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Hospital, Patient, and Clinical Factors Influence 30- and 90-Day Readmission After Primary Total Hip Arthroplasty

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ABSTRACT

Background: The purpose of this study was to analyze the hospital, clinical, and patient factors associated with inpatient readmission after total hip arthroplasty (THA) in the Medicare population and to understand the primary reasons for readmission.

Methods: The Medicare 100% national hospital claims database was used to identify 442,333 older patients (65+) with a primary THA in 3730 hospitals between 2010 and 2013. A multilevel logistic regression analysis with a clustered data structure was used to investigate the risk of all-cause 30- and 90-day readmission, incorporating hospital, clinical, and patient factors.

Results: At 30 days, 5.8% (median) of the patients were readmitted, whereas at 90 days, 10.5% (median) were readmitted. Geographic census region, hospital procedure volume, and nonprofit ownership were the only significant hospital factors among those we studied. Overall, clinical factors explained more of the variation in readmission rates than general hospital factors. Use of a perioperative transfusion was associated with 14% greater risk, patients discharged to home had 28% lower risk, and surgeon volume and length of stay were also significant risk factors. The top 5 most frequently reported primary reasons for 30-day readmission in THA were procedure related: dislocation (5.9%), deep infection (5.1%), wound infection (4.8%), periprosthetic fracture (4.4%), or hematoma (3.4%).

Conclusion: These findings support further optimization of the delivery of care—both intraoperative and postoperative—to reduce the broad variation in hospital readmissions.

Galvanized by the Affordable Care and Patient Protection Act of 2010, health care reform in the United States is resulting in disruptive changes to the reimbursement of orthopedic surgery [1-3]. The traditional fee-for-service paradigm is changing into an episode of care model in which affiliated health care providers coordinate services into a single payment bundle, covering up to 90 days after discharge from the hospital [4]. In theory, patient-centered coordination of care is thought to provide incentives for stakeholders to provide the optimal care at a reduced, sustainable cost. In practice, the success of a bundled care model, from both patient and societal perspectives, is predicated on assuring that quality of care is not sacrificed to simply achieve lower costs and maximize profit for provider stakeholder(s) in control of a patient's payment bundle [1-3].

To achieve these quality goals, the Centers for Medicare and Medicaid Services (CMS) has recently introduced a series of hospital quality measures or benchmarks specifically for total joint arthroplasty [5]. One such hospital quality benchmark, known as

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Each author certifies that all investigations were conducted in conformity with ethical principles of research. This work was performed at Exponent, Inc, Philadelphia, PA.

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Table 1
Centers for Medicare and Medicaid Services Limited Data Set Inpatient Data 2010-2013: Patients Undergoing THA and Rehospitalized (All Cause) in 30 or 90 Days and Demographic Profile and Hospital Characteristics of Primary and Readmitted Patients.

Effect	Level	THA	Readmit 30 Days	Readmit 90 Days	THA (%)	Readmit 30 Days (%)	Readmit 90 Days (%)
	Total	442,333	26,076	45,242	100.0	100.0	100.0
Age	65-69	123,690	5195	9046	28.0	19.9	20.0
	70-74	116,075	5797	9978	26.2	22.2	22.1
	75-79	96,250	5908	10,243	21.8	22.7	22.6
	80-84	68,244	5272	9122	15.4	20.2	20.2
	85+	38,074	3904	6853	8.6	15.0	15.1
CCI	00	243,948	10,752	18,093	55.2	41.2	40.0
	1-2	156,320	10,500	18,310	35.3	40.3	40.5
	3-4	32,600	3341	6050	7.4	12.8	13.4
	5+	9465	1483	2789	2.1	5.7	6.2
Discharge type	Home	77,158	2842	4716	17.4	10.9	10.4
	Home with HHS	146,499	5671	9692	33.1	21.7	21.4
	Other facility	5452	1384	1687	1.2	5.3	3.7
	Rehab facility	51,212	4251	7688	11.6	16.3	17.0
	SNF	162,012	11,928	21,459	36.6	45.7	47.4
Hospital annual TJA volume	001-149	87,287	6102	10,330	19.7	23.4	22.8
	150-299	125,084	7546	13,122	28.3	28.9	29.0
	300-449	83,086	4651	8125	18.8	17.8	18.0
	450-599	53,996	2967	5251	12.2	11.4	11.6
	600+	92,880	4810	8414	21.0	18.4	18.6
Hospital beds	001-149	94,096	5570	9261	21.3	21.4	20.5
	150-299	123,386	7288	12,695	27.9	27.9	28.1
	300-499	114,551	6774	11,882	25.9	26.0	26.3
	500+	110,300	6444	11,404	24.9	24.7	25.2
Hospital ownership	Nonprofit	68,775	4382	7444	15.5	16.8	16.5
	Private	327,524	19,013	33,138	74.0	72.9	73.2
	Public	46,033	2680	4659	10.4	10.3	10.3
	Unknown	1	1	1	0.0	0.0	0.0
Hospital setting	Rural	53,996	3369	5789	12.2	12.9	12.8
	Urban	388,337	22,707	39,453	87.8	87.1	87.2
Hospital stay	1-2	87,078	3303	5344	19.7	12.7	11.8
	3-4	299,757	16,008	28,029	67.8	61.4	62.0
	5+	55,498	6765	11,869	12.5	25.9	26.2
Hospital teaching	No	302,226	17,792	30,803	68.3	68.2	68.1
	Yes	140,107	8284	14,439	31.7	31.8	31.9
Race	Black	19,890	1311	2282	4.5	5.0	5.0
	Other/unknown	8807	494	858	2.0	1.9	1.9
	White	413,636	24,271	42,102	93.5	93.1	93.1
Resident region	Midwest	119,193	7094	12,196	26.9	27.2	27.0
	Northeast	82,893	5078	8645	18.7	19.5	19.1
	South	156,097	9802	17,209	35.3	37.6	38.0
	West	84,150	4102	7192	19.0	15.7	15.9
Gender	Female	276,478	15,893	28,170	62.5	60.9	62.3
	Male	165,855	10,183	17,072	37.5	39.1	37.7

THA, total hip arthroplasty; TJA, total joint arthroplasty; CCI, Charlson Comorbidity Index; HHS, home health service; SNF, skilled nursing facility.

