Original research

The Effects of Depression and Anxiety on 90-day Readmission Rates After Total Hip and Knee Arthroplasty

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ABSTRACT

Background: Patients undergoing total joint arthroplasty have higher rates of anxiety, depression or anxiety and depression than the general population and higher costs of care, which lead to higher levels of postoperative dissatisfaction and readmission rates. We evaluated the readmission rates of patients undergoing total hip or knee arthroplasty with diagnoses of anxiety, depression, or both.
Methods: Our hospital's prospectively collected data from Michigan's statewide total joint database were reviewed from 2013 to 2018. Rates of anxiety, depression or anxiety and depression were determined based on preoperative anxiolytic or antidepressant medications using National Drug Codes.
Results: A total of 4107 cases were included. Of which 4.28% had a readmission within the 90-day global period, and 12% had a history of depression or anxiety or both. For the entire cohort, those on anxiolytic medication were 153% more likely to be readmitted than those not on medication ($P = .017$). When comparing total hip arthroplasty (THA) or total knee arthroplasty (TKA), patients taking anxiolytic medication and undergoing TKA were 120% more likely to undergo readmission within 90 days ($P = .021$). Patients on depression medication alone were not at increased risk of readmission in the TKA cohort ($P = .991$). For THA, neither diagnosis appeared a risk factor for readmission ($P = .852$).
Conclusions: Patients with depression, anxiety, or both undergoing TKA were at a statistically significant risk of readmission within 90 days compared with patients without these diagnoses. Anxiety and depression were both risk factors for readmission, but anxiety appeared to have a more significant impact. Patients undergoing THA on the other hand did not appear to share this risk profile.
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Introduction

Depression and anxiety represent a significant portion of the psychological issues experienced by the general population. According to The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (American Psychiatric Association, 2013), generalized anxiety disorder (GAD) is defined as a disorder characterized by excessive anxiety and worry that is not focused on a single trigger [1]. A major depressive episode is characterized by a combination of depressed mood or loss of interest or pleasure (anhedonia) lasting for most of the day, nearly every day, or both for 2 weeks or more [2]. The incidence of GAD and depression has been demonstrated to be higher in the orthopedic total joint arthroplasty (TJA) population than that in the general population and is reported to be 20.2% and 22.5%, respectively [3,4]. It has been proposed that pain may be a potential cause for this disparity with the general population as a whole [5].

These diagnoses, as comorbidities, have been proposed as risk factors for poorer outcomes after arthroplasty [6]. Investigations specifically related to total knee arthroplasty (TKA) have shown higher rates of knee disability (using the Hospital Anxiety and Depression scale) and a decreased improvement in pain after surgery in patients with a preoperative depression diagnosis [5,7]. A coexisting depression diagnosis has also been shown to be associated with longer hospital length of stay [8]. With preoperative GAD,

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there was an association with higher levels of knee disability, significant functional limitations using Western Ontario and McMaster University Osteoarthritis Index (WOMAC) scores, and decreased overall quality of life [5,9]. Although depression and anxiety are conceptually modifiable risk factors for complications, there are no current recommendations on the effects of preoperative treatment of these conditions, and recent investigations have led to authors urging more research into the possible benefit of preoperative therapy on patient outcomes [10–12].

Readmission after arthroplasty may be due to various factors. The most commonly cited surgery-related reasons for postoperative return to the emergency room are pain, swelling, wound complications, and medication-related side effects [13–16]. In one study, up to 5.3% of patients were readmitted for "failure to cope" [17]. Reasons for these return visits may be amplified in patients with GAD and depression, but this relationship has not been well investigated by current arthroplasty literature.

Readmissions are not an insignificant burden, with reported 90-day rates ranging from 4.5% to 13% and 5.5% to 8% for total hip arthroplasty (THA) and TKA, respectively [14,18–20]. Unplanned emergency department visits as well as readmissions after arthroplasty lead to substantial increases in cost of care [15]. The diagnoses GAD and anxiety complicate care and may increase 30-day and 90-day readmission rates [21,22]. Arthroplasty patients with depression and GAD have been associated with an overall increased cost of care for TJA, one study showing upwards of $3400 for TKA [23,24]. It benefits all the members of the health-care system, as well as the insurers, to identify the risk factors associated with outcomes that would lead to readmissions, complications, and their associated costs.

