Not a Routine Case, Why Expect the Routine Outcome? Quantifying the Infectious Burden of Emergency General Surgery Using the NSQIP

MICHAEL R. ARNOLD, M.D., ANGELA M. KAO, M.D., KYLE W. CUNNINGHAM, M.D., M.P.H., A. BRITTON CHRISTMAS, M.D., BRADLEY W. THOMAS, M.D., RONALD F. SING, D.O., CAROLINE E. REINKE, M.D., M.S.H.P., SAMUEL W. ROSS, M.D., M.P.H.

From the Division of Acute Care Surgery, Department of Surgery, Carolinas Medical Center, Charlotte, North Carolina

Emergent surgeries have different causes and physiologic patient responses than the same elective surgery, many of which are due to infectious etiologies. Therefore, we hypothesized that emergency cases have a higher risk of postoperative SSI than their elective counterparts. The ACS NSQIP database was queried from 2005 to 2016 for all cholecystectomies, ventral hernia repairs, and partial colectomies to examine common emergency and elective general surgery operations. Thirty-day outcomes were compared by emergent status. Any SSI was the primary outcome. There were 863,164 surgeries: 416,497 cholecystectomies, 220,815 ventral hernia repairs, and 225,852 partial colectomies. SSIs developed in 38,865 (4.5%) patients. SSIs increased with emergencies (5.3% *vs* 3.6% for any SSI). Postoperative sepsis (5.8% *vs* 1.5%), septic shock (4.7% *vs* 0.6%), length of stay (8.1 *vs* 2.9 days), and mortality (3.6% *vs* 0.4%) were increased in emergent surgery; *P* < 0.001 for all. When controlling for age, gender, BMI, diabetes, smoking, wound classification, comorbidities, functional status, and procedure on multivariate analysis, emergency surgery (odds ratio 1.15, 95% confidence interval 1.11–1.19) was independently associated with the development of SSI. Patients undergoing emergency general surgery experience increased rates of SSI. Patients and their families should be appropriately counseled regarding these elevated risks when consenting for emergency surgery.

Surgical site infections have been demonstrated to significantly worsen patient quality of life, require longer lengths of stay, and result in higher hospital and discharge costs.[1, 2] Similar complications have been shown to be increased in emergency general surgery (EGS) patients, who have been shown to have mortality rates that are up to six times higher than their elective counterparts.[3] However, little is known about SSI risk in EGS cases, but they are likely to have many well-described risks for the development of SSI.[4, 5] Whereas most EGS procedures are a core group of general surgery operations, the infectious and inflammatory diagnoses specific to EGS differ from general surgery and vary widely in their etiology. The American Association for the Surgery of Trauma has identified 621 separate diagnoses within the practice of EGS,[6] and surgical outcomes after a variety of EGS-only cases have been previously described using NSQIP data.[7] Other studies have shown that risk prediction between elective and EGS cases has been shown to differ significantly, with emergency surgery being underestimated in its surgical risk.[8] Unfortunately, few other studies have directly compared emergency with elective surgical outcomes for the most common general surgery procedures using a large database.

Increased complications, along with an underestimation of the risks associated with EGS, hamper proper counsel to patients and their care partners regarding potential outcomes. This leaves acute care surgeons limited in their

Presented at the Southeastern Surgical Congress 2019 Annual Scientific Meeting, February 27, 2019, Charlotte, NC.

Address correspondence and reprint requests to Samuel W. Ross, M.D., M.P.H., Carolinas Medical Center, 1000 Blythe Boulevard, Suite 601 Medical Education Building, Charlotte, NC 28203. E-mail: Samuel.ross@atriumhealth.org.

Author contributions: Conception and design of study—Michael R. Arnold, Angela M. Kao, Samuel W. Ross, and A. Britton Christmas. Acquisition of data—Michael R. Arnold, Samuel W. Ross, and Caroline E. Reinke. Analysis and/or interpretation of data—Caroline E. Reinke, Kyle W. Cunningham, Samuel W. Ross, and Bradley W. Thomas. Drafting the manuscript—Michael R. Arnold, Samuel W. Ross, Ronald F. Sing, and Kyle W. Cunningham. Revising the manuscript critically for important intellectual content—Michael R. Arnold, Angela M. Kao, Kyle W. Cunningham, A. Britton Christmas, Bradley W. Thomas, Ronald F. Sing, Caroline E. Reinke, and Samuel W. Ross.

