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# Urinary Tract Infection after Colon and Rectal Resections: More Common than Predicted by Risk-Adjustment Models

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- BACKGROUND:** Urinary tract infections (UTIs) are the most common hospital-acquired infections in the United States. We hypothesized that the risk of UTI after colorectal surgery exceeds the risk after other gastrointestinal operations.
- STUDY DESIGN:** We used National Surgical Quality Improvement Program (NSQIP) data from 2005 to 2008 to compute rates of UTI after colorectal resections and other gastrointestinal and general surgery. We used a validated multivariate UTI prediction model to compare risk-adjusted rates of UTI by type of procedure. Then we identified predictors of UTI after colorectal resection using stepwise logistic regression models.
- RESULTS:** Crude UTI rates were significantly greater after colorectal resection (4.1%) than after other gastrointestinal (1.8%) or nongastrointestinal procedures (1.2%; all  $p < 0.001$ ). Even using standard risk-adjustment from the NSQIP, rates of UTI were significantly higher after segmental colectomy (2.8%; 95% CI 2.5% to 3.2%), total colectomy (3.5%; 95% CI 2.9% to 4.3%), proctectomy (3.5%, 95% CI 3.1% to 4.2%), proctocolectomy (4.6%, 95% CI 3.8% to 5.7%), and abdominoperineal resection (5.6%, 95% CI 4.6% to 6.8%) than after noncolorectal gastrointestinal surgery (2.6%, 95% CI 2.2% to 2.9%). Factors associated with UTI after colorectal resections include age, sex, functional status, American Society of Anesthesiologists class, and resection type.
- CONCLUSIONS:** Colorectal resections incur substantial risk of postoperative UTI, exceeding rates predicted by the NSQIP model. Because of their patients' unanticipated high incidence of UTI, surgeons with a specialty interest in colorectal surgery risk being flagged as "high outliers," particularly if they perform many rectal resections. A simple set of risk factors discriminates 10-fold differences in the rate of UTI after colorectal resection. (J Am Coll Surg 2011;213:784–792. © 2011 by the American College of Surgeons)
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Nosocomial urinary tract infections (UTIs) account for more than 35% of hospital-acquired infections in United States hospitals.<sup>1</sup> In addition to the substantial morbidity associated with UTIs,<sup>2</sup> patients who experience a UTI in

the inpatient setting have a 3-fold higher risk of mortality.<sup>3</sup> Outcomes reporting stimulated by organizations such as the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP),<sup>4</sup> has made prevention of postoperative complications, including UTI, a priority for many institutions. The Centers for Medicare and Medicaid Services have identified catheter-associated UTIs as a "preventable" hospital complication for which payment may be denied, raising the specter of large financial losses for hospitals subjected to nonpayment for this complication.<sup>5,6</sup> And the Joint Commission has designated the prevention of catheter-associated UTI a National Patient Safety Goal for 2012.<sup>7</sup> So, given the multiple incentives to reduce UTIs, evidence-based prevention strategies need to be developed for patients at highest risk.

In the NSQIP, colorectal surgery accounts for the greatest share of all postoperative morbidity and mortality in the general surgery cohort.<sup>8</sup> Although colorectal resections are

**Disclosure Information:** Authors have nothing to disclose. Timothy J Eberlein, Editor-in-Chief, has nothing to disclose.

**Disclaimer:** The ACS-NSQIP and the hospitals participating in the ACS-NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Presented at the American Society of Colon and Rectal Surgeons Annual Meeting, Vancouver, BC, Canada, May 2011.

Received June 27, 2011; Revised August 19, 2011; Accepted August 19, 2011.

