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Original Research

The Impact of Hospital Exposures Prior to Total Knee Arthroplasty on Postoperative Outcomes

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A B S T R A C T

Background: Total knee arthroplasty (TKA) procedures are expected to grow exponentially in the upcoming years, highlighting the importance of identifying preoperative risk factors that predispose patients to poor outcomes. The present study sought to determine if preoperative healthcare events (PHEs) influenced outcomes following TKA.
Methods: This was a retrospective review of all patients who underwent TKA at a single institution from June 2011 to April 2022. Patients who had a PHE within 90 days of surgery, defined as an emergency department visit or hospital admission, were compared to patients with no history of PHE. Patients who underwent revision, nonelective, and/or bilateral TKA were excluded. Chi-squared analysis and independent sample t-tests were used to determine significant differences between demographic variables. All significant covariates were included in binary logistic regressions used to predict discharge disposition, 90-day readmission, and 1-year revision.
Results: Of the 10,869 patients who underwent TKA, 265 had ≥1 PHE. Patients who had a PHE were significantly more likely to require facility discharge (odds ratio [OR]: 1.662; $P = .001$) than patients who did not have a PHE. Any PHE predisposed patients to significantly higher 90-day readmission rates (OR: 2.173; $P = .002$). Patients with ≥2 PHEs were at a significantly higher risk of 1-year revision (OR: 5.870; $P = .004$) compared to patients without a PHE.
Conclusions: Our results demonstrate that PHEs put patients at significantly greater risk of facility discharge, 90-day readmission, and 1-year revision. Moving forward, consideration of elective surgery scheduling in the context of a recent PHE may lead to improved postoperative outcomes.
Level III Evidence: Retrospective Cohort Study.

Introduction

The number of total knee arthroplasty (TKA) procedures is expected to grow exponentially over the next 2 decades [1,2]. Although complications are relatively rare following TKA [3], negative outcomes such as increased length of stay, hospital readmissions, and the need for revision still pose a significant threat to patient health and wellbeing following surgery [4]. These complications cause physical, financial, and emotional burdens for patients, indicating a need for further study of preventative measures that can be taken prior to surgery [5]. Therefore, understanding the preoperative risk factors associated with poor postoperative outcomes following TKA is necessary for ensuring quality care and improved results [5,6].

Many preoperative risk factors have been identified as having the potential to affect surgical outcomes, such as age, diet, tobacco use, medical history, and various comorbidities [5,7]. Among these, preoperative healthcare events (PHEs) have become an increasingly relevant potential risk factor for complications following TKA [8–10]. A PHE includes any emergency room visit or hospital admission prior to surgery, regardless of its relation to the affected joint. These experiences may influence the need for postoperative hospital use in a number of ways. For example, posthospital syndrome, in which patients have functionally declined following the physical stress of a hospital stay, may render patients more

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susceptible to further complications following surgery [9,11–13]. Alternatively, the experience of a PHE is often an indication of underlying comorbidities, the presence of which may serve as either the root cause or the reason for exacerbation of postoperative complications [6]. For these reasons, PHEs remain a progressively significant area of investigation for surgeons who aim to mitigate adverse outcomes following TKA.

Past studies have already shown that the experience of a PHE is associated with unplanned postoperative hospital visits within 90 days following both total hip arthroplasty and TKA [8–10]. The present study sought to determine if preoperative healthcare exposure within 90 days prior to surgery is associated with adverse outcomes within the first year following TKA. We hypothesized that patients who had a PHE within 90 days of surgery would experience a greater rate of facility discharges, readmission within 90 days of surgery, and revisions within 1 year following surgery. Identifying the factors that drive these PHEs may aid in surgical decision-making but also in advising patients on when an emergency department (ED) visit is merited following surgery [10]. Moreover, understanding the effects of PHEs on postoperative outcomes may influence surgeons in scheduling elective TKAs for patients following a recent PHE [11].