30-day, all-cause risk-standardized readmission, is compiled for each hospital relative to a national average and reported publicly on the Internet (https://www.medicare.gov/hospitalcompare/search.html). Thus, prospective patients can consider this information when deciding where to have their surgery performed. Furthermore, hospitals that are found by CMS to have "excess" 30-day readmission rates can be financially penalized by retrospectively having up to 3% of their payments withheld or "clawed back" [6]. Although 30-day readmission rates are considered to be a hospital quality measure, 90-day readmissions are equally relevant as the maximum window for an episode of care, during which the stakeholders in the payment bundle are liable for all of the costs associated with patient treatment, regardless of whether or not the reason for readmission is related to the index orthopedic surgery [1-3]. Thus, both hospital and bundled care providers currently have both concerns and explicit incentives to minimize 30- and 90-day readmissions risks.

In light of these developments, recent research has been focused on the factors associated with hospital readmissions after THA [6-12]. Previous studies have examined patient factors and clinical factors associated with readmission in a single institution [6-12]. Comparatively few studies have examined THA readmission across multiple institutions [10,11,13,14], and little is known about the role of hospital factors and how they influence the overall risk of readmission after primary THA.

To add to the knowledge base on 30- and 90-day readmissions after THA, we studied the hospital as the unit of analysis and asked the following research questions for the Medicare population of primary THA patients: (1) Which hospital factors influence 30- and 90-day readmissions after primary THA? (2) Which clinical factors influence 30- and 90-day readmissions? (3) What are the principal reasons for 30- and 90-day hospital readmissions and are they procedure related?

Materials and Methods

This study is based on analysis of the 100% Medicare inpatient limited data set (LDS), from which we identified 442,333 patients (65+ years old) who received a primary THA between 2010 and 2013 (Table 1). The LDS files contain conventional fee-for-service claims submitted to CMS for payment, and in recent years, 12-13 million claims for hospital services are processed annually by CMS.

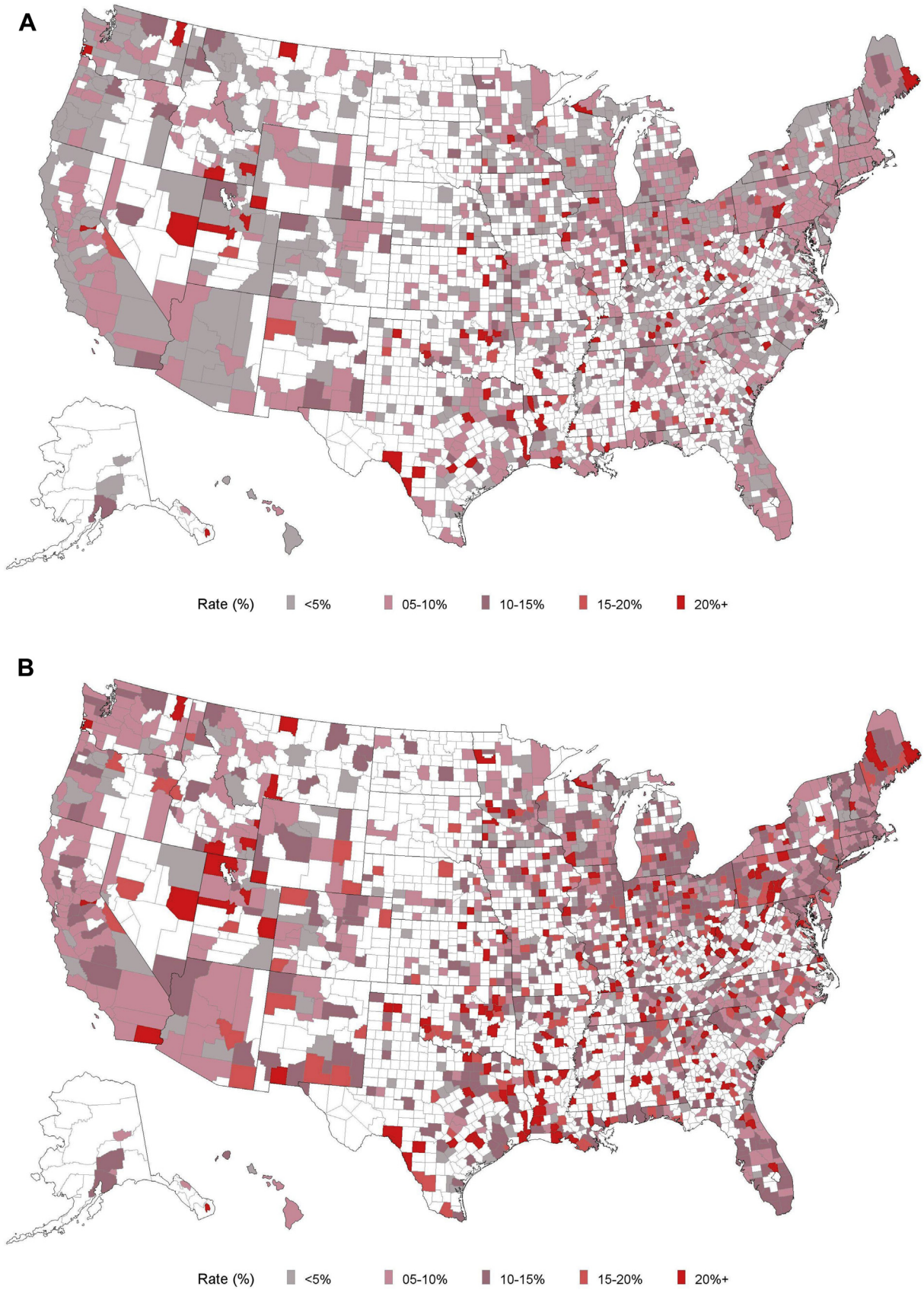

Fig. 1. Geographic variation in (A) 30- and (B) 90-day all-cause hospital readmission after total hip arthroplasty by state and county in the 100% Medicare data set (2010-2013).