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**Abbreviations and Acronyms**

ASA	= American Society of Anesthesiologists
NSQIP	= National Surgical Quality Improvement Program
UTI	= urinary tract infection

recognized as a high-risk group,<sup>8-10</sup> it is not clear whether their susceptibility to UTI derives from characteristics of the patients undergoing colorectal operations—and therefore amenable to equitable NSQIP risk adjustment at the patient level—or from procedure-specific characteristics, which would require additional adjustment for procedure-related risk. In the NSQIP, colorectal resections are included among a broad set of gastrointestinal and hepatobiliary operations that may not fully account for procedure-specific differences in risk within the category.<sup>11</sup> In this study, we sought to evaluate the adequacy of the NSQIP risk-adjustment algorithm for colorectal resections, and to define characteristics of colorectal surgery patients at highest risk for postoperative UTI. Identification of the highest risk patients could then lead to evidence-based efforts to reduce UTIs.

**METHODS****Data source**

We obtained the participant use data file from the American College of Surgeons NSQIP for the calendar years 2005 through 2008. The files contain deidentified data as defined by the Health Insurance Portability and Accountability Act Privacy Rule. The American College of Surgeons NSQIP and the hospitals participating in the quality improvement effort are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. Our study was considered exempt from human subjects review by the Lahey Clinic institutional review board.

A complete summary of the NSQIP sampling methods, data collection, and outcomes has been detailed previously.<sup>4,12</sup> Patients age 16 and over, undergoing inpatient or outpatient procedures with general, epidural, or spinal anesthesia, are eligible for inclusion. Trauma surgery, transplant surgery, vascular access surgery, and endoscopic-only procedures are excluded. The first 40 consecutive operations that meet inclusion criteria in each 8-day cycle are included, and no more than 5 inguinal herniorrhaphies and 5 breast biopsies are included in each 8-day cycle to ensure diversity of operations in the case mix. Trained nurse-reviewers retrospectively collect data on 135 variables, including preoperative risk factors, intraoperative variables,

and postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures, using standardized definitions to identify postoperative complications within 30 days of surgery.

**Patient and procedure selection**

We used the current procedural terminology codes for the primary procedure to classify each operation within 1 of 9 categories used for risk modeling in the NSQIP.<sup>11,13</sup> Using the current procedural terminology codes described by Ingraham and colleagues,<sup>14</sup> plus 2 codes for ileoanal pouch procedures available before 2007, we identified patients undergoing colon and/or rectal resections, and classified them as segmental colectomy (44139 to 44144, 44160, 44204 to 44206, 45402, 45550), proctectomy (44145 to 44147, 44207 to 44208, 45111 to 45119, 45123, 45130, 45135, 45397), total colectomy (44150 to 44151, 44210), proctocolectomy (44152 to 44158, 44211 to 44212, 45121), or abdominoperineal resection (45110, 45126, 45395). All other alimentary tract operations (codes 43500 to 49429 or 49650 to 4999) were classified as noncolorectal gastrointestinal surgery.

**Preoperative risk factors and postoperative outcomes**

We collected all preoperative risk factors included in the NSQIP risk-adjustment model for UTI in general surgery.<sup>15</sup> We treated missing laboratory data as discrete categories, in accordance with other studies using this dataset.<sup>14</sup> Procedural relative value units were calculated by linkage of current procedural terminology codes to listings from the 2008 Medicare Physician Fee Schedule.

The primary outcome was the occurrence of UTI within 30 days of the index operation. The NSQIP defines UTI as the presence of 1 clinical characteristic (fever, urgency, frequency, dysuria, or suprapubic tenderness) in the presence of a urine culture with more than  $10^5$  organisms, or 2 clinical characteristics in the presence of a positive urinalysis, gram stain, culture with  $10^2$  to  $10^5$  organisms, or physician's diagnosis of UTI.<sup>16</sup>

**Statistical analysis**

All analyses were performed using the SAS 9.2 statistical software package (SAS Institute). We analyzed categorical predictors using chi-square tests, and continuous variables using 2-sided *t*-tests. We constructed a multiple logistic regression model incorporating all 19 preoperative risk factors from the NSQIP UTI risk model in effect during the time of this study: age, sex, American Society of Anesthesiologists (ASA) physical status class, functional status, type

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