Understanding Variation in 30-Day Surgical Readmission in the Era of Accountable Care: Effect of the Patient, Surgeon, and Surgical Subspecialties

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**Importance**
Readmission is a target area of quality improvement in surgery. While variation in readmission is common, to our knowledge, no study has specifically examined the underlying etiology of this variation among a variety of surgical procedures performed in a large academic medical center.

**Objective**
To quantify the variability in 30-day readmission attributable to patient, surgeon, and surgical subspecialty levels in patients undergoing a major surgical procedure.

**Design, Setting, and Participants**
Retrospective analysis of administrative claims data of patients discharged following a major surgical procedure at a tertiary care center between January 1, 2009, and December 31, 2013. A total of 22,559 patients were included in this study and underwent a major surgical procedure performed by 56 surgeons practicing in 8 surgical subspecialties.

**Main Outcomes and Measures**
In-hospital morbidity, 30-day readmission, and proportional variation in 30-day readmission at patient, surgeon, and surgical subspecialty levels.

**Results**
Among the 22,559 patients in this study, patient age, race/ethnicity, and payer type differed across surgical subspecialties. Preoperative comorbidity was common and noted in 65.1% of patients. Postoperative complications were noted in 21.6% of patients varying from 2.1% following breast, melanoma or endocrine surgery to 37.0% following cardiac surgery.

The overall 30-day readmission was 13.2% (n = 2,975). Readmission varied considerably across the 8 different surgical subspecialties, ranging from 24.8% following transplant surgery (n = 557) to 2.1% following breast, melanoma, or endocrine surgery (n = 32). After adjusting for patient- and surgeon-level variables, factors associated with readmission included African American race/ethnicity (odds ratio, 1.23; 95% CI, 1.11-1.36; P < .001), increasing comorbidity (Charlson Comorbidity Index score of 1: odds ratio, 1.16; 95% CI, 1.02-1.32; P = .02; and a Charlson Comorbidity Index score of ≥2: odds ratio, 1.38; 95% CI, 1.24-1.53; P < .001), postoperative complication (odds ratio, 1.19; 95% CI, 1.08-1.32; P = .001), and an extended length of stay (odds ratio, 1.78; 95% CI, 1.61-1.96; P < .001). The majority of the variation in readmission was attributable to patient-related factors (82.8%) while surgical subspecialty accounted for 14.5% of the variability, and individual surgeon-level factors accounted for 2.8%.

**Conclusions and Relevance**
Readmission occurred in more than 1 in 10 patients, with considerable variation across surgical subspecialties. Variation in readmission was overwhelmingly owing to patient-level factors while only a minority of the variation was attributable to factors at the surgical subspecialty and individual surgeon levels.
Readmission has been targeted as a potential area of quality improvement that could also help decrease health care costs. Readmission has become a particularly important topic for physicians and hospitals given the Centers for Medicare and Medicaid Hospital Readmission Reductions Program (HRRP). Under the HRRP, hospitals with higher than expected readmission rates incur financial penalties in the form of decreased remuneration. Additionally, hospital-wide readmissions are made publicly available as a quality measure for patient care. While the HRRP has largely focused on 3 medical conditions (myocardial infarction, pneumonia, and heart failure), the Centers for Medicare and Medicaid has expanded the HRRP to include total hip and knee arthroplasty, with additional surgical procedures to be incorporated in the near future.

Readmission following surgery can vary considerably, with the reported incidence of readmission ranging from 3.8% to 41.0%. Factors that may account for this variability are poorly understood and may be associated with patient-, surgeon-, and hospital-level factors. For example, patient-level factors, such as age and preoperative medical comorbidity, have been noted to influence the risk of 30-day readmission following surgery. Although less extensively studied, factors pertaining to the surgeon, surgical subspecialty, and hospital may also be important effect modifiers of readmission risk. Specifically, surgeon-level factors, such as a surgeon’s subspecialty and operative case volume, may be important in understanding variations in readmission. While several studies have examined surgeon or hospital volumes and their relation to readmission, these studies have largely focused on isolated procedures. In addition, most of these data have used nationally available administrative data sets. While these data sets provide a large cohort and adequate sample size, they lack the granularity to examine surgeon-specific variation. In addition, almost all previous studies on readmission have used standard univariable and multivariable analyses rather than hierarchical modeling. While univariable and multivariable analyses rather than hierarchical modeling may be important in understanding variations in readmission, these studies have largely focused on isolated procedures. In addition, most of these data have used nationally available administrative data sets. While these data sets provide a large cohort and adequate sample size, they lack the granularity to examine surgeon-specific variation.