The association of both anxiety and depression with the rates of readmission in patients undergoing TJA remain unclear. Our goal was to use our hospital's data, generated from a statewide total joint database Michigan Arthroplasty Registry Quality Collaborative Initiative (MARCQI), to establish if depression, anxiety or depression and anxiety were significant risk factors for readmission in our patients undergoing elective TJA. The authors predict that the rates of readmissions will be significantly higher in patients who are taking antidepressants or antianxiolytics.

Material and methods

After receiving institutional review board approval, the MARCQI database was used to retrieve prospectively collected data on THA and TKA surgeries performed at our institution's 2 hospitals from the years 2013-2018.

Please note, support for MARCQI is provided by Blue Cross and Blue Shield of Michigan (BCBSM) and Blue Care Network as part of the BCBSM Value Partnerships program. Although BCBSM and the MARCQI work collaboratively, the opinions, beliefs, and viewpoints expressed by the authors do not necessarily reflect the opinions, beliefs, and viewpoints of BCBSM or any of its employees.

A total of 4107 primary total hip and knee arthroplasty cases were performed during the study period (2846 TKA and 1261 THA). The cases were performed by multiple surgeons with varying levels of expertise and included different vendors and components. The THA surgeries were performed using posterior, direct anterior, and anterolateral approaches. Inclusion criteria comprised all primary TKA and THA surgeries performed between 2013 and 2018 at our institution's 2 affiliated hospitals. Exclusion criteria included all revision procedures.

Data were collected from the MARCQI database. The clinical and surgical data were specifically extracted by trained MARCQI nurses. The selected data parameters included gender, race, age, body mass index (BMI), preoperative smoking use, pre-existing diabetes

mellitus (DM), illicit drug use, preoperative alcohol (EtOH) use, length of stay, readmission rates, and discharge disposition. These demographic data are shown in Table 1. National Drug Codes were used to identify patients who were on anxiolytic, antidepressant or anxiolytic and antidepressant medications by reviewing electronic medical records (Table 2). All collected data were kept on password-protected computers for patient confidentiality.

Independent sample t-tests were used to compare continuous variables between study groups. Chi-square tests, or Fisher's exact tests when sample sizes were appropriate, were performed to compare percentages of categorical variables between groups. Multivariable logistic regression modeling was conducted to identify potential risk factors for all-cause readmission (Table 3). Age, sex, and BMI were adjusted for in the regression modeling. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported to determine the strength of the association between clinical factors and likelihood of readmission (Table 4). Statistical significance was defined as $P \leq .05$. All analyses were performed with SPSS, version 23.0 (IBM Corp., Armonk, NY).

Results

Total Knee/Total Hip Arthroplasty

There was a total of 4107 cases (1261 THA and 2846 TKA surgeries) after inclusion/exclusion criteria were applied. Patients undergoing TKA were statistically older than patients undergoing THA (THA 66.1 vs TKA 67.3, $P < .001$).

Of the 4107 patients, 3631 (88%) were not taking any form of antidepressant, anxiolytic or antidepressant and anxiolytic medication. The other 476 patients (12%) had a history of depression, anxiety or depression and anxiety based on medication use. Three hundred six patients (7.5%) were taking antidepressant medications, 121 (2.9%) were taking anxiolytic medications, and 49 (1.2%) were taking both antidepressant and anxiolytic medications. The percentage of patients taking antidepressant, anxiolytic or antidepressant and anxiolytic medications was higher in the TKA group (12%) than that in the THA population (10%) (Table 1). Using univariate analysis, females (THA 7.0%, $P = .003$, TKA 10.2%, $P < .001$) and Caucasians (THA 8.0%, $P = .006$, TKA 10.0%, $P < .001$) were more likely to be taking antidepressant, anxiolytic or antidepressant and anxiolytic medications (Table 1).

