

Clinical Science

# Assessing the predictive accuracy of the American College of Surgeons National Surgical Quality Improvement Project Surgical Risk Calculator in open ventral hernia repair



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Hernia repair;  
Surgical outcomes;  
Risk modeling;  
Risk stratification;  
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## Abstract

**BACKGROUND:** Preoperative surgical risk assessment continues to be a critical component of clinical decision-making. The ACS Universal Risk Calculator estimates risk for several outcomes based on individual risk profiles. Although this represents a tremendous step toward improving outcomes, studies have reported inaccuracies among certain patient populations. This study aimed to assess the predictive accuracy of the American College of Surgeons' (ACS) Risk Calculator in patients undergoing open ventral hernia repair (VHR).

**METHODS:** A review of patients undergoing open, isolated VHR between 7/1/2007 and 7/1/2014 by a single surgeon was performed. Risk factors and outcomes were collected as defined by National Surgical Quality Improvement Project. Thirty-day outcomes included serious complication, venous thromboembolism, medical morbidity, surgical site infection (SSI), unplanned reoperation, mortality, and length of stay (LOS). Patient profiles were entered into the ACS Surgical Risk Calculator and outcome-specific risk predictions recorded. Prediction accuracy was assessed using the Brier score and receiver-operator area under the curve (AUC).

**RESULTS:** One hundred forty-two patients undergoing open VHR were included. ACS predictions were accurate for cardiac complications (Brier = .02), venous thromboembolism (Brier = .08), reoperation (Brier = .10), and mortality (Brier = .01). Significantly, underestimated outcomes included SSI (Brier = .14), serious complication (Brier = .30), and any complication (Brier = .34). Discrimination ranged from highly accurate (mortality, AUC = .99) to indeterminate (SSI, AUC = .57). Predicted LOS was 3-fold shorter than observed (2.4 vs 7.4 days,  $P < .001$ ).

The authors declare no conflicts of interest.

This study was reviewed and approved by the institutional review board at the Hospital of the University of Pennsylvania.

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**CONCLUSIONS:** The ACS Surgical Risk Calculator accurately predicted medical complications, reoperation, and 30-day mortality. However, SSIs, serious complications, and LOS were significantly underestimated. These findings suggest that additional considerations are needed to better estimate complications after open VHR.

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Incisional ventral hernias complicate 10% to 20% of intra-abdominal surgeries and continue to challenge even the most experienced surgeons.<sup>1,2</sup> Outcomes are determined by a complex interplay of patient comorbidities and intra-operative characteristics, and with the generally high-comorbid burden of the typical patient and the increasingly complex abdominal wall defects being treated today, surgical morbidity remains unacceptably high.<sup>3–5</sup> Moreover, patients with failed hernia repairs are significantly more likely to recur with future attempted repairs. The health care economic burden for ventral hernia, as a result, is estimated at a staggering \$3.2 billion annually.<sup>5,6</sup>

Surgical risk assessment in the preoperative setting represents a quickly growing area of interest and a potential opportunity to intervene at the population level to improve outcomes in a cost-efficient manner.<sup>7</sup> The American College of Surgeons' (ACS) Universal Surgical Risk Calculator aims to better inform individual patient surgical risk for a given procedure by incorporating comorbid risk profiles and operative characteristics.<sup>8</sup> This tool has a wealth of advantages, including robust statistical methodology, wide applicability to a range of procedures, and a relatively facile user interface.<sup>9</sup>

Without question, the advent of the ACS Risk Calculator is a tremendous step toward improving patient outcomes. However, recent studies have demonstrated that the Risk Calculator may have some shortcomings in predicting outcomes for various patient populations and surgical procedures, particularly regarding serious complications and hospital length of stay (LOS).<sup>10,11</sup> Because public access was granted only recently, few validation studies exist that assess the predictive accuracy of the ACS Risk Calculator. With the potential consequences regarding patient outcomes as well influence on insurance reimbursement policy, critical analysis of the Surgical Risk Calculator's performance is urgently needed across a broad range of patients and operations.<sup>12</sup> The purpose of this study was to assess the ability of the ACS Risk Calculator to predict 30-day complication risk in patients undergoing open ventral hernia repair (VHR).

## Methods

### Study design

After receiving institutional review board approval, retrospective review of a prospectively maintained hernia database was conducted of all patients undergoing open

VHR performed by the senior author (S.J.K.) in consecutive fashion between 6/2007 and 6/2014. Adult patients were included if an isolated VHR was done via an open approach for any indication. With the exception of lysis of adhesions, patients undergoing concurrent procedures such as bowel resection, ostomy manipulation, other intra-abdominal surgeries, or panniculectomy were excluded from analysis. Similarly, patients were excluded if preoperative data or outcomes were missing or if there was no documentation of 1-month follow-up. Current Procedural Terminology codes considered were: 49,560/49,565 (repair initial/recurrent incisional or ventral hernia; reducible) and 49,561/49,566 (repair initial/recurrent incisional or ventral hernia; incarcerated or strangulated). The Surgeon Adjustment of Risks option of the ACS Risk Calculator was kept at '1 = no adjustment necessary' for all predictions. All data were entered into the ACS Risk Calculator website and predicted outcome probabilities recorded for each patient.<sup>8</sup>

### ACS-defined patient and operative characteristics

Baseline demographic and comorbidity data were classified according to ACS National Surgical Quality Improvement Project (NSQIP)–supplied definitions.<sup>13</sup> Wound classification was defined by Centers for Disease Control parameters<sup>14</sup> and American Society of Anesthesiologists physical status was recorded.<sup>15</sup> Factors considered present if documented within 30 days before surgery included steroid use for chronic medical condition, ascites, hypertension requiring medication, congestive heart failure, and dyspnea. Factors requiring documentation within 48 hours before surgery included systemic infection (systemic inflammatory response syndrome, sepsis, or septic shock), ventilator dependence, and acute renal failure. Previous cardiac events considered were myocardial infarction within 6 months before surgery, percutaneous coronary intervention at any time, angina within 1 month before surgery, or any cardiac surgery aside from pacemaker/defibrillator insertion, and smoking was considered if within 1 year of surgery. For all comorbidities, guidelines set forth by the Agency for Healthcare Research and Quality were used.<sup>16,17</sup> Additional perioperative variables collected included etiology of ventral hernia, prior wound infections, and operative details of any previous VHRs. The Ventral Hernia Working Group (VHWG) classification was used to grade hernias.<sup>18</sup> Operative notes were queried for use of mesh during VHR, type

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