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Role of patient- and surgery-specific risk in receipt of outpatient preoperative testing

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ABSTRACT

Objective: To determine the independent association of patient- and surgery-specific risk with receipt of outpatient preoperative testing.
Methods: Using administrative data from 2010–2013 (Marketscan® Commercial Claims and Encounters), we constructed a retrospective cohort of 678,368 privately-insured, non-elderly US adults who underwent one of ten operations, including one lower-risk and one higher-risk operation from five surgical specialties. Outcomes were receipt of nine outpatient tests in the 30 days before surgery and cost of those tests. Patient-specific risk was based on Revised Cardiac Risk Index (RCRI) and, alternatively, the Charlson Comorbidity Index (CCI). Surgery-specific risk was based on operation (higher- versus lower-risk within each specialty). Multivariable logistic regression models were constructed to measure the independent association of patient- and surgery-specific risk with the receipt of tests.
Results: Receipt of tests ranged from 0.9% (pulmonary function tests) to 46.8% (blood counts), and 65.2% of patients received at least one test. Mean cost per patient for all tests was $124.38. Higher RCRI was strongly associated (Odds Ratio (OR) > 2) with receipt of stress tests and echocardiograms, and more modestly associated [OR < 2] with receipt of most other tests. Undergoing higher-risk operations was strongly associated with receipt of most tests. Results were similar using the CCI for patient-specific risk.
Conclusion: Surgery-specific risk is strongly associated with receipt of most preoperative tests, which is consistent with preoperative testing protocols based as much or more on the planned operation as on patient-specific risk factors. Whether this pattern of preoperative testing represents optimal care is uncertain.

1. Introduction

In an era of increased attention on overuse of medical services, preoperative testing has come under scrutiny.[1–4] Evidence that preoperative testing improves outcomes is lacking[5,6] and testing practices vary widely.[7,8] Many have raised concerns that preoperative testing is overused.[1,2] Choosing Wisely recommendations to perform fewer preoperative tests were made by numerous professional societies, including the American Society of Anesthesiologists and the American College of Surgeons.[9]

Recent clinical guidelines have recommended that preoperative testing not be performed "routinely."[10–12] The American Society of Anesthesiologists Practice Advisory for Preanesthesia Evaluation recommends that tests be ordered selectively "after consideration of specific information obtained from sources such as medical records, patient interview, physical examination, and the type or invasiveness of the planned procedure and anesthesia."[10] The American College of Cardiology/American Heart Association (ACC/AHA) guidelines on perioperative cardiovascular evaluation recommend against testing for coronary artery disease when the combined surgical and patient characteristics predict a risk of a major adverse cardiac event of less than 1%.[11]

While guidelines recommend that patient- and surgery-specific risk assessment should guide preoperative testing, how these factors affect testing in actual practice is unknown. Several recent studies have examined predictors of preoperative testing, but these studies were limited to a single test,[13–15] or focused exclusively on low-risk operations and procedures,[7,8,16,17] precluding the ability to assess the contribution

Abbreviations: ACC/AHA, American College of Cardiology/American Heart Association; CCI, Charlson Comorbidity Index; JHSCS, Johns Hopkins Surgical Classification System; OR, Odds Ratio; RCRI, Revised Cardiac Risk Index

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of surgery-specific risk. In this study, we aimed to measure the independent association of patient- and surgery-specific risk with the receipt of preoperative tests in a range of operations using a nationwide data source.

2. Materials and methods

2.1. Data

We used MarketScan® Commercial Claims and Encounters (Truven Health Analytics) from 2010 to 2013. MarketScan® collects utilization and expenditure data for employees, retirees, and their dependents from more than 250 medium- and large-sized employers and health plans from across all 50 states and the District of Columbia. The database includes data from inpatient and outpatient visits for approximately 43 to 55 million beneficiaries in each of the years we examined, which represents approximately twenty percent of all privately insured individuals in the US. This study was exempted by the Johns Hopkins University Institutional Review Board.

