

Thirty-Day Unplanned Readmission after Total Knee Arthroplasty at a Teaching Community Hospital: Rates, Reasons, and Risk Factors

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Abstract

Unplanned readmission after total knee arthroplasty (TKA) has an increasing prevalence in the United States. Readmissions are now a metric for hospital quality of care, yet there are mixed results and variables associated with unplanned readmission. In this changing healthcare, it is critical for community healthcare institutions to identify risk factors for unplanned readmissions following TKA. Retrospective chart review and a hospital administrative database query to report causes, demographics, and medical comorbid risk factors result in 30-day readmission after undergoing primary TKA between 2011 and 2016 at a teaching community hospital. This study identified 7,482 primary TKA procedures of which 210 (2.8%) were unplanned readmissions. Gastrointestinal bleed (9.05%) and periprosthetic infection (8.10%) were the most common causes of readmission. Age 65 and older (odds ratio [OR], 1.64; 95% confidence interval [CI], 1.21–2.21; $p = 0.0012$), male (OR, 1.37; 95% CI, 1.03–1.83; $p = 0.0302$), length of stay > 3 days (OR, 2.04; 95% CI, 1.45–2.86; $p < 0.0001$), and discharge to rehab (OR, 2.21; 95% CI, 1.49–3.26; $p \leq 0.0001$) were correlated significantly with risk of 30-day readmission. Chronic airway disease (OR, 2.81; 95% CI, 1.54–5.14; $p = 0.0008$) and obesity (OR, 1.45; 95% CI, 1.006–2.10; $p = 0.0463$) were significant risk factors. Higher Charlson comorbidity index was not a predictor of time to readmission within 30 days after TKA.

Keywords

- total knee arthroplasty
- readmission
- total joint arthroplasty
- medical comorbidities

Total joint arthroplasty (TJA) has become a highly successful procedure by providing substantial pain relief and improved function in patients with degenerative joint disease. As the population grows, primary total knee arthroplasty (TKA) procedures are estimated to increase by 700% over the next 20 years.¹ Despite the established benefit of TKA, these procedures are costly and can have associated unplanned complications. In 2015, TJA was reported as the largest procedural cost in the United States with a projected cost increase of \$40.8 billion for all joint replacements and \$17.4 billion specifically for TKA.^{2,3} The rising healthcare costs secondary to TJA have led to a shift in current Medicare reimbursement. The traditional fee for service payments has now evolved into reimbursements linked to the quality of care. The Affordable Care Act

connected quality of care to post procedure hospital readmission by establishing the Hospital Readmission Reduction Program. In 2014, the program began to financially penalize hospitals for readmissions above the national average.⁴ Cram et al reported a readmission rate of 4 to 8.5% for primary TKA and 14.1% for revision TKA within 30 days of the procedure.⁵ Increasing readmissions after TKA means larger financial consequences for orthopedic institutions and ultimately the medical system.

Recent literature suggests that early hospital readmissions following TJA are a primary driver for increases in hospital costs. Previous studies reveal 60% of patients may experience at least one complication following TJA.⁶ Concomitantly, 40% of the 90-day readmissions are secondary to

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surgical complications.⁷ Multiple nonmodifiable and modifiable variables have been associated with these early readmissions but have been poorly reproduced. The impact on readmissions from factors such as diabetes, obesity, smoking, discharge disposition, and length of stay (LOS) has mixed conclusions on readmissions after TKA.⁵⁻¹⁶

Most retrospective literature on TJA readmissions has been conducted at large academic centers. Notably, most TKAs performed at these institutions are by fellowship trained adult reconstruction specialists. Our data are collected from 30 orthopedic surgeons who perform TKAs with only one fellowship trained surgeon. Therefore, we believe our data are more representative and relatable to community orthopedic surgeons performing TKA. The purpose of this study was to determine the incidence of unplanned readmission following primary TKA, to determine the nonmodifiable and modifiable risk factors linked to these readmissions, and to identify predisposing comorbidities for readmission.

