely to have THA (39.9% vs 31.8%) as the primary procedure and have private insurance (52.0% vs 40.9%). Patients readmitted to a non-index hospital also had a higher prevalence of comorbidities, such as various cardiovascular diseases, chronic kidney disease, and rheumatoid arthritis and collagen vascular disease (Table II).

Figure 2 shows the factors that were associated with non-index readmission. Among these, reason for readmission had the strongest association with non-index readmission: compared to patients who were readmitted for orthopaedic complications, those who were readmitted for other conditions were 2.5-times more likely to be readmitted to a non-index hospital (aOR 2.52; 95% CI 2.41 to 2.63). Other factors associated with non-index readmission included older age (aOR 75+ years vs < 65 years: 1.33; 95% CI 1.16 to 1.52), higher socioeconomic status (aOR least disadvantaged vs most disadvantaged: 1.21; 95% CI 1.12 to 1.31), and having private health insurance (aOR 1.59; 95% CI 1.52 to 1.66). Patients who underwent the initial procedure at a private hospital were more likely to be readmitted to a non-index hospital (aOR 1.71; 95% CI 1.65 to 1.79). Patients who underwent TKA procedures were less likely to have a non-index readmission compared to those with THA (aOR 0.71; 95% CI 0.68 to 0.74). Additionally, patients from regional/remote areas had lower odds of non-index readmission (aOR vs major cities 0.88; 95% CI 0.83 to 0.92) (Figure 2).

Rates of 90-day and one-year mortality among readmitted patients were 1.4% and 3.3%, respectively (Table II). Patients who had non-index readmission had a higher crude rate of 90-day mortality than those who had index readmission (1.8% vs 0.9%) (Table II). After accounting for potential confounders using logistic models with IPW, non-index readmission was significantly associated with higher 90 day mortality (aOR 1.69; 95% CI 1.39 to 2.05) (Figure 3). Analysis of one-year mortality also showed a positive association between non-index readmission and mortality (aOR 1.31; 95% CI 1.16 to 1.47). When stratified by readmission cause, we found that the associations between non-index readmission and mortality were similar for patients readmitted with orthopaedic complications and other conditions (90-day mortality aOR 1.61; 95% CI 0.98 to 2.64, and aOR 1.67; 95% CI 1.35 to 2.06, respectively; p-heterogeneity = 0.64). Similar increases in odds of one-year mortality were observed for readmissions due to orthopaedic complications (aOR 1.40; 95% CI 1.06 to 1.84) and other conditions (aOR 1.27; 95% CI 1.11 to 1.45) (p-heterogeneity = 0.43).

Table 1. Selected characteristics of patients with total joint arthroplasty (2003 to 2022), overall and by procedure type.