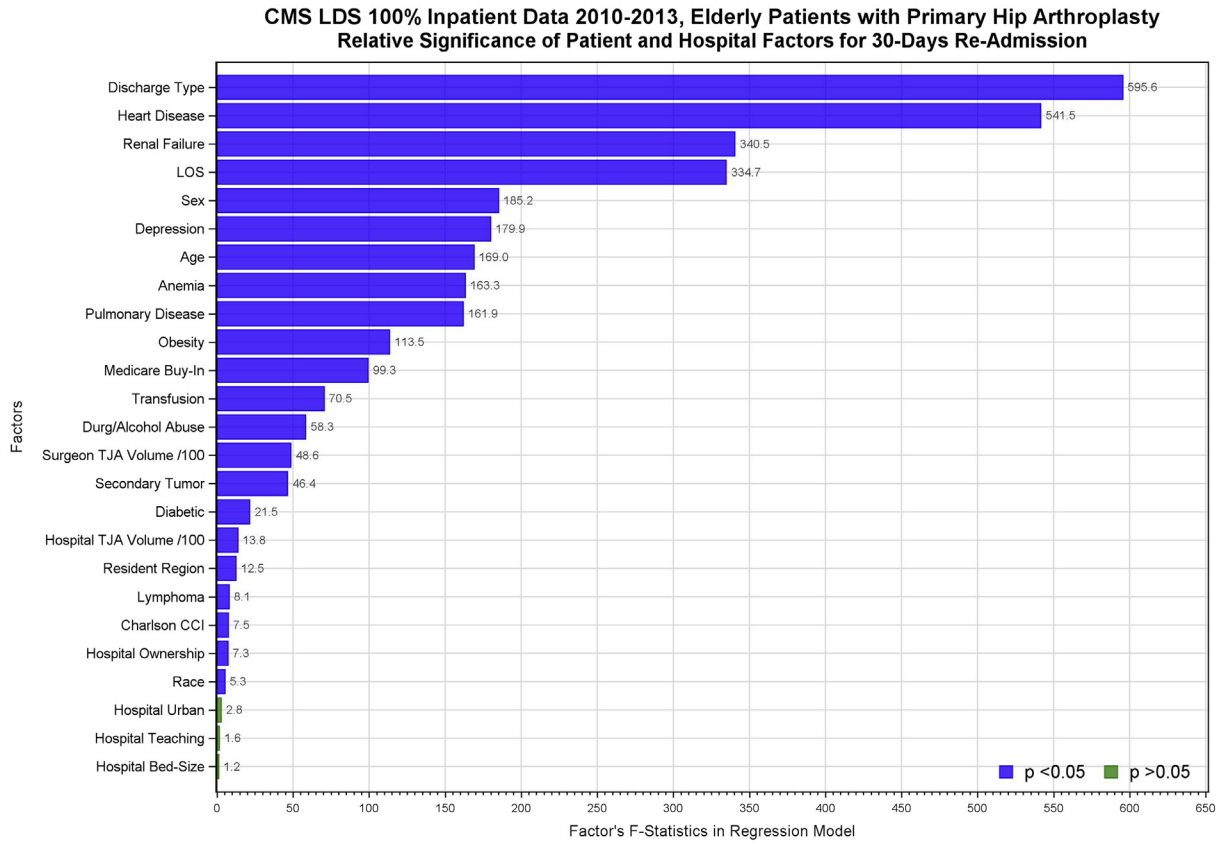

Fig. 2. Relative significance of patient, hospital, and clinical factors for 30-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013), based on the *F* statistics of fixed-effect model. TJA, total joint arthroplasty; CCI, Charlson Comorbidity Index; LOS, length of stay; CMS, Centers for Medicare and Medicaid Services; LDS, limited data set.