### Methods

**Data Sources and Patient Population**

Data were collected for all patients discharged following a major therapeutic procedure defined by the Agency for Healthcare Research and Quality and performed in the care of 1 of 8 surgical specialties included in the Department of Surgery at Johns Hopkins Hospital (JHH) from January 1, 2009, through December 31, 2013. Patients who did not survive to hospital discharge were excluded from the study. Twenty-five diagnostic and procedural codes for the index hospitalization and subsequent readmission as coded by the International Classification of Diseases, Ninth Revision coding lexicon were used to collect and categorize data. Patient comorbidity was defined according to the Charlson Comorbidity Index (CCI) and categorized into 3 groups (ie, 0, 1, or ≥2). Index hospitalization was defined as the inpatient admission during which the surgical procedure was performed. Readmission was defined as rehospitalization at JHH within 30 days of discharge from the index hospitalization. Planned readmissions (eg, chemotherapy) were excluded. The JHH Institutional Review Board approved this study; individual patient consent was waived and not required.

**Surgeon Volume and Length of Stay**

To explore the effect of surgical volume on readmission, a mean annual surgical volume was calculated for each surgeon by dividing the total number of cases performed by the number of years active. Because JHH is a high-volume quaternary care center, previously used values categorizing surgical volume in nationwide samples as high or low did not provide appropriate cutoffs for stratifying surgeon volume. For example, less than 2% of JHH surgeons fell below the published cutoff for a high volume of 21 cases per year. To avoid outlier bias, surgeons who performed fewer than 21 surgeries per year were excluded from the study cohort, leaving surgeons who were then classified as either high- or very high-volume surgeons, using JHH specialty-specific median values for surgical volume (Table 1). The length of stay (LOS) for each surgical subspecialty was dichotomized at the 75th percentile and categorized as expected LOS vs extended LOS.

**Statistical Analysis**

Categorical variables were compared using the Pearson χ² test while continuous variables were compared using the nonparametric Kruskal-Wallis test. To study the potential association of patient- and surgeon-level factors with 30-day readmission, a multilevel multivariable logistic regression model was built with random intercepts at the surgeon and the surgical subspecialty levels. The multilevel hierarchical logistic model was used to identify the independent proportion of variability attributable to each level of the hierarchical structure (eg, surgical service or individual surgeon) while minimizing the effects of dependency between observations within the sampling clusters. Following definitions for a logistic distribution, the overall patient variance was constrained to σ²/3. Null (no explanatory variables) and full (relevant explanatory variables) models were used to obtain cluster-level variances at each level. These cluster-level variances were then used to calculate the relative proportions of variance in 30-day readmission attributable to each level within the model (ie, surgical service, individual surgeon, and patient). All tests of statistical significance were 2-sided and defined by an α priori P value of less than .05. Statistical analyses were performed using the GLLAMM package for STATA statistical software, version 12.1, for Windows (StataCorp).

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Table 1. Sociodemographic and Clinical Characteristics of Patients Discharged From 2009 to 2013

