



## Original Article

# Rates, causes, and types of readmissions after total joint arthroplasty

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## ABSTRACT

**Objectives:** The aim of the study was to investigate the causes and rates of readmissions within 90 days after primary and revision knee and hip arthroplasties.

**Patients and methods:** A total of 1,516 patients (290 males, 1,226 females; mean age  $64.7 \pm 10.5$  years; range, 21 to 91 years) who underwent primary total hip arthroplasty (THA), primary total knee arthroplasty (TKA), revision THA, and revision TKA between January 2013 and December 2014 were retrospectively analyzed. All readmissions within 90 days as of discharge dates of patients were analyzed and were categorized as planned readmissions related to the index admission, unplanned readmissions related to the index admission, planned readmissions unrelated to the index admission and unplanned readmissions unrelated to the index admission.

**Results:** Readmission rate in the overall of study group was found to be 5.61%. This rate varied depending on the procedure applied, ranging between 2.35 and 6.74%. Unplanned readmissions related to the index admission within 90 days consisted of 60.0% of total readmissions. A total of 82.0% of readmissions within 90 days was due to surgical reasons. Planned readmissions unrelated to the index admission within 90 days were also frequently seen (31.76%). Totally 48.23% of total readmissions within 90 days occurred within the first 30 days. A total of 48.23% of the total readmissions and 58.82% of the readmissions which were unplanned and related to the index admission occurred within the first 30 days.

**Conclusion:** After knee and hip arthroplasties, readmissions occur due to various reasons. Therefore, it is of utmost importance to identify the readmission type in the evaluation of readmissions which may increase the effectiveness of precautions to be taken.

**Keywords:** Joint arthroplasty, readmission, readmission type.

Readmission is defined as the admission of a patient within a specific period of time after the index admission.<sup>[1]</sup> There is a serious increase in the interest in readmissions recently. Among the reasons for this interest, it is possible to mention the following factors: the belief that readmissions are due to the lack of care quality.<sup>[2-4]</sup> and unplanned readmissions are undesirable and stressful situations for patients, physicians, and the health system<sup>[5,6]</sup> besides they are significant cost factors.<sup>[4,7,8]</sup> It is highly important to use readmission rates, while evaluating the quality and performance of hospitals.<sup>[3,9]</sup> Therefore, minimizing unnecessary readmissions decrease the health expenditures, while it provides a unique opportunity to servers and policymakers, since it enables health

resources to be used more effectively and improves the care quality.<sup>[10]</sup>

Readmission is a complex phenomenon which occurs with the common effect of several factors, not only a single factor.<sup>[8,10-15]</sup> Readmission types should be categorized to identify the reasons and to take necessary precautions for reducing the readmission rates.<sup>[16,17]</sup> The points to take into consideration in grouping are that whether the readmission is determined during the discharge of the patient (planned) and whether it is about the index admission. Readmissions can be categorized under four different groups: planned readmissions related to the index admission; unplanned readmissions related to the index admission; planned readmissions unrelated to

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the index admission; and unplanned readmissions unrelated to the index admission.<sup>[18]</sup>

Using readmissions as the indicator of the care quality is seriously criticized, as hospitals have not enough power to control all reasons for readmission. However, the readmission rate is a criterion which is commonly used in the evaluation of the joint arthroplasty results.<sup>[19]</sup> Readmission rates may vary depending on whether the surgery is primary or revision and also arthroplasty is applied to knee or hip. These rates can be also affected by certain variables such as the index admission diagnosis, time period that the readmissions are monitored, regarded readmission type, and the characteristics of patient population in the study.

The aim of this study was to identify the readmission rates, readmission types, and readmission reasons for the patients who underwent joint arthroplasty in a tertiary hospital within 90 days in the period of following the discharge. Our study is original, as it, for the first time, evaluates the primary and revision knee and hip arthroplasties, different readmission types, and the readmission within 7, 30, 60, and 90 days as combined in this patient population.