Materials and Methods

Following institutional review board approval, query reports from our institution's electronic procedure database using Current Procedural Terminology (CPT) 27447 identified 7,482 primary TKAs performed from June 1, 2011 to June 1, 2016. Patient readmission within 30 days from index procedure was confirmed by electronic record review and chart exploration. Readmissions within 30 days after TKA were excluded if the patient underwent subsequent contralateral elective total knee (five patients) or total hip (three patients). Unicompartamental as well as revision TKA procedures was not included in the study. This reduced the 30-day readmission cohort to 210 patients.

A combination of administrative data review using CPT codes and retrospective chart exploration was used to confirm readmission diagnosis, patient demographics, and clinical comorbidities. The causes of unplanned readmission were assessed to determine if they were related or unrelated to the index procedure. All readmissions were classified into categories on the basis of primary cause of readmission based on diagnosis codes and confirmed by patient chart review. Each readmission was reported with an emphasis on the top 10 causes.

The parameters obtained from administrative data review were body mass index (BMI), discharge status (rehab versus home), age, gender, race, and LOS. The choice of threshold for BMI value was based on the consensus of 30 kg/m² which represents the threshold between obese and overweight. Medical comorbidities were assessed via diagnosis codes from the hospitals administrative data but supplemented and modified as necessary based on history and physical exam during chart review. The Charlson comorbidity index is an index that quantifies overall health quality on the basis of comorbidities.⁸ All 210 readmitted patients underwent retrospective chart review and each Charlson comorbidity score was assigned based on previous medical diagnosis documented in the patient's history and physical exam. All 19

patients readmitted for gastrointestinal (GI) bleed were reviewed for type of anticoagulation use, need for transfusion, and GI prophylaxis use.

Continuous variables were reported as means, standard deviation and range, and the categorical variables as number and percent. Student's *t*-test was used to analyze between-group differences for continuous variables, and chi-square test or Fisher's exact test for categorical variables. Analysis of variance was used to compare the mean readmission days by the Charlson comorbidity index category. A logistic regression model was used to identify independent significant predictors for 30-day readmission after TKA. Odds ratio (OR) with 95% confidence interval (CI) was reported for each predictor. All the analyses were performed with the use of SAS software, version 9.4 (SAS Institute, Cary, NC). A *p*-value of < 0.05 was considered to indicate statistical significance.

Results

Incidence and Reasons for Readmission

The query of institutional electronic database identified 7,482 primary TKAs. After applying our exclusion criteria, 210 (2.8%) were unplanned readmissions within 30 days of the index procedure. The average age of readmission of patients was 68.5 (standard deviation [SD]: 10.9) and they were mostly male (40.9%). GI bleed occurred in 19 (9.01%) patients and was the most common cause of readmission within 30 days. Periprosthetic infection led to 17 (8.10%) readmissions. Pulmonary emboli caused 11 (5.2%) and cellulitis caused 11 (5.2%) readmissions. Deep vein thrombosis, hematoma, and ambulatory dysfunction were the other top five common reasons attributed to unplanned readmission within 30 days of discharge (► **Table 1**).

A total of 19 patients were readmitted due to GI bleed. The average age of the patients transfused was 70.8 (SD: 11.7) and they were predominantly female and Caucasian. Average LOS of patients was 4.1 days and they were readmitted with

Table 1 Reasons for readmission at 30 days post-TKA hospital discharge

Readmit diagnosis	Frequency (n = 210)	% Readmissions
Gastrointestinal bleed	19	9.05%
Periprosthetic joint infection	17	8.10%
Pulmonary emboli	11	5.24%
Cellulitis	11	5.24%
Hematoma	10	4.76%
Deep venous thrombosis	10	4.76%
Ambulatory dysfunction	6	2.86%
Sepsis	5	2.38%
Congestive heart failure exacerbation	5	2.38%
Acute kidney injury	5	2.38%

Abbreviation: TKA, total knee arthroplasty.

