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Variations in hospitals costs for surgical procedures: inefficient care or sick patients?

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Abstract

BACKGROUND: Reducing unwanted variations has been identified as an avenue for cost containment. We sought to characterize variations in hospital costs after major surgery and quantitate the variability attributable to the patient, procedure, and provider.

METHODS: A total of 22,559 patients undergoing major surgical procedure at a tertiary-care center between 2009 and 2013 were identified. Hierarchical linear regression analysis was performed to calculate risk-adjusted fixed, variable and total costs.

RESULTS: The median cost of surgery was $23,845 (interquartile ranges, 13,353 to 43,083). Factors associated with increased costs included insurance status (Medicare vs private; coefficient: 14,934; 95% CI = 12,445.7 to 17,422.5, $P < .001$), preoperative comorbidity (Charlson Comorbidity Index = 1; coefficient: 10,793; 95% CI = 8,412.7 to 13,174.2; Charlson Comorbidity Index ≥ 2; coefficient: 24,468; 95% CI = 22,552.7 to 26,383.6; both $P < .001$) and the development of a postoperative complication (coefficient: 58,624.1; 95% CI = 56,683.6 to 60,564.7; $P < .001$). Eighty-six percent of total variability was explained by patient-related factors, whereas 8% of the total variation was attributed to surgeon practices and 6% due to factors at the level of surgical specialty.

CONCLUSIONS: Although inpatient costs varied markedly between procedures and providers, the majority of variation in costs was due to patient-level factors and should be targeted by future cost containment strategies.

An estimated 18% of the annual gross domestic product is spent each year in health care costs, making the United States health care system the most expensive worldwide.[1] In particular, surgical care represents the most costly encounter within the health care system with over $400 billion spent annually on the care of surgical patients.[2,3] Reducing unwanted and "wasteful" spending has been identified as a potential area for cost containment.[4] Defined as variations in costs unexplained by disease characteristics, patient preferences or the dictates of evidence-based medicine, unwanted and wasteful spending has been reported for a wide variety of diseases and procedures as well as among providers performing the same procedure.[5–9] For example, in a study of patients undergoing colorectal, cardiac, and spinal

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surgery, Miller et al reported the costs of surgery to vary by 11.6% between hospitals.[8] In a separate study, Nelson-Williams et al reported that the cost of hepato-pancreaticobiliary surgery varied by $9,000 between hospitals even after accounting for patient, disease, and hospital characteristics.[5,9] Understanding factors driving these variations in costs are important to develop targeted interventions to reduce unwanted and wasteful spending. Although previously thought to be due to regional differences and varying payment models, recent reports have linked variations in costs to provider preferences and postoperative outcomes.[10–13] However, these reports were limited due to a lack of detailed financial information and were therefore unable to identify specific areas for cost saving and quality improvement. Furthermore, to the best of our knowledge, no study has explicitly quantified system-wide variation at the level of the patient, provider, and procedure. Given this, the objective of the present study was to characterize the variability in inpatient surgical costs across a large quaternary academic surgical department. Specifically, we sought to define factors associated with an increased cost, as well as quantitate the variability in hospital costs attributable to the patient, surgeon, and surgical subspecialty using hierarchical modeling.

Methods

Data sources and patient population

This cross-sectional, retrospective analysis was performed using administrative claims and cost accounting data from a single-tertiary care hospital between January 01, 2009 and December 31, 2013. Patients undergoing a major surgery defined as a "major therapeutic procedure" according to the Agency for Health care Quality and Research were identified.[14] For each patient record, standard sociodemographic information including age, sex, race, insurance status, as well as 25 diagnostic and procedure codes were recorded. Patient comorbidity was defined according to the Charlson Comorbidity Index (CCI), categorizing patients into 3 groups; CCI = 0, CCI = 1, and CCI $\geq$ 2.[15] Postoperative complications were defined using a previously validated set of International Classification of Disease, Ninth Revision, Clinical Modification diagnostic codes and included surgical site infections and/or wound dehiscence, sepsis and/or septic shock, venous thromboembolism (pulmonary embolism or deep vein thrombosis), stroke, myocardial infarction, and pneumonia.[16]

Financial variables

In addition to clinical and demographic characteristics, detailed financial information including total, fixed, and variable costs were extracted from the institutional EPSi cost accounting system (Allscripts Healthcare Solutions Inc., Chicago, IL).[17] Fixed costs represent costs that do not vary with patient volume and are related to structural and/or building costs, maintenance, and the costs of utilities.[18] Conversely variable costs are defined as costs that vary with patient volume, examples of which include costs for medication and surgical supplies.[18] Total costs were calculated as the sum of fixed and variable costs for each patient and were defined as the primary outcome of interest.[18] Charges or expected payments were not include within the current analysis as these may be influenced be preexisting contractual agreements with payers and as such may not reflect the actual financial burden to the health care system. Data pertaining to physician professional fees or salary data were not collected to ensure physician anonymity and compliance to data use agreements.

Statistical analysis

Categorical variables were reported as whole numbers with percentages and compared using the Pearson's chi-square test. Continuous variables were reported as medians with interquartile ranges (IQR) and compared using the nonparametric Kruskal–Wallis test. As financial variables were right-skewed, all cost variables were log-transformed and entered into a hierarchical multivariable linear regression model adjusting for patient demographics (age, gender, sex, and insurance status), preoperative comorbidity (CCI score), and the development of postoperative complications. To account for the clustering of patients, a random effects intercept was specified at the provider and surgical specialty levels. Results of the multivariable regression analysis were then used to calculate risk-adjusted costs for each patient and were compared between surgical specialty, between providers and within providers. Cluster-level variances were used to calculate the relative proportions of variance in hospital costs attributable to each level within the hierarchical model (ie, surgical service, surgeon, and patient).[19] A coefficient of variation (CV) was used to compared variations in hospital costs by procedure, surgeon, and within the practices of the same surgeon. The CV is a measure of dispersion as is calculated as the ratio of the standard deviation to the sample mean, whereby a greater CV represents a greater dispersion or variability of the underlying distributions while a lower CV represents less variation of the underlying distribution.[20] A P value of .05 was used to define statistical significance. All analyses were performed using STATA statistical software, version 14.0 for Windows (StataCorp, College Station, TX). This study was approved by the Johns Hopkins University Institutional Review Board.

Results

Baseline patient characteristics and postoperative outcomes

A total of 22,559 patients were identified who underwent a major surgery performed by 56 surgeons from 8