ARTICLE IN PRESS

UROLOGIC ONCOLOGY

Urologic Oncology: Seminars and Original Investigations ∎ (2017) ∎∎∎–∎∎∎

Original article

National Surgical Quality Improvement Program surgical risk calculator poorly predicts complications in patients undergoing radical cystectomy with urinary diversion

Shay Golan, M.D.[a,*], Melanie A. Adamsky, M.D.[a], Scott C. Johnson, M.D.[a], Nimrod S. Barashi, M.D.[a], Zachary L. Smith, M.D.[a], Maria V. Rodriguez, M.D.[a], Chuanhong Liao, M.S.[b], Norm D. Smith, M.D.[a], Gary D. Steinberg, M.D.[a], Arieh L. Shalhav, M.D.[a]

[a] *Department of Surgery, Section of Urology, University of Chicago, Chicago, IL*
[b] *Department of Public Health Sciences, University of Chicago, Chicago, IL*

Received 17 July 2017; received in revised form 12 September 2017; accepted 18 September 2017

Abstract

Purpose: To evaluate the accuracy of the American College of Surgeons National Surgical Quality Improvement Programs (ACS-NSQIP) surgical risk calculator in patients undergoing radical cystectomy (RC) with urinary diversion.

Materials and methods: Preoperative characteristics of patients who underwent RC with ileal conduit or orthotropic neobladder (ONB) between 2007 and 2016 were entered into the proprietary online ACS-NSQIP calculator to generate 30-day predicted risk profiles. Predicted and observed outcomes were compared by measuring Brier score (BS) and area under the receiver operating characteristic curve (AUC).

Results: Of 954 patients undergoing RC, 609 (64%) received ileal conduit and 345 (36%) received ONB. The calculator underestimated most risks by 10%–81%. The BSs exceeded the acceptable threshold of 0.01 and AUC were less than 0.8 for all outcomes in the overall cohort. The mean (standard deviation) predicted vs. observed length of stay was 9 (1.5) vs. 10.6 (7.4) days (Pearson's $r = 0.09$). Among patients who received ONB, adequate BS (<0.01) was observed for pneumonia, cardiac complications, and death. The receiver operating characteristic curve analysis revealed moderate accuracy of calculator for cardiac complications (AUC $= 0.69$) and discharge to rehab center (AUC $= 0.75$) among patients who underwent RC with ONB.

Conclusions: The universal ACS-NSQIP calculator poorly predicts most postoperative complications among patients undergoing RC with urinary diversion. A procedure-specific risk calculator is required to better counsel patients in the preoperative setting and generate realistic quality measures.

Keywords: Bladder cancer; Radical cystectomy; Complications; Risk calculator

1. Introduction

Radical cystectomy (RC) with urinary diversion remains the standard treatment for localized muscle invasive bladder cancer [1] or high risk, nonmuscle invasive urothelial carcinoma [2]. This complex procedure is associated with significant risk of morbidity and mortality even in high-volume centers [3]. Postoperative complications rates have been reported to be as high as 64% when a standardized reporting methodology has been used [4].

In addition to the high surgical complexity of RC, advanced age and multiple comorbidities, which often exist in bladder cancer patients, place them at increased risk for perioperative complications. Thus, patient selection is critical when balancing the benefits and potential harms of RC. Risk assessment tools can assist in clinical decision-

Funding: This research was supported by the National Center for Advancing Translational Sciences of the National Institutes of Health, United States, Grant no. UL1 TR000430.

* Corresponding author.
E-mail address:
shaygo1@gmail.com (S. Golan).

http://dx.doi.org/10.1016/j.urolonc.2017.09.015
1078-1439/

making and patient counseling. For example, the European Association of Urology (EAU) and the American Society of Clinical Oncology (ASCO) guidelines recommend using the Charlson comorbidity index before RC [5]. Other comorbidity indices, such as the American Society of Anesthesiologists (ASA) score, Elixhauser index and Eastern Cooperative Oncology Group (ECOG) performance status may be predictive of mortality after RC [6]. Although comorbidity and performance indices improve preoperative assessment, a surgical risk calculator, which can accurately predict the risk of specific complications in an individual patient, has a tremendous advantage. Furthermore, in a changing climate of healthcare payment models, reforms have been proposed which could link Medicare reimbursement at the hospital and physician level to quality indicators [7], which would include surgical complication rates. Thus, it is critically important to establish realistic quality measures.

