NSQIP Evaluation
Gavin Meredith - ACI

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Development and evaluation of the universal ACS NSQIP surgical risk calculator: a decision aid and informed consent tool for patients and surgeons.
Bilimoria KY. Liu Y. Paruch JL. Zhou L. Kmiecik TE. Ko CY. Cohen ME,
BACKGROUND: Accurately estimating surgical risks is critical for shared decision making and informed consent. The Centers for Medicare and Medicaid Services may soon put forth a measure requiring surgeons to provide patients with patient-specific, empirically derived estimates of postoperative complications. Our objectives were to develop a universal surgical risk estimation tool, to compare performance of the universal vs previous procedure-specific surgical risk calculators, and to allow surgeons to empirically adjust the estimates of risk.
STUDY DESIGN: Using standardized clinical data from 393 ACS NSQIP hospitals, a web-based tool was developed to allow surgeons to easily enter 21 preoperative factors (demographics, comorbidities, procedure). Regression models were developed to predict 8 outcomes based on the preoperative risk factors. The universal model was compared with procedure-specific models. To incorporate surgeon input, a subjective surgeon adjustment score, allowing risk estimates to vary within the estimate's confidence interval, was introduced and tested with 80 surgeons using 10 case scenarios.
RESULTS: Based on 1,414,006 patients encompassing 1,557 unique CPT codes, a universal surgical risk calculator model was developed that had excellent performance for mortality (c-statistic = 0.944; Brier score = 0.011 [where scores approaching 0 are better]), morbidity (c-statistic = 0.816, Brier score = 0.069), and 6 additional complications (c-statistics > 0.8). Predictions were similarly robust for the universal calculator vs procedure-specific calculators (eg, colorectal). Surgeons demonstrated considerable agreement on the case scenario scoring (80% to 100% agreement), suggesting reliable score assignment between surgeons.
CONCLUSIONS: The ACS NSQIP surgical risk calculator is a decision-support tool based on reliable multi-institutional clinical data, which can be used to estimate the risks of most operations. The ACS NSQIP surgical risk calculator will allow clinicians and patients to make decisions using empirically derived, patient-specific postoperative risks. Copyright 2013 American College of Surgeons.

Impact of analysis of frozen-section margin on reoperation rates in women undergoing lumpectomy for breast cancer: evaluation of the National Surgical Quality Improvement Program data.
Boughey JC. Hieken TJ. Jakub JW. Degnim AC. Grant CS. Farley DR. Thomsen KM. Osborn JB. Keeney GL. Habermann EB.
BACKGROUND: Reoperation for positive margins after lumpectomy for breast cancer is common. Intraoperative analysis of frozen-section (FS) margins permits immediate re-excision, avoiding reoperation. The aim of this study was to compare reoperation rates between an institution using routine FS analysis of all margins and the National Surgical Quality Improvement Program (NSQIP) data.

METHODS: We designed a retrospective cohort analysis comparing the NSQIP data from a FS single institution with the national NSQIP data from 2006 to 2010. Women undergoing lumpectomy for cancer were identified (N = 24,217), and reoperation rates were compared by the use of chi(2) analyses and multivariable logistic regression. During this time period, NSQIP did not differentiate between reoperations for complications or oncologic reasons. Reoperation rates for mastectomy patients (N = 21,734) and lumpectomy patients without cancer (N = 2,777) over the same time period were analyzed as controls, because reoperations after these procedures likely would be for reasons other than positive margins.

RESULTS: The 30-day reoperation rate after lumpectomy for cancer was greater nationally than at the FS institution (13.2% vs 3.6%, P < .001). Multivariable analysis showed that patients in the national NSQIP data set were over four times as likely to undergo reoperation as those at the FS institution's (odds ratio 4.19). The reoperation rates were similar between the two, both for patients undergoing mastectomy (4.7% vs 4.5%, P = .84) and those undergoing lumpectomy for benign diagnosis (2.9% vs 5.9%, P = .39).

CONCLUSION: Intraoperative FS margin analysis decreases the number of reoperations for patients undergoing breast conservation for breast cancer. This technique has important implications for patient satisfaction and cost of care.

Measuring surgical quality: comparison of postoperative adverse events with the american college of surgeons NSQIP and the Thoracic Morbidity and Mortality classification system.

Ivanovic J. Seely AJ. Anstee C. Villeneuve PJ. Gilbert S. Maziak DE. Shamji FM. Forster AJ. Sundaresan RS.

