Predicting Complications Following Robot-Assisted Partial Nephrectomy with the ACS NSQIP® Universal Surgical Risk Calculator

Jared S. Winoker, David J. Paulucci, Harry Anastos, Nikhil Waingankar, Ronney Abaza, Daniel D. Eun,* Akshay Bhandari, Ashok K. Hemal, John P. Sfakianos and Ketan K. Badani†

From the Department of Urology, Icahn School of Medicine at Mount Sinai Hospital (JSW, DJP, HA, NW, JPS, KKB), New York, New York, Robotic Urologic Surgery, OhioHealth Dublin Methodist Hospital (RA), Columbus, Ohio, Temple University School of Medicine (DDE), Philadelphia, Pennsylvania, Division of Urology, Columbia University at Mount Sinai (AB), Miami Beach, Florida, and Wake Forest School of Medicine (AKH), Winston-Salem, North Carolina

Purpose: We evaluated the predictive value of the ACS NSQIP® (American College of Surgeons National Surgical Quality Improvement Program®) surgical risk calculator in a tertiary referral cohort of patients who underwent robot-assisted partial nephrectomy.

Materials and Methods: We queried our prospectively maintained, multi-institutional database of patients treated with robot-assisted partial nephrectomy and input the preoperative details of 300 randomly selected patients into the calculator. Accuracy of the calculator was assessed by the ROC AUC and the Brier score.

Results: The observed rate of any complication in our cohort was 14% while the mean predicted rate of any complication using the calculator was 5.42%. The observed rate of serious complications (Clavien score 3 or greater) was 3.67% compared to the predicted rate of 4.89%. Low AUC and high Brier score were calculated for any complication (0.51 and 0.1272) and serious complications (0.55 and 0.0352, respectively). The calculated AUC was low for all outcomes, including venous thromboembolism (0.67), surgical site infection (0.51) and pneumonia (0.44).

Conclusions: The ACS NSQIP risk calculator poorly predicted and discriminated which patients would experience complications after robot-assisted partial nephrectomy. These findings suggest the need for a more tailored outcome prediction model to better assist urologists risk stratify patients undergoing robot-assisted partial nephrectomy and counsel them on individual surgical risks.

Abbreviations and Acronyms

ACS = American College of Surgeons

ASA® = American Society of Anesthesiologists®

BMI = body mass index

BS = Brier score

COPD = chronic obstructive pulmonary disease

LOS = length of stay

NSQIP® = National Surgical Quality Improvement Program®

null-BS = null model BS

RAPN = robot-assisted partial nephrectomy

ROR = return to operating room

UTI = urinary tract infection

Editor's Note: This article is the second of 5 published in this issue for which category 1 CME credits can be earned. Instructions for obtaining credits are given with the questions on pages 946 and 947.

ROBOT-ASSISTED partial nephrectomy is a challenging procedure, particularly when there is complex tumor anatomy. Postoperative surgical complications following RAPN are reported in up to 30% of cases with a major (Clavien 3 or greater) complication rate of 3% to 6%.[1] The ability to identify patients at increased risk for complications may allow for preoperative management of modifiable factors and influence the choice of management. From a monetary perspective accurate risk stratification could translate to improved quality of the care delivered and to associated reimbursements. In a recent report CMS (Centers for Medicare and Medicaid Services) expressed interest in implementing new measures to tie surgeon remuneration to patient counseling, including a discussion of complication risks prior to elective procedures.[2]

Several risk calculators have been created and validated for a variety of surgical procedures.[3–6] ACS developed the first universal surgical risk calculator, which was built on preoperative and postoperative data on approximately 2.7 million operations performed at more than 500 NSQIP® participating hospitals in the United States between 2010 and 2014.[7–9] The calculator is an easily accessible online tool to predict individualized postoperative complications of more than 2,500 procedures based on patient specific factors. Demographic and comorbidity variables are input and the individual risk probability is returned for each of the 13 outcomes within 30 days after surgery.

To our knowledge the ACS NSQIP universal surgical risk calculator has not been validated for RAPN and little is known about the applicability of the tool to urological surgery. Our goal was to evaluate the predictive value of the calculator in a tertiary referral cohort of patients undergoing RAPN.

MATERIALS AND METHODS

Study Design
The ACS NSQIP surgical risk calculator is a free tool that is accessible online (http://riskcalculator.facs.org). To calculate predicted probability of postoperative complications the user interface requires inputting the CPT code for the planned procedure as well as patient and case specific information. Variables include age group, gender, BMI, ASA® class I to V, chronic steroid use (yes or no), diabetes (no, oral medication or insulin), hypertension requiring medication, congestive heart failure within prior 30 days, severe COPD and dialysis.

Several variables, including smoking status within 1 year of surgery and medication requirements of diabetes, were unknown or unavailable in our patients. All patients were assumed to be nonsmokers and all with diabetes were assumed to depend on oral medication. Other variables not explicitly available to us were answered the same for all patients. Specifically they were input into the calculator as functional status (independent), emergency case (no), ascites within prior 30 days (no), systemic sepsis within the prior 48 hours (no), dyspnea (no), ventilator dependence (no), disseminated cancer (no), dialysis (no) and acute renal failure (no).

Based on the individual patient data entered into the calculator the predicted risk probabilities of 13 surgical outcome categories were returned. Outcomes included any complication, serious complication (Clavien 3 or greater), pneumonia, cardiac complication (cardiac arrest or myocardial infarction), surgical site infection, UTI, venous thromboembolism, renal failure (progressive renal insufficiency or acute renal failure), readmission, ROR, death, discharge to a nursing or rehabilitation facility and LOS. Patient readmission, ROR and discharge to a facility were not specifically documented but rather were inferred from information in the database.

Patient Population
We randomly selected 300 patients from our prospectively maintained multi-institutional database of 1,260 treated with RAPN from 2008 to 2016 and entered those data into the calculator. Predicted rates of complications and actual rates of observed complications were recorded.

Statistical Analysis
Predicted probabilities and observed postoperative outcomes were recorded and compared for each mentioned complication category. All statistical analyses were performed with SPSS®, version 22.0.

Model Discriminability Receiver Operating Characteristic Analysis
Validation and evaluation of the predictive accuracy of the ACS NSQIP risk calculator were performed with the ROC AUC and BS. AUC ranges from 0 to 1. AUC positive predictive ability is interpreted as failure—0.5 to 0.59, poor—0.6 to 0.69, fair—0.7 to 0.79, good—0.8 to 0.89 or excellent—0.9 to 1.0.[10] The converse is true for AUC negative predictive ability, including failure—0.41 to 0.5, poor—0.31 to 0.4, fair—0.21 to 0.3, good—0.11 to 0.20 or excellent—0.0 to 0.10.

Model Calibration Brier Score
To evaluate calculator calibration, which is the agreement between observed outcomes and predictions across the range of predictions,[11] we compared the predicted risk probabilities from the calculator to binary outcomes of each complication using BS.[12] BS is a statistical test that calculates the mean squared difference (or error) between the predicted risk and the actual outcome of an event or complication. The score ranges from zero to 1 with a BS of zero indicating perfect prediction.