Material and methods

Study design

After obtaining institutional review board approval, we retrospectively reviewed all patients who underwent a TKA at a single academic orthopaedic institution between June 2011 and April 2022. Patients were included if they underwent primary, elective, unilateral TKA and were at least 18 years of age at the time of surgery. Patients were excluded if they underwent revision TKA, nonelective TKA, and staged or same-day bilateral TKA. Patients whose demographic, preoperative healthcare utilization, and/or outcome data were incomplete were also excluded. Our study population was stratified into 2 cohorts: patients who had a PHE within 90 days of surgery and patients with no history of a PHE. A PHE was defined as any ED visit or hospital admission within 90 days prior to their TKA surgery. We then further divided our PHE cohort into patients who had one or more PHEs (hereafter, any PHE) and those who had at least 2 PHEs (hereafter, ≥2 PHEs). Finally, we performed a subanalysis of PHE patients to stratify risk based on ED visits vs hospital admissions.

Data collection

Demographic variables included sex, age at surgery, smoking status, race, body mass index (kg/m^2), and Charlson comorbidity index (CCI). Surgical time (minutes), facility discharge, and postoperative readmission and revision dates were also collected. Surgical time was calculated as the difference in time between initial skin incision and final closure. All data were obtained using our electronic medical records database (Epic Caboodle, version 15; Verona, WI).

Data analysis

All statistical analyses were performed using SPSS v25 (IBM Corporation, Armonk, New York). We first created a binary variable to differentiate patients who had a PHE prior to surgery from those who did not. For all demographic and clinical characteristics, categorical variables were reported as frequencies with percentages and continuous variables as means with standard deviations. We used independent sample, 2-sided t-tests to assess continuous demographic variables for significance. To assess categorical demographic variables, chi-squared tests were used. All significant covariates were included in binary logistic regressions used to predict discharge disposition, 90-day readmission, and 1-year revision [14] in order to determine the risk of an adverse event following a PHE. We defined significant covariates as any demographic variable that demonstrated a significant difference between groups, including CCI and surgical time. A *P*-value of less than .05 was considered statistically significant for all measures.

Results

Demographic variables

Of the 10,869 patients identified who met criteria for this study, 10,604 did not have a PHE, and 265 did. Within the PHE cohort, 34 patients had ≥2 PHEs. The PHE cohort had higher percentage of females (67.5% vs 66.6%), were younger (66.06 [range 32-93] vs 66.20 [range 23-99]), and had a greater percentage of current smokers (7.2% vs 6.5%); however, these differences were not statistically significant ($P = .739$, $P = .815$, and $P = .365$, respectively). The PHE cohort also demonstrated a lower percentage of white patients (53.1% vs 56.5%) and a lower average body mass index (31.78 [range 16.8-61.2] vs 32.10 [range 15.3-68.9]) compared to the no PHE cohort, though these results were also not statistically significant ($P = .349$ and $P = .454$, respectively). Patients with a PHE did, however, have significantly higher CCI scores (2.19 [range 0-14] vs 1.14 [range 0-14]; $P < .001$) and a longer average surgical time (108.12 [range 38-228] vs 100.01 [range 30-311]; $P < .001$). Full demographics are listed in Table 1.

Risk of adverse events

Patients who had any PHE were significantly more likely to require facility discharge (odds ratio [OR]: 1.662; 95% confidence interval [CI]: 1.246-2.218; $P = .001$) than patients who did not have a PHE. Patients who had ≥2 PHEs, however, were not more likely to have facility discharge (OR: 1.511; 95% CI: 0.688-3.320; $P = .304$). Additionally, any PHE was associated with significantly higher 90-day readmission rates than no PHEs (OR: 2.173; 95% CI: 1.345-3.511; $P = .002$), while ≥2 PHEs did not predispose patients to greater 90-day readmissions compared to no PHEs (OR: 2.133; 95% CI: 0.636-7.151; $P = .220$). Patients with any PHE were not significantly more likely to have 1-year revision (OR: 1.419; 95% CI: 0.618-3.256; $P = .409$). Patients with ≥2 PHEs, however, were almost 6 times more likely to have a revision within 1 year (OR: 5.870; 1.752-

Table 1
Demographic comparison.