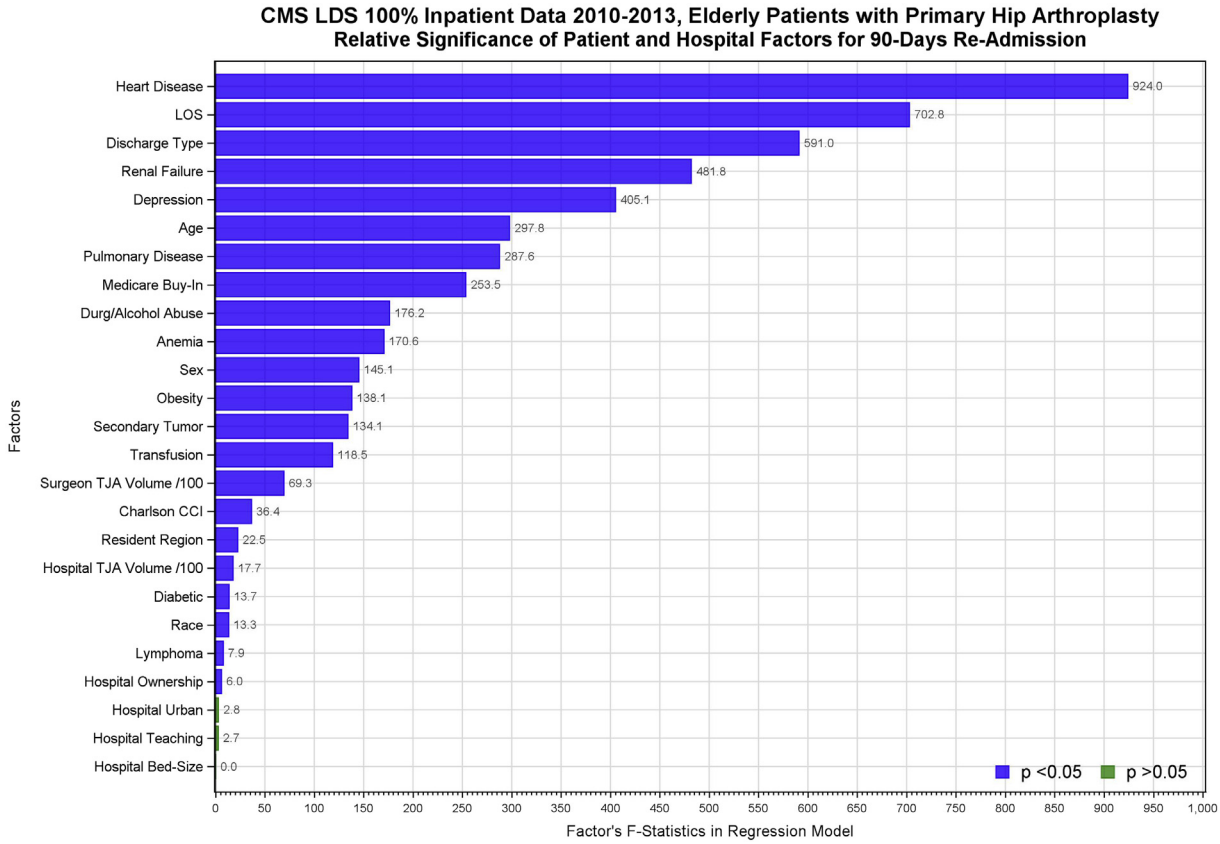

Fig. 3. Relative significance of patient, hospital, and clinical factors for 90-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013), based on the *F* statistics of fixed-effect model.

In 2010-2013, approximately 20%-25% of Medicare beneficiaries received their care through a Medicare-approved HMO under the Medicare Advantage program. Records of hospital care through a Medicare Health Maintenance Organization (HMO) are not submitted to CMS and not part of the LDS data file. The LDS data capture the vast majority of patients in the Medicare program and are broadly representatively of the hospital experience of patients who receive THA in the US. A unique, encrypted beneficiary ID is used to identify an initial THA admission and any subsequent readmission across multiple years in the data set for each beneficiary in the LDS data. Hospitals are uniquely identified by a non-encrypted provider ID in the data set; helping incorporation of hospital characteristics in the present study. Because the Medicare is a nationwide program, patients need not return to the same hospital as their initial THA to be tracked and identified, an advantage over many institution-based studies where out-of-system re-admission cannot be tracked.

Primary THA procedures were identified using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) code 81.51. During the study period, claims data were submitted by 3730 hospitals to Medicare for THA. Hospital and surgeon volume estimates were limited to the Medicare population and, as a proxy for experience, were assumed to correlate with the overall volume of the hospital or of the surgeon. Patients aged <65 years, enrolled in an HMO, or residing outside the 50 US states were excluded in this analysis. To evaluate preoperative factors, including comorbidities, hospital volume, and surgeon volume, we used the patient claims history for 1 year before their index THA as a "look-back period." For those patients who received their primary THA in 2010, we used the 100% inpatient data from 2009 for the look-back period. Patients were tracked longitudinally for 30 and 90 days after their primary THA procedure. Patients who died within the 30-day or 90-day period without encountering readmission were excluded because they did not have the opportunity to be readmitted. We determined readmission as the appearance of new hospital claims record for the patient within 30 or 90 days of the patient's discharge date. Patients who returned to the hospital only for rehabilitation service (ICD-9-CM: V57.x) and not associated with complications or other medical issues were not included.

We used a multilevel logistic regression analysis with a clustered data structure, in which the hospital was considered the "cluster" or top-level unit of analysis. The model incorporated a "multilevel" approach, including individual level factors (eg, age, gender, comorbidity) and group level (hospital) factors (eg, bed size, type of hospital) in the same model. By using a "clustered" approach, patients were grouped or clustered by the hospital in which they were treated. Thus, we accounted for those who were treated in the same hospital and shared a common institutional-level risk of readmission, above and beyond their personal risk factors. These clustered records were captured as a hospital random effect (ie, a random intercept) for each hospital, and the additional risk factors were added to the overall hospital level.

We studied the hospital geographic location (rural or urban), bed size, type of hospital (eg, profit vs nonprofit, teaching vs nonteaching) as hospital factors, and length of stay (LOS), discharge status (home vs skilled nursing facility [SNF]), and use of transfusion as clinical factors. We included the following individual patient factors: age, gender, race, census region, Medicare buy-in status (a proxy for socioeconomic status), Charlson Comorbidity Score, and the presence of one or more specific comorbidities including anemia, depression, diabetes, drug/alcohol abuse, heart failure, lymphoma, obesity, pulmonary condition, renal disease, and/or the diagnosis of a secondary tumor.

Statistical analyses were performed using the SAS statistical software, release 9.4 (Cary, NC). The results were considered significant for statistical tests with $P < .05$. For many factors with the same significant P value (eg, <.0001), we examined, additionally, the type III tests of fixed effect as measured by the F statistics, as an indicator for the relative importance of these hospital and patient factors on 30-day or 90-day readmissions. The type III F statistics of a particular factor measure the additional reduction in the error variance after all the other factors had been included. It thus reflects the factor's independent contribution toward accounting for the variations in the dependent variable.

Results

We observed a wide variation in hospital readmission 30 days after THA (interquartile range: 3.4%-9.1%, mean ± standard deviation: 7.5% ± 9.6%, median: 5.8%), as well as 90 days after THA (interquartile range: 7.3%-14.7%, mean ± standard deviation: 12.7% ± 12.2%, median: 10.5%). This interhospital variation was significantly based on their geography (Fig. 1). Patients in the western states had the lowest readmission rates of 4.9% at 30 days and 8.5% at 90 days. Other census regions had 30-day readmission rate at 6.0%-6.3% and 90-day rates at 10.2%-11.0%. Relative to the West, these rates were 10%-16% (30 days) and 7%-18% (90 days) higher, after adjusting for other factors ($P < .0001$, Fig. 2). Besides geography, hospital procedure volume ($P < .0001$) and nonprofit ownership (compared with public hospital odds ratio: 1.10, $P < .0001$) were the only significant hospital factors among those we studied. Significant effects associated with hospital volume and nonprofit ownership hospital factors and 90-day readmission were also observed (Fig. 3). Hospital's teaching status, urban/rural location, and size of hospital had no measurable association with readmission risk.

