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Advances in perioperative quality and safety

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ABSTRACT

For decades, safe surgery focused on intraoperative technique and decision-making. The traditional hierarchy placed the surgeon as the leader with ultimate authority and responsibility. Despite the advances in surgical technique and equipment, too many patients have suffered unnecessary complications and suboptimal care. Today, we understand that the conduct of safe and effective surgery requires evidence-based decision-making, multifaceted treatment approaches to prevent complications, and effective communication in and out of the operating room. In this manuscript, we describe three significant advances in quality and safety that have changed the approach to surgical care: the National Surgical Quality Improvement Program, evidence-based bundled prevention of surgical site infections, and the Surgical Safety Checklist.

The National Surgical Quality Improvement Program – Pediatrics

History of NSQIP

The National Surgical Quality Improvement Program (NSQIP) has played a significant role in the transformation of surgical care by emphasizing the importance of data and transparency. Originally developed as a quality improvement program at the Veterans Health Administration, NSQIP was designed to examine surgical outcomes through developing risk-adjusted models for non-cardiac procedures.

In 1986, Congress called for a formal evaluation of surgical morbidity and mortality at the Veterans Health Administration (VA).[1] As a result of this mandate, the National VA Surgical Risk Study (NVASRS) was initiated in 1991. This was a prospective observational study that aimed to characterize patient risk factors, operative details, and perioperative complications for patients undergoing non-cardiac surgical procedures at 44 VA hospitals.[2] Following study completion, the NVASRS was further implemented at all VA medical centers that performed surgery, achieving great success, with a 47% reduction in mortality and 43% reduction in morbidity within 30 days of surgery.[3] The name of the program was subsequently changed to the VA NSQIP.

In 1999, NSQIP was expanded to non-VA centers by the American College of Surgeons (ACS) through a pilot program funded by the Agency for Healthcare Research and Quality.[3] Three non-VA centers (Emory University, University of Kentucky, and University of Michigan) implemented NSQIP and compared their patient outcomes to VA patients' data. The NSQIP model for postoperative mortality was applied to the non-VA patients and demonstrated excellent predictive power (AUC 0.94 for general surgery, 0.92 for vascular surgery).[4] NSQIP was then adopted by the ACS and was expanded to the private sector. Today, ACS NSQIP for adult surgical care provides comparative data for process improvement of surgical mortality and morbidity by collecting over 100 variables representing preoperative risk factors, intraoperative variables, and 30-day outcomes.

NSQIP pediatrics

Following the success of the ACS NSQIP in the adult population, there was significant interest in developing a similar program for children's surgery. Through collaboration with the American Pediatric Surgical Association and ACS, the ACS NSQIP Pediatric was developed.[3] Unlike adult NSQIP, ACS NSQIP Pediatric was designed to include pediatric subspecialties from the start, including

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otolaryngology, orthopedic surgery, plastic surgery, neurosurgery, urology, gynecology, and general and thoracic surgery. In 2008, a 1-year pilot program was initiated at 4 academic, tertiary children's hospitals to evaluate and refine variables and data collection.[5,6] In 2010, ACS NSQIP Pediatric expanded its program to include 29 institutions in the program's second phase, with the aim of developing and validating models to stratify outcomes based on potential risk factors.[7] During the year-long second phase, data for over 37,000 patients were collected with greater than 90% 30-day follow up. These data were used to generate risk-stratified models allowing a comparison of outcomes for each hospital with regard to pediatric mortality as well as providing national benchmarks for clinically relevant outcomes.[7] After validation of the risk-adjusted model, the ACS NSQIP Pediatric became available to all children's hospitals and currently has over 100 participating hospitals.

ACS NSQIP pediatric methodology

The NSQIP database is comprised of over 120 variables from the preoperative period to 30-day outcomes. The foundation of NSQIP lies in strict and consistent variable definitions. A Surgical Clinical Reviewer (SCR) trained by NSQIP collects these variables, and SCRs undergo annual audits for at least 95% abstraction accuracy. Intra- and inter-hospital collaborations by SCRs provide group learning that minimizes definitional variability over time.

Cases are sampled systematically to limit high volume procedures (such as appendectomy and tonsillectomy), capture low volume procedures (such as congenital diaphragmatic hernia and tracheoesophageal fistula repairs), and limit selection bias. Trauma, cardiac and transplant procedures are excluded from ACS NSQIP Pediatric.[3,6] Risk-adjusted hospital level reports are released by the ACS NSQIP on a semiannual basis. Risk-adjustment is performed using outcome-based regression models that are publically available at https://riskcalculator.facs.org/peds/. For example, the estimated risk of any complication for a patient undergoing surgery for esophageal atresia with tracheoesophageal fistula is around 25%, with a mortality risk approaching 5% (Fig. 1). This tool can be beneficial for informed consent as well as counseling patients and parents on risks specific to the individual patient.