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Surgical Subspecialty, No. (%)</th>
<th>Cardiac</th>
<th>GIS</th>
<th>Trauma</th>
<th>HPB</th>
<th>BME</th>
<th>Thoracic</th>
<th>Transplant</th>
<th>Vascular</th>
<th>Total</th>
<th>P Value</th>
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<tr>
<td>Total</td>
<td>4578 (20.3)</td>
<td>4217 (18.7)</td>
<td>1665 (7.4)</td>
<td>4403 (19.5)</td>
<td>1539 (6.8)</td>
<td>1791 (7.9)</td>
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<td>2117 (9.4)</td>
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<td>Age, median (IQR), y</td>
<td>63 (53-71)</td>
<td>54 (43-66)</td>
<td>40 (26-56)</td>
<td>60 (49-69)</td>
<td>52 (40-61)</td>
<td>61 (51-69)</td>
<td>53 (41-61)</td>
<td>63 (49-73)</td>
<td>58 (46-68)</td>
<td>&lt;.001</td>
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<tr>
<td>Sex</td>
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<td></td>
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<td>52.7 (21.2)</td>
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<td>Male</td>
<td>3040 (66.4)</td>
<td>1978 (46.9)</td>
<td>1034 (62.1)</td>
<td>2152 (48.9)</td>
<td>351 (22.8)</td>
<td>932 (52.0)</td>
<td>1253 (55.7)</td>
<td>996 (44.3)</td>
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<td>2239 (53.0)</td>
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<td>1188 (77.2)</td>
<td>969 (48.0)</td>
<td>701 (35.3)</td>
<td>977 (46.2)</td>
<td>587 (24.7)</td>
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<td>Race/ethnicity</td>
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<td>African American</td>
<td>671 (14.7)</td>
<td>720 (17.1)</td>
<td>949 (57.0)</td>
<td>606 (13.8)</td>
<td>318 (20.7)</td>
<td>262 (14.6)</td>
<td>671 (29.8)</td>
<td>587 (27.7)</td>
<td>4784 (21.2)</td>
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<td>103 (6.7)</td>
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<td>1294 (28.3)</td>
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<td>694 (45.1)</td>
<td>634 (35.4)</td>
<td>545 (24.2)</td>
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<td>96 (5.4)</td>
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<td>Other</td>
<td>209 (4.6)</td>
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<td>44 (2.6)</td>
<td>137 (3.1)</td>
<td>58 (3.8)</td>
<td>56 (3.1)</td>
<td>407 (18.1)</td>
<td>97 (4.6)</td>
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<td>Self-pay or no charge</td>
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<td>9 (0.4)</td>
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<td>52.7 (21.2)</td>
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<td>0</td>
<td>1078 (23.6)</td>
<td>2236 (53.0)</td>
<td>1073 (64.4)</td>
<td>1324 (30.1)</td>
<td>649 (42.2)</td>
<td>391 (21.8)</td>
<td>574 (25.5)</td>
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<td>7879 (34.9)</td>
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<tr>
<td>1</td>
<td>1453 (31.7)</td>
<td>680 (16.1)</td>
<td>324 (19.5)</td>
<td>552 (11.9)</td>
<td>184 (12.0)</td>
<td>216 (12.1)</td>
<td>145 (6.4)</td>
<td>557 (26.3)</td>
<td>4081 (18.1)</td>
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<td>≥2</td>
<td>2047 (44.7)</td>
<td>1301 (30.9)</td>
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<td>2557 (58.1)</td>
<td>706 (45.9)</td>
<td>1184 (66.1)</td>
<td>1530 (68.0)</td>
<td>1006 (47.5)</td>
<td>10599 (47.0)</td>
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<td>Volume</td>
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<td>52.7 (21.2)</td>
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<tr>
<td>High†</td>
<td>925 (20.2)</td>
<td>830 (19.7)</td>
<td>872 (52.4)</td>
<td>2004 (45.5)</td>
<td>55 (3.6)</td>
<td>571 (31.9)</td>
<td>934 (41.5)</td>
<td>917 (44.3)</td>
<td>7128 (31.6)</td>
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<tr>
<td>Very high‡</td>
<td>3653 (79.8)</td>
<td>3387 (80.3)</td>
<td>793 (47.6)</td>
<td>2399 (54.5)</td>
<td>1484 (69.4)</td>
<td>1220 (68.1)</td>
<td>1315 (58.5)</td>
<td>1180 (55.7)</td>
<td>15431 (68.4)</td>
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</table>

Abbreviations: CCI, Charlson Comorbidity Index; BME, breast, melanoma, and endocrine surgery; GIS, gastrointestinal surgery; HMO, health maintenance organization; HPB, hepatopancreaticobiliary surgery; IQR, interquartile range.