Overall, patients' clinical factors had a much stronger association with the risk of readmission than general hospital factors, based on the relative values in the F statistics for each variable (Figs. 2 and 3). Patients who required blood transfusion during the primary surgery were associated with 14% greater risk ($P < .0001$); each additional surgeon volume of 100 procedures had 7% reduction in risk ($P < .0001$); patients discharged to home had 28% less risk than those discharged to another institution such as an SNF ($P < .0001$); and LOS of 1-2 or 3-4 days was associated with ≥30% reduction in risk of readmission, compared with patients requiring 5+ days of hospital stay ($P < .0001$). Based on the F statistics, these effect sizes were at least comparable to other equally significant but fixed patient factors, such as age, gender, comorbidities, and socioeconomic status (Figs. 2 and 3).

The top 5 most frequently reported primary reasons for 30-day readmission in THA were procedure related (Fig. 4): dislocation (5.9%), deep infection (5.1%), wound infection (4.8%), periprosthetic fracture (4.4%), or hematoma (3.4%). The top 5 reasons for 90-day readmission were the same as those at 30 days (Fig. 5). The top 5 most commonly reported primary procedures during readmission before 30 days were transfusion of packed cells (10.8%), revision of femoral component (7.9%), closed reduction for dislocation of the hip (4.8%), revision of acetabular and femoral components (4.4%), and open reduction of fracture with internal fixation (3.5%; Fig. 6). The top 5 most commonly reported primary procedures during readmission before 90 days were the same as those at 30 days (Fig. 7).

Discussion

Hospital readmission after THA is a controversial topic because of its implications for quality of care, hospital reimbursement, and bundled payments. We studied the factors relating to 30- and 90-day readmissions after primary THA by analyzing the 100% Medicare data set, which captures the outcomes for almost a half

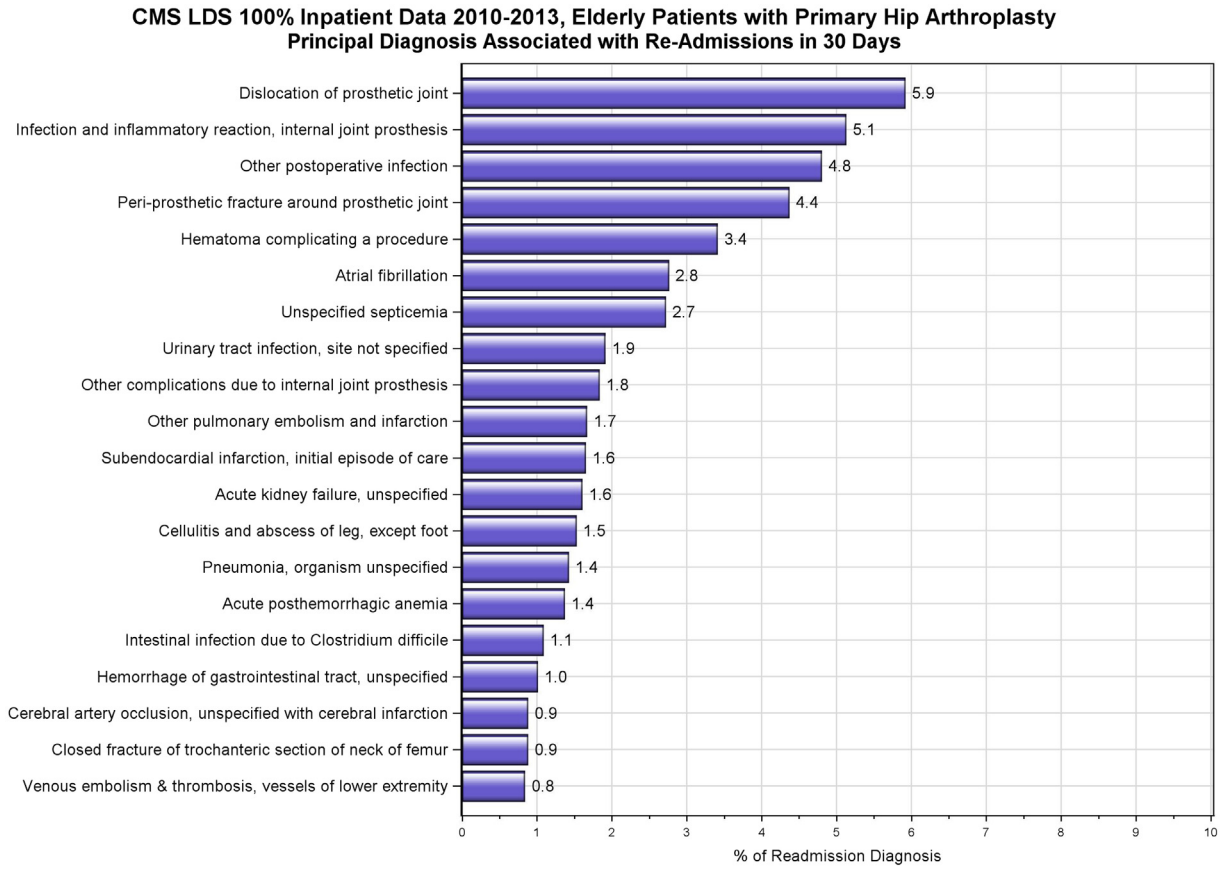

Fig. 4. Principal diagnosis associated with 30-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013).