## PATIENTS AND METHODS

This retrospective cohort study included patients who were admitted Ankara Numune Training and Research Hospital for primary total hip arthroplasty (THA), primary total knee arthroplasty (TKA), revision THA, and revision TKA between January 2013 and December 2014. No sampling method was used and all the patients who met the criteria were included in the study. Readmission was defined as the readmission of a patient after the discharge following the index admission for any reasons to the hospital where knee or hip arthroplasty was done. To calculate the readmission rates, the number of the readmitted patients was used, but not the number of readmissions. The time period for readmission was 90 days. Seven-, 30-, and 60-day periods were also analyzed to examine the features of readmissions.

*Exclusion criteria were as follows:* referral from an external clinic in the index admission in which the surgical procedure was performed or transferring the patients to another clinic after the surgical procedure; discharge against medical advice and deaths during the index admission period. Quadruplet grouping offered by the American Hospital Association (2011)<sup>[18]</sup> was used for classifying the readmissions according to the

types: readmissions planned and related to the index admission, readmissions unplanned and related to the index admission, readmissions planned and unrelated to the index admission, readmissions unplanned and unrelated to the index admission. Among these types, readmissions planned and unrelated to index admission, as evident from its name, were not related to the treatment in index admission. However, in all-cause readmissions studies, these readmissions should also be included in calculation and grouped appropriately. For instance, admission of a patient who underwent TKA in index admission and planning another TKA for the other joint after one month was a readmission planned and unrelated to index admission. To identify the readmission types, main diagnoses of readmissions classified according to ICD 10-AM (International Statistical Classification of Diseases and Related Health Problems, 10<sup>th</sup> Revision, Australian Modification) and the information in the index admission and readmission report of patients were considered.<sup>[20]</sup>

A written informed consent was obtained from each patient. The study protocol was approved by the Uşak University Social and Humanities Scientific Research and Publication Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki. Data of the patients were obtained from the hospital information system. The admissions within this study period due to any of total primary and revision knee and hip arthroplasties were initially determined in data collection stage. A total of 1,527 patients were found through the scanning with this method. Two patients who died during the index admission, eight patients who were discharged against medical advice, and one patient who was transferred from another clinic were excluded from the study. Finally, a total of 1,516 patients (290 males, 1,226 females; mean age  $64.7 \pm 10.5$  years; range, 21 to 91 years) were included in the study.

### Statistical analysis

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Categorical variables were expressed in number and frequency, while continuous variables were expressed in mean  $\pm$  standard deviation (SD). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether the data showed a normal distribution between the readmitted and non-readmitted patients. Continuous numerical and discrete numerical data in the independent groups were analyzed using

**TABLE 1**  
Demographic characteristics of patients

Procedure type	Gender		Age Mean±SD	Total	
	n	%		n	%
<b>Total hip arthroplasty, primary</b>					
Female	196	67	58.7±13.8	292	19.26
Male	96	33			
<b>Total knee arthroplasty, primary</b>					
Female	907	86	66.0±8.4	1050	69.26
Male	143	14			
<b>Total hip arthroplasty, revision</b>					
Female	54	64	65.6±13.6	85	5.61
Male	31	36			
<b>Total knee arthroplasty, revision</b>					
Female	69	78	68.0±9.2	89	5.87
Male	20	22			

SD: Standard deviation.

the Mann-Whitney U test. Categorical variables for readmitted and non-readmitted patients were analyzed using the Pearson chi-square test. A *p* value of <0.05 was considered statistically significant.

## RESULTS

Of the patients, those who underwent TKA were older than those who underwent THA, while revision patients were older than primary patients. Demographic characteristics of the patients are shown in Table 1.

The rates and types of the readmissions according to the procedures are summarized in Table 2. Accordingly, 85 patients were readmitted in the study group within 90 days and the readmission rate was

5.61%. A total of 76 patients in the study group were readmitted for once, eight patients for twice, and one patient for thrice. Therefore, the total number of readmissions was 95. The readmission rates were as follows: 6.74% for revision TKAs, 6.16% for primary THAs, 5.62% for primary TKAs, and 2.35% for revision THAs. The readmission rate for THAs in primary procedures was higher than the TKAs in primary procedures, which was vice versa in revision procedures.