BACKGROUND: Monitoring surgical outcomes is critical to quality improvement; however, different data-collection methodologies can provide divergent evaluations of surgical outcomes. We compared postoperative adverse event reporting on the same patients using 2 classification systems: the retrospectively recorded American College of Surgeons (ACS) NSQIP and the prospectively collected Thoracic Morbidity and Mortality (TM&M) system.

STUDY DESIGN: Using the TM&M system, complications and deaths were documented daily by fellows and reviewed weekly by staff for all thoracic surgical cases conducted at our institution (April 1, 2010 to December 31, 2011). The ACS NSQIP recording was performed 30 to 120 days after index surgery by trained surgical clinical reviewers on a systemic sampling of major cases during the same time period. Univariate analyses of the data were performed.

RESULTS: During the study period, 1,788 thoracic procedures were performed (1,091 were designated "major," as per ACS NSQIP inclusion criteria). The ACS NSQIP evaluated 182 of these procedures, representing 21.1% and 16.7% of patients and procedures, respectively. Mortality rates were 1.4% in TM&M vs 2.2% in ACS NSQIP (p = 0.42). Total patients and procedures with complications reported were 24.4% and 31.1% by TM&M vs 20.2% and 39.0% by ACS NSQIP (p = 0.23 and 0.03), respectively. Rates of reported cardiac complications were higher in TM&M vs ACS NSQIP (5.8% vs 1.1%; p = 0.01), and wound complications were lower (2.5% vs 6.0%; p = 0.01).

CONCLUSIONS: Although overall rates were similar, significant differences in collection, definitions, and classification of postoperative adverse events were observed when comparing TM&M and ACS NSQIP. Although both systems offer complementary value, harmonization of definitions and severity classification would enhance quality-improvement programs.

Quality improvement in gastrointestinal surgical oncology with American College of Surgeons National Surgical Quality Improvement Program.

Lucas DJ. Pawlik TM.

OBJECTIVE: To assess the impact of American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) participation on outcomes in gastrointestinal surgical oncology.

STUDY DESIGN: A total of 6,076 resections for esophageal, gastric, pancreatic, hepatobiliary, and colorectal cancers at 316 hospitals from the 2006 to 2011 ACS NSQIP were examined. Thirty-day complication rates were analyzed longitudinally over time with the use of multiple regression; we adjusted for operation type and preoperative risk factors.
RESULTS: The procedure mix was 3% esophagectomy, 5% gastrectomy, 16% pancreatectomy, 4% hepatectomy, 63% colectomy, and 9% proctectomy. Median age was 66 years, and 52% were male, 41% were American Society of Anesthesiologists class 2, and 52% were American Society of Anesthesiologists 3. Depending on anatomic surgical site, 21-45% of patients experienced a postoperative complication and 1.1-4.4% died. The incidence of patients with any complication decreased from 28 to 24% over the period (risk-adjusted odds ratio 0.95 per year, 95% confidence interval 0.94-0.96). In contrast, there was no substantial change in risk-adjusted mortality over the period (odds ratio 1.03, 95% confidence interval 0.99-1.07).

CONCLUSION: There was a decrease in complications over time for ACS NSQIP participants in gastrointestinal surgical oncology, but mortality did not decrease. Copyright 2014 Mosby, Inc. All rights reserved.

Macro vs micro level surgical quality improvement: a regional collaborative demonstrates the case for a national NSQIP initiative.

BACKGROUND: The Florida Surgical Care Initiative (FSCI) is a quality improvement collaborative of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) and the Florida Hospital Association. In the wake of a dramatic decrease in complications and cost documented over 15 months, we analyzed the semiannual measures reports (SAR) to determine whether this improvement was driven by specific institutions or was a global accomplishment by all participants.

METHODS: Reports from NSQIP were analyzed to determine rank change of participants. Odds ratio (OR) of observed-to-expected incidence of the 4 FSCI outcomes (catheter-associated urinary tract infection [CAUTI], surgical site infection [SSI], colorectal, and surgery in patients older than 65 years) were used to assess individual and group performance. Data from SAR 2 (October 2011 to April 2012) were compared with data from SAR 3 (May to July 2012). Poorly performing hospitals were tracked to determine evidence of improvement. Individual facility performance was evaluated by determining proportion of hospitals showing improved rank across all measures.

RESULTS: Fifty-four hospitals were evaluated. SAR 2 reported 28,112 general and vascular surgical cases; SAR 3 added 10,784 more. The proportion of institutions with OR < 1 for each measure did not change significantly. Only urinary tract infection and colorectal measures demonstrated increased number of hospitals with OR < 1. Each institution that was a significant negative outlier in SAR 2 demonstrated improvement. Three of 54 hospitals demonstrated improvement across all 4 measures. Of 15 hospitals with improved performance across 3 measures, all included elderly surgery.

