

Using Quality Improvement Databases to Advance Medical Knowledge

Opportunities and Challenges

Good outcome measures are vital feedback indicating what works and what does not. Every thriving sector of the economy harnesses this kind of information to spur learning. Health care is the outlier.¹

BUSINESS strategy experts Michael E. Porter and Elizabeth Olmsted Teisberg have recently proposed a model for change in American health care that emphasizes the power of improvements in quality to create a more efficient and less costly system of care. In their view, the systematic assessment of clinical results is fundamental to any such change.^{1,2} In this issue of ANESTHESIOLOGY, Kheterpal *et al.* draw novel insights into postoperative acute kidney injury (AKI) in general surgical patients from data collected by the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), a rigorous, validated outcomes monitoring project.³ The work of Kheterpal *et al.* casts new light on the risks and outcomes associated with AKI, demonstrating the great potential and the fundamental challenges of using quality-improvement databases to advance medical knowledge.

Porter and Teisberg point to ACS-NSQIP as the type of clinical results database that "should become the norm for the treatment of every medical condition."² Originating in an effort to improve the quality of surgical care in U.S. Veterans Administration medical centers,⁴ ACS-NSQIP has since been adapted for use in a range of nongovernmental institutions.⁵ Over 200 U.S. medical centers, including community facilities and tertiary care hospitals, now participate voluntarily in the program's structured, prospective monitoring of sampled surgical cases. Trained nurse data collectors obtain detailed information on patient and procedure variables extending from the preoperative period to 30 days postoperatively.⁵ Risk-adjusted outcome data provided by ACS-NSQIP has been used for quality improvement by participating hospitals and health systems⁶; research using aggregated ACS-NSQIP data has provided risk models for the development of specific postoperative complications^{7,8} and estimates of operative morbidity and mor-

tality in U.S. Veterans' Administration hospitals and university medical centers.^{9,10}

Kheterpal *et al.* examine ACS-NSQIP data from more than 150,000 surgical cases performed at 121 sites in 1 yr, describing the risk factors and 30-day mortality associated with AKI after general surgical procedures. Excluding cardiac and vascular operations, where the risk of postoperative renal failure is well established,¹¹ they observe a 1% incidence of AKI after general surgery. Through logistic regression modeling, Kheterpal *et al.* define a set of independent predictors of postoperative AKI and derive a prognostic risk score. As they describe, presence of six or more risk factors was associated with an 8.9–9.5% incidence of postoperative renal failure, compared to a 0.2% incidence associated with zero to two risk factors. Development of postoperative AKI was associated with a 30-day mortality of 42%, compared to a control mortality of 8.6% ($P < 0.001$), highlighting AKI as a grave prognostic indicator.³

Does the ability to better predict risk help us to improve the quality of care? The answer is complex. Some risk factors for AKI, like gender and age, are not modifiable, and it is unknown if optimization of other risk factors, such as diabetes or hypertension, can reduce the risk of renal injury. Aside from the avoidance of known nephrotoxins, practitioners still lack proven strategies for renal protection in general surgical patients at high risk for AKI.^{11,12} Nonetheless, the ability to predict risk is an essential step in the assessment and improvement of quality. Improved prediction models will allow patients, practitioners, administrators, insurers, and regulators to make more meaningful comparisons of outcomes between hospitals through better risk-adjustment. Improved tools for risk-stratification will allow future studies of renal-protection interventions to target high-risk patients. Kheterpal's study provides insight into possible avenues for further investigation by highlighting modifiable risk factors for AKI such as hypertension, diabetes, and congestive heart failure.

Kheterpal's analysis relies on the rigorous follow-up of ACS-NSQIP, which provides 30-day outcome data for all patients in the study cohort. As perioperative outcomes research comes to focus on complex, multifactorial outcomes, such as renal failure and postoperative cognitive dysfunction,¹³ researchers and clinicians alike will require a detailed understanding of clinical results beyond hospital discharge. Reliable methods to monitor outcomes at 30 days and beyond are thus central to any meaningful effort at perioperative quality improvement. As Kheterpal's work demonstrates, the consistent 30-day

This Editorial View accompanies the following article: Kheterpal S, Tremper KK, Heung M, Rosenberg AL, Englesbe M, Shanks AM, Campbell DA Jr: Development and validation of an acute kidney injury risk index for patients undergoing general surgery: Results from a national dataset. ANESTHESIOLOGY 2009; 110:505–15.

Accepted for publication November 3, 2008. The authors are not supported by, nor maintain any financial interest in, any commercial activity that may be associated with the topic of this article.

follow-up of ACS-NSQIP underpins its value as a quality improvement tool and as the basis for meaningful research on complications whose consequences extend beyond the window of hospitalization.

Despite these strengths, the current study is inherently limited by challenges common to any analysis of such a database as the ACS-NSQIP. As with any examination of observational data, associations between risk factors and outcomes in the ACS-NSQIP dataset are subject to the influence of unmeasured confounding variables. The ACS-NSQIP dataset lacks several categories of potentially important patient data, such as intraoperative hemodynamics, fluid management, urine output, and nephrotoxin exposure. Although the associations that can be drawn from ACS-NSQIP data may greatly inform our understanding of a disease process, the potentially confounding effects of unmeasured variables limit our ability to establish causality between risk factors and clinical outcomes.

A further challenge presented by the ACS-NSQIP lies in its design as a quality-improvement tool rather than a protocol-driven research instrument, as the data it collects vary according to patient factors and individual physician practices. Importantly for the present study, a preoperative serum creatinine value was not available for 9.4% of patients. As the definition of AKI here relies, in part, on a rise in creatinine from a preoperative value, the large fraction of patients without baseline measurements represents an important source of potential bias. Through a rigorous analysis, the authors convincingly demonstrate a minimal impact of these missing values on their study results. Still, the challenge of assessing and quantifying the impact of missing information represents a major hurdle in adapting quality-improvement data to research seeking valid answers to study questions.

These challenges are common limitations of research using quality-monitoring databases. Beyond rigorous methods of study design and statistical analysis, the solution to such dilemmas ultimately lies in developing the quantity and quality of data made available through efforts such as ACS-NSQIP. With the development and spread of electronic medical records and anesthesia information management systems, the future of operative outcomes research may lie in the ability to link the detailed measurement of intraoperative variables with rigorous, prospectively collected postoperative information.

In their analysis of ACS-NSQIP data, Kheterpal *et al.* thus adapt a powerful quality-measurement tool to advance our understanding of AKI after general surgery. The power of ACS-NSQIP as a research tool and the value of the analysis by Kheterpal *et al.* embody important aspects of the promise that Porter and Teisberg envision in the spread of

systematic results monitoring in healthcare.¹ For anesthesiologists, the strengths of ACS-NSQIP and the work of Kheterpal *et al.* should come as a call to support the development of systems to reliably measure patient outcomes beyond the immediate postoperative period. Further, by supporting implementation of anesthesia information management systems and working to link intraoperative data with postoperative outcome measurement, anesthesiologists can contribute to a more complete understanding of the interplay of physiology, intraoperative management, and patient outcomes. Through such efforts, anesthesiology as a specialty has the opportunity to move medicine away from its status as an outlier among developed industries and towards a model of practice in which the rigorous measurement of clinical results fosters learning and contributes to safer patient care.

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