Incidence of 30-day readmission after total knee arthroplasty and its associated factors in Hong Kong

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ABSTRACT

Introduction: Total knee arthroplasty (TKA) is one of the most commonly performed orthopaedic procedures worldwide, due to the increased prevalence of osteoarthritis associated with an ageing global population. Although many studies have focused on the causes of readmission among TKA patients within 30 days post-surgery, none have been conducted in Hong Kong. This study investigated the 30-day readmission rate, causes, and risk factors among TKA patients in Hong Kong.

Methods: This retrospective review included patients who underwent TKA at a local university-affiliated hospital between 2001 and 2020. Eligible patients were identified using the Clinical Data Analysis and Reporting System and electronic patient records. Their data were analysed to determine the 30-day readmission rate, risk factors, and underlying causes.

Results: Among the 3827 TKA patients included, the male-to-female ratio was 1:2.78 (1012:2815) and the mean age (±standard deviation) was 71.11±8.82 years. Of these patients, 3.4% underwent unplanned readmission to hospitals through the Accident and Emergency Department within 30 days of TKA. The most common causes of readmission were knee pain (33.1%), knee swelling (26.2%), and gastrointestinal-related conditions (8.5%). Age ≥80 years (odds ratio [OR]=1.63; P=0.01) and hypertension (OR=2.08; P<0.001) were risk factors for readmission. Bilateral simultaneous TKA (OR=0.42; P=0.005) was associated with lower risk of readmission.

Conclusion: The readmission rate in this study was 3.4%, comparable to rates in previous reports. Enhanced patient education and optimised perioperative pain management are needed to minimise hospital readmissions. Fall prevention, cautious painkiller prescribing, and improved nursing care are recommended to prevent readmission.

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New knowledge added by this study

- Pain (33.1%) and swelling (26.2%) are the most common causes of readmission after total knee arthroplasty (TKA) in Hong Kong.
- Age ≥80 years and hypertension are major risk factors for readmission, whereas simultaneous bilateral TKA is associated with a lower risk of readmission.
- The male-to-female ratio is 1:2.78 in Hong Kong, which is lower than the ratio in other countries.

Implications for clinical practice or policy

- Pain management and education should be enhanced.
- Fall prevention, cautious painkiller prescribing, and improved nursing care are recommended.

Introduction

Due to the increasing incidence of osteoarthritis associated with the ageing global population, total knee arthroplasty (TKA) has become one of the most commonly performed orthopaedic procedures worldwide. The most common approach to determine causes and risk factors involves analysing readmission episodes among TKA patients within 30 days post-surgery.[1,2] The 30-day readmission rate provides insight into the prevalence of

香港全膝關節置換術後30天內再住院率及相關因素

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引言：隨着全球人口老化，骨關節炎問題日趨嚴重，全膝關節置換術成為其中一種最常進行的骨外科手術。雖然有不少文獻集中研究接受全膝關節置換術的患者在術後30天內再住院的情況及原因，但香港卻沒有同類研究。本研究找出本港患者的30天內再住院率、原因及風險因素。

方法：本回顧性研究包括於2001至2020年期間在本港某所大學附設醫院接受全膝關節置換術的患者。我們透過醫療資料分析及匯報系統及電子病歷篩選出合資格患者，然後分析他們的資料，以找出30天內再住院率、風險因素及背後原因。

結果：本研究共納入3827名接受全膝關節置換術的患者，男女比例為1:2.78（1012:2815），平均年齡（±標準差）為71.11±8.82歲。在這些患者中，3.4%在接受全膝關節置換術30天內經急症室計劃外再住院。再住院的最常見原因為膝痛（33.1%）、膝蓋腫脹（26.2%）及胃腸道相關疾病（8.5%）。年齡達80歲或以上（勝算比=1.63；P=0.01）及高血壓（勝算比=2.08；P<0.001）是再住院的風險因素。接受雙側同步全膝關節置換術（勝算比=0.42；P=0.005）與較低再住院風險相關。