The most frequent readmission type was the readmission that unplanned and related to the index admission. More interestingly, this readmission type was higher in revision procedures. Four of six readmissions in the revision knee arthroplasty

**TABLE 2**  
Distribution of readmission types according to the procedures

	Readmission type								Total	
	Unrelated		Related							
	Planned	Unplanned	Planned	Unplanned	n	RR	n	RR		
Total hip arthroplasty, primary (n=292)	5	1.10	3	1.03	0	0.00	10	3.42	18 6.16	
Total knee arthroplasty, primary (n=1050)	21	2.00	2	0.19	1	0.09	35	3.33	59 5.62	
Total hip arthroplasty, revision (n=85)	0	0.00	0	0.00	0	0.00	2	2.35	2 2.35	
Total knee arthroplasty, revision (n=89)	1	1.12	1	1.12	0	0.00	4	4.49	6 6.74	
Total (n=1,516)	27	1.78	6	0.40	1	0.07	51	3.36	85 5.61	

RR: Readmission rates.

**TABLE 3**  
Readmission types according to the time periods

Readmission types	0-7 day		0-30 day		0-60 day		0-90 day	
	n	%	n	%	n	%	n	%
Unplanned and related to initial admission	11	0.73	30	1.98	48	3.17	51	3.36
Planned and unrelated to initial admission	2	0.13	8	0.53	19	1.25	27	1.78
Unplanned and unrelated to initial admission	1	0.07	2	0.13	5	0.33	6	0.40
Planned and related to initial admission	0	0.00	1	0.07	1	0.07	1	0.07
Total readmission	14	0.92	41	2.70	73	4.82	85	5.61
Total admission	1,516		1,516		1,516		1,516	
% within total initial hospitalization.								

and both of the two readmissions in the revision hip arthroplasty were the readmissions unplanned and related to the index admission. Another most frequent readmission type in the study group was the readmission that planned and unrelated to the index admission. Most of the readmissions in this group occurred with the diagnosis of gonarthrosis or coxarthrosis with the aim of placing another joint prosthesis. The readmission rate accounted for 1.78% of readmission in the overall study group, constituting almost one-third (31.76%) of the total readmissions. Readmissions planned and unrelated to the index admission were more frequently observed in the primary procedures than revision procedures. Five (27.78%) of 18 readmissions in primary THAs and 21 (36%) of 59 readmissions after primary TKAs were the readmissions planned and unrelated to the index admission.

Readmission rates for the general study group according to readmissions types within 7, 30, 60, and

90 days were analyzed in Table 3. The readmission rates increased in other readmission types, except for the readmissions planned and related to the index admission, as the time period extended. Nearly half of the total readmissions (48.24%) occurred within 30 days (Table 4). The time period that the readmissions types occurred varied. A significant part of the readmissions unplanned and related to the index admissions occurred in 0 to 7 and 0 to 30 days (21.57% and 58.82%, respectively). However, unrelated and planned readmissions increased after 30 days (19 of 27 readmissions occurred after 30 days), as readmissions unplanned and related to index admission due to such reasons as embolism, acute renal failure, anemia related to the joint prosthesis performed in the index admission occurred in early periods. However, readmissions planned and unrelated to index admission due to such reasons as a prosthesis placement to another joint and cataract occurred in late periods.

**TABLE 4**  
Types and the percentage distribution of readmissions according to the time period

Readmission types	0-7 day		0-30 day		0-60 day		0-90 day	
	n	%	n	%	n	%	n	%
Unplanned and related to initial admission	11	78.57	30	73.17	48	65.75	51	60.00
%	21.57		58.82		94.12		100.00	
Planned and unrelated to initial admission	2	14.29	8	19.51	19	26.03	27	31.76
%	7.41		29.63		70.37		100.00	
Unplanned and unrelated to initial admission	1	7.14	2	4.88	5	6.85	6	7.06
%	16.67		33.33		83.33		100.00	
Planned and related to initial admission	0	0.00	1	2.44	1	1.37	1	1.18
%	0.00		100.00		100.00		100.00	
Total readmission	14	100.00	41	100.00	73	100.00	85	100.00
%	16.47		48.24		85.88		100.00	

