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Does Hospital Teaching Status Matter? Impact of Hospital Teaching Status on Pattern and Incidence of 90-day Readmissions After Primary Total Hip Arthroplasty

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ABSTRACT

Background: Given financial and clinical implications of readmissions after total hip arthroplasty (THA) and the potential for varied expenditures related to a hospital's teaching status, this study sought to characterize 90-day hospital readmission patterns and assess likelihood of readmission based on teaching designation of a Medicare beneficiaries' (MB's) index THA hospital.

Methods: Retrospective analysis of 2016-2018 Centers for Medicare and Medicaid Services-linked data identified primary THA hospitalizations and readmissions within 90 days. Hospitals were categorized as teaching or nonteaching (Council of Teaching Hospitals and Health Systems). Chi-squared analysis and Fisher exact test assessed differences between readmission hospitals and the index hospital teaching status. Multivariate logistic regression models estimated risk-adjusted probability of experiencing at least one 90-day readmission.

Results: Analysis identified 433,959 index THA admissions with an all-cause 90-day readmission rate of 9.12%. Most readmissions were to the same hospital regardless of index THA hospital teaching status (67.5% index teaching; 68.2% index nonteaching). Crossover in hospital teaching status from the index procedure to readmission location was more common for those with index THA at a teaching hospital (18.9%) than for MBs with index THA performed at a nonteaching hospital (6.2%). Controlling for patient characteristics, no significant relationship was found between 90-day readmission and index hospital teaching status (odds ratio 0.98, confidence interval 0.947–1.011).

Conclusions: Overall, while certain patterns of readmission after the index THA were observed, after controlling for patient characters and comorbidities, there was no significant association between 90-day all-cause readmission and index hospital teaching status.

Introduction

Teaching hospitals play a critical role within the United States health-care system through research, medical education, and often providing care to patient with lower socioeconomic means [1,2]. However, academic medical centers have also classically been associated with higher overall cost, at least in part thought to be related to caring for more complex patients [3-7]. With increasing adoption of alternate payment models, concern for subsequent transfer of financial burden for postsurgical complications to certain hospitals (eg, academic centers) has kindled further interest in understanding risk factors for complications, as well as distribution of care among different hospitals [8,9].

Readmission to a hospital after primary total hip arthroplasty (THA) has been identified as a key undesirable outcome as it represents a potentially modifiable expenditure per episode of care [10]. In 2004, the estimated cost of Medicare unplanned

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readmissions after prior hospitalization totaled over $17 billion [11]. Within alternative payment models, hospitals are required to reimburse Centers for Medicare and Medicaid Services (CMS) if the hospital is above the target pricing because of readmissions within 90 days of the index procedure. Considering overall costs at academic hospitals have classically been thought to be higher than those at nonacademic hospitals, characterizing the patterns of readmissions among these hospitals is critical to better understand potential varied burden among hospitals and need for resource allocation [3,12,13].

Limited prior work has critically evaluated differences in readmission patterns among hospitals based on teaching status. Boylan et al. used the New York Statewide Planning and Research Cooperative System and found a lower risk of 90-day readmission with primary THA performed at a teaching hospital than that at a nonteaching hospital [4]. Work outside of orthopedics assessing Medicare's Hospital Readmission Reduction Program among teaching hospitals found that revenue gains from an avoided readmission were 10%-15% higher for teaching than for nonteaching hospitals [14]. Taken together, these prior studies suggest that readmission hospital type with respect to academic teaching status—and similarly location of index THA procedure—may have meaningful consequences for overall health-care expenditures [15].

The purpose of this work was to determine whether or not Medicare beneficiaries (MBs) choosing to have their index THA at a teaching hospital were more or less likely to have a readmission during the study period than those with an index THA performed at a nonteaching hospital, after controlling for selected comorbid conditions. In addition, we sought to characterize the patterns of readmissions based on index hospital teaching status. We further investigated whether baseline patient characteristics and comorbid conditions as well as index hospitalization characteristics were associated with a higher likelihood that MBs will experience readmission within 90 days.

Material and methods

Data source

We used the CMS Inpatient Standard Analytical Files (IPSAF) linked data for 2016, 2017, and 2018 for retrospective analysis. All hospital services used by an individual MB can be linked to that MB through the Medicare program's beneficiary identifier code. This study used only hospital inpatient claims.