Table 2 GI bleed demographics and disposition

	Readmission for GI bleed (n = 19)	All other readmissions (n = 191)	p-Value
Age	70.8 (11.7)	68.2 (10.6)	0.3178
Gender (male)—no%	6 (31.6%)	80 (41.9%)	0.3836
Race			
Caucasian	16 (84.2%)	168 (88.0%)	0.7122
African American	0 (0%)	4 (2.1%)	0.9999
Biracial	3 (15.8%)	19 (9.9%)	0.4289
Discharge status			
Routine home	1 (5.3%)	35 (18.3%)	0.2083
Home health	12 (63.2%)	95 (49.7%)	0.2645
SNF	2 (10.5%)	26 (13.6%)	0.9999
Rehab	3 (15.8%)	32 (16.8%)	0.9999
Days to readmission	8.4 (7.3%)	11.5 (8.7%)	0.1214
Length of stay—mean (SD)	4.1 (5.1%)	3.2 (2.1)	0.4590
CCI—mean (SD)			
0	6 (31.6%)	58 (30.4%)	0.5920
1	1 (5.3%)	30 (15.7%)	
2	4 (21.1%)	43 (22.5%)	
≥3	8(42.1%)	56 (29.3%)	

Abbreviations: CCI, Charlson Comorbidity Index; GI, gastrointestinal; SD, standard deviation; SNF, Skilled Nursing Facility.

an average of 8 days post TKA (►Table 2). Seven (36.8%) patients had a past medical history of gastroesophageal reflux disease. Of those seven patients, four were taking a proton pump inhibitor, one was taking an H2 blocker, and two patients were not on any GI prophylaxis prior to their readmission. The remaining patients readmitted for GI bleed were not taking any GI prophylactic medications (►Table 3).

Ten of the nineteen patients (52.6%) readmitted with GI bleed were found to be hemodynamically unstable during their readmission requiring packed red blood cell transfusion. There were four (57.1%) patients taking Coumadin that required transfusion. While patients taking ASA 325 mg twice daily, five (62.5%) patients required transfusion during their readmission (►Table 3).

All 19 patients readmitted with GI bleed were taking anticoagulation medications upon readmission. Six (31.6%) patients were on Aspirin 325 mg twice daily and two (10.5%) patients were on Plavix 75 mg and Aspirin 325 mg twice daily. Regimens of Plavix 75 mg and ASA 325 mg daily, weight-based Lovenox in addition to Plavix 75 mg and ASA 325 mg, Xarelto 15 mg, and finally Brilinta each caused one (5.2%) readmission, respectively. Additionally, five patients (26%) of the nineteen patients were on Coumadin alone, with two (10.5%) patients on Coumadin and ASA 81 mg daily. Of

Table 3 GI bleed patient analysis

Patient	GERD	Preop GI prophylaxis	DVT prophylaxis	Transfused
1	No	None	Coumadin	No
2	No	None	Coumadin	Yes
3	No	None	ASA 325 BID	Yes
4	No	None	Brilinta/TPA	No
5	No	None	Coumadin	Yes
6	No	None	ASA 325 BID & Plavix 75 mg	No
7	No	None	Coumadin & ASA 81 QD	Yes
8	No	None	ASA 325 BID & Plavix 75 mg	Yes
9	No	None	ASA 325 QD & Plavix 75 mg	Yes
10	No	None	ASA 325 BID	Yes
11	No	None	ASA 325 BID	Yes
12	Yes	None	ASA 325 BID	Yes
13	No	None	ASA 325 BID	No
14	Yes	Ranitidine	ASA 325 BID	No
15	Yes	None	Coumadin & ASA 81 QD	No
16	Yes	Pantoprazole	Coumadin	No
17	Yes	Pantoprazole	Coumadin	Yes
18	Yes	Pantoprazole	Plavix 75, ASA 325 QD, Lovenox	No
19	Yes	Pantoprazole	Xarelto 15 mg	No

Abbreviations: ASA, acetylsalicylic acid (Aspirin); GERD, gastroesophageal reflux disease; GI, gastrointestinal.

those seven patients taking Coumadin 5 (71.4%) had supratherapeutic international normalized ratios on readmission (►Table 3).

