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Original Article

The Effect of Comorbidities on Discharge Disposition and Readmission for Total Joint Arthroplasty Patients

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ABSTRACT

Background: As the annual demand and number of total joint arthroplasty cases increase, so do concerns of outcomes of patient with specific comorbidities relative to outcomes and costs of care.
Methods: The study cohort included 2009 primary total knee arthroplasty (TKA) patients and 905 total hip arthroplasty patients. Discharge disposition was classified as discharge to any facility or home. The comorbidities of the patients who were readmitted and those without a 90-day event were also evaluated.
Results: In the TKA population, age, female gender, nonsmoking status, venous thromboembolism (VTE) history, and diabetes were significantly associated with discharge to extended care facility (ECF) on univariate analysis, unlike body mass index. With multivariate analyses, female gender, age, VTE history, and diabetes were associated with ECF placement, but smoking was not. In the total hip arthroplasty population, age, female gender, and nonsmoking status were significantly associated with discharge to ECF on univariate analysis, whereas body mass index, diabetes, and VTE history were not. On multivariate analyses, female gender and age were associated with ECF, but smoking was not. The only significant finding for the readmission data was an increased rate of readmission for TKA patients of older age.
Conclusion: The potential of projecting patient discharge and readmission allows physicians to counsel patients and improve patient expectations.

Total joint arthroplasty (TJA) is well accepted as a reliable and suitable surgical procedure to improve a patient's quality of life [1]. TJA greatly reduces direct costs attributed to osteoarthritis when compared with conservative management [2]. As the annual demand [3] and number of TJA cases increase, so do concerns regarding the associated costs. Discharge dispositions and readmission rates represent a significant measure of both medical and financial resources.

As reimbursement models move toward bundling payments, every aspect of cost is being scrutinized. Risk adjustment will become increasingly important for cost control and patient access. It is imperative to determine which comorbidities create a higher risk for high cost discharge disposition such as extended care facility (ECF) or rehabilitation facility and/or adverse outcomes. As comorbidities in patients increase, so do postoperative complications [4].

Two of the largest costs associated with TJA are downstream and related to discharge to an ECF and/or readmission to a hospital. Furthermore, once at an ECF, Keswani et al [5] showed that patients are more likely to have severe adverse events after discharge. There is limited literature evaluating risk factors associated with these costs, discharge placement, and readmission. It is, however, important moving forward to identify the higher risk patients for these associated costs and managing patient expectations. Identifying key risk factors will help stratify patients, optimize them for surgery, and hopefully improve patient outcomes.

In 2012, a group of Michigan hospital systems as well as a major insurance company came together to form the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI). This initiative enabled hospitals to gather data for a quality-based total

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Table 1
Demographics of the Patient Population.

Demographics	Total Hip Arthroplasty	Total Knee Arthroplasty
Patients	905	2009
Age, y (SD)	66.87 (10.06)	65.32 (11.27)
Sex, female:male	544:361	1347:662
Body mass index, kg/m^2 (SD)	30.25 (6.30)	32.93 (6.94)
Diabetes, yes:no	111:534	297:1166
Smoking status, yes:no	129:775	155:1848
History of DVT/PE, yes:no	50:851	104:1902
Length of stay, d (SD)	2.40 (1.03)	2.41 (1.52)
90-d readmissions	50 (5.52%)	111 (5.52%)

DVT/PE, deep venous thrombosis/pulmonary embolism; SD, standard deviation.

joint registry. This study used one of the participating hospital's data set to evaluate the comorbidities, associated discharge, and readmission status of their patients. Unlike other discharge and hospital data, this was not "administrative data." Specifically trained orthopedic nurse data abstractors collected all data prospectively. We focused on identifying comorbidities that were associated with increased level of discharge disposition and readmissions rate for primary total hip and knee patients. We hypothesized that higher body mass index (BMI), age, female sex, smoking, diabetes, and history of venous thromboembolism were associated with higher-level discharge disposition and higher readmission rates.

Materials and Methods

Using our hospitals' MARCQI joint registry database, we identified all patients who underwent elective primary TJA from May 2012 to October 2014. All cases were unilateral primary TJAs. Institutional review board's approval was obtained for the study. Trained MARCQI data collectors gathered the values prospectively.

All patients undergoing primary TJA within the quality database during the specified dates were included. Patients undergoing bilateral procedures were excluded as were patients having arthroplasty for fractures. All patients were admitted to the hospital on the day of surgery. Postoperatively, each patient underwent a standardized hospital pathway protocol for pain control, deep venous thrombosis (DVT) prophylaxis, physical therapy, and discharge planning. All patients were provided preoperative information about the hospital stay and expectations for discharge, encouraged to attend a preoperative total joint class, and were seen preoperatively for medical clearance and presurgical testing.