For surgeons at participating hospitals, more personalized data is available. Observed-to-expected ratios are provided in tables for each complication with clear identification of better or worse than expected performance. Hospital-level performance over time is also provided to help identify areas for improvement. For example, a group in the Kaiser Permanente Northern California system used their NSQIP semiannual reports to identify prolonged intubations as an area for improvement. Using quality improvement methodology, they established a team with stakeholders, mapped out issues contributing to prolonged intubation, and identified interventions to reduce the length of intubation. In 12 months, the number of patients intubated longer than 48 hours approached the national benchmark. A similar approach was taken to reduce their rate of postoperative pneumonia, and after 7 months had improved their rate to zero.[8]

Through ACS NSQIP Pediatric, procedures with high risk of morbidity and mortality have been identified. Examples of these procedures include: appendectomy, tracheostomy, and ventriculoperitoneal shunts. Targeted collection of these procedures with specific variables was initiated to further study these entities and gain insight to areas for potential improvement.

Advantages and limitations of ASC NSQIP Pediatric

There are several distinct benefits of the methodology of NSQIP and access to multi-level outcomes data that enhance quality improvement efforts. Uniform collection of clinically abstracted data is superior to administrative or billing data available through the Pediatric Health Information System, Kids' Inpatient Database (KID), or from Center for Medicare and Medicaid Services. In a study by Lin et al., patient data from KID was compared to ACS NSQIP Pediatric, which demonstrated more complete capture of blood transfusion in ACS NSQIP Pediatric.[9] NSQIP data can also be used to augment traditional morbidity and mortality conference which has been shown to underestimate the incidence of post-operative complications.[10,11] NSQIP also provides participating centers with a participant use file that has been used to develop a risk assessment tool to predict patient mortality with high reliability.[12] Similarly, models to predict surgical site infection (SSI) with improved risk stratification over traditional methods such as surgical wound class have been developed.[13] These data have been used to identify patients at increased risk for complications, which would benefit from future research efforts and quality improvement. In a study by Bucher et al., neonates were identified as having two-times greater odds of death and 20% greater odds of having perioperative morbidity compared to non-neonates.[14]

Increased transparency of data through NSQIP and emphasis on quality improvement has helped to spark collaboration amongst centers that typically compete locally. Several state and regional collaboratives have formed and many have been able to leverage financial support for quality improvement efforts from insurers.[15] These collaboratives have studied many areas within and achieved significant improvements in evidence-based practices and reduction in SSI.[16–18]

Continued challenges in pediatric surgery (and ACS NSQIP Pediatric) include the overall low complication and mortality rates in a wide breath of cases combined with limited sample sizes for cases with higher morbidity and mortality rates.[19] For example, there were only 125 patients who underwent myelomeningocele repair in 2013 out of over 60,000 patients collected from over 50 ACS NSQIP Pediatric hospitals.[20] Although the case sampling method of ACS NSQIP Pediatric is designed to reduce selection bias, only a small fraction of the cases performed at an institution are submitted for review. As a result, actual rates of surgical outcomes may be misrepresented for an institution based on chance alone. A study by Gross et al. compared the Children's Hospital of Wisconsin's institutional database (containing all cases performed over a 2-year period) to the cases sampled by ACS NSQIP Pediatric. Although ACS NSQIP Pediatric broadly identified the procedures with higher post-operative event rates, it overestimated the rate of 30-day complications (4.4% overall vs. 12.5% NSQIP).[21] Another limitation identified is that many complications may be underestimated by only evaluating 30-day outcomes. Many clinically-relevant procedure-specific outcomes are not robustly captured in the ACS NSQIP Pediatric such as anastomotic leak after bowel surgery.[21] Misclassifications may also occur that attribute complications to an unrelated surgical procedure.

Despite rigorous training and definitions, the collection and quality of some variables remain a challenge. For example, investigations on surgical wound classification have revealed inconsistent reporting between surgeons, SCRs and operating room nurses for common procedures such as appendectomy within a single institution.[22] Our own investigations of ACS NSQIP Pediatric have revealed similar inaccuracies with regard to wound class on a national level. These examples emphasize the importance of collaboration between the surgeon champion and the SCR to maximize data quality.

One seemingly untapped resource of ACS NSQIP Pediatric is the potential to conduct local quality improvement projects based on the data provided. Contrary to the adult literature, examples of quality improvement sparked by ACS NSQIP Pediatric are lacking