Variable	Total patients	Total hip arthroplasty patients	Total knee arthroplasty patients	p-value*
Procedures, n (%)	394,248 (100.0)	149,456 (37.9)	244,792 (62.1)	
Mean patient age, yrs (SD)	68.8 (10.1)	67.9 (11.5)	69.4 (9.2)	< 0.001
Female, n (%)	218,276 (55.4)	79,452 (53.2)	138,824 (56.7)	< 0.001
Socio-economic status, n (%)				< 0.001
Q1 (most disadvantaged)	74,925 (19.0)	25,721 (17.2)	49,204 (20.1)	
Q2	93,917 (23.8)	34,725 (23.2)	59,192 (24.2)	
Q3	72,466 (18.4)	26,799 (17.9)	45,667 (18.7)	
Q4	50,406 (12.8)	19,654 (13.2)	30,752 (12.6)	
Q5 (least disadvantaged)	75,667 (19.2)	32,732 (21.9)	42,935 (17.5)	
Remoteness of residence, n (%)				< 0.001
Major cities	263,123 (66.7)	100,061 (67.0)	163,062 (66.6)	
Regional/remote areas	131,125 (33.3)	49,395 (33.0)	81,730 (33.4)	
Private insurance	226,668 (57.5)	89,555 (59.9)	137,113 (56.0)	< 0.001
Pre-surgery transfer during index admission	2,615 (0.7)	1,232 (0.8)	1,383 (0.6)	< 0.001
Median length of stay, days (IQR)	7 (5 to 14)	7 (4 to 13)	7 (5 to 15)	< 0.001
Comorbidity profile, n (%)				
Diabetes	60,516 (15.3)	18,036 (12.1)	42,480 (17.4)	< 0.001
Hypertension	160,406 (40.7)	54,461 (36.4)	105,945 (43.3)	< 0.001
Myocardial infarction	4,619 (1.2)	1,944 (1.3)	2,675 (1.1)	< 0.001
Cardiac arrhythmias	42,685 (10.8)	15,945 (10.7)	26,740 (10.9)	0.012
Valvular disease	5,283 (1.3)	2,151 (1.4)	3,132 (1.3)	< 0.001
Congestive heart failure	9,502 (2.4)	3,662 (2.5)	5,840 (2.4)	0.200
Peripheral vascular disease	4,503 (1.1)	1,875 (1.3)	2,628 (1.1)	< 0.001
Stroke	5,789 (1.5)	2,222 (1.5)	3,567 (1.5)	0.454
Chronic pulmonary disease	40,109 (10.2)	14,616 (9.8)	25,493 (10.4)	< 0.001
Pulmonary circulation disorders	5,630 (1.4)	1,658 (1.1)	3,972 (1.6)	< 0.001
Chronic kidney disease	15,610 (4.0)	5,659 (3.8)	9,951 (4.1)	< 0.001
Liver disease	3,422 (0.9)	1,391 (0.9)	2,031 (0.8)	< 0.001
Rheumatoid arthritis and collagen vascular disease	46,058 (11.7)	16,822 (11.3)	29,236 (11.9)	< 0.001
Cancer	9,339 (2.4)	3,925 (2.6)	5,414 (2.2)	< 0.001
Index hospital type, n (%)				< 0.001
Public	149,771 (38.0)	55,042 (36.8)	94,729 (38.7)	
Private	244,477 (62.0)	94,414 (63.2)	150,063 (61.3)	
In-hospital mortality	425 (0.1)	180 (0.1)	245 (0.1)	0.059
90-day readmission	37,431 (9.5)	13,526 (9.1)	23,905 (9.8)	< 0.001

Characteristics were present at the index hospitalization with total hip or knee arthroplasty surgery.

*Chi-squared test was conducted for categorical variables; t-test or Mann-Whitney test was used for continuous variables.

IQR, interquartile range; SD, standard deviation.

Discussion

In this population-wide study, we found that 9.5% of patients were readmitted within 90 days following total joint

replacement surgery and among these, 53.7% were readmitted to a hospital other than the operating hospital (i.e. non-index readmission). Non-index readmission was more

Table II. Selected characteristics of patients readmitted within 90 days following total hip or knee arthroplasty (2003 to 2022), overall and by readmission to index and non-index hospital.