The data collected included gender, age, date of surgery, date of discharge, BMI, diagnosis of diabetes at the time of surgery, smoking status, history of DVT, history of pulmonary embolism (PE), and readmission to hospital within 90 days of discharge. Diabetes was defined categorically as yes or no. Patients in the yes category were diagnosed with either type 1 or type 2 diabetes vs those that had neither. BMI was recorded at the time of surgery. Smoking status was classified as never or previous and/or current. History of a PE or DVT anytime before the procedure was noted. Discharge disposition was stratified by the level of service intensity, and defined as a facility (rehabilitation center, short-term nursing facility, ECF etc.) or home with or without home care and/or outpatient services. When evaluating readmission data, only patients who had an actual readmission event or no event were included. Patients who had an emergency department visit without admission were classed as no event.

Data were analyzed using both univariate and multivariate analyses. Chi-square analysis was used for frequencies, Student *t* test for continuous variables, and Fisher exact test was used for the univariate readmission analysis. Logistic regression models with odds ratio algorithms were used in assessing factors affecting discharge disposition and readmission. Data were analyzed using SPSS Version 22.0 (IBM Corporation, Armonk, NY) software. A P value <.05 was used to indicate statistical significance.

Results

There were a total of 2914 total joint procedures performed by 21 surgeons during this period (2009 total knee arthroplasties [TKAs] with an age range 33-95 years, 905 total hip arthroplasties [THAs] with an age range 24-95 years). Five surgeons contributed to more than 70% of the data. In the THA population, 361 patients were men, 544 patients were women. In the TKA population, 662 patients were men, 1347 patients were women.

In the total knee population, discharge disposition was found to be associated with several factors. For women undergoing TKA, 302 patients were discharged to ECF compared with 93 men ($P < .001$). The logistic regression showed that the women were 1.68 times more likely ($P = .002$) to go to an ECF. Three hundred seventy-five nonsmokers and 18 smokers went to ECF ($P = .009$). On the logistic regression model, smoking was ruled out as being associate with a discharge to ECF, $P = .634$. Patients with a history of DVT/PE went to an ECF 38.5% (40/104) of the time compared with 18.7% (355/1901) of patients with no history ($P < .001$), and patients with the positive history were 1.89 times more likely to go to an ECF than those with no history ($P = .023$). Patients with diabetes went to ECF 24.6% (73/297) of the time compared with 16.2% (189/1166) in those without diabetes ($P = .001$). Those with diabetes were 1.68 times more likely to go to ECF ($P = .002$). Patients going to ECF were typically older than those who did not (74.84 vs 64.93 years, $P < .001$). Every year of age had an odds ratio of 1.12 as seen on logistic regression. BMI was not associated with discharged disposition in the TKA population, $P = .616$ (Table 1).

In the total hip patients, discharge disposition was also found to be associated with multiple factors. Proportionally more women went to ECF (145/544 women vs 59/361 of men, $P < .001$) and the women had 1.491 times more likely ECF placement ($P = .035$) on logistic regression. Those who did not smoke had a higher

Table 2
Univariate Comparisons of Discharge Dispositions and Readmission Status Within Variables Within the THA Population.

Discharge Disposition, THA Variables	ECF	Home	*P* Value	Readmission, THA Variables	Readmission	No Event	*P* Value
Men	59 (16.3%)	302 (83.7%)	<.001	Men	24 (7.2%)	307 (92.7%)	.24
Women	145 (26.7%)	399 (73.3%)		Women	26 (5.3%)	469 (94.7%)	
Smoking	19 (14.7%)	110 (85.3%)	.023	Smoking	6 (5.0%)	113 (95%)	.83
Nonsmoking	184 (23.7%)	591 (76.3%)		Nonsmoking	44 (6.2%)	662 (93.8%)	
DVT/PE history	13 (26%)	37 (74%)	.559	DVT/PE history	3 (6.8%)	41 (93.2%)	.74
No history	191 (22.4%)	660 (77.6%)		No history	47 (6.0%)	732 (94%)	
Diabetic	28 (25.2%)	83 (74.8%)	.28	Diabetic	8 (8.2%)	90 (91.8%)	.51
Nondiabetic	110 (20.6%)	424 (79.4)		Nondiabetic	31 (6.8%)	458 (93.2%)	

DVT/PE, deep vein thrombosis/pulmonary embolism; ECF, extended care facility; THA, total hip arthroplasty.

Table 3
Univariate Comparison of Ages and BMI of Those Who Went to ECF and Those Who Went Home, As Well As Those Who Were Readmitted Against Those Who Had No 90-d Event.