CONCLUSIONS: The increase in quality achieved across this population of surgical patients was the result of a quality assessment process driven by NSQIP rather than disproportionate improvement of some raising the bar for all. The NSQIP process, applied collaboratively across a population by committed institutions, produces dramatic results. Copyright 2014 American College of Surgeons.

Evaluation of initial participation in public reporting of American College of Surgeons NSQIP surgical outcomes on Medicare's Hospital Compare website.

BACKGROUND: In October 2012, The Centers for Medicare and Medicaid Services (CMS) began publicly reporting American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) surgical outcomes on its public reporting website, Hospital Compare. Participation in this CMS-NSQIP initiative is voluntary. Our objective was to compare CMS-NSQIP participating hospitals with ACS NSQIP hospitals that elected not to participate.

STUDY DESIGN: Hospital Compare and American Hospital Association Annual Survey data were merged to compare CMS-NSQIP participants with nonparticipants. Regression models were developed to assess predictors of participation and to assess if hospitals differed on 32 process, 10 patient experience (Hospital Consumer Assessment of HealthCare Providers and Systems [HCAHPS]), and 16 outcomes (Hospital Compare and Agency for Healthcare Research Quality) measures. Additionally, performance on 2 waves of publicly reported ACS NSQIP surgical outcomes measures was compared.

RESULTS: Of the 452 ACS NSQIP hospitals, 80 (18%) participated in CMS-NSQIP public reporting. Participating hospitals had more beds, admissions, operations, and were more often accredited (Commission on Cancer and the Council of Teaching Hospitals [COTH] [p < 0.05]). Only COTH membership remained significant in adjusted analyses (odds ratio 2.45, 95% CI 1.12 to 5.35).
Hospital performance on process, HCAHPS, and outcomes measures were not associated with CMS-NSQIP participation for 54 of 58 measures examined. Hospitals with "better-than-average" performance were more likely to publicly report the Elderly Surgery measure (p < 0.05). In wave 2, an increased proportion of new participants reported "worse-than-average" outcomes.

CONCLUSIONS: There were few measurable differences between CMS-NSQIP participating and nonparticipating hospitals. The decision to voluntarily publicly report may be related to the hospital's culture of quality improvement and transparency. Copyright 2014 American College of Surgeons.

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Optimizing ACS NSQIP modeling for evaluation of surgical quality and risk: patient risk adjustment, procedure mix adjustment, shrinkage adjustment, and surgical focus.


The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) collects detailed clinical data from participating hospitals using standardized data definitions, analyzes these data, and provides participating hospitals with reports that permit risk-adjusted comparisons with a surgical quality standard. Since its inception, the ACS NSQIP has worked to refine surgical outcomes measurements and enhance statistical methods to improve the reliability and validity of this hospital profiling. From an original focus on controlling for between-hospital differences in patient risk factors with logistic regression, ACS NSQIP has added a variable to better adjust for the complexity and risk profile of surgical procedures (procedure mix adjustment) and stabilized estimates derived from small samples by using a hierarchical model with shrinkage adjustment. New models have been developed focusing on specific surgical procedures (eg, "Procedure Targeted" models), which provide opportunities to incorporate indication and other procedure-specific variables and outcomes to improve risk adjustment. In addition, comparative benchmark reports given to participating hospitals have been expanded considerably to allow more detailed evaluations of performance. Finally, procedures have been developed to estimate surgical risk for individual patients. This article describes the development of, and justification for, these new statistical methods and reporting strategies in ACS NSQIP.
American College of Surgeons National Surgical Quality Improvement Program as a quality improvement tool: a single institution’s experience with vascular surgical site infections.
Vascular surgical site infections (VSSIs) result in significant patient morbidity and hospital cost. The objective of this study is to report a single hospital’s experience using the National Surgical Quality Improvement Program (NSQIP) as an instrument to decrease VSSIs. After review of initial NSQIP data, changes in antibiotic dosage and timing, surgical preparation, patient warming, and oxygenation were put into practice. Records of all patients undergoing vascular surgical operations during a two-year period were reviewed and VSSIs were identified. Statistical comparisons were made between groups before and after implementation of these changes. A total of 478 cases met our criteria. Practice changes were introduced in October 2009 and fully implemented by January 2010. Two hundred forty-three cases were performed in 2009 and 235 in 2010. When operations during the two time periods were compared, significantly fewer VSSIs were identified in 2010 than in 2009 (P = 0.036). NSQIP enabled our institution to identify an unacceptably high level of VSSIs. By implementing changes in our clinical practice, we were able to significantly lower our rate of VSSI.