process of joint decision-making between patients and their surgeons.[9] Furthermore, nearly 10 per cent of Centers for Medicare & Medicaid Services (CMS) reimbursement is tied to surgical outcomes.[10, 11] Surgeons must be able to adequately describe expected outcomes and manage expectations, whereas health-care organizations need appropriate reimbursement, without incurring undue liability or reimbursement penalties, for providing care that is associated with a higher risk of complications. Most importantly, patients and their families need to understand when a "routine" operation is not routine anymore because of the emergency settings, infectious and often septic nature of the patients, and etiology of their disease requiring emergent surgery. In addition, the critical knowledge that their outcomes will not be what they could expect from a similar operation in the elective setting is key to managing the patient and family's expectations of their surgical course.[12, 13] Anecdotally, this difference is most clearly seen in the sequela of the infectious etiologies present in many of these operations with wound infections. SSIs are one complication that causes a great deal of detriment to patients and their quality of life postoperatively not only because of the patients' ready ability to see the complication at the skin but also because of subsequent multiple possible procedures, need for antibiotics, financial impact, future hernia formation risk, and poor scar cosmesis, to name just a few.[1, 2]

Therefore, the aim of our study was to quantify the increased risk of SSI in EGS cases that had readily available elective counterparts. We hypothesized that emergency cases have a higher rate of postoperative SSI than the same elective procedures. Some single-center smaller studies have examined this question in different contexts but suffer from small population sizes and lack of power. Therefore, to examine the SSI risk between EGS cases and their elective counterparts, the ACS NSQIP was used to gain a large national sample size with robust surgery-specific data collection.

Methods

Data Source

The ACS NSQIP database was queried from 2005 to 2016 for three commonly performed procedures with both elective and emergent counterparts in general surgery. Procedures were also chosen for the increasing level of invasiveness and to stratify the perceived level of infectious risk. Both open and laparoscopic variants of cholecystectomy, ventral hernia repair (VHR), and partial colectomy (PC) were included. NSQIP data collection, pre- and intraoperative risk factors, and outcomes have been described in detail in multiple other studies.[14–17] To date, more than 600 hospitals participate in NSQIP data collection,[18] and more than 250 variables are now recorded for each participant with additional variables now available for key procedures such as colorectal, pancreatic, and hysterectomy surgeries. Patients for these procedures were identified by the CPT code: open (47600, 47605, and 47610) and laparoscopic cholecystectomy (47562, 47563, and 47564); open (49560, 49561, 49565, and 49566) and laparoscopic VHRs (49654, 49655, 49656, and 49657); and open (44140, 44141, 44143, 44144, and 44160) and laparoscopic PCs (44188, 44204, 44205, and 44206).

Study Design

The procedures selected were done so to give a breadth of cases commonly performed by both general and acute care surgeons that had emergency and elective counterparts, to evaluate the effect of emergent physiology and infectious/inflammatory etiologies on the same procedure type. After identification of patients, the cases were coded for the laparoscopic technique and by procedure type. If a patient had more than one of the aforementioned procedures (there was a small amount of overlap), the patient was coded for the more invasive and potentially complicated procedure: PC > VHR > cholecystectomy. The primary dependent variable was elective status as coded in the NSQIP. Only patients with this variable coded were included in the univariate and multivariate analyses. Multivariate logistic regression was then used to identify the independent association between emergent status and patient outcomes.

NSQIP Outcome Measures

NSQIP variables are recorded by dedicated abstractors specially trained in surgical outcomes and data collection and include preoperative demographics, comorbidities, laboratory values, operative and postoperative details, 30-day complications and mortality, and disposition. The primary outcomes of interest in this study were an aggregate of SSIs coded in the NSQIP as wound disruption, superficial SSI, deep SSI, and organ space SSI. This aggregate of SSI has been used in multiple previous studies using the NSQIP.[14–17] Secondary outcomes of interest were mortality, reoperation, 30-day readmission, and hospital length of stay (LOS).