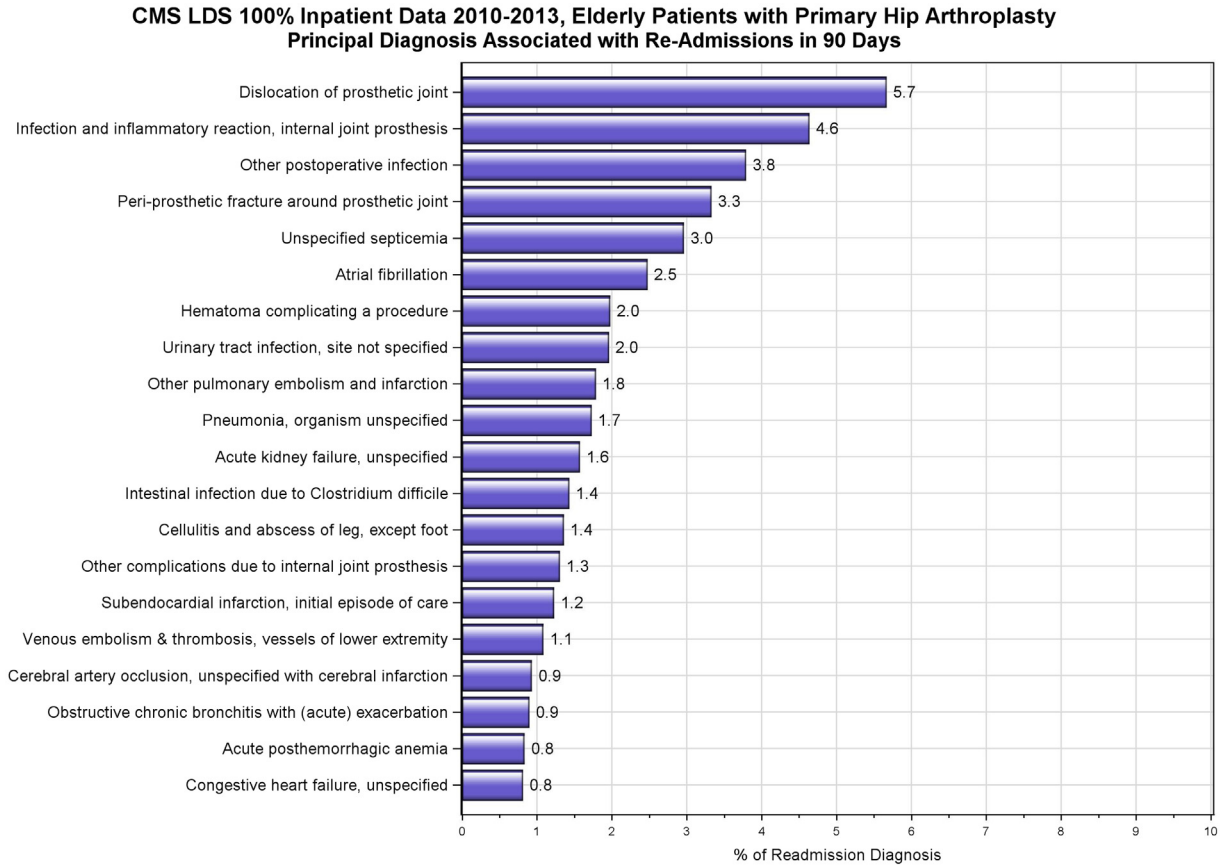

Fig. 5. Principal diagnosis associated with 90-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013).

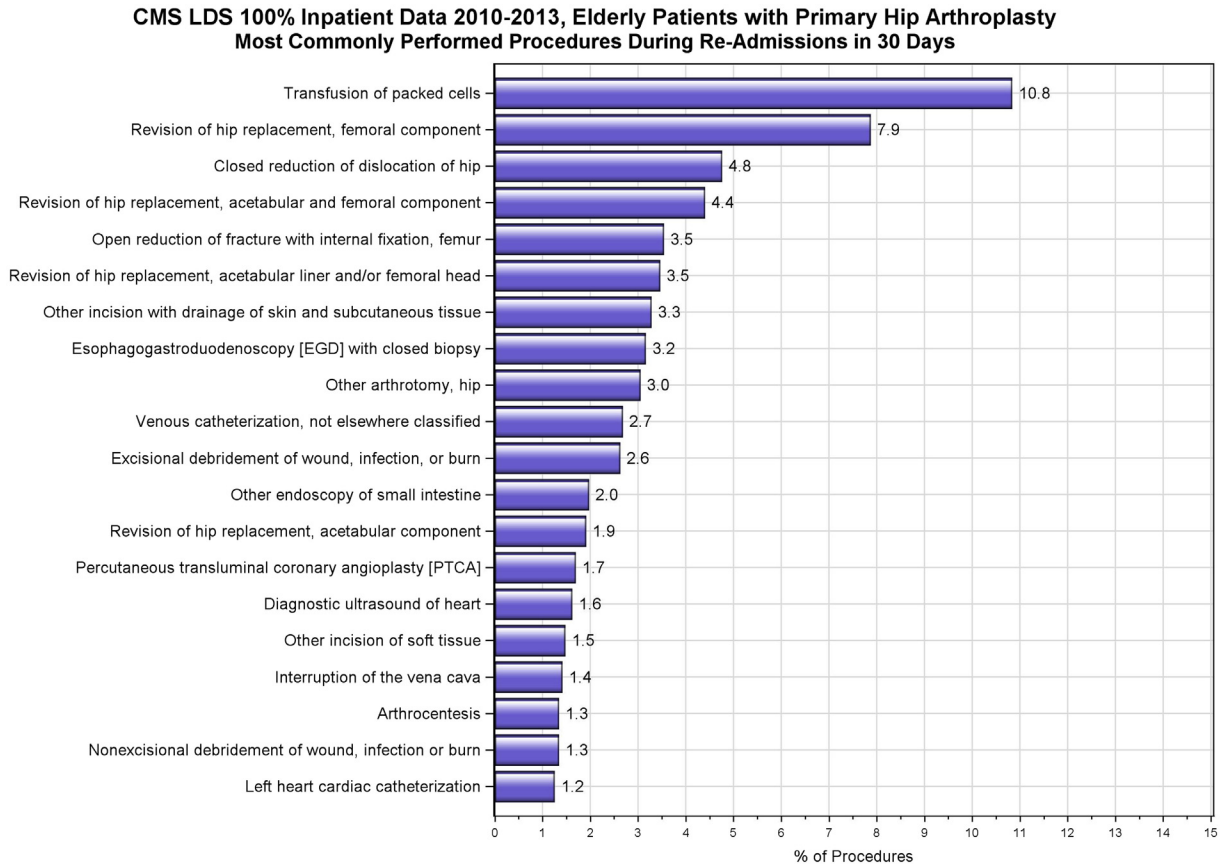

Fig. 6. Most commonly performed procedures during 30-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013).

million patients with essentially 100% follow-up. Our results suggest that procedure-related factors and hospital factors have a role in readmission risk. We also found that dislocation, periprosthetic fracture, and infection were among the most frequently reported reasons for readmission.