Study population

The study population consisted of all US hospitalizations in which a fee-for-service MB underwent a primary THA for either a left or right hip from January 1, 2016, to September 30, 2018. Primary THA procedures were identified by International Classification of Disease-10-Clinical Modification procedure codes. Exclusion criteria included conditions listed by CMS that would exclude the MBs' hospitalization from being part of the CJR bundle, including hip fracture, periprosthetic facture, mechanical complication associated with the implant, selected malignant neoplasm, undergoing a partial arthroplasty, or the removal, revision, or resurfacing of a hip device [16]. A MB was only allowed to have one index THA procedure on each side during the study period. Finally, any MB with a primary THA index hospitalization during the first quarter of 2016 was excluded if that MB had a primary THA procedure performed during the last quarter of 2015.

Unit of analysis and key study event

The unit of analysis was the primary index THA hospitalization and each readmission that the MB had during the 90 days after discharge from the index THA hospitalization. The IPSAF files for 2016, 2017, and 2018 were searched by the MB's unique ID to identify all hospitalizations each MB had during the study period.

Each index hospital was categorized as either teaching or nonteaching (academic or nonacademic) based on the list of hospital provider numbers from the Council of Teaching Hospitals and Health Systems [17]. Then, for each hospital readmission in the study period, we determined if the MB used the same hospital as was used for their index THA or a different hospital. Each readmission was subsequently categorized into one of the following readmission outcomes: (1) index THA at teaching hospital and readmission at the same teaching hospital; (2) index THA at teaching hospital and readmission at a different teaching hospital; (3) index THA at teaching hospital and readmission at a nonteaching hospital; (4) index THA at a nonteaching hospital and readmission at the same nonteaching hospital; (5) index THA at a nonteaching hospital and readmission at a different nonteaching hospital; and (6) index THA at a nonteaching hospital and readmission at a teaching hospital. For the purpose of this article, we focus primarily on whether or not the MB had all their readmissions at the same hospital or at least one readmission at a different hospital.

Definitions of readmission events

Readmission events were identified by counting the number of days from discharge to the date of the readmission. In addition, readmission for CMS-defined complications for primary THA encounters, including acute myocardial infarction, pneumonia, pulmonary embolism, sepsis, mechanical complication, surgical bleeding, and wound infection, were also identified using CMS readmission criteria.

Statistical analysis

Univariate differences between MBs in their observed use of readmission hospital(s) compared to index hospital were assessed using χ^2 analysis or the Fisher exact test. Multivariate logistic regression models using significant ($P \leq .01$; 99% confidence interval [CI]) patient comorbidities estimated the risk-adjusted probability of a MB experiencing at least one 90-day readmission. To answer the primary research question, differences between study groups were considered statistically different if the P value was less than or equal to 0.01 given the large data set analyzed and to decrease the potential for false positive significance. All analyses were performed with SAS 9.4 (SAS Institute, Cary, NC).

Results

Analysis of the CMS IPSAF data identified a total of 433,959 index THA hospital admissions for MBs during the 3-year study period from 2016 to 2018. Overall, the 90-day all-cause readmission rate was 9.12% (39,586 index admissions with 47,830 readmissions), with similar observed rates of readmission among those with index THA at a teaching hospital compared to those at a nonteaching hospital (9.15% and 9.11%, $P = .7138$, respectively; Fig. 1). Of all MBs with readmissions within 90 days, 24% had the index THA at a teaching hospital, and 76% had their index THA at a nonteaching institution.

Readmissions specifically to the same index hospital (teaching or nonteaching) were similar between the two groups with 67.5%

for index THA at a teaching hospital compared to 68.2% with index THA at a nonteaching hospital. However, if a patient did not return to the same exact hospital for a readmission after the primary THA (which was the most common pattern recognized), crossover in hospital teaching status from index procedure to readmission location was more common for those with index THA at a teaching hospital than for MBs with index THA performed at a nonteaching hospital (18.9% crossover for index teaching vs 6.2% crossover with index nonteaching; Fig. 1). A more rigorous analysis of *all* readmissions within the 90-day time period to the same hospital demonstrated no significant difference in proportion of patients with *all* readmissions at the same teaching hospital compared to the same nonteaching hospital (67.36% compared to 66.08%, $P = .0216$; Table 1).

