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The nature, patterns, clinical outcomes, and financial impact of intraoperative adverse events in emergency surgery

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Abstract

BACKGROUND: Little is known about intraoperative adverse events (iAEs) in emergency surgery (ES). We sought to describe iAEs in ES and to investigate their clinical and financial impact.

METHODS: The 2007 to 2012 administrative and American College of Surgeons-National Surgical Quality Improvement Program databases at our tertiary academic center were: (1) linked, (2) queried for all ES procedures, and then (3) screened for iAEs using the ICD-9-CM–based Patient Safety Indicator "accidental puncture/laceration". Flagged cases were systematically reviewed to: (1) confirm or exclude the occurrence of iAEs (defined as inadvertent injuries during the operation) and (2) extract additional variables such as procedure type, approach, complexity (measured by relative value units), need for adhesiolysis, and extent of repair. Univariate and multivariate analyses were performed to assess the independent impact of iAEs on 30-day morbidity, mortality, and hospital charges.

RESULTS: Of a total of 9,288 patients, 1,284 (13.8%) patients underwent ES, of which 23 had iAEs (1.8%); 18 of 23 (78.3%) of the iAEs involved the small bowel or spleen, 10 of 23 (43.5%) required suture repair, and 8 of 23 (34.8%) required tissue or organ resection. Compared with those without iAEs, patients with iAEs were older (median age 62 vs 50; $P = .04$); their procedures were more complex (total relative value unit 46.7, interquartile range [27.5 to 52.6] vs 14.5 [.5 to 30.2]; $P < .001$), longer in duration (>3 hours: 52% vs 8%; $P < .001$), and more often required adhesiolysis (39.1% vs 13.5% $P = .001$). Patients with iAEs had increased total charges ($31,080 vs $11,330, $P < .001$),

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direct charges ($20,030 vs $7,387, $P < .001$), and indirect charges ($11,460 vs $4,088, $P < .001$). On multivariable analyses, iAEs were independently associated with increased 30-day morbidity (odds ratio, 3.56 [CI, 1.10 to 11.54]; $P = .03$) and prolonged postoperative length of stay (LOS; LOS >7 days; odds ratio, 5.60 [1.54 to 20.35]; $P = .01$]. A trend toward increased mortality did not reach statistical significance.

CONCLUSIONS: In ES, iAEs are independently associated with significantly higher postoperative morbidity and prolonged LOS.

With more than 2 million admissions per year in the United States,[1] emergency surgery (ES) accounts for a considerable proportion of the surgical population. Furthermore, mortality rates are significantly higher for ES patients compared with non-ES patients.[2] This patient population is particularly challenging because of the acuteness of disease at presentation, the emergent nature of intervention needed for salvage, and the unfeasibility of perioperative planning and/or optimization of comorbidities. Even for procedures carrying low risks in the elective setting, ES has been suggested to result in significantly higher postoperative morbidity, mortality,[3–6] and 30-day readmission rates.[7] However, little is known about the rate or risk of intraoperative adverse events (iAEs) and their postoperative sequelae in ES patients. Regenbogen et al[6] found that a low Surgical Apgar Score, arguably a marker of tumultuous intraoperative course,[8] independently predicts higher 30-day readmission rates, specifically for ES patients. In related previous work by our research group, we studied iAEs in all abdominal surgery, and found that more severe iAEs in abdominal surgery are associated with worse 30-day clinical outcomes[9] and higher hospital charges.[10] Nonetheless, data on the epidemiology and consequences of iAEs in the specific subset of ES patients remains sparse. In this article, we sought to investigate, in depth, the nature, patterns, clinical outcomes, and financial impact of iAEs in ES.

Methods

Patient population

The 2007 to 2012 American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database at our tertiary academic center was initially linked to its administrative counterpart for all general surgery procedures performed under general anesthesia. ACS-NSQIP is a prospectively collected outcomes registry with a well-validated methodology,[11,12] where an independent nurse reviewer systematically collects prespecified preoperative, intraoperative (not including iAEs), and postoperative variables.

Emergency surgery

As systematically defined by ACS-NQIP criteria, surgeries performed during the index hospitalization were defined as emergent only if the surgeon and/or anesthesiologist reported the case as such. All other cases were excluded from the final patient population.

Defining and identifying iAEs

An "adverse event" is defined as "an injury caused by medical management rather than the underlying disease".[13] We defined an iAE as an inadvertent injury that occurred during the operation. As per our previously described methodology,[9,14] the ICD-9-CM–based Patient Safety Indicator "accidental puncture and/or laceration" (APL) was used to screen the linked database for potential iAEs. All flagged charts were then systematically reviewed to confirm the occurrence of iAEs. Patients who were flagged with APL and had a confirmed iAE by review of operative reports were placed in the "iAE group". Patients without the APL indicator constituted the "no iAE group". Patients flagged with APL but deemed to be false positives on operative report review were excluded from the study population.

Additional intraoperative variables

Additional intraoperative variables were extracted from both the operative notes and the administrative database, including the type of surgery performed, complexity of surgery (measured by relative value units [RVUs]), the phase of surgery during which the injury occurred (access, dissection, retraction or resection and/or reconstruction), the surgical approach (open vs laparoscopic), the nature and severity of the iAE, and the extent of surgical interventions required to repair the iAE. The severity of the iAE (class I to VI) was recorded based on the recently validated severity classification system developed by Kaafarani et al[9].

Operative complexity

Operative complexity was assessed using each procedure's RVU (by the Centers for Medicare and Medicaid Services Resource Based Relative Value Scale) based on Current Procedural Terminology (CPT) codes. RVUs have been shown to better predict surgical outcomes than complexity scores established by panels of surgical specialists,[15,16] and have been repeatedly confirmed to independently predict postoperative morbidity in general surgery.[17–19]