Our work is limited to administrative data, albeit the same data used by used by CMS for establishing national quality measures and benchmarks for THA [5]. The reasons for readmission were based on ICD-9-CM diagnosis codes, which may be difficult to unambiguously link to the quality of the index procedure without additional clinical information. For example, without the details of why a patient had a dislocation or a periprosthetic fracture, these complications could reflect a problem with discharge disposition, as they may not have been safe for home and fell at home, or the rehabilitation facility was not attentive and they fell at that location. Under such circumstances, a periprosthetic fracture would not necessarily reflect on the quality of operative procedure, assuming the operative X-rays indicated the device was properly placed without malposition of the components. These ambiguities in diagnosis precluded us from broadly categorizing reasons for readmission at the present time. Our present findings are also limited to the time frame between 2010 and 2013 and may be influenced by changes in readmission rates over time, especially in response to changes in reimbursement policy.

We are aware of one other study examining hospital factors and 30-day readmission after primary THA [9], limiting our ability to make comparisons with the literature. Consistent with previous research [9], we found that hospital procedure volume had an inverse effect on 30- and 90-day readmissions. We also found that nonprofit ownership was inversely related to readmission risk, which was not discussed in a previous study [9]. Surprisingly, the geographic location of a hospital is an independent risk factor. Hospitals located in the western states exhibited significantly lower readmission rates for THA compared with other regions of the United States. The reasons underlying this geographic disparity between hospitals remain unclear at this time.

Clinical factors that we found to be associated with the risk of readmission include blood transfusion, LOS of $\geq$5 days, and discharge to an SNF. Earlier work conducted at a single center also identified these risk factors [8]. Previous studies have further emphasized the patient-related factors such as comorbidities that play a major role in readmission after surgery [6,8,9,15]. To reduce risk of readmission, perhaps patients with increased potential for postoperative transfusions could be identified during pretesting and managed appropriately. For example, perioperative tranexamic acid and different strategies for deep venous thrombosis prophylaxis are reported to result in reduced requirement for blood transfusions [16,17]. A longer LOS may indicate a patient with a more complicated course of recovery after primary THA [18]. However, if patients and families are made aware of the reduced complication rate associated with a shorter LOS and home discharge, they may be able to modify routines and allow family members to convalesce at home. In addition to patient factors during and after surgery, our analysis of presurgical medical treatments showed that preoperative medical screening for heart disease and renal failure was a strong indicator for increased readmission at 30 and 90 days after surgery. If such findings are confirmed, it may be that there is a subset of patients whose presurgical screening may show that they are too “high risk” to be part of a bundled payment approach to THA.

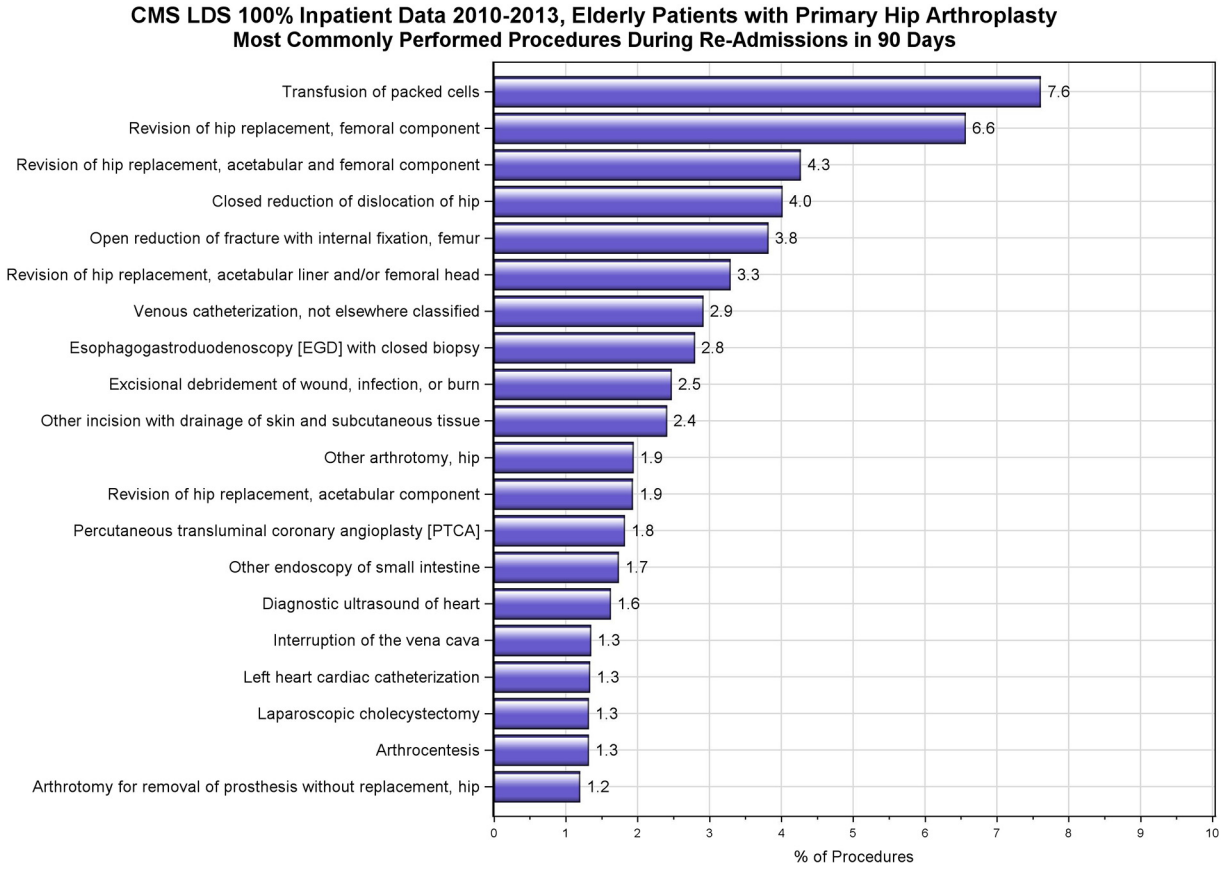

Fig. 7. Most commonly performed procedures during 90-day readmission after total hip arthroplasty in the 100% Medicare data set (2010-2013).

