
Intraoperative Adverse Events: Risk Adjustment for Procedure Complexity and Presence of Adhesions Is Crucial



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- BACKGROUND:** Benchmarking the quality of intraoperative care by comparing the rates of intraoperative adverse events (iAEs) necessitates adequate risk adjustment. We sought to identify the patient- and procedure-related risk factors for iAEs.
- STUDY DESIGN:** Our 2007 to 2012 institutional American College of Surgeons NSQIP and administrative databases were linked and then screened for iAEs using the Patient Safety Indicator “Accidental Puncture/Laceration.” Intraoperative adverse events were confirmed by systematic review of medical records. Comorbidities were assessed using American College of Surgeons NSQIP variables. Adhesiolysis was determined using CPT codes for lysis of adhesions. Operative complexity was determined using relative value units. Multivariable models were constructed to identify independent predictors of iAEs. Sensitivity analyses were performed in uniform samples of operations.
- RESULTS:** Of 9,292 patients, 218 iAEs were confirmed in 183 patients. Median patient age was 56 years old and 54% were female. Compared with patients without iAEs, iAE patients were older (median 61 vs 56 years; $p < 0.001$), more functionally dependent (9% vs 5%; $p = 0.028$), and had higher American Society of Anesthesiologists class (≥ 3 in 45% vs 35%; $p = 0.004$); their procedures were more complex (median relative value units 29 vs 23; $p < 0.001$), more likely open (48% vs 21%; $p < 0.001$), and more often required adhesiolysis (44% vs 18%; $p < 0.001$). In multivariable analyses, adhesiolysis (odds ratio = 2.34; 95% CI, 1.71–3.21; $p < 0.001$), higher operative complexity (third vs first relative value units quartile: odds ratio = 3.36; 95% CI, 1.66–6.78; $p < 0.001$; fourth vs first quartile: odds ratio = 5.97; 95% CI, 3.01–11.86; $p < 0.001$), and open surgical approach (odds ratio = 2.04; 95% CI, 1.39–3.01; $p < 0.001$) independently predicted iAEs. Sensitivity analyses confirmed adhesiolysis and higher operative complexity as independent iAE predictors.
- CONCLUSIONS:** Adhesiolysis and higher operative complexity predict an increased risk for iAE. Attempts to benchmark the quality of intraoperative care need to adequately risk adjust for these factors. (J Am Coll Surg 2015;221:345–353. © 2015 by the American College of Surgeons)
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Reducing medical errors and preventing adverse events have become two national health care priorities since the publication of a series of Institute of Medicine reports more than a decade ago.^{1,2} Efforts at assessing and

benchmarking the quality of care have rapidly expanded, and so too have attempts to report outcomes and safety-related data.³⁻⁵ Not surprisingly, the validity of quality-assessment data continues to be debated; proponents

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Abbreviations and Acronyms

ACS = American College of Surgeons
iAE = intraoperative adverse event
OR = odds ratio
PSI = Patient Safety Indicator
RVU = relative value unit

argue it incentivizes improvement, and skeptics fear the unintended consequences of inaccurate risk and severity adjustments.^{6,7}

In surgery, quality assessment and reporting have focused primarily on postoperative adverse events.⁸ The most comprehensive example is the NSQIP, which systematically collects large amounts of perioperative data and generates risk-adjustment models to predict postoperative outcomes.⁹⁻¹⁶ Other groups have developed severity classification schemes, such as the Clavien-Dindo Classification, the Accordion Classification, and the postoperative morbidity index, to reflect the wide range of postoperative complications being measured and reported.¹⁷⁻²¹

Intraoperative adverse events (iAEs) are a subset of surgical complications that have, until recently, received far less attention.²² One study of malpractice claims found that intraoperative errors occurred in >75% of closed malpractice claims related to surgical care.²³ We recently described the nature, patterns, and outcomes of iAEs in a general surgery population,²⁴ then created and validated a novel severity classification for iAEs.²⁵ Using our institution's NSQIP data, we estimated that a large proportion of patients experiencing iAEs had a history of abdominal surgery,²⁴ raising the possibility that adhesiolysis is a major risk factor for the occurrence of an iAE.

In this study, we sought to identify unique risk factors that independently predict an increased risk for iAEs. Identifying such factors is essential for adequate risk adjustment when benchmarking the quality of intraoperative surgical care and comparing the rates of iAEs across different procedures, surgeons, and/or hospitals.²²

METHODS**Patient population**

All adult patients undergoing abdominal surgery under general anesthesia in a tertiary care academic center from January 2007 to October 2012 were included. The hospital-wide comprehensive administrative database was linked with our institutional American College of Surgeons NSQIP database and cases captured by both databases were selected for additional analysis.

Identification of intraoperative adverse events

Using the ICD-9-CM–based algorithm for “Accidental Puncture or Laceration,” the 15th AHRQ Patient Safety Indicator (PSI #15), we queried the linked database for potential occurrences of an accidental intraoperative injury. As PSI #15 has at least an 8% to 15% false-positive rate^{26,27} and captures all technical complications, not iAEs only, the medical records of all flagged cases were further reviewed using a systematic methodology to confirm or rule out the occurrence of an iAE and gather additional relevant intraoperative information. Details on the methodology have been published elsewhere.²⁵ Reoperations within 30 days of another index procedure and cases that were flagged with PSI #15 but had no iAEs during review were excluded from additional analysis.

Defining an intraoperative adverse event

An adverse event is defined as “an injury caused by medical management rather than the underlying disease.”²⁸ We defined an iAE as an inadvertent injury during the operation. A major iAE was defined as a class 3, 4, or 5, as per our recently validated severity classification scheme, for which repair necessitated tissue/organ resection, reconstruction, or reoperation within 7 days.²⁵

American College of Surgeons National Surgical Quality Improvement Program variables

The ACS NSQIP methodology of data collection has been described previously and validated repeatedly.^{29,30} Data on prespecified preoperative, intraoperative, and postoperative variables are systematically and prospectively collected by a trained and dedicated nurse. The ACS NSQIP methodology does not collect data specifically on iAEs.

Operative procedures

The operative procedures were classified as foregut (eg, bariatric, gastric), hepatopancreaticobiliary (eg, liver, gallbladder, bile duct, spleen, adrenal, and pancreas), intestinal (eg, small and large bowel), or abdominal wall surgery (eg, hernia repair and abdominal wall reconstruction). In addition, procedures were classified as open vs laparoscopic.

For the sensitivity analyses, the uniform sample of operations included gastrectomy (partial or total stomach resection with gastrojejunostomy or Roux-en-Y reconstruction, including gastric bypass surgery and sleeve gastrectomy), enterectomy (small or large bowel resection, including closure of fistulas and creation, closure, or revision of stomas), hepatectomy (partial liver resection), and pancreatectomy (partial or total pancreatic resection, including pancreaticojejunostomy).

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