Variables	ECF	Home	*P* Value	Readmission	No Event	*P* Value
TKA age, y (SD)	74.84 (8.59)	64.93 (9.42)	.001	71.69 (10.90)	66.54 (9.94)	<.001
TKA BMI, kg/m^2 (SD)	32.77 (7.32)	32.97 (6.85)	.616	32.22 (6.48)	32.98 (7.02)	.27
THA age, y (SD)	73.55 (9.58)	62.93 (10.58)	.001	65.24 (9.63)	65.31 (11.3)	.96
THA BMI, kg/m^2 (SD)	30.30 (7.27)	30.24 (6.01)	.928	30.15 (7.45)	30.21 (6.21)	.94

BMI, body mass index; ECF, extended care facility; THA, total hip arthroplasty; TKA, total knee arthroplasty.

likelihood of going to an ECF on univariate testing, $P = .023$, but on multivariate testing, there was shown to be no difference, $P = .37$. DVT/PE history did not play a role in THA patient disposition as seen in Table 2. The average age of those who went to ECF were also older than those who did not (73.55 vs 62.93 years, $P < .001$), and for every year of age, a patient was 1.108 times more likely to go to ECF ($P < .001$). BMI was not associated with ECF difference, $P = .928$.

Readmission within 90 days was associated only with age in the total knee population, as those readmitted were older on average (71.69 vs 66.54 years, $P < .001$). Older age was not associated with readmission within 90 days in the THA population (65.24 vs 65.31 years, $P = .96$). Gender, smoking status, DVT/PE history, and diabetes were not associated with readmission in both THA and TKA populations as seen in Tables 2-4.

Discussion

Discharge to higher intensity care facilities and readmissions have a tremendous impact on the total cost of care for joint arthroplasty [6-8]. The ability to identify risk factors associated with discharge to higher care facilities is critical as health systems move to a bundled payment system, as well as management of patient expectations (Tables 5 and 6). In 2012, our database was formed with Blue Cross of Blue Shield of Michigan to improved quality of care within the state. The hope was that by identifying patterns of care and linking them with outcomes, we could change behavior among providers and achieve quality commonality across multiple hospital systems. The database allowed analysis of the comorbidities within our hospital that were affecting discharge and readmission status of our patients. This has the potential to allow us to project patient discharge and readmission status in advance of admission. We could therefore have the ability to counsel patients and their families in advance of the procedure for what are reasonable expectations. In addition, these sorts of data can be used for cost projections as we begin to better control the costs of the entire continuum of care. A similar project is being rolled out for the entire MARCQI registry to look at our statewide population.

Recently, readmission data for the hospitals within the MARCQI consortium was reviewed internally. When hospitals were compared without risk stratification, there were clear differences between a number of the member hospitals readmission rates. Interestingly, when risk stratification was applied, little to no real differences could be demonstrated between the member hospitals in the consortium. Perhaps, readmission should not be used as a quality indicator when comparing hospitals with one another without the addition of other statistical correction.

Literature has shown better patient-reported outcome measures in those discharged home when compared with those going elsewhere [5,9]. As the number of patient-driven outcomes data grows, maximizing these results is of importance for the patient and the surgeons. Schwarzkopf et al [10] looked at a California hospital discharge data set of 2010 and found that patients with more comorbidities, higher age, black race, and Medicaid insurance were more likely to go to higher care facilities. Our data had similar findings. We also showed that women were more likely to be discharged to a higher-level care facility for both TKA and THA. In addition, TKA patients with a history of diabetes, smoking, and DVT/PE also had a higher likelihood of going to a higher-level care facility.

Unlike a previous study [11], obesity was not found to be associated with discharge to higher level care facilities in our total knee population, but it was found to be a factor in our THA population. The number of obese patients receiving TKA [12] as well as those with metabolic syndrome is increasing [13], and it will continue to do. Experts predict that 11% of the American population will have a BMI of at least 40 kg/m^2 by 2030 [14]. Although every 5-unit increase in BMI beyond 30 kg/m^2 is associated with approximately $250-$300 higher hospitalization cost in primary TKA [15], it may not affect discharge disposition as we have shown.

Interestingly, history of smoking did not significantly influence patients' discharge disposition with the multivariate analyses. Although the univariate analysis did show a significant difference leaning toward smokers going home (TKA: 11.6% vs 20.3%, $P < .001$; THA: 14.7% vs 23.7% $P = .023$), when confounding variables were included in the multivariable analysis no significant difference could be found (TKA $P = .63$, THA $P = .37$). This brings up an important analytical point for review of large data sets and patient comorbidities. One should not assume that any patient variable exists in a vacuum and affects patients independent of their other risk factors. Although the National Surgical Quality Improvement Program data mining [5] found smoking as an independent

Table 4
Univariate Comparisons of Discharge Dispositions and Readmission Status Within Variables Within the TKA Population.