結論：本研究的再住院率為3.4%，與其他報告及文獻相若。我們認為需加強教育患者及改進圍手術期疼痛管理，以減低再住院情況，並建議防止跌倒、謹慎處方止痛藥及改善護理程序，以避免患者再住院。

postoperative complications, whereas the length of stay after readmission reflects the severity of those complications. A review of readmission causes is needed to assess the quality of hospital care and determine the adequacy of patient education (eg, wound management).[3] An understanding of the 30-day readmission rate, causes, and risk factors can help hospitals improve clinical guidelines, reduce medical and surgical complications,[4] and reduce the financial burden of treatment for these complications.[5]

Although multiple studies worldwide have adequately explored the 30-day readmission causes, rate, and length of stay among TKA patients,[6,7] revealing important clinical insights, no such studies have been conducted in Hong Kong. The current study aimed to investigate the 30-day readmission rate, causes, and risk factors among TKA patients in the city.

Methods

This retrospective study included all patients who underwent TKA at our local university-affiliated hospital and were readmitted through an Accident and Emergency Department (AED) between 2001 and 2020. It evaluated the epidemiological characteristics, readmission causes, and preoperative co-morbidities of TKA patients.

We utilised data from the Clinical Data Analysis and Reporting System (CDARS), a well-established platform developed by the Hospital Authority (HA). The CDARS contains patient data, such as laboratory reports and radiological images; it covers all outpatients and inpatients at 43 public hospitals and institutions across seven service clusters in Hong Kong. Records in the CDARS include the details of patients with unplanned 30-day readmission to the AED of an HA hospital from either their homes or rehabilitation facilities, along with their discharge information. This platform is extensively used by research teams across Hong Kong.[8] We obtained a list of TKA patients who underwent surgery at the study hospital and were readmitted to an HA hospital within 30 days. We matched these patient names with their corresponding electronic patient records to determine the reasons for readmission.

For patients who experienced 30-day readmission, both the records in the CDARS and electronic patient records were reviewed. For patients who did not require 30-day readmission, only CDARS records were reviewed. Medication records (ie, dispensing dates, dosages, and durations) were extracted from CDARS records to identify co-morbidities (online supplementary Appendix). All patient data were de-identified.

Based on factors described by Roger et al,[6] we classified reasons for readmission into the following categories: orthopaedics-related, surgery-related, gastrointestinal-related, urological-related, neurological-related, cardiac-related, respiratory-related, renal-related, medication-related, and others. Orthopaedic specialists performed the classification to determine the cause of readmission.

The inclusion criteria were a recent history of TKA at our institution, readmission through the AED of an HA hospital, and inpatient admission. The exclusion criteria were a history of knee surgery, incomplete clinical assessment data, and/or orthopaedic tumours in the knee (for paediatric patients only).

Analyses of readmission cause, number, and rate, as well as organ dysfunction episodes, were episode-based. The analysis of risk factors for readmission was patient-based. Risk factors/co-morbidities were identified based on medications prescribed to the patients. If a patient received antihypertensive medication, that patient was assumed to have hypertension.

Data analysis was performed using R (R Foundation for Statistical Computing, Vienna, Austria) and R Studio software. All statistical tests were two-sided, and a 5% significance threshold was applied. The investigators and their research assistants were responsible for data collection and had access to the source data and study records. To

evaluate categorical variables, Chi squared tests and/or Fisher's exact tests were conducted, depending on the observed frequencies. To evaluate continuous variables, the Kruskal–Wallis test was used.

Results

In total, 3878 records were initially reviewed; of these, 43 were excluded due to the presence of tumours (ie, osteosarcoma in the distal tibia), three were excluded due to incorrect data entry for revision surgery, and five were excluded because they constituted duplicate entries for the same readmission episode (online supplementary Fig 1).