Variable	No PHE (n = 10,604)	PHE (n = 265)	*P*-value
Sex			.739
Male	3545 (33.4%)	86 (32.5%)	
Female	7059 (66.6%)	179 (67.5%)	
Age (y, ± SD)	66.20 ± 9.74	66.06 ± 10.64	.815
Smoking status			.365
Never smoker	6302 (59.4%)	146 (55.1%)	
Former smoker	3610 (34.0%)	100 (37.7%)	
Current smoker	692 (6.5%)	19 (7.2%)	
Race			.349
White	5990 (56.5%)	141 (53.2%)	
Black	1997 (18.8%)	59 (22.3%)	
Other	2617 (24.7%)	65 (24.5%)	
BMI (kg/m^2, ± SD)	32.10 ± 6.34	31.78 ± 6.77	.454
CCI (±SD)	1.14 ± 1.60	2.19 ± 2.47	<.001
Surgical time (min, ±SD)	100.01 ± 29.25	108.12 ± 30.93	<.001

BMI, body mass index; SD, standard deviation.

19.664; $P = .004$) compared to patients without a PHE. Reasons for revision for these patients included infection and arthrofibrosis. The postoperative outcomes are outlined in Table 2.

PHE subanalysis

Within our PHE cohort, 238 patients had preoperative ED visits, and 55 patients had preoperative hospital admissions. Hospital admissions were associated with greater likelihood of facility discharge (OR: 2.390; 95% CI: 1.038-5.507; $P = .041$) compared to preoperative ED visits (OR: 1.592; 95% CI: 1.172-2.162; $P = .003$). While ED visits significantly predicted the likelihood of 90-day readmissions (OR: 2.290; 95% CI: 1.398-3.750; $P < .001$), hospital admission did not (OR: 2.390; 95% CI: 0.151-8.340, $P = .910$). Neither ED visits (OR: 1.582; 95% CI: 0.688-3.637; $P = .281$) nor hospital admissions (OR: 0; 95% CI: –; $P = .998$) predicted the likelihood of 1-year revisions within the PHE cohort. The complete subanalysis of these PHEs can be found in Table 3.

Discussion

The study of potential risk factors presented by TKA patients may aid physicians in reducing postoperative complications and improving outcomes [5]. Previous studies have demonstrated the importance of identifying preoperative risk factors for TKA using risk stratification protocols, which are based on patient comorbidities [1,8,9,15]. Recent studies, however, have shown that these comorbidities may not be comprehensive enough in predicting risk of postoperative complications and readmissions [8,10]. Therefore, our study sought to determine whether the experience of a PHE predisposes patients to greater risk following TKA. We hypothesized that patients who underwent a PHE within 90 days of surgery would experience a greater rate of facility discharge, 90-day readmission, and revision within 1 year of surgery. The results of our study supported our hypothesis, as patients with any PHE had higher rates of facility discharge and 90-day readmission following surgery, while patients with ≥2 PHEs experienced more revisions within 1 year. The relationship between PHEs and postoperative healthcare utilization detected in our study may aid physicians in patient counseling and in timing of elective TKA cases following a recent PHE.

Our study demonstrated the significant impact of PHEs on facility discharge, 90-day readmission, and 1-year revision following TKA. Specifically, the experience of any PHE yielded a significantly greater likelihood of facility discharge and 90-day readmission, while 1-year revision rates were the only category for which having ≥2 PHEs was a significant predictor. These results suggest that the number of PHEs experienced by a patient may differentially predict the type of postoperative healthcare utilization required. In a similar study by Creager et al. [8], both any PHE and ≥2 PHEs were significant predictors of 30-day readmissions following TKA. Moreover, patients in the Creager et al. study had an even greater risk of 30-day readmissions if they experienced ≥2 PHEs prior to TKA. These results are contrary to the ones found in our study, as ≥2 PHEs only predicted 1-year revision risk and were not associated with the other outcome variables that we assessed. However, this study included urgent care visits in its PHE cohort, which may have caused its results to vary from ours. This distinction underscores the importance of evaluating PHE type when studying how healthcare utilization affects postoperative outcomes. A study by Kiskaddon et al. [10] showed that preoperative ED visits significantly affected patient discharge disposition following TKA. Unlike our study, the above paper did not include hospital admissions as a PHE. Nonetheless, the findings of the study support our results, as our subanalyses showed that both ED visits and hospital admissions significantly affected discharge disposition in TKA patients. PHEs may influence the likelihood of postoperative healthcare use in a number of ways. First, PHEs may be indicative of underlying comorbidities that may cause and/or increase the likelihood of complications following TKA [6]. Second, posthospital syndrome, a period of generalized risk following hospital admission due to stressors such as pharmaceutical use, sleep deprivation, poor nutrition, and immobility, can affect a patient's future postsurgical course [9,12,13]. Future studies should focus on elucidating the underlying factors that lead to PHEs and differences in postoperative healthcare utilization.