There are more than 25 complications or variables used in the NSQIP; however, they are not categorized or grouped in a manner to allow for appropriate statistical analysis or reporting. Therefore, in addition to SSIs [categorized earlier], complications were grouped in a similar strategy to the authors' prior works: general complications [the component SSI, failure to wean ventilator, acute renal insufficiency, UTI, peripheral nerve injury, bleeding requiring transfusion, and deep vein thrombosis/thrombophlebitis] and major complications [pneumonia, respiratory failure, pulmonary embolism, acute renal failure (ARF), cerebrovascular accident (CVA), cardiac arrest, myocardial infarction, sepsis, and septic shock]. Grouping into these categories was based on the level of complication severity with SSIs involving the surgical site, general complications involving less severe medical diagnoses, and major complications involving potentially severe and possibly lethal diagnoses. A similar methodology has been used in previous studies.[14–17]

In addition, a modified version of the Charlson Comorbidity Index (CCI) was applied to the NSQIP data because there is no inherent risk scoring system present within the NSQIP.[19] The CCI is a scoring system that has been extensively validated, specifically for surgery patients.[20–22] Age groups and major comorbidities are ranked from one to six points. Points are then summated to provide the total patient score.[23] Previous studies have verified that the CCI adapted to large administrative databases have had similar sensitivity in stratifying mortality,[24, 25] and this strategy has been used in the NSQIP by two other groups,[26, 27] and our specific modification has been reported previously.[14]

Statistical Analysis

All data were analyzed using Statistical Analysis Software, version 9.3 (SAS Institute, Inc., Cary, NC), after the study was approved by the Carolinas Medical Center Institutional Review Board. Descriptive statistics were reported as means with corresponding standard deviations for continuous variables and percentages for categorical variables. Global univariate analyses were carried out for patients by elective and emergent status. Categorical variables were evaluated using Pearson's chi-squared and Fisher's exact tests where appropriate. Continuous and ordinal variables were evaluated using Wilcoxon-Mann-Whitney and Kruskal-Wallis tests. Multivariate logistic regression was performed to evaluate the independent association of emergency operation with SSI, controlling for clinically relevant confounding variables such as age, gender, tobacco use, diabetes, CCI, BMI, functional status, procedure type, and wound classification. Laparoscopy status was colinear with wound classification, so only the latter was used. Odds ratios (ORs) with corresponding 95 per cent confidence intervals (CIs) were used to report the results of the multivariate regression models. Statistical significance was set at $P < 0.05$, and all reported P values are two tailed.

Results

There were 863,164 patients during the time period identified in the NSQIP. These patients had 367,336 laparoscopic and 62,497 open cholecystectomies; 39,504 laparoscopic and 186,343 open VHRs; and 80,991 laparoscopic and 146,628 open PCs. These were categorized into the highest level of invasiveness if there were two operative types such as 416,497 cholecystectomies, 220,815 VHRs, and 225,852 PCs. Overall, 55.3 per cent of operations were performed laparoscopically. On average, patients were middle aged (55.3 ± 16.6 years), female (61.4%), and overweight (BMI 30.9 ± 9.7 kg/m^2), and had few comorbidities (CCI 0.5 ± 1.3). The most common medical problems were hypertension (44.2%), diabetes (15.3%), tobacco use (19.2%), exertional dyspnea (6.4%), and COPD (4.7%). There were 604,537 patients with emergency status recorded, and elective operations accounted for 69.7 per cent of cases.

The average hospital LOS was 4.7 ± 9 days. There were 16,421 (1.9%) cases of pneumonia, 24,012 (2.8%) patients with postoperative sepsis, and 15,295 (1.8%) patients with septic shock. There were 27,348 (3.2%) superficial SSIs, 7,518 (0.9%) deep SSIs, 6,262 (0.7%) wound disruptions, and 20,069 (2.3%) organ space SSIs. The aggregate total patients with any SSI were 38,865 (4.5%). There were 28,893 (3.4%) patients who required reoperation, whereas 7 per cent required readmission. General complications were present in 19.8 per cent of patients, whereas major complications occurred in 58,662 (6.8%) patients. There were 12,969 deaths within 30 days of operation, for a mortality rate of 1.5 per cent.

Demographics and Operative Details by Emergency Status

Patient demographics and comorbidities by emergency status are reported in Table 1. Emergent patients were on average older, more likely to be male, and had a lower BMI and more comorbidities ($P < 0.0001$ for all). In addition, emergency operative patients were less likely to be independently functional, and more likely to be smokers, have frequent alcohol use, and excessive weight loss within the last six months ($P < 0.0001$ for all). Virtually all comorbidities were higher in the emergency patients except exertional dyspnea, including many associated with poor wound healing and SSIs such as steroid use, diabetes, end-stage renal disease, bleeding disorders, radiation and chemotherapy, and disseminated cancer ($P < 0.05$ for all).