Basic demographic data

Of the 3827 valid patient records, 2855 were included in the initial analysis after removal of duplicate records for 972 patients who underwent two unilateral TKAs during different admission episodes. Of the 3827 patients, 2815 (73.6%) were women and 1012 (26.4%) were men. The mean ages were 71.11 years for TKA patients who did not experience readmission and 73.10 years for TKA patients who experienced readmission (Table 1[6,9-12]). The mean postoperative length of stay (±standard deviation) was 6.85±6.19 days (Table 2). Thus, the readmission rate at our institution was 3.4%, similar to rates reported worldwide (Table 1).[6,7,13] There was an increase in the 30-day readmission rate between 2001 and 2020 (Table 2). The number of TKAs performed in our institution increased from 2001 to 2014 and remained consistently high (>200 TKAs annually except in 2020) [online supplementary Fig 2], in line with published literature.[14]

In total, 130 patients with valid readmission records were analysed to identify causes and risk factors (online supplementary Fig 1). Of these patients, 90 (69.2%) were women and 40 (30.8%) were men. The median length of stay after readmission was 2 days (interquartile range=1.25-5) and the mean time between surgery and readmission was 22 days (Table 3).

Causes of readmission and associated risk factors

Unilateral knee pain (33.1%), unilateral knee swelling (26.2%), and gastrointestinal-related conditions (8.5%) were the most common causes of readmission (Table 4). Hypertension (67.7%) and diabetes mellitus (22.7% before March 2017 from which our institution modified the preoperative management pathway) were the most common co-morbidities among readmitted patients. Additionally, hypertension (odds ratio [OR]=2.08; P<0.001) and age ≥80 years (OR=1.63; P=0.01) were identified as significant risk factors for readmission

TABLE 1. Comparison of results with reports worldwide

	Hong Kong, China	France (Roger et al[6])	United States (Phruetthiphat et al[9])	Canada (Ross et al[10])	United States (Kurtz et al[11])	United Kingdom (Ali et al[12])
30-day readmission rate	3.4%	1.5%	2.2%	3.5%	4.9%	6.6%
Proportion of females versus males	73.6% vs 26.4%	64.3% vs 35.7%	62.4% vs 37.6%	61.2% vs 38.8%	63.4% vs 36.6%	57.8% vs 42.2%
Mean age of all patients (mean age of readmitted patients), y	71.11 (73.10)	69 (N/A)	62.2 (64.0)	67.46 (70.38)	N/A	N/A
Most common reasons for readmission	Pain (26.9%), swelling (9.2%)	Further surgery (1.2%), surgical site infection (0.7%)	Superficial wound infection (63.6%)	Surgical site infection (22.0%), bleeding (9.3%), pain and/or swelling (6.6%)	Other postoperative infection (4.5%), internal joint prosthesis infection (4.5%), atrial fibrillation (3.4%)	Pain and/or swelling (16.1%), periprosthetic infection (12.8%), wound complications (11.9%)
Most common co-morbidities	Hypertension (51.0%), diabetes mellitus (19.8%)	Hypertension (61.2%), obesity (39.3%), diabetes mellitus (14.9%)	Hypertension (65.2%), obesity (72.1%), diabetes mellitus (31.7%)	N/A	Heart disease, renal failure	N/A
Risk factors for readmission	Hypertension (OR=2.08), old age (OR=1.63)	Discharge to rehabilitation facility (OR=2.53), obesity (OR=2.58)	Length of stay (interval from operation to discharge) [OR=1.40]	N/A	N/A	Psychosis (OR=1.69), neurological disorders (OR=1.40)

Abbreviations: N/A = not applicable; OR = odds ratio

TABLE 2. Trends in patient readmission (n=3827)