Modifiable and Nonmodifiable Risk Factors

The univariate analysis identified independent risk factors associated with increased likelihood for readmission to post-operative discharge to rehabilitation facility ($p < 0.0001$), longer inpatient hospital LOS > 3 days ($p < 0.0001$), age > 65 years old ($p < 0.0001$), and being biracial ($p = 0.035$) (►Table 4). The average LOS for readmitted patients was 3.3 (SD: 2.6) days with 51.43% of patients being discharged to home with home health. The multivariate analysis indicated age 65 and older (OR, 1.64; 95% CI, 1.21–2.21; $p = 0.0012$), male (OR, 1.37; 95% CI, 1.03–1.83; $p = 0.0302$), LOS > 3 days (OR, 2.04; 95% CI, 1.45–2.86; $p < 0.0001$), and discharge to rehab (OR, 2.21; 95% CI, 1.49–3.26; $p \leq 0.0001$) were correlated significantly with risk of 30-day readmission (►Table 5).

Table 4 Demographic and discharge disposition

	Readmit group (n = 210)	Non-readmit Group (n = 7,272)	p-Value
	Mean (SD) or group %	Mean (SD) or group %	
Age	68.5 (10.9)	64.9 (9.8)	< 0.0001
Gender (Male)-no%	86 (40.48%)	2,555 (35.13%)	0.0820
Race			
Caucasian	184 (87.62%)	6,518 (89.63%)	0.3468
African American	4 (1.90%)	62 (0.85%)	0.1137
Biracial	22 (10.48%)	491 (6.75%)	0.0353
Discharge status			
Routine home	37 (17.62%)	1,897 (26.09%)	0.0057
Home health	108 (51.43%)	4,139 (56.92%)	0.1135
SNF	28 (13.33%)	688 (9.46%)	0.0600
Rehab	36 (17.14%)	461 (6.34%)	< 0.0001
Length of stay	3.3 (2.6)	2.5 (1.3)	< 0.0001

Abbreviations: SD, standard deviation; SNF, Skilled Nursing Facility.

Note: p-Values in bold denote statistical significance at $p < 0.05$.

Table 5 Multivariate analysis of predictors of readmission within thirty days

Variable	Odds ratio	95% Confidence interval		p-Value
Ethnicity				
White	0.859	0.544	1.356	0.5136
Black	1.949	0.639	5.94	0.2405
Discharge to rehabilitation	2.207	1.493	3.26	< 0.0001
Length of stay >3 days	2.035	1.448	2.86	< 0.0001
Gender (Male)	1.372	1.03	1.827	0.0302
Age 65+	1.639	1.21	2.213	0.0012
Risk factor				
Chronic kidney disease	1.956	0.916	4.17	0.08
Chronic airway obstruction disease	2.81	1.535	5.14	0.0008
Obesity and morbid obesity	1.454	1.006	2.10	0.046
Atrial fibrillation	1.03	0.571	1.86	0.92
Coronary atherosclerosis	1.06	0.662	1.71	0.79

Note: p-Values in bold denote statistical significance at $p < 0.05$.

Medical Comorbidities

The univariate analysis of medical comorbidities leading to readmission within 30 days was obesity ($p = 0.0301$), coronary atherosclerosis ($p = 0.025$), atrial fibrillation ($p = 0.026$), chronic airway obstructive disorder ($p = 0.0002$), and chronic kidney disease ($p = 0.008$). Notably, several medical comorbidities trended toward statistical significance such as primary hypertension and hyperlipidemia (► **Table 6**). Multivariate analysis indicated chronic airway disease (OR, 2.81; 95% CI, 1.54–5.14; $p = 0.0008$) and obesity (OR, 1.45; 95% CI, 1.006–2.10; $p = 0.0463$) (► **Table 5**). Additionally, Charlson comorbidity index was not shown to be significantly related to the readmission time within 30 days. ($p = 0.0965$) (► **Table 7**).