Operative characteristics and number of procedures within each operative type by emergency status are reported in Table 2. The American Society of Anesthesia classification was significantly higher in the emergent patients, with the majority being Class III, and they had higher rates of Class IV and V than elective cases ($P < 0.0001$). As expected, emergency cases had higher rates of inpatient cases and increased white blood counts and creatinine levels compared with their elective counterparts ($P <$ 0.0001 for all). Despite these facts, there were clinically similar, but statistically significant, rates of laparoscopy between elective and emergent cases (53.7% *vs* 58.8%; $P < 0.0001$). For all procedure types, there was a much higher rate of elective case mix, with rates of elective cases being 2 to 15 times that of emergency cases ($P < 0.0001$ for all). Finally, wound class was much more likely to be contaminated or dirty, with emergency procedures having 7.9 times the rate of dirty cases ($P < 0.0001$).

Patient Outcomes by Emergency Status

Rates of SSI by procedure type are reported in Table 3. Rates of SSI increased with increasing procedure invasiveness, with cholecystectomy having the lowest and PC having the highest rates (1.7% < 5% < 9.2%; $P < 0.0001$). Laparoscopic cases were much more likely to have SSIs than open cases for all procedure types ($P < 0.0001$ for all). Consequently, the SSI rate was lowest in the laparoscopic cholecystectomy group (0.9%) and highest in the open PC group (11.5%). However, the largest increase in the rate of SSI between laparoscopic and open procedures was in cholecystectomy, with 8.7 times increase in SSIs.

Outcomes by emergency status for all procedures are reported in Table 4. There was an increase in all infectious complications in the emergency group, including a 1.7 times increase in UTI, 3.4 times increase in pneumonia, 3.9 times increase in sepsis, and 7.8 times increase in septic shock ($P < 0.0001$). All components of the aggregate SSI outcome were also increased in the emergency cases, and the overall rate of SSI was 5.3 per cent in the emergency group, which was a 47 per cent increase in the relative risk of SSI ($P < 0.0001$ for all). There were increased rates of general complications, major complications, reoperation, and readmission in the emergent patients ($P < 0.0001$). This correlated to an increased hospital LOS of more than five days and a nine times increase in the mortality rate at 30 days (3.6% *vs* 0.4%; $P < 0.0001$ for all) when compared with elective patients.

TABLE 1. *Patient Characteristics by Emergency Status*

	Emergent (n = 183,099)	Elective (n = 421,438)	*P* Value
Age (years)	56.2 ± 18	55 ± 15.9	<0.0001
Male (%)	40.3	38.3	<0.0001
BMI (kg/m^2)	30.7 ± 8.4	31.1 ± 7.7	<0.0001
CCI	0.6 ± 1.5	0.4 ± 1.2	<0.0001
Systemic (%)			
Independent functional status	94.6	98.9	<0.0001
Smoker	20.1	18	<0.0001
Ethanol use	2.8	1.8	<0.0001
>10% body mass loss in the last six months	3.6	1.7	<0.0001
Endocrine (%)			
Steroid use	5.6	3.7	
Diabetes	16.4	15.3	<0.0001
Cardiovascular (%)			
Hypertension	44.5	43.7	<0.0001
Congestive heart failure	1.9	0	<0.0001
MI in the last six months	0.8	0.2	<0.0001
Prior CVA	2.3	1.1	<0.0001
History of cardiac surgery	5	3.6	<0.0001
Pulmonary (%)			
COPD	6.2	4	<0.0001
Exertional dyspnea	5.2	5.7	<0.0001
Renal (%)			
End-stage renal disease	1.8	0.6	<0.0001
ARF	1.1	0.1	<0.0001
Hematologic/oncologic (%)			
Bleeding disorder	7.7	2.2	<0.0001
Disseminated cancer	4.5	3.1	<0.0001
Chemotherapy in the last 30 days	2.2	1.8	0.003
Radiation therapy in the last 30 days	0.7	0.5	0.012