Variable	All readmission	Readmission to index hospital	Readmission to non-index hospital**	p-value††
Procedures, n (%)	37,431 (100.0)	17,338 (46.3)	20,093 (53.7)	
Procedure type, n (%)				< 0.001
Total hip arthroplasty	13526 (36.1)	5,513 (31.8)	8,013 (39.9)	
Total knee arthroplasty	23,905 (63.9)	11,825 (68.2)	12,080 (60.1)	
Mean patient age, yrs (SD)	70.8 (10.4)	70.0 (10.3)	71.5 (10.4)	< 0.001
Female, n (%)	19,007 (50.8)	8,847 (51.0)	10,160 (50.6)	0.373
Socio-economic status, n (%)				< 0.001
Q1 (most disadvantaged)	8,161 (21.8)	3,736 (21.5)	4,425 (22.0)	
Q2	10,199 (27.2)	4,867 (28.1)	5,332 (26.5)	
Q3	6,865 (18.3)	3,449 (19.9)	3,16 (17.0)	
Q4	4,315 (11.5)	1,923 (11.1)	2,392 (11.9)	
Q5 (least disadvantaged)	5,566 (14.9)	2,156 (12.4)	3,410 (17.0)	
Remoteness of residence, n (%)				< 0.001
Major cities	22,509 (60.1)	10,070 (58.1)	12,439 (61.9)	
Regional/remote areas	14,922 (39.9)	7,268 (41.9)	7,654 (38.1)	
Private insurance	17,543 (46.9)	7,087 (40.9)	10,456 (52.0)	< 0.001
Median length of stay, days (IQR)	7 (5 to 14)	7 (5 to 13)	7 (5 to 15)	< 0.001
Comorbidity profile, n (%)				
Diabetes	6,868 (18.3)	3,161 (18.2)	3,707 (18.4)	0.588
Hypertension	16,282 (43.5)	7,358 (42.4)	8,924 (44.4)	< 0.001
Myocardial infarction	854 (2.3)	351 (2.0)	503 (2.5)	0.002
Cardiac arrhythmias	5,739 (15.3)	2,445 (14.1)	3,294 (16.4)	< 0.001
Valvular disease	858 (2.3)	332 (1.9)	526 (2.6)	< 0.001
Congestive heart failure	1,766 (4.7)	717 (4.1)	1,049 (5.2)	< 0.001
Peripheral vascular disease	755 (2.0)	310 (1.8)	445 (2.2)	0.003
Stroke	908 (2.4)	375 (2.2)	533 (2.7)	0.002
Chronic pulmonary disease	4,641 (12.4)	2,105 (12.1)	2,536 (12.6)	0.160
Pulmonary circulation disorders	886 (2.4)	386 (2.2)	500 (2.5)	0.096
Chronic kidney disease	2473 (6.6)	1,089 (6.3)	1,384 (6.9)	0.018
Liver disease	511 (1.4)	247 (1.4)	264 (1.3)	0.357
Rheumatoid arthritis and collagen vascular disease	5,139 (13.7)	2,249 (13.0)	2,890 (14.4)	< 0.001
Cancer	1,307 (3.5)	545 (3.1)	762 (3.8)	< 0.001
Index hospital type, n (%)				< 0.001
Public	18,078 (48.3)	9,601 (55.4)	8,477 (42.2)	
Private	19,353 (51.7)	7,737 (44.6)	11,616 (57.8)	
Readmission reason, n (%)				< 0.001
Orthopaedic complications	14,594 (39.0)	8,834 (51.0)	5,760 (28.7)	
Other conditions	22,837 (61.0)	8,504 (49.0)	14,333 (71.3)	
Length of stay (days), median (IQR)	2 (0 to 6)	2 (0 to 6)	2 (0 to 7)	0.883

(Continued)

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Variable	All readmission	Readmission to index hospital	Readmission to non-index hospital**	p-value††
90-day mortality	513 (1.4)	157 (0.9)	356 (1.8)	< 0.001
1-year mortality	1,222 (3.3)	440 (2.5)	782 (3.9)	< 0.001

Characteristics were present at the index hospitalization with total joint arthroplasty.

*Those who were readmitted to a hospital other than the index (operating) hospital.

†Chi-squared test was conducted for categorical variables; t-test or Mann-Whitney test was used for continuous variables.

‡IQR, interquartile range; SD, standard deviation.