**TABLE 5**  
Reasons for unplanned and related readmissions according to the time periods

Reasons of readmissions	0-7 day		8-30 day		31-60 day		61-90 day		0-90 day	
	n	%	n	%	n	%	n	%	n	%
Surgical	6	54.55	17	89.47	16	88.89	2	100.00	41	82.00
Prosthetic device infection	2	18.18	8	42.11	8	44.44	0	0.00	18	36.00
Mechanical complications of prosthetic device	3	27.27	5	26.32	2	11.11	1	50.00	11	22.00
Surgical wound infections	0	0.00	2	11.53	2	11.11	0	0.00	4	8.00
Disruption of operation wound	0	0.00	0	0.00	1	5.56	0	0.00	1	2.00
Embolism and thrombosis	1	9.09	1	5.26	1	5.56	0	0.00	3	6.00
Pain	0	0.00	1	5.26	1	5.56	1	50.00	3	6.00
Hemorrhage and hematoma	0	0.00	0	0.00	1	5.56	0	0.00	1	2.00
Medical	5	45.45	2	10.53	2	11.11	0	0.00	9	18.00
Anemia	2	18.18	0	0.00	0	0.00	0	0.00	2	4.00
Acute renal failure	1	9.09	2	10.53	1	5.56	0	0.00	4	8.00
Gastrointestinal problems	2	18.18	0	0.00	1	5.56	0	0.00	3	6.00
Total	11	100.00	19	100.00	18	100.00	2	100.00	50	100.00

Table 5 shows the causes and time to occur of readmissions unplanned and related to the index admission are analyzed. In general, surgical based

readmissions are more frequently seen compared to medical-based readmissions in all time periods and this feature became clearer as the time extended.

**TABLE 6**  
Comparison of the readmitted and non-readmitted patients based on categorical variables

Variable	Non-readmitted	Readmitted	n	% Readmission rate	Chi-square	p*
	n	n				
<b>Gender</b>						
Female	1187	39	1226	3.18		
Male	279	11	290	3.79	0.117	0.732
Total	1466	50	1516	3.30		
<b>Age (With grouping)</b>						
<65	672	18	690	2.61		
≥65	793	32	825	3.88	1.522	0.217
Total	1465	50	1515	3.30		
<b>Complication</b>						
No	1096	32	1128	2.84		
Yes	370	18	388	4.64	2.402	0.121
Total	1466	50	1516	3.30		
<b>Intensive care unit</b>						
No	1432	48	1480	3.24		
Yes	34	2	36	5.56	0.087	0.335
Total	1466	50	1516	3.30		
<b>Comorbidity</b>						
No	256	6	262	2.29		
Yes	1210	44	1254	3.51	0.663	0.415
Total	1466	50	1516	3.30		

\* p<0.05.

TABLE 7 Comparison of the readmitted and non-readmitted patients in terms of continuous variables						
Variable	Readmitted/non-readmitted	n	Mean rank	Sum of ranks	U	p
Age (No grouping)	Non-readmitted	1,465	755.53	1,106,855.00	33,010.00	0.168
	Readmitted	50	830.30	41,515.00		
Length of hospital stay	Non-readmitted	1,466	752.94	1,103,813.50	28,502.50	0.007*
	Readmitted	50	921.45	46,072.50		

\* p<0.05.

Medical-based readmissions were mostly seen in the early stages of time period, particularly within the first seven days. The rate of surgical and medical-based readmissions within the first seven days was close to each other (55% vs. 45%, respectively). However, this rate was approximately nine times within 31 to 60-day period. Two most frequently observed factors in the surgical based readmissions were the prosthesis infections (18 readmissions and 36%) and mechanic complications of the prostheses (11 readmissions and 22%, respectively). The problems (infection and mechanic complication) based on the prosthesis constituted 70.73% of surgical based readmissions and 58.0% of all readmissions.

Age, gender, comorbidities, complications, the length of stay in the intensive care unit and hospital in the index admission were analyzed to assess whether they had an effect on readmissions. It was found that none of the analyzed data groups indicated a normal distribution ( $p<0.05$ ).

Whether the categorical variables (gender, age, complication, intensive care unit, and comorbidities) related to readmitted and non-admitted patients varied between readmitted and non-admitted patients were analyzed (Table 6). The readmission rates were higher in male patients, the patients who were  $\geq 65$  years, who developed a complication during the index admission, received intensive care treatment, and had a comorbidity compared to the opposite group. However, this high rate was not found to be statistically significant.