TABLE 2. *Operative Details by Emergency Status*

	Emergent (n = 183,099)	Elective (n = 421,438)	*P* Value
American Society of Anesthesia Classification			
I	6.2	7.3	<0.0001
II	39.5	50	
III	41.9	39.9	
IV	11.7	2.8	
V	0.8	0.02	
Preoperative WBC	10.2 ± 5.4	7.6 ± 2.9	<0.0001
Preoperative creatinine	1 ± 0.9	0.9 ± 0.6	<0.0001
Inpatient	90.1	48.9	<0.0001
Laparoscopic	53.7	58.8	<0.0001
Cholecystectomy (n = 285,847)	34.3	65.7	<0.0001
Laparoscopic (n = 256,726)	34.1	65.9	
Open (n = 37,311)	35.2	64.8	
VHR (n = 158,500)	13.3	86.7	<0.0001
Laparoscopic (n = 33,630)	6.1	93.9	
Open (n = 128,513)	15.8	84.2	
PC (n = 160,190)	40	60	<0.0001
Laparoscopic (n = 62,366)	17.2	82.8	
Open (n = 98,994)	54.2	45.8	
Wound class (%)			
Clean	8.4	29.7	<0.0001
Clean-contaminated	45.7	59.4	
Contaminated	26.9	8.6	
Dirty/infected	19	2.4	
Operative time (min)	108.5 ± 77.3	113.6 ± 96.6	

Totals will not be summative given the overlap in case type and possible conversions with dual codes; rates for procedure section using procedure number as denominator for the rate.

TABLE 3. *SSI by Procedure Type*

	No SSI (%)	SSI (%)	*P* Value
Cholecystectomy (n = 285,847)	98.3	1.7	<0.0001
Laparoscopic (n = 256,726)	99.1	0.9	
Open (n = 37,311)	92.2	7.8	
VHR (n = 158,500)	95	5	<0.0001
Laparoscopic (n = 33,630)	98.9	1.1	
Open (n = 128,513)	94	6	
PC (n = 160,190)	90.8	9.2	<0.0001
Laparoscopic (n = 62,366)	94.8	5.2	
Open (n = 98,994)	88.5	11.5	

Totals will not be summative given the overlap in case type and possible conversions with dual codes.

Multivariate Analysis by Emergency Status

The results of the multivariate analysis for the outcome of SSIs are reported in Table 5. Dependent functional status was the only variable in the model that was not associated with SSI. Age, BMI, and CCI have increased risk of SSI per point ($P < 0.0001$). Tobacco use and diabetes were associated with increased SSI risk, and each increasing level of wound classification had increasing odds of SSI (clean contaminated < contaminated < dirty; $P < 0.0001$ for all). Interestingly, VHR had higher odds of SSI than PC (OR 5.9 *vs* 5.6) when compared with cholecystectomy ($P < 0.0001$ for both). Even when controlling for these variables, emergency status still had an increased relative odds of SSI by 15 per cent (OR 1.150, 95% CI 1.114–1.186).

Discussion

The purpose of this study was to compare 30-day outcomes between elective and EGS cases. Other studies have documented increased complication rates for emergency procedures, but stratification was according to risk of procedures with multiple procedural types combined into a single category. In addition, no study has looked specifically at SSI or used the aggregated variable for SSI previously.[7] Importantly, rather than pooling all cases, this study examined only the most common general surgical procedures, including cholecystectomies, VHRs, and PCs. Our goal was to provide procedure-specific risks for the most common operations performed in general surgery that also have well-known elective counterparts. This correlated with our clinical intent

TABLE 4. *Patient Outcomes by Emergency Status*

	Emergent (n = 183,099)	Elective (n = 421,438)	*P* Value
SSI	5.3	3.6	<0.0001
Wound disruption	1.1	0.5	<0.0001
Superficial SSI	3.5	2.6	<0.0001
Deep SSI	1.1	0.7	<0.0001
Organ space SSI	3.9	1.8	<0.0001
General complications*	40.3	20.7	<0.0001
Ventilator >48 hours	4.8	0.7	<0.0001
Acute renal insufficiency	0.7	0.3	<0.0001
Bleeding requiring transfusion	10	3.6	<0.0001
Deep vein thrombosis/thrombophlebitis	1.4	0.4	<0.0001
UTI	2	1.2	<0.0001
Major complications	14.1	3.7	<0.0001
ARF	1	0.2	<0.0001
Pulmonary embolism	0.7	0.4	<0.0001
Unplanned intubation	2.6	0.8	<0.0001
Pneumonia	3.7	1.1	<0.0001
Myocardial infarction	0.7	0	<0.0001
CVA	0.3	0	<0.0001
Cardiac arrest	0.9	0.2	<0.0001
Sepsis	5.8	1.5	<0.0001
Septic shock	4.7	0.6	<0.0001
Reoperation	4.6	2.5	<0.0001
Readmission	8.9	6.1	<0.0001
LOS (days)	8.1 ± 10.4	2.9 ± 5.8	<0.0001
Death	3.6	0.4	<0.0001

* Includes the component variables of wound complication.