Postoperative length of stay, d (mean±SD)		6.85±6.19	
Readmission through AED within 30 days [No. (%)]		130 (3.40%)	
Year	**No. of cases**	**No. of readmissions**	**30-day readmission rate**
2001	19	0	0%
2002	96	0	0%
2003	63	1	1.6%
2004	77	2	2.6%
2005	81	0	0%
2006	97	1	1.0%
2007	96	3	3.1%
2008	112	6	5.4%
2009	184	2	1.1%
2010	209	4	1.9%
2011	234	8	3.4%
2012	278	7	2.5%
2013	307	12	3.9%
2014	348	14	4.0%
2015	340	16	4.7%
2016	352	13	3.7%
2017	289	15	5.2%
2018	261	8	3.1%
2019	231	9	3.9%
2020	153	9	5.9%

Abbreviations: AED = Accident and Emergency Department; SD = standard deviation

TABLE 3. General epidemiology of readmitted patients (n=130)*

Age, y	73.10±8.02
Sex	
Female	90 (69.2%)
Male	40 (30.8%)
Co-morbidities	
Obesity	3 (2.3%)
Diabetes mellitus	26 (20.0%)
Hypertension	88 (67.7%)
COPD	4 (3.1%)
Rheumatoid arthritis	4 (3.1%)
Bleeding disorder	3 (2.3%)
Time-related surgical outcomes	
Length of stay after readmission, d	2 (1.25-5)
Time between surgery and readmission, d	22 (16-28)

Abbreviation: COPD = chronic obstructive pulmonary disease

* Data are shown as No. (%), mean±standard deviation or median (interquartile range)

(Table 5 and online supplementary Table 1). Patients who underwent bilateral TKA had a 58% lower risk of readmission (Table 6), possibly because they had better health condition before surgery and received more rigorous preoperative screening for high-risk co-morbidities.

Discussion

Our results suggest that there is a substantial rate of readmission due to pain and swelling among TKA patients in Hong Kong, which is higher than the rates in previous studies (Table 1).[6,9-12] Hospital resources should be reviewed to determine whether these patients require admission because most readmitted patients have non-severe conditions. To reduce the unnecessary allocation of clinical resources to non-severe cases, alternatives such as designated nurse clinics[15] and patient consultation hotlines can provide medical advice for managing minor conditions (eg, pain and swelling) at home. These measures can reduce the workload of orthopaedic surgeons and improve postoperative follow-up care.

Hypertension and age ≥80 years were significant risk factors for readmission. The mean age of TKA patients in Hong Kong was higher than the mean ages of TKA patients in similar studies worldwide (Table 1)[6,9-12]; this difference aligns with the fact that Hong Kong has the longest life expectancy globally (mean age of 85.16 years in 2022).[16]

The increased risk of readmission with old age, consistent with findings in a previous study,[17] may be related to the greater likelihood for older individuals to visit the AED for non-orthopaedic issues. In contrast, patients who underwent simultaneous bilateral TKA had a lower risk of readmission (OR=0.42; P=0.005) [Table 6].

At our institution, patients who underwent simultaneous bilateral TKA were aged <75 years and had no clinically significant cardiovascular co-morbidities (eg, stroke). Furthermore, in March 2017, our institution introduced routine glycated haemoglobin screening to identify diabetic and prediabetic patients, with the goal of minimising postoperative complications. Diabetes mellitus is known to increase the risk of periprosthetic joint infection after surgery.[18] Patients with elevated glycated haemoglobin levels were referred to endocrinologists for better management of diabetes mellitus prior to TKA, thereby decreasing the OR for readmission from 1.24 to 0.74 (Table 5 and online supplementary Table 1). Considering that a substantial number of patients with the aforementioned co-morbidities exhibit a higher risk of readmission, the perioperative protocol could be improved. Suggested changes could include better coordination with each patient's family medicine specialists or general practitioners, who usually have a better understanding of the patient's underlying