Validation of new readmission data in the American College of Surgeons National Surgical Quality Improvement Program.
BACKGROUND: Hospital readmissions are gathering increasing attention as a measure of health care quality and as a cost-saving target. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) recently began collecting data related to 30-day postoperative readmissions. Our objectives were to assess the accuracy of the ACS NSQIP readmission variable by comparison with the medical record, and to evaluate the readmission variable against administrative data.
STUDY DESIGN: Readmission data captured in ACS NSQIP at a single academic institution between January and December 2011 were compared with data abstracted from the medical record and administrative data.
RESULTS: Of 1,748 cases captured in ACS NSQIP, 119 (6.8%) had an all-cause readmission event identified, and ACS NSQIP had very high agreement with chart review for identifying all-cause readmission events (κ = 0.98). For 1,110 inpatient cases successfully matched with administrative data, agreement with chart review for identifying all-cause readmissions was also very high (κ = 0.97).
CONCLUSIONS: The ACS NSQIP accurately captured all-cause and unplanned readmission events and had good agreement with the medical record with respect to cause of readmission. Administrative data accurately captured all-cause readmissions, but could not identify unplanned readmissions and less consistently agreed with chart review on cause. The granularity of clinically collected data offers tremendous advantages for directing future quality efforts targeting surgical readmission.

American College of Surgeons National Surgical Quality Improvement Program Pediatric: a beta phase report.
PURPOSE: The American College of Surgeons (ACS) National Surgical Quality Improvement Program Pediatric (NSQIP-P) expanded to beta phase testing with the enrollment of 29 institutions. Data collection and analysis were aimed at program refinement and development of risk-adjusted models for inter-institutional comparisons.
METHODS: Data from the first full year of beta-phase NSQIP-P were analyzed. Patient accrual used ACS-NSQIP methodology tailored to pediatric specialties. Preliminary risk adjusted modeling for all pediatric and neonatal operations and pediatric (excluding neonatal) abdominal operations was performed for all cause morbidity (other than death) and surgical site infections (SSI) using hierarchical logistic regression methodology and eight predictor variables. Results were expressed as odds ratios with 95% confidence intervals.
RESULTS: During calendar year 2010, 29 institutions enrolled 37,141 patients. 1644 total CPT codes were entered, of which 456 accounted for 90% of the cases. 450 codes were entered only once (1.2%...
of cases). For all cases, overall mortality was 0.25%, overall morbidity 7.9%, and the SSI rate 1.8%. For neonatal cases, mortality was 2.39%, morbidity 18.7%, and the SSI rate 3%. For the all operations model, risk-adjusted morbidity institutional odds ratios ranged 0.48-2.63, with 9/29 hospitals categorized as low outliers and 9/29 high outliers, while risk-adjusted SSI institutional odds ratios ranged 0.36-2.04, with 2/29 hospitals low outliers and 7/29 high outliers.

CONCLUSION: This report represents the first risk-adjusted hospital-level comparison of surgical outcomes in infants and children using NSQIP-P data. Programmatic and analytic modifications will improve the impact of this program as it moves into full implementation. These results indicate that NSQIP-P has the potential to serve as a model for determining risk-adjusted outcomes in the neonatal and pediatric population with the goal of developing quality improvement initiatives for the surgical care of children. Copyright 2013 Elsevier Inc. All rights reserved.

NSQIP lite: a potential tool for global comparative effectiveness evaluations.
Farmer DL. 
Archives of Surgery. 147(9):803-4, 2012 Sep. [Comment. Journal Article]

The power of the National Surgical Quality Improvement Program--achieving a zero pneumonia rate in general surgery patients.
Fuchshuber PR. Greif W. Tidwell CR. Klemm MS. Frydel C. Wali A. Rosas E. Clopp MP. 
The National Surgical Quality Improvement Program (NSQIP) of the American College of Surgeons provides risk-adjusted surgical outcome measures for participating hospitals that can be used for performance improvement of surgical mortality and morbidity. A surgical clinical nurse reviewer collects 135 clinical variables including preoperative risk factors, intraoperative variables, and 30-day postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures. A report on mortality and complications is prepared twice a year. This article summarizes briefly the history of NSQIP and how its report on surgical outcomes can be used for performance improvement within a hospital system. In particular, it describes how to drive performance improvement with NSQIP data using the example of postoperative respiratory complications--a major factor of postoperative mortality. In addition, this article explains the benefit of a collaborative of several participating NSQIP hospitals and describes how to develop a "playbook" on the basis of an outcome improvement project.