TABLE 5. *Multivariate Analysis: Adjusted Odds for SSI*

	OR or Parameter Estimate	CI	*P* Value
Emergency status	1.150	1.114–1.186	<0.0001
Age (per year)	1.004	1.003–1.005	<0.0001
BMI (per kg/m^2)	1.029	1.027–1.031	<0.0001
CCI (per point)	1.075	1.067–1.084	<0.0001
Tobacco use	1.417	1.373–1.463	<0.0001
Diabetes	1.086	1.049–1.125	<0.0001
Functional status (dependent *vs* independent)	1.091	0.949–1.255	0.060
Wound class (*vs* clean)			
Clean-contaminated	2.498	2.379–2.624	<0.0001
Contaminated	3.396	3.203–3.601	<0.0001
Dirty	3.734	3.515–3.966	<0.0001
Procedure (compared with cholecystectomy)			
VHR	5.929	5.641–6.232	<0.0001
PC	5.609	5.396–5.830	<0.0001

for the use of these data in providing patients and families with factual expectations that the result of their operation would not likely have the same outcome as the well-known elective version. Using the NSQIP database, this study demonstrates that infectious complications of the most common procedures, including SSI, pneumonia, and sepsis, not only occur at a higher rate in EGS patients but that they are also independently associated with emergency classification, even after controlling for multiple confounders such as procedure type and wound classification. This was associated with a 47 per cent increase in SSI rates in the emergent cases.

These findings are not surprising given the anecdotal experience but are actually the opposite finding of one of the only previous NSQIP studies to report on SSI between elective and emergency cases. Becher et al.[28] performed a similar NSQIP study that actually showed no significant difference in superficial or deep SSI between emergency and nonemergency groups. Their study used only the 2008 NSQIP database, which may explain their findings, given a smaller sample size. Their study included 124,637 patients and a much broader range of surgeries, whereas ours included the records of 863,164 patients of three specific procedures. This increases the significance of the study; however, there were changes with the database as well since that time that may explain the difference in results. The most obvious of which is the number of hospitals involved. In 2008, there were 211 hospitals participating in the NSQIP. By 2016, there were 680 institutions providing data.[29] Other complications have been previously shown to be associated with EGS cases compared with elective cases. For example, Gawande et al.[30] demonstrated an increased risk of retained surgical instruments in emergency cases. Other studies have shown that these increased complications are not consistent between institutions.[31] Still others have shown increased complications with emergency VHR, but these are limited to single institutional studies or arbitrarily categorized operations to low, medium, or high risk.[32, 33]

This study examined all three general surgical procedures together and found that emergency cases are associated with increased infectious complications. Furthermore, each procedure was found to have increasing association with wound infections by the level of invasiveness. Cholecystectomies had the lowest rate of wound infections, followed by ventral hernias, and finally PCs had the strongest association with wound infections on univariate analysis. This confirms single institutional studies demonstrating lower complication rates, including ventral hernia and colorectal cases, in patients undergoing laparoscopic *versus* open surgeries.[34–37] The reduction in SSI rates in laparoscopic surgeries is thought to be multifactorial, including smaller incisions, less surgeon contact with the incisions, and smaller immunological impact, compared with open operations.[36] Interestingly, the odds of SSI was actually higher in VHRs than that in PCs on the multivariate analysis, possibly related to the level of contamination sometimes seen in incarcerated hernias that require primary open repair or biologic mesh. Furthermore, the data show that the use of laparoscopy was colinear with wound classification. This finding is most likely due to the selection bias of surgeons when it comes to laparoscopic cases in the emergency setting or due to the actual surgical need, given gross contamination and poor visualization. It would be reasonable to suspect that in the setting of gross contamination, surgeons may be more likely to perform an open surgery because of an anticipated need, perceived improvement in access to the entire abdomen, better visualization, or better ability to irrigate the abdomen thoroughly. In addition, cases will be coded open in the NSQIP even if they started laparoscopy, so cases that required conversion to open because of the level of contamination or need for visualization would not have been coded for laparoscopy.