TABLE 4. Causes of readmission among total knee arthroplasty patients (n=130)*

	Cause of readmission	All cause	Primary cause
Orthopaedics-related	Unilateral knee pain	43 (33.1%)	35 (26.9%)
	Unilateral knee pain (non-operated side)	1 (0.8%)	1 (0.8%)
	Bilateral knee pain	2 (1.5%)	1 (0.8%)
	Back pain	7 (5.4%)	1 (0.8%)
	Foot/ankle pain	5 (3.8%)	3 (2.3%)
	Unilateral knee swelling	34 (26.2%)	12 (9.2%)
	Unilateral lower limb swelling	6 (4.6%)	2 (1.5%)
	Bilateral lower limb swelling	7 (5.4%)	3 (2.3%)
	Fracture	1 (0.8%)	0
	Numbness	3 (2.3%)	0
	Gout	4 (3.1%)	4 (3.1%)
	Pseudogout	1 (0.8%)	1 (0.8%)
	Rheumatoid arthritis flare	1 (0.8%)	1 (0.8%)
	Bruising	3 (2.3%)	2 (1.5%)
	Costochondritis	1 (0.8%)	0
Surgery-related	Superficial wound problem	5 (3.8%)	4 (3.1%)
	Postoperative deep vein thrombosis	1 (0.8%)	1 (0.8%)
Gastrointestinal-related		11 (8.5%)	8 (6.2%)
Urological-related		6 (4.6%)	5 (3.8%)
Neurological-related		10 (7.7%)	9 (6.9%)
Cardiac-related		9 (6.9%)	9 (6.9%)
Respiratory-related		9 (6.9%)	4 (3.1%)
Renal-related		2 (1.5%)	1 (0.8%)
Medication-related	NSAID-induced renal failure	1 (0.8%)	0
	Tramadol-related vomiting/constipation	3 (2.3%)	3 (2.3%)
	Apixaban-induced bleeding	2 (1.5%)	2 (1.5%)
	Warfarin withdrawal-related clotting disruption	1 (0.8%)	1 (0.8%)
Others	Slip and fall	6 (4.6%)	6 (4.6%)
	Paronychia and cellulitis	2 (1.5%)	1 (0.8%)
	Dental problems	1 (0.8%)	1 (0.8%)
	Anaemia	2 (1.5%)	2 (1.5%)
	Angioedema	1 (0.8%)	1 (0.8%)
	Hypoglycaemia	1 (0.8%)	1 (0.8%)
	Psychiatric conditions	2 (1.5%)	1 (0.8%)
	Fever and chill	2 (1.5%)	1 (0.8%)
	Generalised weakness	1 (0.8%)	1 (0.8%)
	CAPD-induced peritonitis	1 (0.8%)	1 (0.8%)
	Sepsis	2 (1.5%)	1 (0.8%)

Abbreviations: CAPD = continuous ambulatory peritoneal dialysis; NSAID = non-steroidal anti-inflammatory drug
* Data are shown as No. (%)

medical conditions, to develop effective preoperative and postoperative care plans.

Overall, 4.6% (n=6) of the patients were readmitted primarily due to falls (Table 4). This finding highlights the need for enhanced nursing support and education to prevent post-surgical falls among TKA patients. Furthermore, stronger occupational therapy and household aid programmes can help prevent falls at home and improve patient rehabilitation. Another 4.6% of