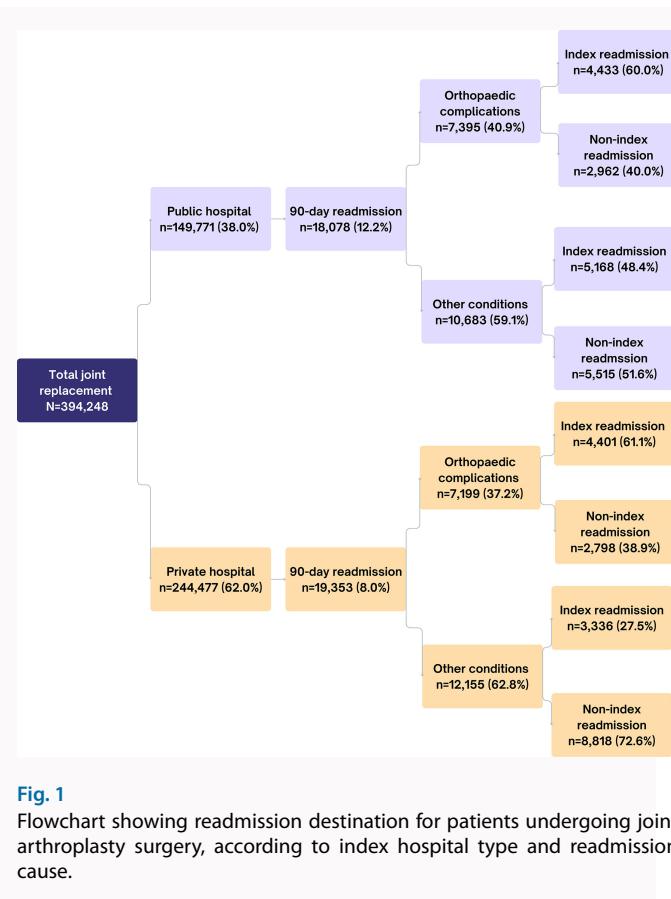


Fig. 1 Flowchart showing readmission destination for patients undergoing joint arthroplasty surgery, according to index hospital type and readmission cause.

prevalent where the readmission was due to conditions other than orthopaedic complications, which constituted 61.0% of all readmissions. Factors associated with non-index readmission included older age, higher socioeconomic status, private index hospital, private health insurance, and residence in a rural or remote area. Non-index readmission following joint replacement was associated with a significant increase in the odds of 90-day and one-year all-cause mortality, after adjusting for observed confounders. When stratified by reason for readmission (orthopaedic complications vs other conditions), similar increases in odds of mortality were observed, although this did not attain statistical significance for 90-day mortality in patients readmitted for orthopaedic complications.

Our 90-day readmission rates following THA (9.1%) and TKA (9.8%) align with those of previous studies and with a systematic review,^{7,18–20} which reported pooled 90-day readmission rates of 7.7% for THA and 9.7% for TKA. A recent

study using data from NSW public hospitals between 2015 and 2018, reported a 60-day readmission rate of 11.9% for TKA and 10.6% for THA.¹⁸ The lower rates found in our study likely reflect its coverage of both public and private hospitals. Only 38.0% of all joint arthroplasty procedures were performed in public hospitals, and these patients had a much higher 90-day readmission rate (12.0%) compared to those who had procedures in private hospitals (8.0%). Additional analyses indicate that patients from private hospitals generally had fewer comorbidities compared to those from public hospitals (Supplementary table v). However, a more significant finding was the difference in median length of stay: five days (IQR 4 to 8) for public hospitals and nine days (IQR 5 to 16) for private hospitals. This extended period of inpatient care in private hospitals may facilitate more comprehensive postoperative management, potentially leading to fewer readmissions.

We reported that more than half (53.7%) of all readmissions following total joint arthroplasty were to a hospital different from the one where the procedure was performed. Our rate of 90 day non-index readmission for patients who had their procedure in a public hospital (42.2%) was higher than the rate of 60-day non-index readmission reported by the recent NSW study that included public hospitals only (36.0%).¹⁸ Few international studies have delved into the rate of non-index readmission following joint arthroplasty surgery.^{7,21} The USA study of Medicare beneficiaries reported non-index readmission rates of 24% and 26.5% following THA and TKA, respectively.⁷ The much higher rates we observed can likely be explained Australia's dual system of public and private hospitals serving distinct roles.^{22,23} Private hospitals in Australia largely focus on elective procedures and most do not have emergency departments. Therefore, patients who undergo joint arthroplasty procedures at a private hospital are very unlikely to have an emergency readmission to the same private hospital.

In our study, higher socioeconomic status and having private insurance were both associated with higher rates of non-index readmission. Patients with a higher socioeconomic status are more likely to have private insurance and therefore to undergo a joint arthroplasty procedure at a private hospital or as a privately-funded patient in a public hospital. However, Brooke et al⁷ reported that the proportion of publicly-funded USA Medicaid joint arthroplasty patients was similar between index and non-index readmissions, which may reflect structural differences between the USA and Australian health systems. Patients with a THA were more likely to be admitted to a non-index hospital than those with