Age and length of hospital stay were used to compare the continuous variables from the index admission. When age variable in the index admission was analyzed, it was found that readmitted patients were older than non-readmitted ones. However, the difference was not found to be statistically significant ( $U=330,110.00$ ;  $p>0.05$ ). When the length of the hospital stay in the index admission was analyzed, readmitted patients stayed longer than non-readmitted

ones, indicating a statistical significance ( $U=28,502.50$ ;  $p<0.05$ ) (Table 7).

## DISCUSSION

The present study is one of the limited number of studies which evaluates total and revision knee and hip arthroplasties together in the same patient group.<sup>[21]</sup> Selected different time periods and readmission types in measuring readmissions were also evaluated as combined, which renders this study original.

Readmission rates within 90 days after the joint arthroplasty differed significantly according to the joint type where the procedure was applied to. The readmission rate (6.16%) in THAs was slightly higher than the rate in TKAs (5.62%) in primary procedures. However, when the readmission rates of unplanned and related to the index admission, a better indicator to indicate the care quality, were compared and we observed an increase in the difference (3.42% and 3.33%, respectively). The values between 3.0% and 4.70% have been reported in the literature for joint procedures and the same time periods.<sup>[2,22,23]</sup> The compared study findings indicate that the readmission rates may vary from one study to another one. In addition, we observed that readmission rates based upon the THAs were higher than the rates based upon the TKAs. This difference is thought to be related to the absence of readmission, due to the frequently observed joint stiffness after the TKAs. As there was no readmission in our study due to joint stiffness. Expert opinions confirm that readmission is not common in the Turkish population due to joint stiffness. It is even an outpatient treatment. However, since this study is the only study that we have obtained to date, which analyzes readmissions on TKAs and THAs in the Turkish population, it would not be possible to compare it with the literature findings.

On contrary to the primary procedures, readmission rates in revision procedures were found

to be 6.74% for knee revision arthroplasty and 2.35% for hip revision arthroplasty and knee revision arthroplasty was almost two times more than the hip arthroplasty. These rates were 4.49% and 2.35% in the knee and hip revision arthroplasties, respectively in terms of readmissions unplanned and related to the index admission. In addition, although the readmission rate after revision TKA was higher than the readmission rate after the primary procedure (TKA; primary procedure: 3.33%, revision: 4.49%), it was the opposite in the THA (THA; primary procedure: 3.42%, revision: 2.35%), as we compared the joint procedures. The revision procedures have higher readmission rates, as they are more traumatic, more difficult for the physicians and necessitate more resource for the hospital. However, lower readmission rate after the revision THA cannot be explained yet. Readmission rates in 90 days after revision THA were found in different values such as 7.9%,<sup>[24]</sup> 13%<sup>[5]</sup> and 21.7%.<sup>[21]</sup> However, the readmission rates after revision TKA for the same period were 6.4%<sup>[24]</sup> and 23.1%<sup>[21]</sup> in the literature.

One of the most common readmission types after TKAs and THAs is the readmissions planned and unrelated to the index admissions. Most of these readmissions are due to the insertion of a prosthesis in another joint of the patient. Indeed, these readmissions are the consequences of two-stage procedure rather than simultaneous bilateral arthroplasty. In our study, readmissions planned and unrelated to index admission constituted 36% of the total readmissions after primary knee arthroplasties (21/59 readmissions), 28% of primary hip arthroplasties (5/18 readmissions), and 32% of the total readmissions (27/85 readmissions). Zmistowski et al.<sup>[23]</sup> found that 15.3% of all readmissions were planned readmissions. Readmissions planned and unrelated to index admissions were not found to be associated with treatment in index admission. Yet, they can be monitored with financial concerns.<sup>[25]</sup>

Another important factor that affects the readmission rates is the analyzed time period. It is obvious that the readmissions within 30 days after the discharge are often regarded in the literature as the time period for readmissions. However, the index admissions and the related and unplanned readmissions within 30 days form 58.82% of the total readmissions within 90 days. In other words, regarding the readmission time period in knee and hip arthroplasties as 30 days refers to taking more than 40% of the readmissions unplanned and related

to index admissions out of context. This rate has been reported in the literature ranging between 50 and 71%.<sup>[23,26]</sup>