† By surgical service based on the following mean annual surgeon volumes: cardiac surgery (n < 200); GIS (n < 100); trauma surgery (n < 50); HPB (n < 100); BME (n < 28); thoracic surgery (n > 104); transplant surgery (n > 80); and vascular surgery (n > 84).
‡ By surgical service based on the following mean annual surgeon volumes: cardiac surgery (n > 200); GIS (n > 100); trauma surgery (n > 50); HPB (n > 100); BME (n > 28); thoracic surgery (n > 104); transplant surgery (n > 80); and vascular surgery (n > 84).
Variation in 30-Day Surgical Readmission in the Era of Accountable Care

Original Investigation Research

Table 2. Median LOS, Postoperative Morbidity, Readmission Within 30 Days of Discharge, and Median Time to Readmission for Patients Discharged From 2009 to 2013

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Surgical Subspecialty</th>
<th>Cardiac</th>
<th>GIS</th>
<th>Trauma</th>
<th>HPB</th>
<th>BME</th>
<th>Thoracic</th>
<th>Transplant</th>
<th>Vascular</th>
<th>Total</th>
<th>P Value</th>
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<tr>
<td>LOS of index admission, median (IQR), d</td>
<td>Cardiac</td>
<td>8 (6-13)</td>
<td>6 (3-10)</td>
<td>5 (2-10)</td>
<td>6 (4-10)</td>
<td>1 (1-1)</td>
<td>5 (3-8)</td>
<td>8 (4-14)</td>
<td>3 (1-8)</td>
<td>6 (3-10)</td>
<td>&lt;.001</td>
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<tr>
<td>Any complication, No. (%)</td>
<td>Cardiac</td>
<td>1695 (37.0)</td>
<td>704 (16.7)</td>
<td>327 (19.6)</td>
<td>764 (17.4)</td>
<td>32 (2.1)</td>
<td>304 (17.0)</td>
<td>643 (28.6)</td>
<td>401 (18.9)</td>
<td>4870 (21.6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>30-d Readmission, median (IQR), d</td>
<td>Cardiac</td>
<td>438 (9.6)</td>
<td>663 (15.7)</td>
<td>187 (11.2)</td>
<td>686 (15.5)</td>
<td>32 (2.1)</td>
<td>171 (9.6)</td>
<td>557 (24.8)</td>
<td>241 (11.4)</td>
<td>2975 (13.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time to readmission, median (IQR), d</td>
<td>Cardiac</td>
<td>10 (5-17)</td>
<td>8 (4-15)</td>
<td>8 (4-15)</td>
<td>8 (4-16)</td>
<td>11 (4-18)</td>
<td>10 (6-17)</td>
<td>11 (6-19)</td>
<td>9 (5-16)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>LOS at readmission, median (IQR), d</td>
<td>Cardiac</td>
<td>5 (3-10)</td>
<td>5 (3-8)</td>
<td>4 (2-8)</td>
<td>5 (3-9)</td>
<td>4 (2-5)</td>
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<td>4 (3-8)</td>
<td>5 (3-9)</td>
<td>5 (3-9)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: BME, breast, melanoma, and endocrine surgery; GIS, gastrointestinal surgery; HPB, hepatopancreaticobiliary surgery; IQR, interquartile range; LOS, length of stay.

Results

Sociodemographic Patient Characteristics

A total of 22,559 patients treated by 56 surgeons representing 8 surgical subspecialties at JHH were identified (Table 1). The median age of the overall cohort was 58 years (interquartile range [IQR], 46-68 years), with most patients being male (n = 11,880; 52.7%). Most patients were white (n = 15,909; 70.5%) followed by African American (n = 4,784; 21.2%) and Asian (n = 520; 2.3%) individuals. Government or private insurance were the predominant types of insurance coverage (n = 21,189; 93.9%), with Medicare being the most common payer type (n = 7,617; 33.8%). Comorbidities were common in the patient population, with 47.0% (n = 10,599) of patients categorized as having a CCI score of 2 or higher. Most patients were white (n = 15,431; 68.4%) as defined by specific surgical subspecialty volume. The proportion of patients seen by each subspecialty varied with the highest number of patients treated by cardiac (n = 4,578; 20.3%) followed by hepatopancreaticobiliary (n = 4,403; 19.5%) surgery. In contrast, breast, melanoma, and endocrine surgery (BME) treated the smallest number of patients (n = 1,539; 6.8%; Table 1). Preoperative comorbidities were most prevalent among patients cared for by thoracic and transplant surgery (CCI score of ≥2: 66.1% and 68.0%, respectively).