The role of Surgical Champions in the American College of Surgeons National Surgical Quality Improvement Program--a national survey.
Raval MV. Bentrem DJ. Eskandari MK. Ingraham AM. Hall BL. Randolph B. Ko CY. Morton JM. 
BACKGROUND: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) empowers surgeons and medical centers to reliably collect, analyze, and act on clinically collected outcomes data. How individual ACS NSQIP leaders designated as Surgeon Champions (SC) utilize the ACS NSQIP at the hospital level and the obstacles they encounter are not well studied.
MATERIALS AND METHODS: All SC representing the 236 hospitals participating in the ACS NSQIP were invited to complete a survey designed to assess the role of the SC, data use, continuous quality improvement (CQI) efforts, CQI culture, and financial implications.
RESULTS: We received responses from 109 (46.2%) SC. The majority (72.5%) of SC were not compensated for their CQI efforts. Factors associated with demonstrable CQI efforts included longer duration of participation in the program, frequent meetings with clinical reviewers, frequent presentation of data to administration, compensation for Surgical Champion efforts and providing individual surgeons with feedback (all P < 0.05). Almost all SC stated ACS NSQIP data improved the quality of care that patients received at the hospital level (92.4%) and that the ACS NSQIP provided data that could not be obtained by other sources (95.2%). All SCs considered future funding for participation in the ACS NSQIP secure.
CONCLUSIONS: Active use of ACS NSQIP data provide SC with demonstrable CQI by regularly reviewing data, having frequent interaction with clinical reviewers, and frequently sharing data with hospital administration and colleagues. SC thus play a key role in successful quality improvement at the hospital level. Copyright 2011 Elsevier Inc. All rights reserved.
Improving American College of Surgeons National Surgical Quality Improvement Program risk adjustment: incorporation of a novel procedure risk score.


BACKGROUND: Risk-adjusted evaluation is a key component of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP). The purpose of this study was to improve standard ACS NSQIP risk adjustment using a novel procedure risk score.

STUDY DESIGN: Current Procedural Terminology codes (CPTs) represented in ACS NSQIP data were assigned to 136 procedure groups. Log odds predicted risk from preliminary logistic regression model generated a continuous risk score for each procedure group, used in subsequent modeling. Appropriate subsets of 271,368 patients in the 2008 ACS NSQIP were evaluated using logistic models for overall 30-day morbidity, 30-day mortality, and surgical site infection (SSI). Models were compared when including either work Relative Value Unit (RVU), RVU and the standard ACS NSQIP CPT range variable (CPT range), or RVU and the newly constructed CPT risk score (CPT risk), plus routine ACS NSQIP predictors.

RESULTS: When comparing the CPT risk models with the CPT range models for morbidity in the overall general and vascular surgery dataset, CPT risk models provided better discrimination through higher c statistics at earlier steps (0.81 by step 3 vs 0.81 by step 46), more information through lower Akaike's information criterion (127,139 vs 130,019), and improved calibration through a smaller Hosmer-Lemeshow chi-square statistic (48.76 vs 116.79). Improved model characteristics of CPT risk over CPT range were most apparent for broader patient populations and outcomes. The CPT risk and standard CPT range models were moderately consistent in identification of outliers as well as assignment of hospitals to quality deciles (weighted kappa > 0.870).

CONCLUSIONS: Information from focused, clinically meaningful CPT procedure groups improves the risk estimation of ACS NSQIP models. Copyright 2010 American College of Surgeons.

Quality improvement in surgery: the American College of Surgeons National Surgical Quality Improvement Program approach. [Review]


The history and development of the NSQIP, from its inception in the Veterans Administration Health System to its implementation within the private sector sponsored by the ACS, documents the growth of a program that has substantially improved the quality of surgical care and has had a considerable influence on the culture of quality improvement in the profession. The success of the ACS NSQIP is the result of providing hospitals with rigorous, clinical data, networking opportunities, and resources to improve their risk-adjusted outcomes. In this manner, the ACS NSQIP challenges its hospitals and health care providers to continually improve the care they provide. In addition to reducing the complications and mortality experienced by patients after surgical procedures, hospitals that participate in the ACS NSQIP have seen the financial rewards of their quality improvement efforts. Continued growth of the ACS NSQIP will facilitate achievement of the primary goal surrounding the current health care reform debate: efficient, high-quality care.

Preliminary NSQIP results: a tool for quality improvement.


OBJECTIVE: To utilize National Surgical Quality Improvement Program (NSQIP) data to evaluate patient outcomes in otolaryngology-head and neck surgery.

STUDY DESIGN: Retrospective medical chart abstraction of patients undergoing major surgical procedures in the inpatient and outpatient setting.

SETTING: Academic/teaching hospitals with more than 500 beds.