Although emergent circumstances were associated with all complications, our findings demonstrate the specific risk of SSI. This is most likely because of wounds with higher contamination in the emergent setting; as we see in Table 2, the emergent cases had much higher rates of contaminated and dirty cases. On multivariate analysis, this correlated with more than 3.3 times the odds of SSI in contaminated cases and 3.7 times the odds in dirty cases. This reflects our clinical experience and is further supported by the group with highest SSI in these data, open emergent PC, with an 11 per cent SSI rate. These procedures are the most likely to have gross spillage of high bacterial load enteric/stool contents, given the pathology treated by colectomy in the emergent setting is usually perforation, diverticulitis, and/or ischemia. This link between wound class and SSI has been previously demonstrated in the NSQIP and validates most surgeons' clinical experience.[38] Although wound class was one of the highest SSI predictors, even after controlling for wound class, the rates of SSI were higher for all emergency cases, with a 15 per cent increased relative odds of SSI. One can theorize that increased inflammation, hemodynamic instability and subsequent hypoperfusion, tissue ischemia, or transient bacteremia may play a role in this increased risk, but these variables are not found within the NSQIP to test this hypothesis.

The shared decision-making process of whether or not to undergo surgery is an informed discussion between patients or their caregivers, families, and their surgeon but is heavily weighted toward the expertise and experience of the surgeon. Therefore, given the knowledge gap between the physician and the patient, surgeons must be able to adequately describe anticipated outcomes and manage expectations. Patients and their families have the right to understand the potential risks, especially when those risks may be higher than expected from their lay experience with similar cases, whether from personal experience or perception from the media.[12, 13] Inability to adequately describe what serious complications, pain, and suffering may result from an emergency operation likely will incorrectly conflate their previous perception of the surgery with their actual understanding of *this* operation. In our EGS practice, we find it is better to fully inform the patient of the most terrible complications in emergency situations and have them pleasantly surprised if they do not occur. When the opposite occurs, patients and family can and will be rightly angry and frustrated with the medical staff, and furthermore, it has been shown that malpractice losses are, at least in part, a result of inadequate informed consent.[39] By examining three of the most common general surgery cases performed by general and acute care surgeons, this study will help patients and their families better understand the risks associated with emergency cases because surgeons will have the data they need for them to give a truly informed consent.

The most important strength of this study lies in the number of patients included in the NSQIP. With 863,164 surgeries over 12 years, and the well-defined pre- and postoperative variables collected from hospitals across the United States, the results are generalizable to most EGS practices. However, this study also has its limitations related to the lack of EGS-specific variables in the NSQIP because the database was designed to capture all manner of procedures. Although the NSQIP is prospectively collected, the retrospective nature of the analysis can lead to inherent selection bias of who was chosen for inclusion into the NSQIP. In addition, whereas some cases such as colectomy are flagged by many centers as index cases with all recorded in the NSQIP, cholecystectomy is limited per review cycle; otherwise, the volume of cases would overwhelm abstractors. This does limit the number of cholecystectomies recorded in the NSQIP, as we see in our study the number was not even double that of VHR. Cases that were not coded for elective status were not included in the univariate and multivariate analyses, and these missing cases (258,627 patients) could be missing not at random because of difficulty defining the case as elective. Elective cases with emergent reoperations may also fall into this gray area and not be coded for elective status. In addition, these results may vary at different size and resource density facilities; as seen previously, one type of institution may have different outcomes compared with others.[40] Given the large number of institutions included in the NSQIP, and even greater number of patients, these minor limitations are outweighed by the strengths, and the results of this study are likely generalizable to most EGS patients. Of note, our findings illustrate a pitfall of using large databases to benchmark performance. Safety net hospitals, which may see a larger number of emergent cases, disproportionately bear the burden of risk. Even risk-adjustment for comorbidities will underestimate the actual risk of emergent procedures. Policies governing value-based payment programs will need to adjust for this phenomenon or risk financially penalizing institutions already providing indigent care.

Conclusion

Patients undergoing EGS experience increased rates of postoperative SSI, pneumonia, sepsis, and mortality when compared with their elective counterparts. The odds of SSI increased with emergency surgery even after controlling for confounding variables, including procedure type and wound classification, suggesting that the increased inflammation or hemodynamic instability in these settings hampers wound healing independent of the infectious process. These increased risks should be discussed with patients and families preoperatively before emergency surgeries to appropriately manage expectations and reinforce that the increased risk of complications due to emergency circumstances make it anything but a "routine" operation.

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