Bringing Quantitative Risk Assessment Closer to the Patient and Surgeon
A Novel Approach to Improve Outcomes

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Keywords: quantitative risk assessment, surgical outcomes, surgical risk (Ann Surg 2016;xx:xxx–xxx)

Two recently published studies raise serious questions about the effectiveness of the current use of risk-adjusted outcomes comparison (VASQIP/NSQIP) in reducing perioperative mortality, morbidity, and costs.1,2 In this Perspectives article, we provide historical background, discuss the limitations, and offer a new paradigm for the application of quantitative risk assessment to the care of the surgical patient.

BACKGROUND
Risk assessment is fundamental to the practice of medicine and surgery. Most therapies carry an inherent risk of an adverse outcome. It is the care provider’s responsibility to assess this risk relative to the potential benefits of the proposed therapy and convey this information to the patient. It has been implicit knowledge for centuries that the patient’s condition (eg, age, comorbidity, etc.) is closely associated with the risk of an adverse outcome. Statistical techniques (eg, multivariable regression analyses) have been used since the 1970s to assess and order risk factors according to predictive power.3 Beginning in 1987, multivariable models were implemented in 44 Department of Veterans Affairs hospitals performing cardiac surgery to adjust 30-day operative mortality and morbidity for differences in preoperative risk factors.3 The conclusion is that much of the previously reported associations—again using regression models—are the result of temporal bias—that is, improvement in outcomes over time with or without intervention.

The current system of surgical outcomes evaluation, be it through the VASQIP, ACS NSQIP, Society of Thoracic Surgeons databases, or other such databases, has limitations.10 We believe a next generation of such surgical outcomes evaluation methods can surmount these limitations (Table 1); the following expansion on these concepts can provide direction for the future applications of quantitative assessment of patient risk:

- Delay and expense of data collection: the necessary collection of risk and outcomes data is mostly via manual chart abstraction by trained, surgical clinical reviewers after the completion of the episode of care and a 90-day postoperative window. Subsequent risk-adjustment results in a 6-month or longer delay from the episode of care to between-hospital comparisons of risk-adjusted outcomes. The expense of the data collection limits most hospitals to a single surgical clinical reviewer, who can manually abstract about 1600 records/year, a minority of procedures at larger volume hospitals. These costs are probably a significant factor in limiting ACS NSQIP adoption to only 10% to 15% of US acute care hospitals.
- Limited care provider involvement: although the ACS NSQIP requires the participation of a physician champion, it is likely that involvement by many of the other surgeons at participating hospitals requires the participation of a physician champion, it is likely that involvement by many of the other surgeons at participating hospitals.
hospitals is minimal, whereas other members of the surgical team (eg, anesthesia providers and operating room and intensive care unit nurses) are unlikely to have any involvement, therefore rarely seeing the between-hospital risk-adjusted data comparisons.

- No patient involvement: in this era of patient-centered care, there is essentially no patient involvement, because of the time lag in data availability.

Changing the Preoperative Evaluation Paradigm

The same risk and outcomes data can be used to quantitatively assess individual patient risk preoperatively. This is likely to be useful for informed consent, shared decision making, preoperative interventions to minimize risk of adverse outcomes, and perioperative planning. However, we are unaware of any comprehensive and sustained programs achieving this, the burden of data collection likely being a major factor. We propose a new paradigm for the preoperative evaluation of the patient: the incorporation of quantitative risk estimates with an emphasis on integrating the patient and family into the process. However, there are several barriers to be overcome to achieve successful implementation of quantitative preoperative risk assessment.

- Burden of data collection: expecting the surgical team to enter values for the 21 data items in the current ACS NSQIP universal risk model,11 or more in other models, is unrealistic in the current era of compressed clinical time. Instead, parsimony of the number of data elements and the number of separate models required to broadly cover surgical procedures should be the goal. Electronic extraction of much of the required data from the electronic health record (EHR) could minimize the burden of data collection during the busy clinic encounter. As described in future articles by our group, we have conducted analyses of the ACS NSQIP Participant Use Files showing little to no decrement in predictive model discrimination or calibration with a reduction in risk (independent variables) from 28 to 8. The ability of a model to discriminate between the occurrence and nonoccurrence of an adverse outcome is commonly measured with the C-index, which can vary between 0.5 (no discrimination) and 1.0 (perfect discrimination).12 The calibration of a model or goodness-of-fit is a measure of how close the predicted values are to the corresponding observed values. This is often shown as a plot of the expected vs observed values by decile of risk. These analyses show little or no difference in discrimination or calibration for a parsimonious set of the same 8 risk variables used as the independent variables in 8 risk models varying by dependent variable (eg, mortality, ≥1 complication or empirically defined clusters of complications) compared to using up to 28 risk variables. This is possible because (1) there is usually redundancy in predictive capability when a risk model contains more than a few variables as shown previously by Dimick et al13; (2) a generic model encompassing all surgical specialties has similar discrimination and calibration to surgeon specialty-specific models; (3) inclusion of preoperative laboratory values does not add significant improved discrimination or calibration; and (4) we have applied factor analysis to group 18 perioperative complications into 6 data-supported clinically meaningful clusters.

- Incorporation into the EHR: care providers are now required to use the EHR to compute the risks for adverse outcomes, and incorporate the results into the preoperative note/record—

| TABLE 1. Comparison of Current NSQIP Surgical Risk-adjusted Outcomes Evaluation and Proposed Enhancements Resulting in a System for Universal Quantitative Preoperative Risk Assessment |
|-----------------|--------------------------------------------------|
| Limitations to Current Use of Risk-adjusted Surgical Outcomes | Proposed Solutions Resulting in Preoperative Quantitative Risk Assessment |
| Limitation 1: covers a small proportion of patients and operations | Solution 1: cover all patients undergoing operations |
| Limitation 2: significant, costly data collection burden with a plethora of separate models for multiple outcomes, each in a different specific surgical population (For example, the July 2015 ACS NSQIP Interim Semiannual Report Supplement has up to 47 risk variables, 23 outcomes, and 397 risk models) | Solution 2: data-driven parsimony in risk variables (as few as 8) and risk models covering multiple outcomes and a broad range of operations and surgical specialties |
| Limitation 3: does not make use of the EHR | Solution 3: electronic abstraction of a majority of the required risk variables from the EHR, compute the risks for adverse outcomes, and incorporate the results into the preoperative note/record |
| Limitation 4: infrequent sharing of data with surgical staff and patients | Solution 4: use data preoperatively to prospectively inform patients/families of risks and surgical team to optimize care of the patient |
| Limitation 5: may not reduce adverse surgical outcomes | Solution 5: patient-centered care focus: Identifies high risk patients preoperatively for enhanced informed consent and implementation of care processes to reduce adverse outcomes |

CONCLUSIONS

We have summarized some of the limitations of current risk-adjustment quality assessment and improvement programs and proposed enhancements that should make routine quantitative preoperative risk assessment feasible (Table 1). However, such a preoperative...
risk assessment is not intended to replace risk-adjusted outcomes quality improvement programs, because it does not provide for institutional-level outcomes assessment. We expect that quantitative preoperative risk assessment facilitated by parsimony in the required data can be implemented clinically, resulting in reduced data collection costs; expansion of the patient population assessed; and enhanced and patient-centered informed consent. We believe that adopting a new paradigm of real-time, patient-centered outcomes assessment may successfully stand on the shoulders of the current generation of surgical outcomes efforts to effectively reduce surgical morbidity and mortality leading to containment of costs of care.

REFERENCES