SUBJECTS AND METHODS: The American College of Surgeons NSQIP collects data on 135 variables including preoperative risk factors, intraoperative variables, and 30-day-postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures in the inpatient and outpatient setting. As of August 2008, there are currently 47 hospitals submitting data for otolaryngology-head and neck surgery.

RESULTS: Opportunities for improvement were identified in respiratory, wound, and venothromboembolic (VTE) occurrences. Implementation of a standardized VTE and perioperative protocol resulted in a decreased length of stay and observed-to-expected (O/E) morbidity and mortality for all surgical services.
CONCLUSION: NSQIP reports form the basis for quality improvement with targeted interventions in areas of concern that result in changes in patient care processes. The reports are composed of outcomes-based, risk-adjusted data that are submitted by participating hospitals and have recently included data for otolaryngology-head and neck surgery. Actions taken based on NSQIP data demonstrate improvements in patient morbidity and mortality, decreased length of stay, and decreased hospital costs. In a time of increased scrutiny of health care costs and outcomes, NSQIP is an important tool for surgeons to improve quality and decrease costs. 2010 American Academy of Otolaryngology-Head and Neck Surgery Foundation. Published by Mosby, Inc. All rights reserved.

Toward robust information: data quality and inter-rater reliability in the American College of Surgeons National Surgical Quality Improvement Program.
Shiloach M. Frencher SK Jr. Steeger JE. Rowell KS. Bartzokis K. Tomeh MG. Richards KE. Ko CY. Hall BL.

BACKGROUND: Data used for evaluating quality of medical care need to be of high reliability to ensure valid quality assessment and benchmarking. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) has continually emphasized the collection of highly reliable clinical data through its program infrastructure.

STUDY DESIGN: We provide a detailed description of the various mechanisms used in ACS NSQIP to assure collection of high quality data, including training of data collectors (surgical clinical reviewers) and ongoing audits of data reliability. For the 2005 through 2008 calendar years, inter-rater reliability was calculated overall and for individual variables using percentages of agreement between the data collector and the auditor. Variables with > 5% disagreement are flagged for educational efforts to improve accurate collection. Cohen's kappa was estimated for selected variables from the 2007 audit year.

RESULTS: Inter-rater reliability audits show that overall disagreement rates on variables have fallen from 3.15% in 2005 (the first year of public enrollment in ACS NSQIP) to 1.56% in 2008. In addition, disagreement levels for individual variables have continually improved, with 26 individual variables demonstrating > 5% disagreement in 2005, to only 2 such variables in 2008. Estimated kappa values suggest substantial or almost perfect agreement for most variables.

CONCLUSIONS: The ACS NSQIP has implemented training and audit procedures for its hospital participants that are highly effective in collecting robust data. Audit results show that data have been reliable since the program's inception and that reliability has improved every year. Copyright (c) 2010

Missing data in the American College of Surgeons National Surgical Quality Improvement Program are not missing at random: implications and potential impact on quality assessments.
Hamilton BH. Ko CY. Richards K. Hall BL.

BACKGROUND: Studying risk-adjusted outcomes in health care relies on statistical approaches to handling missing data. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) provides risk-adjusted assessments of surgical programs, traditionally imputing certain missing data points using a single round of multivariable imputation. Such imputation assumes that data are missing at random-without systematic bias-and does not incorporate estimation uncertainty. Alternative approaches, including using multiple imputation to incorporate uncertainty or using an indicator of missingness, can enhance robustness of evaluations.

STUDY DESIGN: One year of de-identified data from the ACS NSQIP, representing 117 institutions and 106,113 patients, was analyzed. Using albumin variables as the missing data modeled, several imputation/adjustment models were compared, including the traditional NSQIP imputation, a new single imputation, a multiple imputation, and use of a missing indicator.

RESULTS: Coefficients for albumin values changed under new single imputation and multiple imputation approaches. Multiple imputation resulted in increased standard errors, as expected. An indicator of missingness was highly explanatory, disproving the missing-at-random assumption. The effects of changes in approach differed for different outcomes, such as mortality and morbidity, and effects were greatest in smaller datasets. However, ultimate changes in patient risk assessment and institutional assessment were minimal.

CONCLUSIONS: Newer statistical approaches to modeling missing (albumin) values result in noticeable statistical distinctions, including improved incorporation of imputation uncertainty. In addition, the missing-at-random assumption is incorrect for albumin. Despite these findings, effects on
institutional assessments are small. Although effects can be most important with smaller data-sets, the current approach to imputing missing values in the ACS NSQIP appears reasonably robust.