For the entire study population, 176 patients (4.3%) were readmitted within the 90-day global period. Of the readmissions, 53 (30.1%) were THAs and 123 (69.9%) were TKAs ($P = .862$). Using multivariable regression analysis, regardless of arthroplasty type, age was a significant risk factor for readmission, $P \leq 0.001$. For every 1-year increase in age, the likelihood of readmission increased by 5% (OR: 1.05, 95% CI: 1.03-1.07, $P < .001$). Diabetic patients were also at a higher risk of readmission (OR: 1.57, 95% CI: 1.11-2.21, $P = .011$) (Table 3).

Using multivariable regression analysis for the entire study population, those on anxiolytic medication were 153% more likely to be readmitted than those not on medication (OR: 2.53, CI: 1.18-5.42, $P = .017$). No significant risk for readmission was found with antidepressant or combined antidepressant and anxiolytic medications when looking at the arthroplasty cohorts combined.

THA alone

There were 1261 THAs performed during the study period. When looking at univariate analysis, females undergoing THA were more likely to be taking antidepressant, anxiolytic or antidepressant and anxiolytic medications (7.0%, $P = .003$). Patients that were Caucasian were also more likely to be taking these medications (8.0%, $P = .006$).

Table 1
Demographics of all THA and TKA patients in our cohort.

Variable	THA (N = 1261)						P value	TKA (N = 2846)						P value
	No medication			Depression, anxiety or depression and anxiety				No medication			Depression, anxiety or depression and anxiety			
	Total N	Mean	SD or %	Total N	Mean	SD or %		Total N	Mean	SD or %	Total N	Mean	SD or %	
Age	1136	66.2	10.7	125	65.6	9.5	.540	2495	67.7	9.3	351	65.0	8.8	**<.0001**
BMI	1104	31.6	14.1	123	33	7.2	.287	2482	33.7	9.1	349	34.9	7.6	**.021**
Sex														
Male	1136	491	43%	125	37	30%	**.003**	2495	850	34%	351	60	17%	**<.0001**
Female	1136	645	57%	125	88	70%		2495	1645	66%	351	291	83%	
Race														
Caucasian	1135	739	65%	125	101	81%	**.006**	2495	1580	63%	351	286	81%	**<.0001**
Black	1135	370	33%	125	22	18%		2495	822	33%	351	55	16%	
Other	1135	11	1%	125	1	1%		2495	43	2%	351	1	0%	
Unknown	1135	15	1%	125	1	1%		2495	50	2%	351	9	3%	
Illicit drugs														
No	1092	1069	98%	122	121	99%	.502	2425	2388	98%	349	345	99%	.812
Yes	1092	23	2%	122	1	1%		2425	37	2%	349	4	1%	
ETOH														
No	1096	568	58%	124	67	54%	.641	2468	1327	54%	348	187	54%	.991
Yes	1096	528	48%	124	57	46%		2468	1141	46%	348	161	46%	
Smoking status														
Never	1100	637	58%	124	62	50%	.161	2466	1568	64%	346	215	62%	.582
Previous	1100	326	30%	124	40	32%		2466	710	29%	346	98	28%	
Current	1100	135	12%	124	21	17%		2466	186	8%	346	33	10%	
Unknown	1100	2	0%	124	1	1%		2466	2	0%	346	0	0%	
Diabetic														
No	1136	954	84%	125	99	79%	.172	2495	1946	78%	351	293	83%	.019
Yes	1136	182	16%	125	26	21%		2495	549	22%	351	58	17%	

Bold values represent statistical significance.

Of the 1261 THAs, there were 53 readmissions (4.2%). For the THA population, there were no significant risk factors found for readmission, including age, BMI, sex, alcohol use, diabetes, and medication history. The use of antidepressants or anxiolytics did not impact readmission for patients undergoing THA.

TKA alone

There were 2846 TKAs performed during the study period. The percentage of patients taking antidepressant, anxiolytic or antidepressant and anxiolytic medications was 12%. Using univariate analysis, the incidence of diabetes (17%, $P = .019$) and greater BMI (34.9, $P = .021$) were statistically higher in the patients taking antidepressant, anxiolytic or antidepressant and anxiolytic than those in the no-medication TKA population. Females (10.2%, $P < .001$) and Caucasians (10.0%, $P < .001$) were more likely to be taking antidepressant, anxiolytic or antidepressant and anxiolytic medications.