2.2. Selection of operations

To assess the effect of surgery-specific risk on preoperative testing, we chose two operations from five surgical specialties: general, vascular, orthopedic, urologic, and gynecologic. Our goal was to choose two common operations with gradient of surgery-specific risk (i.e., one "lower-risk" and one "higher-risk" operation in each specialty, not necessarily "low-risk" and "high-risk"). There are no universally accepted methods for classifying the intrinsic surgery-specific risk of different operations. We considered adopting the three-category classification system used in some versions of the ACC/AHA guidelines (i.e., of low-, intermediate-, and high-risk), but this schema is difficult to operationalize due to limited examples of operations within each category, and the ACC/AHA guidelines have moved away from this system in their most recent guidelines.[11] Therefore, we opted to use the Johns Hopkins Surgical Classification System (JHSCS), which classifies operations into five risk categories based on physiologic factors such as expected blood loss and fluid shifts.[18] While the JHSCS includes a fairly comprehensive list of operations in each category, we had to estimate the category for several operations that were not listed. However, we chose operations with high face-validity for having qualitatively different intrinsic risks (e.g., cholecystectomy has higher risk than hemorrhoidectomy, and total prostatectomy has higher risk than transurethral resection of the prostate). The higher-risk operations included laparoscopic cholecystectomy, carotid endarterectomy, total prostatectomy, total knee arthroplasty, and hysterectomy. The lower-risk operations included hemorrhoidectomy, peripheral artery angioplasty or stent, transurethral resection of the prostate, shoulder and knee arthroscopies, and tubal ligation. The *Current Procedural Terminology* codes and the JHSCS category for each operation are listed in Appendix Table A1.

Our intent was to examine elective operations, as patients undergoing urgent or emergent operations may be less likely to undergo outpatient preoperative testing. Therefore, we included only operations performed on an outpatient basis for each of the lower-risk operations and laparoscopic cholecystectomy (the higher-risk general surgery operation). For the other higher-risk operations, we included those performed on an outpatient basis or on the first day of a hospital admission.

2.3. Study population

We included beneficiaries aged 18–64 years who were continuously enrolled in a health plan for one year prior to their operation and had at least one outpatient visit with a primary care provider between one month and one year prior to their operation. If patients had more than one eligible operation, we only included the first they received.

To identify comorbid diagnoses, we searched for *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9) diagnostic codes in inpatient and outpatient records in the 12 months prior to the operation (included ICD-9 codes are listed in Appendix Table A2). As the measure of patient-specific risk, we calculated the revised cardiac risk index (RCRI), similar to previous studies using administrative data.[19–21] Diabetes mellitus, ischemic heart disease, chronic kidney disease, congestive heart failure, and cerebrovascular disease were each assigned 1 point. For this study, we did not assign RCRI points for "high-risk" operations because we wanted to use a separate variable to account for surgery-specific risk, so the possible RCRI ranged from 0 to 5.

2.4. Outcomes

The primary outcome was receipt of nine tests performed as an outpatient during the 30 days before surgery. Included tests were blood counts, metabolic panels, coagulation tests, urinalyses, electrocardiograms, stress tests, echocardiograms, chest radiographs, and pulmonary function tests performed in an outpatient setting (*Current Procedural Terminology* codes are listed in Appendix Table A3).

The costs reported in the analysis are the total payments (not charges), which includes the payments by insurance and by patients. All costs were inflation-adjusted to 2013 dollars using the Consumer Price Index for medical care services.[22] To deal with outliers, we replaced negative costs with $0, and we truncated high costs at the 99th percentile for each test.

Since we were not able to determine the indication for testing, we also assessed use of each test in the 180 days (six 30-day blocks) prior to the operation to compare use of tests in the preoperative month with the baseline use of each test in earlier months.

2.5. Statistical analyses

We tabulated the percentage of patients who received each test prior to their operation. We tabulated the mean cost for each test for patients who received the test, as well as the mean cost per test distributed among all patients.

We used separate logistic regression models to estimate the odds of a patient receiving each preoperative test dependent on patient-specific risk (RCRI), surgery-specific risk (lower-risk or higher-risk surgery), and potential confounders (surgical specialty, age, and sex). Due to the small number of patients with RCRI scores greater than two, we collapsed the RCRI into a three-level categorical variable (0, 1, $\geq$ 2). We accounted for clustering of patients within surgical specialties when calculating the variance. Additionally, we performed two sensitivity analyses and an exploratory analysis. First, we repeated the analyses using the Charlson Comorbidity Index (CCI)[23] as the measure of patient-specific risk instead of using the RCRI. Second, we repeated the analyses using the RCRI as the measure of patient-specific risk and also included indicator variables for each of the eight additional comorbidities (hypertension, hyperlipidemia, liver disease, thromboembolism, chronic pulmonary disease, atrial fibrillation, anemia, and dementia) that may affect the actual or perceived need for a preoperative testing. Finally, as an exploratory analysis, we repeated the main