Patient Outcomes: LOS, Postoperative Complications, and Readmission

Across the entire cohort, the median LOS for the index hospitalization was 6 days (IQR, 3-10 days). The LOS was longest among patients undergoing cardiac (median LOS, 8 days; IQR, 6-13 days) or transplant (median LOS, 8 days; IQR, 4-14 days) surgery. In contrast, the LOS was shortest among patients undergoing BME procedures (median LOS, 1 day; Table 2). Overall, 4,870 patients experienced at least 1 complication, for an overall postoperative morbidity of 21.6%. The incidence of postoperative morbidity ranged from 37.0% among patients undergoing cardiac surgery (n = 1,695) to a low of 2.1% among patients undergoing BME procedures (n = 32; Table 2).

The overall 30-day readmission was 13.2% (n = 2,975). There were no significant differences in age or sex between patients who were and were not readmitted. However, differences by race/ethnicity were noted. Specifically, 16.6% of African American patients were readmitted compared with 12.3% of white patients (P < .001). Not surprisingly, a larger proportion of patients insured with Medicare were readmitted compared with patients covered by commercial insurance (15.1% vs 12.0%; P < .001). Also, sicker patients, specifically those with a CCI score of 2 or higher, were proportionally more likely to be readmitted than those presenting with a CCI score of less than 2 (16.0% vs 10.7%; P < .001). Readmitted patients were proportionally more likely to have incurred a postoperative complication during their index hospitalization compared with patients who were not readmitted (30.4% vs 20.3%; P < .001; Table 3). Similarly, patients readmitted were more likely to have had an extended LOS for their index hospitalization (36.5% vs 21.5%; P < .001). Patients seen by a very high-volume surgeon were proportionately less likely to have been readmitted within 30 days (68.9% vs 65.5%; P < .001).

Substantial variation in 30-day readmission was noted across the different subspecialties (Figure). For example, while 21.1% of patients undergoing BME surgery were readmitted, the proportion of patients readmitted within 30 days following hepatopancreaticobiliary surgery (n = 686; 15.5%), cardiac (n = 438; 9.6%), or transplant (n = 557; 24.8%) surgery was much higher (Figure). Considerable variation in 30-day readmission was noted even within each surgical subspecialty, with individual surgeons having varied rates of readmission in any given subspecialty (Figure). For example, surgeon-specific readmission rates ranged from 9.1% to 32.9% among transplant surgeons, 11.4% to 30.0% among hepatopancreaticobiliary surgeons, and 2.1% to 24.3% among vascular surgeons (Figure).
Insurance status was also associated with greater odds for readmission, with Medicare enrollees demonstrating a 15% greater odds of readmission compared with commercially insured patients (OR, 1.15; 95% CI, 1.03-1.29; P = .01). The presence of a preexisting comorbidity was associated with a stepwise increase in the odds of 30-day readmission. Specifically, compared with individuals having no comorbid illness, patients with a CCI score of 1 demonstrated a 16% greater odds of readmission (OR, 1.16; 95% CI, 1.02-1.32; P = .02) and patients with a CCI score of 2 or higher demonstrated a 38% greater odds of readmission (OR, 1.38; 95% CI, 1.24-1.53; P < .001). Furthermore, patients who developed a postoperative complication demonstrated a 19% greater odds of readmission following surgery (OR, 1.19; 95% CI, 1.08-1.32; P = .001) compared with those who did not develop a postoperative complication. Among all variables, extended LOS was the strongest predictor of 30-day readmission, with patients who had an extended LOS demonstrating a 78% greater odds of readmission compared with patients whose LOS was within the expected range (OR, 1.78; 95% CI, 1.61-1.96; P < .001). However, no effect of surgeon volume on readmission was noted within the different surgical subspecialties (OR, 0.92; 95% CI, 0.76-1.12; P = .42).