Discharge Disposition, TKA Variables	ECF	Home	*P* Value	Readmission, TKA Variables	Readmission	No Event	*P* Value
Men	93 (14.1%)	568 (85.9%)	.001	Men	36 (6.1%)	559 (93.9%)	.92
Women	302 (22.4%)	1045 (77.6%)		Women	75 (6.2%)	1116 (93.8%)	
Smoking	18 (11.6%)	137 (88.4%)	.009	Smoking	7 (5.1%)	129 (94.9%)	.72
Nonsmoking	375 (20.3%)	1472 (79.7%)		Nonsmoking	104 (6.3)	1542 (93.7%)	
DVT/PE history	40 (38.5%)	64 (61.5%)	.001	DVT/PE history	10 (10.6%)	84 (89.4%)	.07
No history	355 (18.7%)	1546 (81.3%)		No history	101 (6.0%)	1589 (94.0%)	
Diabetic	73 (24.6%)	224 (75.4%)	.001	Diabetic	17 (6.6%)	241 (93.4%)	.67
Nondiabetic	189 (16.2%)	977 (83.8%)		Nondiabetic	63 (6.0%)	991 (94%)	

DVT/PE, deep vein thrombosis/pulmonary embolism; ECF, extended care facility; TKA, total knee arthroplasty.

Table 5
Logistic Regression Models Comparing Variables in the THA Population Regarding Discharge to ECF.

Variables	Odds Ratio	*P* Value	95% CI
Gender (female:male)	1.49:1	.03	1.03-2.16
Smoking (yes:no)	1.28:1	.37	0.72-2.27
Age, y	1.108:1	<.001	1.09-1.13

CI, confidence interval; ECF, extended care facility; THA, total hip arthroplasty.

predictor of nonhome discharge, we did not. This study adds to the sparse data about smoking and outcomes in primary joint arthroplasty [5]. No literature is available on readmission rates in primary TJA, and we found no difference in smokers vs nonsmokers in readmission of TKA patients, $P = .72$, and THA patients, $P = .83$. Of note, smoking was previously not shown to be a risk factor for readmission in revision joint arthroplasty [16].

Our data shows that those discharged to ECF are older on average than those discharged home. This agrees with previous data that shows age is a predictor of discharge disposition in other health system specific registries [9,17].

The only comorbidity we found associated with readmission was an increase of average age in the TKA population, $P < .001$. Riley [18] reviewed the TJA Medicare patient population and found that 6% of TKA patients had a readmission for an adverse outcome of surgery. In addition, Ramos et al [19] found that discharge home with health services had a significantly lower 30-day readmission rate compared with those discharged to inpatient rehab facilities. Kansagara et al [20] found that risk prediction models are helpful to support clinical decision-making and are increasingly being integrated into clinical guidelines to reduce hospital readmission. Our data may be used for targeting the said populations on whom to develop specific guidelines and manage patient expectations.

The data presented in this study are unique. Unlike other large database studies that search Current Procedural Terminology codes and/or self-report complications or readmissions, a collaborative quality initiative nurse at our hospital system individually records our data. Our data is not “administrative,” instead it is specifically abstracted for every TJA performed in the hospital.

Our data do have some limitations. We focused on patients treated within a 2-hospital system. Although the two hospitals draw from a very diverse patient population, urban to suburban, economically advantaged and disadvantaged, it is still a single system and the data may not translate to other hospitals or regions. In addition, although we can track readmission to outside hospitals, this data trails many months behind the tracking data herein. Although the data came from 21 surgeons, 5 surgeons contributed to over 70% of the data. Our diabetic data gathering began in 2013, thus missing the patients who were operated on in 2012. Readmission analyses were only performed on those with no events and those readmitted, thus excluding those who had an ER visit but no subsequent admission. This was performed in hopes to extrapolate the greatest difference between those 2 populations. The data is best used as a reference and platform for patient risk stratification. As we refine these sorts of data sets, they could impact decisions on patient access and influence management of care bundles.

Table 6
Logistic Regression Models Comparing Variables in the TKA Population Regarding Discharge to ECF.

Variable	Odds Ratio	*P* Value	95% CI
Gender (female:male)	1.68:1	.002	1.21-2.35
Smoking (yes:no)	1.17:1	.634	0.61-2.23
Age, y	1.12:1	<.001	1.10-1.14
History of DVT/PE (yes:no)	1.89:1	.023	1.09-3.27
Diabetes (yes:no)	1.68:1	.002	1.20-2.36

CI, confidence interval; DVT/PE, deep vein thrombosis/pulmonary embolism; ECF, extended care facility; TKA, total knee arthroplasty.

Conclusions

In TKA patients, discharge to ECF was associated with female gender, increasing age, history of venous thromboembolism, and diabetes. In THA patients, discharge to ECF was associated with female gender and increasing age. Readmission was only associated with increasing age in the TKA population. The ability to identify risk factors associated with discharge to higher care facilities and readmission is critical. The potential of projecting patient discharge and readmission allows physicians to counsel patients and improve patient expectations.

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