In 2013, the American College of Surgeon's National Surgical Quality Improvement Program (ACS-NSQIP) published a surgical risk calculator, designed to estimate patient-specific complication risk [8]. The current version of the calculator was developed based on more than 2.7 million surgical procedures, performed between 2010 and 2014 in 586 medical centers [9]. It incorporates patient-specific clinical variables to predict 30-day postoperative outcomes of a surgical procedure, according to its current procedure terminology (CPT) code. Although a link to the calculator is provided by the American Urological Association (AUA) guidelines mobile application, its ability to predict surgical outcomes after RC has not been externally validated. We therefore sought to examine the ACS-NSQIP calculator's performance in a large RC cohort.

2. Material and methods

2.1. Patient population

After institutional review board approval, we identified 954 patients in our prospectively maintained database who underwent open RC with either ileal conduit (IC) or orthotopic neobladder (ONB) urinary diversion for bladder cancer between January 2007 and December 2016. Preoperative characteristics were obtained, in accordance with the parameters used by the ACS-NSQIP calculator. These include: age, sex, weight, height, functional status, smoking history, ASA performance score, hypertension, diabetes, congestive heart failure, cardiac event, dyspnea, ascites, steroid use, chronic obstructive pulmonary disease, dialysis, renal failure, systemic sepsis, ventilator dependence, disseminated cancer and whether the surgery was emergent or elective (see Appendix A for the definitions of preoperative variables). A CPT code was assigned to each case, according to the type of urinary diversion. "51595" was used for RC with IC and "51596" for RC with ONB. These codes were chosen to represent all the surgical components of the procedure; cystectomy, lymph nodes dissection, and the specific urinary diversion. Patients who underwent continent catheterizable urinary diversion (i.e., "Indiana Pouch") were not included due to lack of reliable CPT coding. The ACS-NSQIP calculator incorporates a feature that allows surgeons to increase the estimated risks based on their subjective impression—the surgeon adjustment score (SAS). In our study, SAS was defined as "1"—"no adjustment," for all patients.

The online calculator was used to obtain predicted 30-day postoperative complications rates for each patient. These complications included pneumonia, cardiac complication, surgical site infections (SSI), urinary tract infection (UTI), venous thromboembolism, renal failure, readmission, return to the operating room and death. The risk of experiencing any complication and any serious complication was calculated as well. Finally, the risk for discharge to a nursing facility and the predicted length of hospital stay (LOS) were calculated (see Appendix A for outcomes definitions). The observed complications rates were determined from our database.

2.2. Outcome measures and statistical analysis

We evaluated the performance of the calculator in terms of discrimination and calibration using the Brier score (BS) and the area under the receiver operating characteristic curve (AUC). The BS is a measure of calibration and discrimination (overall model performance) and is calculated as the average squared difference between the predicted probabilities and the observed rates of binary outcomes [10]. The BS ranges from zero (best forecast) to one (worst forecast) with 0.25 signifying a random forecast. A BS of less than 0.01 was considered to indicate good predictive performance [11]. The AUC (*c*-statistic) is a measure of discrimination that estimates the ability of the model to separate patients at risk of a certain outcome from patients not at risk. An AUC greater than 0.80 was considered good discrimination while less than 0.6 was considered poor discrimination and low accuracy of the model (i.e., sensitivity and specificity). Overestimation and underestimation of the actual complication rates were measured by calculating the percentage error between the calculator's prediction and observed complication rate. To assess the strength of the association between the predicted and the observed LOS, we used the Pearson's correlation.

Descriptive statistics are provided using means and standard deviation for normally distributed (Shapiro-Wilk W test) continuous variables and proportions for discrete variables. To assess for differences between discrete, ordinal and continuous variables, we used Pearson's chi-squared, Mann-Whitney U test, and the Student's t-test, respectively. Statistical tests were 2-sided and were considered statistically significant when $P < 0.05$. Analyses were