The share of surgical reasons was higher than the medical reasons in all of the analyzed time period in the factors, leading to the readmission in the study group. The share of surgical reasons in readmissions within 30 days was found to be 89.0%, and the share of surgical reasons in readmissions within 90 days was found to be 82.0%. These findings were reported in the literature ranging from 40 to 62%<sup>[5,23]</sup> for 30 days and 66 to 75%<sup>[23,27]</sup> for 90 days. In our study, the most common reason for readmissions for all of the analyzed time periods was the surgical site infection (sum of prosthetic device infection, mechanical complications of prosthetic device and surgical wound infections). Our findings are consistent with the literature.<sup>[2,23,27,28]</sup>

Age and gender are also the frequently examined variables in terms of readmission risk factors in the literature. In our study, the readmission rate (3.88%) of the patients aged ≥65 was higher than the readmission rate (2.61%) of those who were in the 0-64 age group. This is also consistent with the literature.<sup>[19,23,27]</sup> There are also studies reporting that age of the patient is not a determinant factor for the readmission risk.<sup>[28,29]</sup> In our study, gender was not found to be a risk factor. However, the readmission rate of males was higher than the rate of females. Although gender was indicated as a significant risk factor for readmissions in some studies in the literature,<sup>[5,23,28-31]</sup> it was not indicated as a risk factor in many others.<sup>[5,22,27-30]</sup>

Furthermore, there is a close relationship between the complications developed after the procedure and the readmissions. Indeed, the reason for the readmissions related to the index admission is the procedure-based complications developed after discharge. Although the complications developed during the index admission do not directly lead to the readmission, these complications increase the readmission possibility for the patient. Glance et al.<sup>[32]</sup> examined the readmissions after serious surgical procedures and found that the most important predictor of readmissions was the complication development. According to these findings, readmission rate for the patients who developed complication after discharge was 78.3%. This rate was 12.3% for the patients who developed a complication during the hospitalization. Finally, this rate was 4.8% for the patients who did not develop any complication. In another study, Morris et al.<sup>[33]</sup> found that the complications occurred during the index admission increased the readmission risk

by 18.3%, and complications after discharge increased the same risk by 58.9%. In our study, the readmission rate for the patients who developed complication was higher as 63% than the rate of the patients who were not readmitted (4.64% vs. 2.84%, respectively). Similarly, the readmission rate (5.56%) for the patients who stayed in the intensive care unit due to life-threatening complications occurred during the index admission was higher than the rate of (3.24%) patients who did not.

In the comparison for readmitted and non-readmitted patients' length of hospital stay was the only variable which was statistically significant. In our study, the length of hospital stay of readmitted patients was higher than non-readmitted. The mean hospitalization time varied from 2.9 to 6 days in previous studies in the literature.<sup>[2,19,30,33]</sup> In our study, the length of hospital stay was very long for both admitted and non-admitted patients, compared to other study findings. Prolonged hospitalization period may affect the readmission rates, particularly due to medical reasons. According to Parvizi et al.,<sup>[34]</sup> 90% of dangerous complications developed within four days after the surgical procedure. In the literature, delaying the discharge for three days after the operation was associated with complications occurred during the hospital stay.<sup>[2,35]</sup> As the main reason for higher share of surgical reasons in readmissions than other studies, prolonged hospitalization period in our study than other studies is thought to have a great role.

Nonetheless, there are some limitations to this study. First, the study was carried out in a single center. Therefore, it was unable to evaluate whether there was any readmission in other institutions. Second, this study has a retrospective design and all data in the records are considered complete and accurate. The readmission rates found in the study were lower than other study findings investigating the readmissions after TKA and THA. Low readmission rate was a highly positive finding. However, the share of this limitations cannot be appreciated as the reason for low readmission rates.

In conclusion, the most common readmission type after TKA and THA are those unplanned and related to the index admission throughout the study. Most of these readmissions were due to the surgical reasons. Mechanical and infection-related prosthetic complications were responsible for more than half of the total readmissions. Therefore, most of the readmissions after TKA and THA were found to be associated with the treatment in

index admission. Based on these findings, certain measures to be taken during the index admission may reduce the readmission rate. However, it is not possible to completely eliminate readmissions due to factors such as age, gender, and comorbidity. Also, the readmissions planned and unrelated to the index admissions are also common after TKA and THA. Most of these readmissions are due to arthroplasty of another joint. These readmissions are not associated to the care quality, but with treatment planning.

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