While the distribution of age, gender, index hospital length of stay (LOS), discharge destination after index THA hospitalization, and comorbidities were found to be statistically significantly different between those who had all readmissions to the same hospital and at least one readmission to a different hospital ($P < .0001$; Table 2), these are of unclear clinical significance given small absolute differences in observed rates. Assessing those with readmission within 90 days to the same hospital, a larger proportion were aged 65-74 years compared to those with at least one readmission to a different hospital (48.50% compared to 42.04%, respectively). Index admission LOS was also noted to be different between those without a readmission, those with a readmission to the same hospital, and those with at least one readmission to a different hospital. A larger percentage of patients who were readmitted had an index LOS of 4-5 days and LOS >5 days (Table 2). Chi-square analysis assessing number of patient comorbidities and all readmission locations by index THA hospitalization demonstrated a significant difference between patients readmitted to the same hospital compared to at least one readmission to a different hospital ($P < .0001$). Overall, given all characteristics analyzed, except race, were found to be statistically significantly different between the groups, we chose to perform further multivariate analysis controlling for these factors.

Table 1
Chi-square analysis for index hospital type and readmission to same vs different hospital.

Index procedure site	All readmission(s) same as index	At least one readmission different from index	*P* value
Teaching hospital	6209 (66.08%)	3187 (33.92%)	.0216
Nonteaching hospital	20,335 (67.36%)	9855 (32.64%)	
Total	26,544	13,042	

Logistic regression modeling controlling for significant patient characteristics and comorbid conditions demonstrated no significant relationship between readmission within 90 days and teaching status of the index hospital (OR 0.98, 0.947– 1.011; Table 3). However, the estimated odds ratios indicated that non-whites had lower odds of 90-day readmission (OR 0.952, CI 0.908 – 0.998), while males had higher odds of readmission (OR 1.056, CI 1.025 – 1.088). MBs with longer index hospital LOS were significantly more likely to have a readmission within 90 days than those with index LOS ≤2 days (OR 2.038 for LOS >5 days, CI 1.887 – 2.201). Compared to patients discharged home, those with discharge to "other destinations" (OR 2. 771, CI 2.531 – 3.033), skilled nursing facility (OR 1.784, CI 1.670 -1.906), long-term care facility (OR 1.504, CI 1.137 – 1.989), and rehab (1.489, 1.420 – 1.560) had significantly increased the odds of readmission.

Of the comorbidities assessed, chronic obstructive pulmonary disease, dialysis-dependence present on admission (POA), congestive heart failure, anemia POA, atrial fibrillation POA, prior venous thromboembolism, and depression diagnoses were associated with the highest odds of 90-day readmission (Table 4). Interestingly, prior THA showed decreased odds of readmission (OR 0.789, CI

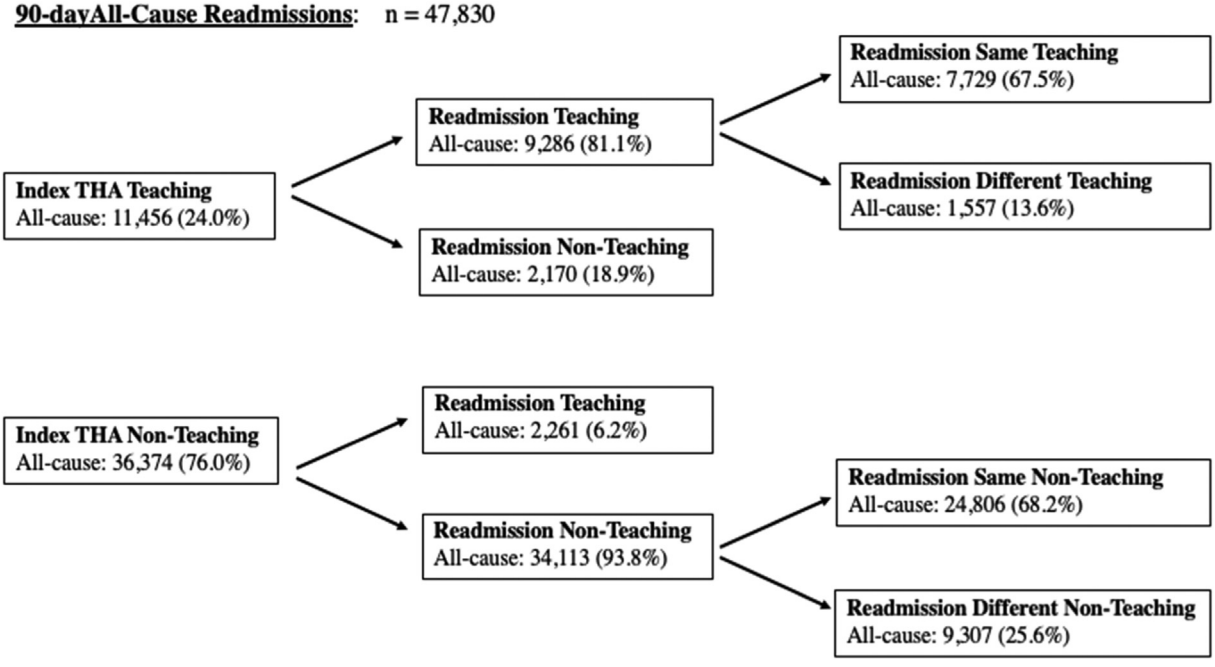

Figure 1. Total 90-day all-cause readmissions with distribution based on index hospital location and readmission hospital teaching designation.

