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Prolonged Length of Stay Is Not an Acceptable Alternative to Coded Complications in Assessing Hospital Quality in Elective Joint Arthroplasty

Stephen Lyman, PhD [a], Kara G. Fields, MS [a], Allina A. Nocon, MPH [a], Benjamin F. Ricciardi, MD [b], Friedrich Boettner, MD [b]

[a] Healthcare Research Institute, Hospital for Special Surgery, New York New York
[b] Department of Orthopedic Surgery, Hospital for Special Surgery, New York New York

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ABSTRACT

We sought to determine if prolonged length of stay (pLOS) is an accurate measure of quality in total hip and knee arthroplasty (THA and TKA). Coded complications and pLOS for 5967 TKA and 4518 THA patients in our hospital discharged between 2009 and 2011 were analyzed. Of 727 patients with pLOS, only 170 also had a complication, yielding a sensitivity of 41.4% (95% CI: 36.7, 46.2) with a positive predictive value (PPV) of just 23.4% (95% CI: 20.3, 26.4). Specificity (94.5% [95% CI: 94.0, 94.9]) and negative predictive value (NPV) (97.5% [95% CI: 97.2, 97.8]) were high, due to the large number of patients without complications or pLOS. This suggests that risk-adjusted pLOS is an inadequate measure of patient safety in primary THA and TKA.

As the United States healthcare system faces challenges in providing and paying for healthcare for our citizens, increasing attention has been placed on improving quality of care as a means of controlling costs [1,2]. This is a rational approach as we should spend our healthcare resources as efficiently as possible and it is more advantageous to spend our healthcare dollars on safe and effective care than on unsafe or ineffective care. In the realm of surgical safety, increased attention has been placed on hospital quality as a way to drive patients to safer, more efficient, hospitals for care.

The Centers for Medicare and Medicaid Services (CMS) began the movement toward hospital quality assessment by adjusting reimbursement for hospitals that adhered to standards of care with required process measurement [1]. The CMS shifted away from process measures as administrative data become more robust, allowing for direct measurement of hospital quality through complication rates, infection rates, readmission rates, mortality, and other objective measures of hospital quality.

An admitted limitation of this approach is that complication assessment is performed through evaluation of the discharge abstract, which was generated for billing purposes. A strange mix of incentives encourages hospitals to "up-code" in order to maximize reimbursement and now "down-code" to minimize exposure as a poor performing hospital. Previous research has demonstrated that the quality of coding in hospitals is highly variable across the country [3,4]. Hospitals with poor coding may also have shortcomings in other aspects of care delivery, but this would be missed through current quality assessment as these hospitals may undercode complications that might reveal inferior care delivery.

In response to this, in 2009, Fry et al [5] posited that prolonged hospitalization was a valid indicator of an adverse outcome in the surgical setting. While a hospital could conceivably game coded complications, a hospital could not realistically game the length of stay for each patient. Based on their finding that 94.1% of coronary artery bypass grafting patients, 91.9% of colon resection patients and 68.5% of total hip arthroplasty (THA) patients had a coded complication with prolonged length of stay (pLOS), the authors concluded that in a Medicare population, for these 3 surgical procedures, adverse surgical outcomes are better defined by risk-adjusted pLOS than coded or observed compilations [5]. However, the significantly lower correlation in THA patients suggests that pLOS may be a less robust quality indicator for THA and other elective orthopedic procedures than for other types of surgery. Further, Fry et al [5] excluded hospitals with "a boutique focus in 1 area" from their analyses suggesting that their conclusions may not be relevant to tertiary care or specialty hospitals. The current study evaluates whether pLOS is a predictor of complication and quality of care in a high volume orthopedic referral center.

Methods

Using our hospital's electronic health record, we identified all primary THA and total knee arthroplasty (TKA) cases among Medicare beneficiaries discharged between January 1, 2009 and December 31, 2011. We calculated each patient's length of stay and identified all coded complications. Fry et al [5] developed a list of ICD-9 Clinical Modification

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Reprint requests: Stephen Lyman, PhD, 535 East 70th Street, New York, NY 10021.

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Table 1
Hospital-Acquired Complications.

Complication	ICD-9-CM Code(s)
Acute myocardial infarction	410.x1
Deep venous thrombosis or pulmonary embolism	453.2, 453.3, 453.4x, 453.8, 453.9,451.1, 451.2, 451.8, 451.9, 415.1x
Intracranial Injury	850-854
Burns	940–949
Retained foreign object	998.4, 998.7
Air embolism	999.1
Blood incompatibility	999.6
Major bleed	286.5, 719.10, 719.16, 719.17, 998.1x
Sepsis, septicemia, or shock	038, 785.52, 785.59, 790.7, 995.91, 995.92, 998.0
Pressure ulcer	707.23, 707.24
Catheter-associated urinary tract infection	599.0, 996.64
Vascular catheter-associated Infection	999.31
Ileus	560.1, 997.4
Pneumonia	480.x, 481, 482.x, 483.x, 485, 486, 487.0, 507.0
Surgical site infection (deep wound and periprosthetic)	996.60, 996.66, 996.67, 996.69, 998.3x, 998.5x, 998.6, 998.83
Dislocation	Hip: 835, 718.2, 718.3 Knee: 836, 718.2, 718.3
Fracture	Hip: 733.8, 733.9, 808, 821.0, 821.11, 820 Knee: 733.8, 733.9, 821.2, 821.3, 822, 823, 827
Mechanical complication	996.4, 996.4x
Peripheral nerve injury	956, 957.8, 957.9

(ICD-9-CM) codes that indicated a "probable postoperative complication" and used this list to identify patients with at least one coded complication. As this list was not provided as a supplement to the original paper, we used our hospital's quality assurance department's list of important post-operative complications, which we track internally and believe are most relevant to peri-operative setting in elective orthopedic surgery (Table 1).