Discussion

TKA has been associated with multiple causes leading to postoperative readmission. Increasing rates of unplanned readmission after TJA are now directly linked to decreasing performance metrics and increasing reimbursement penalizations.⁹ As such, appreciating specific patient and surgical variables impacting readmission is desirable for orthopedic institutions. Results and efforts by many researchers have offered mixed causes and patient predispositions for readmissions. Previous literature has been conducted at larger academic institutions but lacks community-based evidence on unplanned readmission after TKA.^{5–8} The aim of the

Table 6 Comorbidity profile

Primary diagnosis	Readmit group (n = 210)	Non-Readmit group (n = 7272)	p-Value
Hypertension NOS	81 (38.57%)	2831 (38.93%)	0.9163
Hyperlipidemia	50 (23.81%)	1436 (19.75%)	0.1457
Obesity/morbid obesity	39 (18.57%)	973 (13.38%)	0.0301
Hypothyroid	29 (13.81%)	957 (13.16%)	0.7838
Diabetes	30 (14.29%)	942 (12.95%)	0.5714
Depressive disorder	24 (11.43%)	844 (11.61%)	0.9369
Coronary atherosclerosis	22 (10.48%)	477 (6.56%)	0.0249
Primary hypertension	20 (9.52%)	988 (13.59%)	0.0890
Anemia	19 (9.05%)	430 (5.91%)	0.0285
Gastroesophageal reflux	16 (7.62%)	428 (5.89%)	0.2945
Obstructive sleep apnea	15 (7.14%)	446 (6.13%)	0.5485
Anxiety disorder	14 (6.67%)	619 (8.51%)	0.3434
Atrial fibrillation	14 (6.67%)	269 (3.70%)	0.0263
Chronic airway obstructive disorder	13 (6.19%)	132 (1.82%)	0.0002
History of tobacco use	13 (6.19%)	401 (5.51%)	0.6726
Asthma	11 (5.24%)	351 (4.83%)	0.7842
Chronic kidney disease	8 (3.81%)	95 (1.31%)	0.0082

Abbreviation: NOS, not otherwise specified.

Note: p-Values in bold denote statistical significance at $p < 0.05$.

present study performed at a single community institution was to determine the incidence, causes, and predictors of unplanned readmission following primary TKA. In the present analysis, 2.8% of TKA required at least one readmission within 30 days. GI bleed and periprosthetic infection were the most common causes of readmission. Age 65 and over, being male, LOS > 3 days, and discharge to rehab were significant risk factors for 30-day readmission. Chronic

airway disease and obesity were significant medical risk factors for readmission. Interestingly, higher Charlson comorbidity index was not a predictor of time to readmission within 30 days after TKA.

The most common cause for 30-day readmission after TKA at our institution was GI bleed. This contrasts sharply with more recent readmission literature which reports joint-related infections.^{10,11} GI bleeds after TKA are unfortunately not unprecedented. Previous studies have shown up to a 2.3-fold increase in risk of GI bleeding after TKA which remains increased up to 6 weeks postoperatively.¹⁴ Our institution possibly encountered higher rates of GI bleed secondary to standard perioperative intravenous Toradol paired with Aspirin 325 mg twice daily for deep venous thrombosis prophylaxis between 2011 and 2016. The majority of readmitted patients with GI bleeds were taking Aspirin alone or paired with another anticoagulant due to previous medical conditions. Vorhies et al reported 30-day readmissions rates of 5.8% following TKA in Medicare patients¹². In contrast, Avram et al found a 2% readmission rate following TKA, reaffirming that rates are not predictable.¹³ These differences in readmission rates vary by institution and may be explained by patient selection, surgical arthroplasty volume, and postoperative care.

Readmissions are proving to be multifactorial making it difficult to isolate cause and effect. Most recent arthroplasty literature has shown medical comorbidities such as increasing BMI, diabetes mellitus, cardiopulmonary disorders, anemia, steroid use, and bleeding disorders to be predictors of early unplanned readmission.^{10,15,16} Our study revealed chronic airway obstruction disease and obesity were medical comorbidities predictive for 30-day readmission. Variations between studies could stem from differences in patient demographics and perioperative management of patients.