Table 2
Chi-square analysis for patient and index hospitalization characteristics, readmission status, and location.

Patient/index hospitalization characteristic	All index admissions	No readmissions (%)	All Readmission(s) to same hospital (%)	At least one readmission to a different hospital (%)	*P* value
Volume	433,959	394,373	26,544	13,042	
Race					**.0008**
White	390,563 (90.00)	355,172 (90.06)	23,866 (89.91)	11,583 (88.81)	
Non-white	43,396 (10.00)	39,201 (9.94)	2678 (10.09)	1459 (11.19)	
Age categories, y					**<.0001**
<65	39,442 (9.09)	34,279 (8.69)	3517 (13.25)	1646 (12.62)	
65-74	245,747 (56.63)	227,389 (57.66)	12,875 (48.50)	5483 (42.04)	
75-84	123,980 (28.57)	111,415 (28.25)	8047 (30.31)	4518 (34.64)	
≥85	24,790 (5.91)	21,290 (5.40)	2105 (7.93)	1395 (10.70)	
Gender					**<.0001**
Male	173,584 (40.00)	157,868 (40.03)	10,596 (39.92)	5472 (41.96)	
Female	260,375 (60.00)	236,505 (59.97)	15,948 (60.08)	7570 (58.04)	
Index hospital length of stay					**<.0001**
LOS ≤ 2 d	282,681 (65.14)	261,745 (66.37)	14,358 (54.09)	6577 (50.43)	
LOS = 3 d	116,605 (26.87)	103,996 (26.37)	8417 (31.71)	4196 (32.17)	
LOS = 4-5 d	26,688 (6.15)	22,637 (5.74)	2567 (9.67)	1499 (11.49)	
LOS > 5 d	7985 (1.84)	5994 (1.52)	1202 (4.53)	770 (5.91)	
Discharge destination after index THA hospitalization					**<.0001**
Home	150,385 (34.65)	139,687 (35.42)	7504 (28.29)	3190 (24.46)	
Home health	183,498 (42.28)	169,096 (42.88)	9947 (37.47)	4455 (34.16)	
Skilled nursing facility	77,962 (17.97)	67,377 (17.08)	7041 (26.52)	3544 (27.17)	
Rehab facility	15,552 (3.58)	13,013 (3.30)	1555 (5.86)	954 (7.31)	
LTC & other	6592 (1.52)	5200 (1.32)	493 (1.86)	899 (6.89)	
Comorbidities					**<.0001**
≤2 comorbidities	115,651 (26.65)	107,874 (27.35)	5517 (20.78)	2260 (17.33)	
3-4 comorbidities	161,267 (37.16)	148,199 (37.58)	8949 (33.71)	4119 (31.58)	
5-6 comorbidities	93,974 (21.66)	84,242 (21.36)	6379 (24.03)	3353 (25.71)	
≥7 comorbidities	63,067 (14.53)	54,058 (13.71)	5699 (21.47)	3310 (25.38)	

LOS, length of stay; LTC, long-term care.
P value represents comparison between patients with all readmissions to the same hospital to patients with at least one readmission to a different hospital.
Bold text indicates $P < .01$.

0.757 − 0.822), while prior TKA was associated with increased odds of readmission within 90 days (OR 1.172, CI 1.121 − 1.225).

Discussion

Given the projected increase in primary THA procedures over the next decades, as well as increased emphasis on resource utilization and value in joint arthroplasty, understanding the rate and distribution of readmissions in the postoperative period has important clinical and policy-related implications [3,10,18,19]. Classically academic institutions have been associated with increased costs, and while the difference has been reportedly modest once adjusted for severity or complexity of care, the discrepancy in costs remains [20-24]. Considering the anticipated increase in primary THA procedures and, therefore, increased potential for postoperative complications requiring readmission, patterns of postoperative readmission based on hospital teaching status may have meaningful consequences for individual hospital and overall expenditures [3,12,13]. Given paucity of prior work in this area specifically with respect to arthroplasty, the present work sought to improve our understanding of location of resource utilization in the postoperative period in an attempt to improve value related to primary THA.