Cluster-level variances were used to calculate the proportion of 30-day readmission attributable to patient, surgeon, or surgical subspecialty levels. In the unadjusted model without any explanatory variables, 84.1% of the variation in 30-day readmissions was related to patient-specific factors while 12.1% and 3.8% of the variation was accounted for by factors...
related to the surgical subspecialty and individual surgeon, respectively. After accounting for patient- and hospital-level factors, 82.8% of the variability in 30-day readmission was attributable to nonmodifiable factors at the patient level while 14.5% of the variation was attributable to the surgical subspecialty and only 2.8% was attributable to the individual surgeon.

Discussion

Reducing hospital readmission has been identified as an important cost-containment metric by the Centers for Medicare and Medicaid Services. Not only are readmission rates used to determine financial compensation but they also serve as a publicly available quality parameter. Readmission can be viewed as an interplay of a variety of factors at multiple levels across the health care system.29,30 The Donabedian quality of care framework conceptualizes these factors into those related to structure or process and relates them to outcomes (ie, 30-day surgical readmission). Structural factors can be represented by hospital organization, hospital volume, and surgeon volume while process elements include surgical or clinical care pathways.10,31 Although previous reports have associated surgical readmission with patient-, physician-, or hospital-specific factors, to our knowledge, this is the first study to explicitly quantify variation in 30-day readmission following multiple surgical procedures at the patient, surgeon, and surgical subspecialty levels. The assessment of relative contributions demonstrated that more than 80% of the variability in 30-day surgical readmission was attributable to the level of the individual patient. Comparatively, only 14.5% of the variability was associated with surgical service while less than 3% of the overall variability was accounted for by the individual surgeon. On multivariable analysis, patient comorbidity, race/ethnicity, insurance status, a longer LOS, and the development of a postoperative complication were associated with greater odds for a 30-day readmission.

The use of readmission as a quality parameter is based on the underlying premise that it accurately represents the ability of a hospital to provide care and appropriately discharge patients. Similar to findings of this study, recent evidence has demonstrated that readmission may in fact be largely a function of nonmodifiable patient factors, such as lower socioeconomic conditions and poor access to care.30,32-34 Arbaje et al30 identified social factors and unmet functional needs to be associated with greater odds for 30-day readmission. Considering the postdischarge care required by patients who undergo surgery, the effect of these social factors may in fact be magnified for surgical readmissions.32 Contribution of such social factors to readmission is further reiterated by studies reporting racial/ethnic disparities in surgical readmissions.17,35 In their analysis of national Medicare data, Tsai et al35 reported a greater odds for readmission among African American patients compared with white patients. Particularly higher odds of readmission were noted in African American patients treated at minority-serving hospitals.35 Other studies have quantified this disparity, demonstrating that minority-serving hospitals incur a readmission penalty at approximately 3-fold higher than nonminority-serving hospitals.37 This study reports similar findings in that even after adjusting for patient and procedure factors, African American patients demonstrated a 23% greater odds for readmission. Our study adds to this field and highlights the need for further studies to ensure that minority-serving hospitals are not subject to increased penalties under the HRRP. Additionally, findings of this study support growing concerns that rather than being a surrogate for quality of care, readmissions may actually represent hospital usage and access to care driven largely by factors at the patient level, independent of physician-level variability.

Consistent with previous research, this study observed greater odds for readmission in patients who developed a postoperative complication during their index hospitalization.6,32 Further, similar to findings by Lucas and colleagues,29 patients with an extended LOS demonstrated greater odds of readmission within 30 days. The association between LOS and readmission may possibly be a result of postoperative complications or a function of greater preoperative patient comorbidity.29 The latter was supported by greater odds of readmission observed in patients with increasing comorbidity. Similar to findings of this study, Greysen et al36 reported that a worse preoperative functional status was independently associated with a 70% greater odds of readmission. Intuitively,
one might expect that hospitals caring for a higher proportion of sicker patients would have a higher readmission and, therefore, be at greater risk for financial penalties. Not surprisingly, safety net hospitals and large academic centers are among hospitals most likely to be penalized for hospital readmission. This disproportional penalization of hospitals catering to vulnerable populations may in fact serve to widen current health care disparities rather than improving the quality of patient care.