In common with previous work [15], we found infection to be a major reason for readmission. We showed deep infection and wound infection together accounted for 9.9% readmission at 30 days. At 90 days, the readmission rate for all causes of infection was 11.4%. These are numbers of real concern. Further study is needed to determine whether hospital factors such as presurgical screening and treatment can ameliorate infection or whether increased risk of infection is associated with patient factors such as diabetes and obesity or indeed with length of surgery and the more time-consuming technique that may be required with "new" surgical procedures.

In summary, as hospital systems institute bundled payment arrangements, the administration, the physicians, and the payers involved will need to closely monitor the root causes of complications associated with THA and attempt to reduce the rate of 30- and 90-day readmissions. The facility and its physicians will be financially obligated to care for its readmitted patients, and establishments with persistently high readmission rates may need to reevaluate the future of their elective arthroplasty programs. We expect that health care reform will increasingly align the interests of the hospital and surgeon to address the factors influencing readmission after THA. In light of the impressive variability we observed among hospitals across the United States, the results of our study suggest that there may be several different strategies for reducing readmission by optimizing clinical pathways. Previous studies suggest that readmissions are often attributable to patient factors and medical-related causes unrelated to surgery [6,8,9,15]. Our analyses of Medicare data further suggest that the top 5 reasons for 30 and 90-day readmissions may be related directly to the procedure itself. These findings support further optimization of the delivery of care for total hip arthroplasty, from the preoperative to intraoperative to postoperative treatment plan, so that the morbidity and costs of hospital readmissions may be reduced in the future.

References

1. Froimson MI, Rana A, White Jr RE, et al. Bundled payments for care improvement initiative: the next evolution of payment formulations: AAHKS Bundled Payment Task Force. J Arthroplasty 2013;28(8 Suppl):157.
2. McIntyre LF. Exploring new practice models delivering orthopedic care: can we significantly decrease delivery costs and improve quality? Sports Med Arthrosc Rev 2013;21(3):152.
3. Bozic KJ, Ward L, Vail TP, et al. Bundled payments in total joint arthroplasty: targeting opportunities for quality improvement and cost reduction. Clin Orthop Relat Res 2014;472(1):188.
4. Callahan CD, Adair D, Bozic KJ, et al. Orthopaedic surgery under national health reform: an analysis of power, process, adaptation, and leadership: AOA Critical Issues. J Bone Joint Surg Am 2014;96(13):e111.
5. Bozic KJ, Grosso LM, Lin Z, et al. Variation in hospital-level risk-standardized complication rates following elective primary total hip and knee arthroplasty. J Bone Joint Surg Am 2014;96(8):640.
6. Keeney JA, Nam D, Johnson SR, et al. The Impact of risk reduction Initiatives on Readmission: THA and TKA readmission rates. J Arthroplasty 2015;30(12):2057.
7. Avram V, Petruccelli D, Winemaker M, et al. Total joint arthroplasty readmission rates and reasons for 30-day hospital readmission. J Arthroplasty 2014;29(3):465.
8. Mesko NW, Bachmann KR, Kovacevic D, et al. Thirty-day readmission following total hip and knee arthroplasty—a preliminary single institution predictive model. J Arthroplasty 2014;29(8):1532.
9. Paxton EW, Inacio MC, Singh JA, et al. Are there modifiable risk factors for hospital readmission after total hip arthroplasty in a US healthcare system? Clin Orthop Relat Res 2015;473(11):3446.
10. Pugely AJ, Callaghan JJ, Martin CT, et al. Incidence of and risk factors for 30-day readmission following elective primary total joint arthroplasty: analysis from the ACS-NSQIP. J Arthroplasty 2013;28(9):1499.

11. Raines BT, Ponce BA, Reed RD, et al. Hospital acquired conditions are the strongest predictor for early readmission: an analysis of 26,710 arthroplasties. J Arthroplasty 2015;30(8):1299.
12. Saucedo JM, Marecek GS, Wanke TR, et al. Understanding readmission after primary total hip and knee arthroplasty: who's at risk? J Arthroplasty 2014;29(2):256.
13. Cram P, Lu X, Kates SL, et al. Total knee arthroplasty volume, utilization, and outcomes among Medicare beneficiaries, 1991-2010. JAMA 2012;308(12):1227.
14. Singh JA, Inacio MC, Namba RS, et al. Rheumatoid arthritis is associated with higher ninety-day hospital readmission rates compared to osteoarthritis after hip or knee arthroplasty: a cohort study. Arthritis Care Res 2015;67(5):718.
15. Lavernia CJ, Villa JM. Readmission rates in total hip arthroplasty: a granular analysis? J Arthroplasty 2015;30(7):1127.
16. Poeran J, Rasul R, Suzuki S, et al. Tranexamic acid use and postoperative outcomes in patients undergoing total hip or knee arthroplasty in the United States: retrospective analysis of effectiveness and safety. BMJ 2014;349:g4829.
17. Colwell Jr CW, Froimson MI, Mont MA, et al. Thrombosis prevention after total hip arthroplasty: a prospective, randomized trial comparing a mobile compression device with low-molecular-weight heparin. J Bone Joint Surg Am 2010;92(3):527.
18. El Bitar YF, Illingworth KD, Scaife SL, et al. Hospital length of stay following primary total knee arthroplasty: data from the Nationwide Inpatient Sample database. J Arthroplasty 2015;30(10):1710.