In this study, analysis controlling for patient and index hospitalization characteristics did not find an association between readmission within 90 days and teaching status of the index hospital at which a patient underwent primary THA (OR 0.98, CI 0.948 − 1.012, Table 3). For those with an index THA at a nonteaching hospital or a teaching hospital, there was no significant difference in likelihood of *all* readmissions to the same index hospital (67.36% nonteaching compared to 66.08% teaching, $P = .0216$). In addition, while most patients return to the same institution, >30% readmissions were to a different hospital than where the primary procedure was performed demonstrating potential for burden of readmissions to be distributed disproportionately among hospitals.

While prior work has assessed causes and risk factors for readmission with a focus on patient factors, to our knowledge, fewer have assessed the impact of hospital factors on distribution and rates of readmission [10,13,25-27]. The present study demonstrates that for both teaching and nonteaching hospitals, the percent of MBs

Table 3
Estimated odds ratios and 99% conference interval for patient and index hospitalization characteristics.

Patient/index hospitalization characteristic	Any 90-d readmission	
	Odds ratio	Confidence interval
Index teaching (nonteaching reference)	0.98	0.947 − 1.011
Race		
Non-white (white reference)	0.952	0.908 − 0.998
Age Categories, y		
<65 (reference)		
65-74	0.658	0.629 − 0.689
75-84	0.778	0.740 − 0.818
≥85	0.948	0.886 − 1.014
Gender		
Male (female reference)	1.056	1.025 − 1.088
Index hospital length of stay		
LOS ≤ 2 d	Reference	
LOS = 3 d	1.056	1.016 − 1.097
LOS = 4-5 d	1.387	1.314 − 1.463
LOS > 5 d	2.038	1.887 − 2.201
Discharge destination after index THA hospitalization		
Home	Reference	
Home health	1.062	1.026 − 1.100
Skilled nursing facility	1.784	1.670 − 1.906
Rehab facility	1.489	1.420 − 1.560
Long-term care facility	1.504	1.137 − 1.989
Other destinations	2.771	2.531 − 3.033

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Table 4
Estimated odds ratios and 95% conference interval for patient baseline comorbidities.

Comorbidities	Odds ratio	Confidence interval
Obesity	1.113	1.074 – 1.154
Diabetes	1.073	1.034 – 1.113
Depression	1.227	1.181 – 1.274
History smoking	0.982	0.951 – 1.013
Hypertension	1.085	1.051 – 1.121
CIHD	1.179	1.121 – 1.239
History of MI	1.021	0.952 – 1.094
Valvular heart disease	1.021	0.954 – 1.094
CHF	1.374	1.293 – 1.4360
Atrial fibrillation POA	1.227	1.154 – 1.304
COPD	1.428	1.369 – 1.490
Prior revascularization procedure	1.082	1.018 – 1.149
Prior CVA	1.188	1.120 – 1.260
Prior VTE	1.217	1.149 – 1.289
Prior TKA	1.172	1.121 – 1.225
Prior THA	0.789	0.757 – 0.822
Sleep apnea	1.019	0.979 – 1.061
Rheumatoid	1.219	1.139 – 1.306
Osteoarthritis	0.678	0.624 – 0.737
Anemia POA	1.260	1.200 – 1.322
Mild CKD	1.045	0.909 – 1.201
Moderate CKD	1.159	1.092 – 1.230
Severe CKD	1.503	1.281 – 1.763
Dialysis-dependent POA	2.280	1.928 – 2.696
LT aspirin use	0.929	0.896 – 0.964
LT anticoagulation use	1.110	1.052 – 1.171
Osteoporosis	1.059	1.000 – 1.121

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CHF, congestive heart failure; CIHD, chronic ischemic heart disease; CKD, chronic kidney disease; CVA, cerebrovascular accident; MI, myocardial infarction; LT, long-term; POA, present on arrival; VTE, venous thromboembolism.

with all readmissions to the same institution was similar (67.5% for index teaching compared to 68.2% with index nonteaching). However, for MBs who require readmission within 90 days but are not readmitted to the same hospital in which their index procedure was performed, a higher percentage of those with index procedure at a teaching hospital crossed-over to be readmitted at a nonteaching hospital than vice versa (18.9% vs 6.2%). This pattern is consistent with MBs scheduling an elective THA procedure at a teaching hospital, but subsequently presenting to a different hospital for emergent readmissions, such as AMI, pulmonary embolus, pneumonia, or sepsis. We suspect geographic factors such as the relative decreased density of academic compared to nonacademic centers in many areas may impact MBs' willingness to present to an academic hospital. In addition, geographic proximity and telehealth or emergency medical service systems may play a role in patient readmissions although there is limited prior work on this topic [28,29].

