

Discriminative Ability of Commonly Used Indexes to Predict Adverse Outcomes After Radical Cystectomy: Comparison of Demographic Data, American Society of Anesthesiologists, Modified Charlson Comorbidity Index, and Modified Frailty Index

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Abstract

Given the high rate of adverse events after radical cystectomy, we evaluated the discriminative ability of commonly used comorbidity indexes and demographic factors for perioperative complications in patients undergoing radical cystectomy. We found the predictive ability of these factors to be universally poor, highlighting the need for newer models built to identify patients with a greater risk of adverse events after radical cystectomy.

Background: The American Society of Anesthesiologists physical status classification system, modified Charlson Comorbidity Index (mCCI), and modified Frailty Index have been associated with complications after urologic surgery. No study has compared the predictive performance of these indexes for postoperative complications after radical cystectomy (RC) for bladder cancer. **Materials and Methods:** Data from 1516 patients undergoing elective RC for bladder cancer were extracted from the 2005 to 2011 American College of Surgeons National Surgical Quality Improvement Program for a retrospective review. The perioperative outcome variables assessed were occurrence of minor adverse events, severe adverse events, infectious adverse events, any adverse event, extended length of hospital stay, discharge to a higher level of care, and mortality. Patient comorbidity indexes and demographic data were assessed for their discriminative ability in predicting perioperative adverse outcomes using an area under the curve (AUC) analysis from the receiver operating characteristic curves. **Results:** The most predictive comorbidity index for any adverse event was the mCCI (AUC, 0.511). The demographic factors were the body mass index (BMI; AUC, 0.519) and sex (AUC, 0.519). However, the overall performance for all predictive indexes was poor for any adverse event (AUC < 0.52). Combining the most predictive demographic factor (BMI) and comorbidity index (mCCI) resulted in incremental improvements in discriminative ability compared with that for the individual outcome variables. **Conclusion:** For RC, easily obtained patient mCCI, BMI, and sex have overall similar discriminative abilities for perioperative adverse outcomes compared with the tabulated indexes, which are more difficult to implement in clinical practice. However, both the demographic factors and the comorbidity indexes had poor discriminative ability for adverse events.

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Introduction

Predicting adverse outcomes after surgical procedures has become increasingly important in the current medical landscape. In the field of urologic oncology, radical cystectomy (RC) with urinary diversion represents a procedure with one of the greatest rates of morbidity, with 30-day postoperative complications occurring in 50% to 60% of patients.^{1,2} A review of the Premier Healthcare Database in the United States reported that ~84% of the cost variation for RC results from postoperative complications.³ These costs only underscore the importance for surgeons to be better able to identify those patients at greatest risk of complications.

Several tools have been used to assist in preoperative surgical risk stratification and are used routinely in urologic clinical practice. The American Society of Anesthesiologists (ASA) physical status classification system has been used to measure the physiologic reserve of patients when they are considered for surgery, independent of the type of surgical procedure^{4,5} and has been shown to be associated with overall survival and the 90-day cystectomy complication rate⁶ and 30-day morbidity.⁷ The modified Frailty Index (mFI) evaluates 11 comorbidities and functional status as a preoperative risk assessment tool.⁸ The mFI has been validated for prostatectomy, nephroureterectomy, and nephrectomy for 30-day mortality and the incidence of Clavien-Dindo IV (CDIV) complications.⁹ The Charlson Comorbidity Index (CCI) assesses the prognostic effects of a patient's comorbid conditions¹⁰ and has been shown to be significantly associated with predicting overall survival after disease recurrence for patients undergoing RC.¹¹

Although many studies have examined the risk factors for the occurrence of complications after urologic surgery, limited data are available comparing the utility of these 3 commonly used tools. Using the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database, our primary study aim was to compare the discriminative ability of the ASA, CCI, and mFI with the occurrence of postoperative adverse outcomes in patients undergoing RC. Our secondary aim was to evaluate the discriminative ability of demographic variables (eg, age, body mass index [BMI], and sex) for the same postoperative adverse outcomes. Our results will aid in the identification of patients at greater risk of postoperative complications after surgical management, leading to appropriate changes in treatment strategies for this selected group of patients.

Materials and Methods

Sample

The data for the present study were extracted from the American College of Surgeons NSQIP database from 2005 to 2011. The NSQIP is large, national data set with data submitted by > 500 hospitals for > 300 demographic, pre- and postoperative patient variables, with postoperative follow-up data to 30 days available. Data quality is ensured through rigorous inter-rater reliability testing, with an approximate 98% agreement in total.¹² Patients were selected for inclusion in the study by the diagnosis of bladder cancer, defined by International Classification of Diseases, 9th revision, codes 188.0 to 188.9, and performance of RC, defined by Current Procedural Terminology code 51590, 51595, or 51596. No exclusion criteria were used.

Predictor Variables

The demographic variables extracted from NSQIP included age, BMI, and sex. The ASA classification is provided by NSQIP and was directly extracted. To calculate the modified CCI (mCCI), we extracted cerebrovascular disease (defined as cerebrovascular accident [CVA]/stroke with or without a neurologic deficit), chronic pulmonary disease (defined as history of severe chronic obstructive pulmonary disease), congestive heart failure within 30 days before surgery, myocardial infarction (MI) within 6 months before surgery, peripheral vascular disease (defined as a history of revascularization or amputation for peripheral vascular disease or pain at rest or gangrene), diabetes mellitus treated with oral agents or insulin, hemiplegia, renal disease (defined as acute renal failure), liver disease (defined as ascites or esophageal varices), and metastatic solid tumor (defined as disseminated cancer). Tumors without metastases are not recorded in the NSQIP; therefore, they were not factored into the mCCI.

The mFI was calculated based on cerebrovascular problems (defined as a history of angina within 1 month before surgery), respiratory problems (defined as current pneumonia or a history of severe chronic obstructive pulmonary disease), congestive heart failure, MI, a decreased peripheral pulse (defined as a history of revascularization or amputation for peripheral vascular disease), arterial hypertension (requiring medication), cardiac problems (defined as cardiac arrest requiring cardiopulmonary resuscitation, previous percutaneous coronary intervention, or previous cardiac surgery), changes in everyday life (defined as partially dependent, totally dependent, or unknown functional health status before surgery), clouding or delirium (defined as impaired sensorium), history of stroke (defined as CVA/stroke with a neurologic deficit or a history of transient ischemic attacks), and history of diabetes mellitus. The definitions and method used to calculate the respective comorbidity indexes are presented in Table 1.

Outcomes

The primary outcomes of interest in the present study were adverse events within the 30 days after surgery. A serious adverse event was defined as ≥ 1 of coma > 24 hours, cardiac arrest requiring cardiopulmonary resuscitation, death, deep vein thrombosis/thrombophlebitis, MI, unplanned intubation, pulmonary embolism, return to the operating room, sepsis, or stroke/CVA. A minor adverse event was defined as ≥ 1 of the following: acute kidney injury, bleeding/transfusion, pneumonia, surgical site infection, urinary tract infection, and/or wound dehiscence. We also examined infectious adverse events separately, which we defined as ≥ 1 of the following: surgical site infection, urinary tract infection, pneumonia, and/or wound dehiscence.

Secondary outcomes included extended length of stay (defined as days in the hospital exceeding the 75th percentile in the sample), mortality, and discharge to a higher level of care, including rehabilitation, separate acute care, skilled care (not at home), or unskilled facility (not at home).

Statistical Analysis

To evaluate the discriminative ability, we calculated the area under curve (AUC) of the receiver operating characteristic curve for each

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