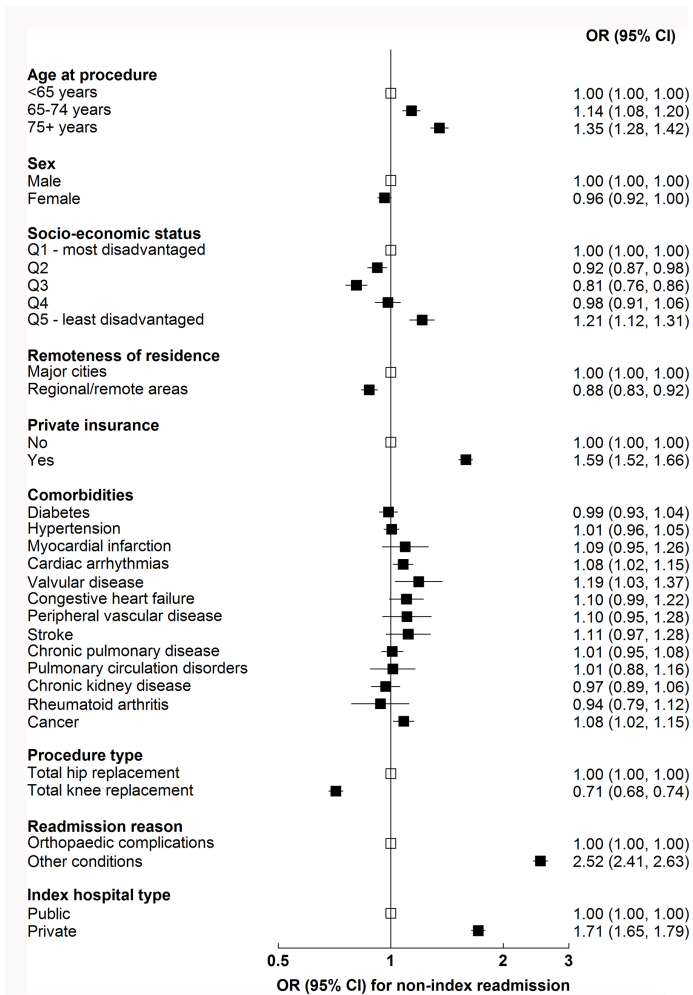


Fig. 2 Factors associated with non-index 90-day readmission following joint arthroplasty surgery. Odds ratios (ORs) with 95% confidence intervals (CIs) are estimated from logistic regression models with adjustment for age, sex, and comorbidities. ORs are shown as empty squares for reference groups and as black squares for other groups. Lines indicate corresponding 95% CIs.

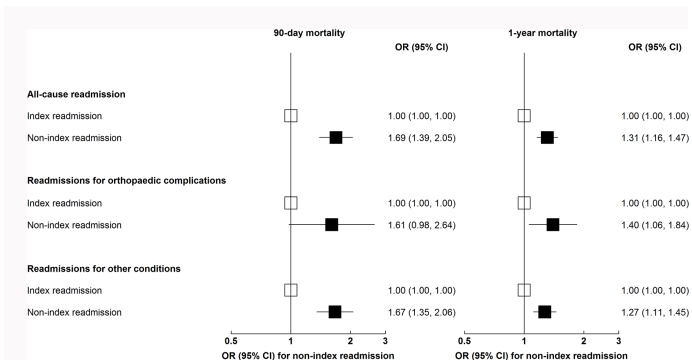


Fig. 3 Associations of non-index readmission with 90-day and one-year mortality, overall and by cause of readmission. *Models were adjusted for age, sex, procedure type, socioeconomic status, regionality, private insurance, readmission cause, comorbidities, and hospital funding type, as appropriate. Odds ratios are shown as empty squares for reference groups and as black squares for other groups. Lines indicate corresponding 95% confidence intervals.

to a surgical or a medical diagnosis related group (DRG). They reported that patients coded to surgical DRGs were less likely to readmit to non-index hospitals, and that the mortality disadvantage associated with non-index readmission was greater for these patients than for those who were coded to medical DRGs. Our study was the first to explore how non-index readmission in joint arthroplasty patients was influenced by whether the readmission was for specific orthopaedic complications, or for other conditions. We found that patients readmitted to a non-index hospital for orthopaedic complications had higher odds of 90-day and one-year mortality than counterparts who were readmitted to the index hospital, although the former association did not attain statistical significance. Returning to the index hospital could offer several advantages for patients with orthopaedic complications, as they could be managed by the original surgical team who are already familiar with the intricacies of the patient's procedure, including specific techniques, instruments, and challenges encountered.^{7,21} A prior study demonstrated that the advantages of being readmitted to an index hospital persisted, irrespective of whether the same physicians were involved in the clinical management.²⁴