The demographic variables assessed in our study also demonstrated key differences between patients with and without PHEs. Among the demographic variables evaluated, both CCI and surgical time were shown to be significantly different between patients with and without a PHE. The CCI portends risk of postoperative mortality based on comorbidities, many of which (myocardial infarction, congestive heart failure, peripheral vascular disease, etc.) often demand hospitalization [16,17]. The significantly greater average CCI score among patients with a PHE (2.19 ± 2.47) compared to those without (1.14 ± 1.60) found in our study is therefore not surprising. Aside from CCI score, surgical time was an additional factor found to be statistically significant. Patients who had a PHE also had a longer average surgical time (108.12 ± 30.93 minutes) than those without a PHE (100.01 ± 29.25 minutes; $P < .001$). Past studies have shown that greater surgical time is associated with various postoperative complications in total joint arthroplasty, including renal, systemic, and wound complications [18–20]. Although the surgical time differences may not be clinically significant, this study highlights the physical burden that PHEs may indirectly place on patients in the postoperative period.

While our results demonstrate the impact of PHEs on postoperative outcomes, this study was not without its limitations. Firstly, our study is retrospective in nature; therefore, the data collected were prone to selection bias. Furthermore, the generalizability of our findings may be limited as the data used in our study were collected from a single institution. Our analyses also include a limited categorization of race and do not account for a variety of insurances such as Medicare and Medicaid, whose findings may better inform physicians of underlying causes of postoperative

Table 2
Logistic regression demonstrating outcomes following TKA.

Variable	Standard error	*P*-value	Odds ratio	Confidence interval
Facility discharge				
Any PHE	0.147	.001	1.662	1.246-2.218
≥2 events	0.402	.304	1.511	0.688-3.320
90-d readmission				
Any PHE	0.245	.002	2.173	1.345-3.511
≥2 events	0.617	.220	2.133	0.636-7.151
1-y revision				
Any PHE	0.424	.409	1.419	0.618-3.256
≥2 events	0.617	.004	5.870	1.752-19.664

Table 3
Stratification of risk based on PHE.

Variable	Standard error	*P*-value	Odds ratio	Confidence interval
Facility discharge				
ED visit	0.156	.003	1.592	1.172-2.162
Hospital admission	0.426	.041	2.390	1.038-5.507
90-d readmission				
ED visit	0.252	<.001	2.290	1.398-3.750
Hospital admission	1.023	.910	1.122	0.151-8.340
1-y revision				
ED visit	0.425	.281	1.582	0.688-3.637
Hospital admission	7734.226	.998	0	-

hospital use. Finally, our data were restricted to include patient encounters that had occurred only within this institution. Our records may therefore be incomplete, as it is possible that patients had additional preoperative or postoperative healthcare events of which we were unaware while collecting data.

Conclusions

Our results demonstrated that patients with any PHE were significantly more likely to experience facility discharge and 90-day readmission, while patients with ≥2 PHEs had a 6 times higher rate of revision within 1 year. Moving forward, consideration of elective surgery scheduling in the context of PHEs may lead to improved postoperative outcomes. Overall, this study demonstrates that PHEs may serve as an indicator of poor preoperative functional status that may carry over into the perioperative and postoperative period and may lead to more complications and readmissions following TKA.

Conflicts of interest

J.C. Rozell serves as a board/committee member for the New York State Society of Orthopaedic Surgeons. R. Schwarzkopf receives royalties from Smith & Nephew. R. Schwarzkopf serves as a paid consultant for Smith & Nephew, Intelijoint, and Zimmer Biomet. R. Schwarzkopf owns stock/stock options in Gauss Surgical, Intelijoint, and PSI. R. Schwarzkopf receives research support from Smith & Nephew as a principal investigator. R. Schwarzkopf serves on the editorial/governing boards of Arthroplasty Today and the Journal of Arthroplasty. R. Schwarzkopf serves as a board member for the American Academy of Orthopaedic Surgeons and the American Association of Hip and Knee Surgeons; all other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101179.

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