The findings in this study with respect to readmission hospital teaching status and distribution align with limited available prior work. Chen et al. in 2019 analyzed readmission data from California Office of Statewide Health Planning and Development database from 1995 to 2010 [8]. This study reported 84.6% of patients who underwent index treatment at an academic center were readmitted to an academic hospital, which is similar to the 81.1% of patients in the present study who had an index THA at a teaching institution and were readmitted to a teaching institution. Similarly, they report 95.5% of those treated at nonacademic centers were readmitted to nonacademic centers, comparable to the 93.8% of patient with the same pattern in our study. While not the focus of this study, the presumed acuity of postoperative complications likely influences the location at which a patient is readmitted, and MBs may be less willing to travel for readmissions than patients with employer-based insurance with narrower networks.

The present work also assessed index hospitalization characteristics with increased odds of readmission in the time period. Increased odds of readmission within 90 days was noted for initial discharge to any destination other than home (Table 3). Fu et al. evaluated discharge to inpatient facilities after THA and found overall increased odds of postdischarge morbidity as well as readmission, even after controlling for predischarge patient characteristics via propensity score adjustment [30]. These findings have important implications for medical system and reimbursement programs as discharge to inpatient and other care facilities increases costs, but does not appear to be protective against readmission within 90 days. Similarly, decreased LOS was not associated with increased odds of readmission in the time period, which supports prior findings reported by Vorhies et al. who found no significant change in 30-day readmission rate with trend of decreasing length from 2002 to 2007 [31].

The present study has several limitations including those inherent to using the CMS IPSAF linked data which cannot necessarily be applied across other patient populations. As several of the CMS definitions are limited to 30-day outcomes, we applied the procedure codes for these definitions but expanded all searches to 90 days to more comprehensively assess 90-day surgical readmissions. Given our choice of primary index THA hospitalization and each readmission as the unit of analysis, each patient may represent multiple readmissions within the 90-day time period. Given the large database nature of the study which relies on medical coding, there is possibility for varied practices of hospital diagnosis coding. While we used the primary diagnosis associated with each readmission, which by definition is related to the primary treatment performed, it is possible that the readmissions identified may not have been directly related to the THA procedure. In addition, the present work used the CMS definition for primary THA hospitalization and, therefore, excluded those with a hip fracture or periprosthetic facture. We suspect patients who undergo elective surgery for osteoarthritis presumably have increased time to consider location of index procedure, compared to those who have a traumatic fracture, and therefore, may be more likely to seek readmission to the same index institution regardless of teaching status. Similarly, the present study did not include patients in whom the index procedure was an outpatient THA, and therefore, further work would be needed to determine if there are differences in readmission patterns for these patients. For the present analysis, we also used the Council of Teaching Hospitals and Health Systems to assign teaching status [17]. Although accepted as a comprehensive list of teaching hospitals, it is possible that it may have not captured all academic institutions [2,17,32,33]. Finally, the present study focused on hospital teaching status, but did not assess other potential hospital characteristics such as size or case volume which may influence readmission patterns [34].

Conclusions

Overall, this work assessed the impact of index hospital teaching status as well as patient comorbidities on 90-day readmissions after THA, an area of important research given potential for varied expenditures related to a hospital's teaching status and the critical role academic hospitals play within the health-care system. While most patients return to the same institution, >30% of readmissions were to a different hospital than where the primary THA was performed demonstrating potential for burden of readmissions to be distributed disproportionately among certain hospitals. Analysis controlling for patient and index hospitalization characteristics did not find an association between readmission within 90 days and teaching status of the index hospital at which a patient underwent primary THA. Additional work is necessary to assess potential hospital or patient characteristics that influence the distribution of readmissions after the primary THA.

Conflicts of interest

D. S. Jevsevar has stock or stock options in Risalto Healthcare, received research support from DePuy Synthes, and is the Biologics and Technology Committee Chair for AAOS Devices, is in the AAOS Registry Oversight Committee, and is Co-chair of AAHKS EBPC.

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