Table 2
List of antidepressant and anxiolytic medications used in our analysis using all relevant National Drug Codes (not listed).

| Medications analyzed | |
Depression	Anxiety
Remeron	Zyban
Lexapro	Xanax
Effexor	Klonopin
Zoloft	Ativan
Celexa	Valium
Wellbutrin	Buspirone
Paxil	
Savella	
Prozac	
Cymbalta	
Pamelor	

Of the 2846 TKAs, there were 123 readmissions (4.3%). For the patients undergoing TKA alone, increased age was a risk factor for readmission with a 3% increased risk for every 1-year increase in patient age (OR: 1.03, $P < .001$). Diabetic patients had 59% increased odds of being readmitted (OR: 1.59, $P = .009$).

Using the multivariable regression analysis, patients on anxiolytic medication undergoing TKA were 120% more likely to undergo readmission within 90 days than patients not on anxiolytic medication (OR: 2.20, 95% CI: 1.12-4.32, $P = .021$) (Table 4). Patients taking only antidepressive medications were not found to be at an

Table 3
Multivariate logistic regression for risk of readmission.

| Variable | Overall | | No readmission | | Readmission | | P value |
	Total N	Mean	Total N	Mean	Total N	Mean	
Age	4107	67.0	3931	66.8	176	69.9	<.0001
BMI	4058	33.2	3884	33.2	174	33.5	.753
Surgery							
THA	4107	1261	3931	1208	176	53	.862
TKA	4107	2846	3931	2723	176	123	
Sex							
Male	4107	1438	3931	1370	176	68	.303
Female	4107	2669	3931	2561	176	108	
Race							
Caucasian	4106	2706	3930	2598	176	108	.452
Black	4106	1269	3930	1206	176	63	
Other	4106	56	3930	53	176	3	
Unknown	4106	75	3930	73	176	2	
Diabetes							
No	4107	3292	3931	3167	176	125	.002
Yes	4107	815	3931	764	176	51	
Group							
No meds	4107	3631	3931	3481	176	150	.079
Dep	4107	306	3931	294	176	12	
Anx	4107	121	3931	111	176	10	
Dep + Anx	4107	49	3931	45	176	4	

Dep, depression; Anx, anxiety.

Table 4
Multivariate regression analysis of risk factors for readmission.

Model	Factor	Odds ratio	95% CI		P value
			Lower	Upper	
All patients (THA + TKA)	Age	1.05	1.03	1.07	**<.001**
	BMI	1.01	0.99	1.02	.268
	Female (vs male)	0.80	0.54	1.18	.261
	ETOH	0.83	0.57	1.21	.339
	DM	1.50	1.00	2.27	.053
	Depression only (vs no meds)	1.22	0.60	2.47	.587
	Anxiety only (vs no meds)	2.53	1.18	5.42	**.017**
	Dep + Anx only (vs no meds)	2.81	0.83	9.52	.097
THA	Age	1.01	0.98	1.04	.385
	BMI	0.99	0.95	1.03	.607
	Female (vs male)	0.78	0.44	1.38	.387
	ETOH	0.78	0.44	1.38	.39
	DM	1.93	0.99	3.75	.053
	Dep or Anx or both (vs no meds)	0.99	0.38	2.57	.984
TKA	Age	1.03	1.02	1.05	**<.001**
	BMI	1.00	0.99	1.01	.665
	Female (vs male)	0.78	0.57	1.08	.136
	ETOH	0.82	0.60	1.13	.229
	DM	1.59	1.12	2.25	**.009**
	Dep only (vs no meds)	1.00	0.53	1.89	.991
	Anx only (vs no meds)	2.20	1.12	4.32	**.021**
	Dep + Anx only (vs no meds)	2.77	0.97	7.95	.058

DM, diabetes mellitus.
Bold values represent statistical significance.

increased risk of readmission in the TKA cohort (OR: 1.00, 95% CI: 0.53-1.89, P = .991). When patients undergoing TKA were taking both depression and anxiety medications, readmission rate was increased, but this variable only trended toward statistical significance (OR: 2.77, 95% CI: 0.97-7.95, P = .058).