While our hospital's clinical care pathways have *a priori* expected lengths of stay, we used a robust risk adjustment methodology in order to predict the expected length of stay with more information than the pathways use. We identified pLOS cases using the methodology established by Fry et al [6] First, multivariable regression was used to calculate a predicted length of stay for each case based on age, sex, and comorbidities. A standardized risk-adjusted postoperative LOS was calculated for each case by subtracting the predicted LOS (multiplied by a constant so that total predicted LOS equaled the total observed LOS for all patients) from the observed length of stay. A modified average moving range (XmR) control chart was assembled with the XmR as the mean of the absolute value of the difference in standardized risk-adjusted postoperative LOS between adjacent discharges and the 3σ upper control limit (UCL) as the XmR multiplied by 2.66. Cases with standardized risk-adjusted postoperative LOS above the UCL were removed, and a new XmR and UCL were calculated. This process was repeated until no case had a standardized risk-adjusted postoperative LOS above the current UCL. Cases with standardized risk-adjusted postoperative LOS that exceeded the final UCL were marked as pLOS.

For patients with pLOS and coded hospital-acquired secondary diagnoses, we determined which hospital-acquired conditions were most likely to contribute to pLOS. For patients with pLOS and no coded hospital-acquired secondary diagnoses, we performed chart audits to determine whether complications were missed and we identified the likely cause of delayed discharge among these patients. We did not perform chart audits for patients with coded hospital-acquired secondary diagnoses or patients without pLOS. Possible reasons for delayed discharge were determined through discussions with our senior attending surgeon (FB) and house staff. After five charts were reviewed by a senior orthopedic resident (BR), we re-assessed these possible reasons and edited the list accordingly.

Possible reasons for delayed discharge included: post-operative monitoring of suspected complication (e.g., rule out deep venous thrombosis (DVT) or elevated INR in patients receiving Coumadin for thromboprophylaxis), hospital acquired condition considered common sequelae to elective orthopedic surgery (e.g., anemia), hospital acquired complication (those listed in Table 1), comorbid condition, wound drainage, slow physical therapy progression, and discharge issues exogenous to medical condition (e.g., travel logistics or in-patient rehabilitation bed availability).

Chart audits were performed by orthopedic residents (PGY-3 to PGY-5) and adult reconstruction (i.e., joint arthroplasty) fellows (PGY-6) who were trained in the auditing process prior to initiation of chart reviews. During the chart review, complications and comorbidities were documented to determine the frequency with which the coders missed a diagnosis that should have appeared in the discharge abstract. We performed duplicate chart audits on a 5% of sample of patient records. Kappa statistics were above 0.8 for coding of complications and comorbidities while there was moderate agreement ($\kappa = 0.42$) in assessing the reason for delayed discharge.

When more than one reason for delayed discharge was identified, the primary reason was assumed to be a complication or hospital acquired condition (if one of the reasons). Otherwise, the primary reason was that which contributed the most additional days as estimated by the auditor. If no number of additional days was listed or all reasons were attributed the same number of additional days, then a hierarchy reflecting clinical relevance was used: staged bilateral, rule out complication/post-operative monitoring, wound drainage, slow physical therapy, and discharge logistics.

Analysis consisted of descriptive statistics as appropriate to summarize the complication, pLOS, and reason for delayed discharge experience. The sensitivity, specificity, positive predictive value, and negative predictive value of pLOS as a surrogate measure for complications in THA and TKA patients were calculated along with 95% confidence intervals.

Results

Over the study period, 5967 Medicare eligible primary TKAs and 4518 Medicare eligible primary THAs were discharged from our institution (Table 2). Patients reflected a usual Medicare population for TKA and THA. Approximately 7% ($n = 727$) of these patients had pLOS using the XmR methodology while 410 (3.9%) had a hospital acquired complication. Of 727 patients with pLOS, only 170 also had a complication, yielding a sensitivity of 41.4% (95% CI: 36.7, 46.2) with a positive predictive value (PPV) of just 23.4% (95% CI: 20.3, 26.4). Specificity (94.5% [95% CI: 94.0, 94.9]) and negative predictive value (NPV) (97.5% [95% CI: 97.2, 97.8]) were high, due to the large number of patients without complications or pLOS (Table 3).

Among all patients with any hospital acquired diagnoses, the most common were anemia (27.0%), nausea and/or vomiting (16.6%), cardiac arrhythmias (12.8%), and hyposmolality or hyponatremia (9.9%) (Table 4). All other hospital acquired conditions accounted for less than 9% of all conditions captured. Among patients with any hospital-

Table 2
Patient Demographics.

	THA ($n = 4518$)	TKA ($n = 5967$)	All ($n = 10485$)
Age, mean (SD)	74.1 (6.2)	74.1 (5.9)	74.1 (6.1)
Female, *n* (%)	2684 (59.4)	3888 (65.2)	6572 (62.7)
Race, *n* (%)			
White	4221 (93.4)	5184 (86.9)	9405 (89.7)
Black	145 (3.2)	308 (5.2)	453 (4.3)
Other	86 (1.9)	244 (4.1)	330 (3.1)
Hispanic	28 (0.6)	122 (2.0)	150 (1.4)
Asian	30 (0.7)	86 (1.4)	116 (1.1)
Native American	8 (0.2)	23 (0.4)	31 (0.3)
Bilateral, *n* (%)	86 (1.9)	530 (8.9)	616 (5.9)