We found that the majority (61.0%) of all readmissions within 90 days of a joint arthroplasty procedure were due to conditions other than orthopaedic complications, and that the majority (62.8%) of these patients were admitted to non-index hospitals. Compared to patients with orthopaedic complications, patients who were readmitted for other conditions were 2.5-times more likely to be readmitted to a non-index hospital, and also had much higher 90-day and one-year mortality rates. As many of these patients presented with acute cardiovascular conditions or infections (see Supplementary table iii), which might require urgent care, it could potentially be beneficial for them to seek care at a hospital closer to their residence. Nonetheless, these patients experienced elevated odds of 30-day and one-year mortality compared with counterparts who were readmitted to the index hospital, even after adjustment using IPWs for potential confounders. In contrast to the findings of Brooke et al¹⁰ comparing patients coded to surgical and medical DRGs, the

TKA. This likely reflects the acute nature of THA complications which include dislocation and periprosthetic fracture, which would be treated at the nearest hospital that has an emergency department.²⁰

Our research found that patients readmitted to a non-index hospital experienced higher odds of mortality within both 90-day and one-year periods. This aligns with previous studies,^{7,21} which also reported an increased risk of mortality following major operations, including THA and TKA, when patients were readmitted to non-index hospitals. However, only Brooke et al⁷ has previously reported a joint replacement-specific association between non-index readmission and 90 day mortality. Their 90-day crude mortality rates (index: 4.8%; non-index: 5.5%) were much higher than ours (index: 0.9%; non-index: 1.8%), likely reflecting their older patient population (mean age 74.5 years vs. 68.8 years). However, their IPW odds ratio for 90 day mortality (aOR 1.27; 95% CI 1.19 to 1.33), was comparable with, although lower than, ours (aOR 1.69; 95% CI 1.39 to 2.05).

Brooke et al⁷ also compared outcomes of non-index readmission according to whether the readmission was coded

magnitude of our IPW odds ratios was similar for patients admitted with orthopaedic complications and other conditions. Our findings suggest that the benefits of returning to the operating hospital extend beyond familiarity with the details of the surgical procedure, and perhaps reflect other positive aspects of continuity of care.

Findings from our study using routinely collected data, must be interpreted within the context of certain limitations. The APDC dataset, an administrative database, may be influenced by disparities in coding practices among clinical coders and healthcare institutions.²⁵ Although we used multivariable modelling incorporating propensity matching to control for a wide range of patient-level and hospital-level confounders, there remains a potential for residual confounding due to unmeasured variables that are linked with mortality. We could not investigate the role of provider continuity because provider details were not available in our datasets. Despite these limitations, we used a large, population-wide dataset from Australia's largest state and employed best-practice statistical analysis to minimize bias and enhance the generalizability of our results.

Over half of the patients in this cohort, who needed readmission within 90 days post-THA and TKA, were readmitted to a different hospital. Factors influencing readmission location included the reason for readmission and the hospital performing the initial surgery. After controlling for confounding, readmission to a non-index hospital linked to higher mortality risk. These findings underscore the need for improved care coordination and clinical integration after joint arthroplasty to boost patient outcomes.

Supplementary material

Tables showing diagnosis and procedure codes used to exclude secondary and non-elective joint arthroplasty procedures; list of International Classification of Diseases 10th Revision codes (ICD-10) to identify comorbidities; the top 15 reasons for readmission according to readmission category; trends in length of stay during the index hospitalization and 90-day readmission rate following total hip and knee replacement surgery (2003 to 2022); and selected characteristics of patients with total joint replacement (2003 to 2022), overall and by hospital type. Plots showing standardized differences in covariates between patients with index versus non-index readmission before and after inverse probability weighting in all patients undergoing joint arthroplasty surgery; and standardized differences in covariates between patients with index versus non-index readmission for non-orthopaedic complications before and after inverse probability weighting in patients undergoing joint arthroplasty surgery.

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Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

Ethical review statement

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