Discussion

As the population continues to age and number of TJA procedures increase, mental health needs to be considered as a significant risk factor because mental illness has a significant impact on outcome [25–27]. Patients with diagnoses of depression, anxiety or depression and anxiety have been shown to have inferior outcomes [5,28,29]. In terms of depression alone, studies estimated a prevalence of 22%-28% in the TJA population [4,30]. These patients have an increased risk of readmission [21,22,31]. The cited works on depression did not investigate rates of anxiety in their cohorts and/ or how this may differ from depression.

Gold et al. reported readmission rates of 7.9% for TKAs and 8.3% for THAs with associated rates of depression of 9% and 8.4%, respectively [22]. In our entire TJA patient base, the 90-day overall rate of readmission was comparatively low at 4.3% (4.2% THAs and 4.3% TKAs), despite having a higher percentage of patients with a history of depression, anxiety or depression and anxiety based on medication use (12%). As noted within our cohort, we were able to determine which patients were on antidepressants (7.5%), anxiolytics (2.9%), and both antidepressant and anxiolytic medications (1.2%), a unique aspect to this study.

Delineation of anxiety and depression is required to determine the independent risk of each condition. For studies that examine depression alone, there is a potential overlap between anxiety/ depression diagnoses that could lead to incorrect conclusions, including underestimating the impact of one specific condition. In one longitudinal study examining over 20,000 patients aged 60 years or older, it was determined that 57% of patients with depression showed evidence of comorbid anxiety, but only 28% of those with clinically significant anxiety had concurrent depression [32]. The authors highlighted the fact that these are distinct conditions that do commonly coexist, especially later in life.

Clinical practitioners should be attentive to patients' mental health status and should comprehend the importance of intervention in these patients. Validated mental health questionnaires may be applied as they may more accurately determine at-risk patients than either prior depression/anxiety diagnosis or medication history, due to undiagnosed and/or untreated disease [29]. Targeted interventions may lower rates of readmission in these at-risk patients, as suggestions may be provided to them about handling situations including wound appearance, drainage, pain management, among other common concerns for patients in the postoperative period. Collaborative treatment algorithms encompassing a variety of interventions have been more effective than standard treatment options in these patients. These range from simple telephone calls to encourage medication compliance, to more complex and structured psychosocial intervention [33]. As highlighted by a study by Kohring et al., even though "treated" and "untreated" depressed patients had similar physical function score improvements postoperatively, the patients who were untreated had a lower magnitude of change [12]. Contrasting this, a study by Halawi et al. concluded that although preoperative depressive symptoms affected overall outcomes, treatment of these symptoms before surgical intervention did not mitigate the inferior outcomes [11]. The authors also recommended further study into alternative or additional interventions that could potentially improve the overall patient experience.

Limitations of our study include the potential for missing or miscoded data, as is the case in all database research. While data from the MARCQI registry are specifically abstracted by trained nurses, there still exists the potential for missing data. This was also true for capture of the medication use, although we believe that using the National Drug Codes for medication was more accurate than International Classification of Diseases, Nineth/Tenth Revision, codes for self-reported diagnoses. There is also overlap in the indications of these medications when it comes to depression,

anxiety, or other mental health diagnoses. We acknowledge that the data analyzed were generated locally from a statewide data-base, which could limit the generalizability of these data to other regions and patient populations.

Conclusions

It is important that depression and anxiety are researched independently of one another as it has been shown they are separate conditions with unique manifestations [32]. To our knowledge, no other study has researched patients with anxiety, depression or anxiety and depression and their effect on 90-day readmission rates after arthroplasty. In our cohort, patients being treated for anxiety were found to be at higher risk than patients treated for depression. This finding may be used in future studies to examine the potential for intervention in either the preoperative or postoperative period to decrease rates of readmission in this population.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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