BMI values, although controversial, have been reported as an independent risk factor for unplanned readmission following TJA.^{15,16} Obesity comprised roughly 20% of the patients undergoing primary TKA. Our study again found a significant correlation between preoperative obesity and unplanned readmission within 30 days after TKA. Obese patients frequently have a higher number of medical comorbidities than nonobese patients; thus, they have a higher risk for complications. Further, obese patients have larger soft tissue envelopes around the knee joint causing prolonged

Table 7 Charlson comorbidity index for patients readmitted 30 days post-TKA

Charlson index	Readmit within 7 days (n = 89)		Readmit 8–15 (n = 57)		Readmit 16–30 (n = 60)		Total	
0	26	29.2%	18	31.58%	20	33.33%	64	31.07%
1	7	7.9%	9	15.79%	15	25.00%	31	15.05%
2	22	24.7%	14	24.56%	11	18.33%	47	22.82%
> = 3	34	38.2%	16	28.07%	14	23.33%	64	31.07%

Abbreviation: TKA, total knee arthroplasty.

dissection and retraction, resulting in higher local wound complications as reported by Belmont et al.¹⁶

Predictors of unplanned readmission in the present study included patient age, increasing LOS, and patient discharge disposition to extended care facility. These findings are not without precedence; however, there have been conflicts in the literature about LOS. Specifically, Cram et al observed a decrease in LOS with an increase in 30-day readmission.⁵ Conversely, studies by Vorhies et al illustrated LOS was not associated with increased readmission in the Medicare population.¹² Many recent publications, such as Zmistowski et al and Bini et al, revealed an increased risk of readmission with discharge to inpatient facility rather than home.^{17–19} Similarly, our analysis echoes these studies and shows an increased risk with discharge to skilled rehab. Increased readmission rates of patients discharged to extended facilities could root from practitioners practicing defensive medicine or seeking surgeon advice. Also, patients requiring rehab facilities are often elderly and have more comorbid conditions increasing their probability for complications.

Limitations of the current study are duly noted. First, the study only examined patients who were readmitted to the same hospital system within 30 days of TKA. Thus, the dataset may have missed patients who sought treatments or were admitted to other institutions causing an underestimated readmission rate. Second, the retrospective nature of the study relying on diagnosis codes for preoperative comorbidities and readmissions. Thus, the study could possibly account for patient with inaccurate diagnosis in the electronic database. Third, we were only able to report trends and not statistical significance between patients readmitted with GI bleeds due to the small sample size. Despite these limitations, this study has several strengths. First, this is the first reported community analysis of unplanned readmission after TKA and the location provides insight for many non-academic large-volume community institutions. Due to the community setting, there are limited hospital patients are likely readmitted to; thus, there is a lower likelihood of patients seeking treatment elsewhere. Second, this retrospective study does rely on previous diagnosis codes; however, chart review was used to analyze all readmitted patients to confirm readmission diagnosis, demographics, and medical comorbidities. Finally, we were able to analyze a large volume of primary TKAs over a 5-year period giving higher power to our study. To our knowledge, this is the first study to encompass a large community arthroplasty cohort analyzing a broad range of perioperative variables and analyzing reasons for postoperative GI bleeding.

Conclusion

Unplanned readmissions are being used as a quality measure for community and academic orthopedic institutions. Understanding relevant comorbidities and reasons for readmission in these unique patient populations will aid hospitals and orthopedic surgeons to optimize patients by decreasing potential risks of morbidity and decreasing medical care costs. From this study, we show that community institutions have differing

variables affecting readmission after TKA from larger academic centers. Community orthopedic surgeons can utilize our results to preoptimize and risk stratify patients undergoing TKA. Future analysis on the effects of giving GI prophylaxis in perioperative period is warranted in community institutions with goals of decreasing the incidence of GI bleed.

Conflict of Interest

None declared.

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