This study analyzed a broad spectrum of surgical patients treated by high-volume surgeons at a tertiary care hospital and demonstrated that more than 80% of the variability associated with the likelihood of 30-day readmission after surgical intervention is at the level of the individual patient. Further, more than 80% of the remaining variability was associated with the surgical service, suggesting that disease- and procedure-related factors may also drive readmission while only less than 3% of the overall variability is accounted for by the surgeon. Variability attributed to the surgical subspecialty may actually represent patient-level variability with regard to disease pathology and the specific therapeutic procedures performed. Patients presenting with more aggressive pathology/disease severity may require more extensive radical surgeries associated with a higher risk of readmission. In contrast, odds of readmission for a specific procedure may vary by pathology. In their review of patients undergoing a pancreaticoduodenectomy, Ahmad and colleagues noted that patients with chronic pancreatitis demonstrated greater odds for readmission relative to patients undergoing pancreaticoduodenectomy for other pathologies. Moving forward, efforts should focus on understanding the complex interplay of factors at the level of the patient, disease, and procedure that may drive readmission. With more than 80% of readmissions accounted for by factors at the patient level, additional emphasis must be placed on understanding nonmodifiable patient-specific variables driving readmission.

The current study should be interpreted with several limitations. First, although the use of administrative claims data allowed for a large sample of patients, it lacked specific details regarding patients’ socioeconomic status, perioperative course, and a more granular understanding of underlying disease processes, which all may affect readmission. To account for this limitation, we used modeling techniques that allowed for the quantification of variability without the need to explicitly identify all important variables at each level. Second, this study represented the experiences at a tertiary care hospital with its own unique patient mix. Therefore, the results may not be generalizable to the entire population; however, data from the current study can provide important insight to challenges faced by hospitals with similar characteristics and case mixes in regards to the assessment of 30-day readmission.

Conclusions

Significant variability was noted in 30-day readmission following surgical procedures. Although some of this variability can be explained by differences in disease pathology and the type of procedure performed, the overwhelming majority of this variability was attributable to nonmodifiable patient-level factors. Although implementation of the HRRP has seen a decrease in hospital readmission, our study echoes growing concerns regarding the use of readmission as a quality metric based on its current methods. Iterations of this program in the future will need to use appropriate statistical modeling of readmission to account for patient case mix, disease severity, and social factors outside the care of the hospital to ensure that appropriate penalties are based on the quality of care. Doing so will not only decrease the financial burden on the health care system but, more importantly, provide greater and more appropriate incentives for improving patient care.

ARTICLE INFORMATION

Accepted for Publication: April 17, 2015.
Published Online: August 5, 2015.

Author Contributions: Drs Pawlik and Gani had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Gani, Kim, Schneider, Pawlik. Acquisition, analysis, or interpretation of data: Gani, Lucas, Schneider. Drafting of the manuscript: Gani, Schneider. Critical revision of the manuscript for important intellectual content: Gani, Lucas, Kim, Schneider, Pawlik. Statistical analysis: Gani, Lucas, Kim, Schneider. Administrative, technical, or material support: Gani, Pawlik. Study supervision: Schneider, Pawlik.

Conflict of Interest Disclosures: None reported.

REFERENCES

Variation in 30-Day Surgical Readmission in the Era of Accountable Care

Invited Commentary

Variation Reduction to Reduce Readmission: A Figment of Imagination or Reality of the Future?

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One of the principles of the Six Sigma methodology is variation reduction. Since the publication of the Institute of Medicine's monograph, “To Err is Human: Building a Safer Health System,” health care systems and the Centers for Medicare and Medicaid Services have been interested in reducing variation through the application of standard process measures in an attempt to achieve the following 6 pillars of high-quality health care: safety, timeliness, effectiveness, efficiency, equity, and patient centeredness. The standardization of process measures and management pathways has clearly led to improved results in many clinical situations. However, we face a significant problem in medicine, referred to as common cause variation in the principles of the Six Sigma. This is the variation introduced by uncontrollable patient factors. The study by Gani et al addresses a gap in knowledge regarding the problem of readmission. This article tackles the issue of variability in readmission rates and reveals that variability is primarily due to the common cause of patient-related factors (including race/ethnicity, insurance status, comorbidity, complications, and length of stay) rather than surgeon- or surgical subspecialty-specific factors. There are limitations in this administrative claims-derived data set, including the lack of

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JAMA Surgery November 2015 Volume 150, Number 11 1049
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