Risk adjustment in the American College of Surgeons National Surgical Quality Improvement Program: a comparison of logistic versus hierarchical modeling.
Cohen ME, Dimick JB, Bilimoria KY, Ko CY, Richards K, Hall BL.

**BACKGROUND:** Although logistic regression has commonly been used to adjust for risk differences in patient and case mix to permit quality comparisons across hospitals, hierarchical modeling has been advocated as the preferred methodology, because it accounts for clustering of patients within hospitals. It is unclear whether hierarchical models would yield important differences in quality assessments compared with logistic models when applied to American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) data. Our objective was to evaluate differences in logistic versus hierarchical modeling for identifying hospitals with outlying outcomes in the ACS-NSQIP.

**STUDY DESIGN:** Data from ACS-NSQIP patients who underwent colorectal operations in 2008 at hospitals that reported at least 100 operations were used to generate logistic and hierarchical prediction models for 30-day morbidity and mortality. Differences in risk-adjusted performance (ratio of observed-to-expected events) and outlier detections from the two models were compared.

**RESULTS:** Logistic and hierarchical models identified the same 25 hospitals as morbidity outliers (14 low and 11 high outliers), but the hierarchical model identified 2 additional high outliers. Both models identified the same eight hospitals as mortality outliers (five low and three high outliers). The values of observed-to-expected events ratios and p values from the two models were highly correlated. Results were similar when data were permitted from hospitals providing < 100 patients.

**CONCLUSIONS:** When applied to ACS-NSQIP data, logistic and hierarchical models provided nearly identical results with respect to identification of hospitals' observed-to-expected events ratio outliers. As hierarchical models are prone to implementation problems, logistic regression will remain an accurate and efficient method for performing risk adjustment of hospital quality comparisons.

Implementation of the National Surgical Quality Improvement Program: critical steps to success for surgeons and hospitals.
Velanovich V, Rubinfeld I, Patton JH Jr, Ritz J, Jordan J, Dulchavsky S.

The National Surgical Quality Improvement Program (NSQIP), as administered by the American College of Surgeons, became available to private sector hospitals across the United States in 2004. The program works to improve surgical outcomes by providing high-quality, risk-adjusted data to surgeons at a given hospital to stimulate discussion and define target areas for improvement. Although the NSQIP began in the early 1990s with Veterans Administration hospitals and expanded to private sector hospitals nearly 5 years ago, the "how to" process for NSQIP implementation has been left to individual institutions to manage on their own. The NSQIP was instituted at a large tertiary hospital in 2005, identifying through experience 12 critical steps to help surgeons and hospitals implement the NSQIP.

Fifteen years of the National Surgical Quality Improvement Program in review.
Itani KM.

Since 1994, the National Surgical Quality Improvement Program (NSQIP) has become a tool for the study of outcomes in surgery. Through carefully designed studies, patient risk factors, structures, and processes of care and their impact on various outcomes were carefully described within many specialties and subspecialties of surgery. "Fifteen years of NSQIP" is a celebration of the work of Shukri Khuri and his colleagues during this time frame. By summarizing their extensive contributions, a perspective is given as to the impact and breadth of their observations and recommendations on quality improvement for specific operations in various specialties under various conditions. A total of 128 articles published in the peer-reviewed literature dealing mostly with findings from the Veterans Affairs (VA) hospital system are summarized.

The National Surgical Quality Improvement Program: learning from the past and moving to the future.
Hammermeister K.
The National Surgical Quality Improvement Program (NSQIP) has achieved remarkable success over the 15 years of its existence, initially in the Veterans Health Administration and more recently in private and US Department of Defense hospitals. However, the NSQIP is at a critical juncture because of the cost and other limitations of data collection largely by manual chart abstraction. A potential solution is the documentation of care by surgical teams using the NSQIP data set as the foundation for standardized data that can be reused electronically for multiple other purposes, such as discharge abstracts, billing, and other Centers for Medicare and Medicaid Services and insurer requirements for data. It is likely that the innovative design of portions of the electronic medical record will be time efficient and acceptable to surgical care providers once they experience its advantages.

Assessing surgical quality using administrative and clinical data sets: a direct comparison of the University HealthSystem Consortium Clinical Database and the National Surgical Quality Improvement Program data set.
Davenport DL. Holsapple CW. Conigliaro J.
The use of "clinical" versus "administrative" data sets for health care quality assessment continues to be debated. This study directly compares the University HealthSystem Consortium Clinical Database (UHC CDB) and the National Surgical Quality Improvement Program (NSQIP) in terms of their assessment of complications and death for 26 322 surgery patients using analyses of variance, correlation, and multivariable logistic regression. The NSQIP had more variables with significant correlation with outcomes. The NSQIP was better at predicting death (c-index 0.94 vs 0.90, P < .05) and complications (c-index 0.78 vs 0.76, P = .07), especially for higher risk patients. The UHC CDB missed and misclassified several major complications. The data sets are similar in their explanatory power relative to outcomes, but the clinical data set is better, particularly at identifying higher risk patients and specific complications. It should prove more useful for initiating and monitoring clinical process improvements because of more clinically relevant variables.

Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program: an evaluation of all participating hospitals.
Hall BL. Hamilton BH. Richards K. Biliomria KY. Cohen ME. Ko CY.
BACKGROUND/OBJECTIVE: The National Surgical Quality Improvement Program (NSQIP) has demonstrated quality improvement in the VA and pilot study of 14 academic institutions. The objective was to show that American College of Surgeons (ACS)-NSQIP helps all enrolled hospitals.
METHODS: ACS-NSQIP data was used to evaluate improvement in hospitals longitudinally over 3 years (2005-2007). Improvement was defined as reduction in risk-adjusted "Observed/Expected" (O/E) ratios between periods with risk adjustment held constant. Multivariable logistic regression-based adjustment was performed and included indicators for procedure groups. Additionally, morbidity counts were modeled using a negative binomial model, to estimate the number of avoided complications.
RESULTS: Multiple perspectives reflected improvement over time. In the analysis of 118 hospitals (2006-2007), 66% of hospitals improved risk-adjusted mortality (mean O/E improvement: 0.174; P < 0.05) and 82% improved risk adjusted complication rates (mean improvement: 0.114; P < 0.05). Correlations between starting O/E and improvement (0.834 for mortality, 0.652 for morbidity), as well as relative risk, revealed that initially worse-performing hospitals had more likelihood of improvement. Nonetheless, well-performing hospitals also improved. Modeling morbidity counts, 183 hospitals (2007), avoided ~9598 potential complications: ~52/hospital. Due to sampling this may represent only 1 of 5 to 1 of 10 of the true total. Improvement reflected aggregate performance across all types of hospitals (academic/community, urban/rural). Changes in patient risk over time had important contributions to the effect.
CONCLUSIONS: ACS-NSQIP indicates that surgical outcomes improve across all participating hospitals in the private sector. Improvement is reflected for both poor- and well-performing facilities. NSQIP hospitals appear to be avoiding substantial numbers of complications- improving care, and reducing costs. Changes in risk over time merit further study.

Surrounded by quality metrics: what do surgeons think of ACS-NSQIP?.
Neuman HB. Michelassi F. Turner JW. Bass BL.
BACKGROUND: In an era of proliferating systems of quality assessment, surgeon confidence in metric tools is essential for successful initiatives in quality improvement. We evaluated surgeons'
awareness and attitudes about ACS-NSQIP, which is the only national, surgeon-developed, risk-adjusted, system of surgical outcome assessment.

METHODS: A 33-item survey instrument was constructed and content validity established through content expert review; test-retest reliability was assessed (weighted-kappa = 0.72). Survey administration occurred in three institutions with varying ACS-NSQIP experience. Summary statistics were generated and subgroup analyses performed (Fisher's exact test).

RESULTS: One-hundred and eight surgeons participated. Practice experience varied (27% residents, 33% < 10, 12% 10-20, and 28% > 20 years). Seventy-two percent had fellowship training. Surgeons were familiar with ACS-NSQIP structure, including prospective data collection (70%), case-sampling (63%), and reporting as observed/expected ratios (83%). Surgeons knew some collected data-points but misidentified EKG-findings of MI (67%), surgeon case-experience (41%), and anastomotic dehiscence (79%). Most felt ACS-NSQIP would improve quality of care (79%) and identify areas for improvement (92%). Surgeons were less confident regarding utility at an individual level, with only 46% believing surgeon-specific outcomes should be reported. Few thought ACS-NSQIP data should be available publicly (45%), used for marketing (26%), or direct pay-for-performance (24%). Reservations were most pronounced among surgeons with institutional ACS-NSQIP experience.

CONCLUSION: While surgeons accept ACS-NSQIP at an institutional level, skepticism remains surrounding measurement of individual outcomes and public reporting. Surgeons at institutions with a longer duration of experience with ACS-NSQIP tended to be more cynical about potential data applications. Ongoing education and assessment of surgeons' perceptions of quality improvement initiatives is necessary to ensure surgeons remain engaged actively in determining how quality of care data is measured and utilized.

The NSQIP: a new frontier in surgery. [Review] [11 refs]
Khuri SF.
[Journal Article. Review]