TABLE 5. Risk factors for readmission*

	Non-readmitted patients (n=3697)	Readmitted patients (n=130)	Odds ratio (95% CI)	P value
Age, y	71.02±8.84	73.10±8.02	N/A	<0.001
Age ≥80 y	682 (18.4%)	35 (26.9%)	1.63 (1.10- 2.42)	0.01
Sex				
Female	2725 (73.7%)	90 (69.2%)	1.25 (0.85-1.82)	0.26
Male	972 (26.3%)	40 (30.8%)		
Co-morbidities (n=2855)	n=2725	n=130		
Diabetes mellitus	539 (19.8%)	26 (20.0%)	1.01 (0.65- 1.57)	0.95
Diabetes mellitus (before March 2017) [n=2231]†	407/2134 (19.1%)	22/97 (22.7%)	1.24 (0.76- 2.03)	0.38
Diabetes mellitus (on or after March 2017) [n=624]†	136/591 (23.0%)	4/33 (12.1%)	0.74 (0.25-2.23)	0.60
Hypertension	1367 (50.2%)	88 (67.7%)	2.08 (1.43-3.03)	<0.001
COPD/asthma	224 (8.2%)	10 (7.7%)	0.80 (0.55-1.15)	0.22
Rheumatoid arthritis	119 (4.4%)	2 (1.5%)	0.34 (0.08-1.40)	0.12
Use of antiplatelets and anticoagulants	1838 (67.4%)	81 (62.3%)	0.93 (0.48-1.80)	0.83
Use of antiplatelets and anticoagulants (excluding aspirin)	183 (6.7%)	12 (9.2%)	1.41 (0.77-2.61)	0.27

Abbreviations: 95% CI = 95% confidence interval; COPD = chronic obstructive pulmonary disease

* Data are shown as No. (%) or mean±standard deviation, unless otherwise specified

† Stratified into two groups for analysis due to modification of preoperative management pathway in March 2017

TABLE 6. Numbers of unilateral and bilateral patients according to episode-based data

	Readmitted patients (n=130)	Non-readmitted patients (n=3697)	Odds ratio (95% CI)	P value
Unilateral	119	3032	0.42 (0.23-0.79)	0.005
Bilateral	11	665		

Abbreviation: 95% CI = 95% confidence interval

patients were readmitted due to the adverse drug effects (Table 4 and online supplementary Table 2), particularly from tramadol/codeine/morphine and related medications; symptoms included vomiting and constipation. These results indicate a need for cautious painkiller prescribing to prevent future medication-related readmissions.

Strengths and limitations

To the best of our knowledge, this is the first study on the readmission rate, causes, and risk factors among TKA patients within 30 days post-surgery. It also compared data collected in Hong Kong with results from other studies, yielding insights for local orthopaedic surgeons who seek to improve suboptimal surgical outcomes.

Notably, there were some limitations. Patient data in the CDARS may be incomplete because some doctors might have omitted the International Classification of Diseases, Ninth Revision codes for certain co-morbidities. To mitigate this issue, prescribed drugs were used to identify patients' co-morbidities. However, this approach may have missed some patients with co-morbidities and no associated medication records.

Conclusion

This study showed that older TKA patients with hypertension were more likely to be readmitted through the AED within 30 days post-surgery. The most common reasons for readmission were pain, swelling, and gastrointestinal-related symptoms. To reduce readmissions, hospitals should place greater emphasis on pain and wound management for TKA patients. Furthermore, patient education efforts should be strengthened to increase awareness of pain and wound management.

Author contributions

Concept or design: OWK Tsui, PK Chan.
Acquisition of data: OWK Tsui, PK Chan, JHY Leung.
Analysis or interpretation of data: OWK Tsui, PK Chan, JHY Leung.
Drafting of the manuscript: OWK Tsui.
Critical revision of the manuscript for important intellectual content: All authors.

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

Declaration

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Ethics approval

This research was approved by the Institutional Review Board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster, Hong Kong (Ref No.: UW-22-313). The requirement for patient consent was waived by the Board due to the retrospective nature of the research.

Supplementary material

The supplementary material was provided by the authors and some information may not have been peer reviewed. Accepted supplementary material will be published as submitted by the authors, without any editing or formatting. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by the Hong Kong Academy of Medicine and the Hong Kong Medical Association. The Hong Kong Academy of Medicine and the Hong Kong Medical Association disclaim all liability and responsibility arising from any reliance placed on the content. To view the file, please visit the journal online (https://doi.org/10.12809/hkmj2310733).

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