Recurring emergency general surgery: Characterizing a vulnerable population

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Author Disclosures

Jose Diaz, Jr, MD – Acute Innovations, received money as a consultant.

Reviewer Disclosures

The reviewers have nothing to disclose.

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BACKGROUND: Limited data exist for long-term outcomes after emergency general surgeries (EGSs) in the United States. This study aimed to characterize the incidence of inpatient readmissions and additional operations within 6 months of an EGS procedure.

METHODS: In this retrospective observational study, we identified adults (≥18 years old) undergoing one of seven common EGS procedures (appendectomies, cholecystectomies, small bowel resections, large bowel resections, control of gastrointestinal [GI] ulcers and bleeding, peritoneal adhesiolysis, and exploratory laparotomies) who were discharged alive in the 2010–2015 National Readmissions Database. Outcomes included the rates of all-cause inpatient readmissions and of undergoing a second EGS procedure, both within 6 months. Multivariable logistic regression models identified risk factors of reoperation, adjusting for patient, clinical, and hospital factors.

RESULTS: Of 706,678 patients undergoing an EGS procedure 131,291 (18.6%) had an inpatient readmission within 6 months. Among those readmitted, 15,178 (11.6%) underwent a second EGS procedure, occurring at a median of 45 days (interquartile range, 15–95). After adjustment, notable predictors of reoperation included male sex (adjusted odds ratio [aOR], 1.06 [95% confidence interval, 1.01–1.10]); private, nonprofit hospitals (aOR, 1.09 [1.02–1.17]); private, investor-owned hospitals (aOR, 1.09 [1.00–1.85]); discharge to short-term hospital (aOR, 1.35 [1.04–1.74]); discharge with home health care (aOR, 1.19 [1.13–1.25]); and index procedure of control of GI ulcer and bleeding (aOR, 9.38 [8.75–10.05]), laparotomy (aOR, 7.62 [6.92–8.40]), or large bowel resection (aOR, 6.94 [6.44–7.47]).

CONCLUSION: One fifth of patients undergoing an EGS procedure had an inpatient readmission within 6 months, where one in nine of those underwent a second EGS procedure. As half of all second EGS procedures occurred within 6 weeks of the index procedure, identifying patients with the highest health care needs (index procedure type and discharge needs) may identify patients at risk for subsequent reoperation in nonemergency settings. (*J Trauma Acute Care Surg.* 2019;86: 464–470. Copyright © 2018 American Association for the Surgery of Trauma)

LEVEL OF EVIDENCE: Epidemiological, level III.

KEY WORDS: Emergency general surgery; readmissions; outcomes; recurring operation.

Trauma and acute care surgeons care for a growing number of acutely ill high-risk patients who require emergency general surgery (EGS) procedures. Currently, 7.1% of all inpatient hospital admissions, or more than 3 million patients annually, undergo an EGS evaluation, of which 30% undergo a surgical procedure.[1] EGS procedures have been independently associated with increased odds of morbidity and mortality in numerous studies. Specifically, half of all EGS patients experience a postoperative complication, with 33% having a major complication.[2–4] Postoperative complications have been correlated with 30-day readmission rates, along with patient comorbidities and hospital disposition.[5,6] Thirty-day postoperative mortality rate is as high as 13%, which is significantly higher than patients undergoing the same procedures electively.[2]

In 2013, the American Association for the Surgery of Trauma Committee of Severity Assessment and Patient Outcomes defined the scope of EGS as "Any patient (inpatient or emergency department) requiring an emergency surgical evaluation (operative or non-operative) for diseases within the realm of general surgery as defined by the American Board of Surgery." The diseases and procedures of EGS span 621 *International Classification of Diseases, Ninth Revision, Schedule Modification* (*ICD-9*) codes and 149 *Current Procedural Terminology* codes, respectively.[7]

Despite the recent advances in defining the scope and outcomes of EGS, there is a paucity of data regarding long-term EGS outcomes. In 2013, Shafi et al.[8] published a comprehensive assessment, on behalf of the American Association for the Surgery of Trauma, to define EGS, providing the first list of *ICD-9* diagnosis codes. Other studies followed looking at outcomes, readmissions, and their risk factors in EGS from national databases within 30 days of operation.[2,6,9] To our knowledge, few have carefully characterized long-term EGS outcomes. As such, this study sought to characterize readmission rates and subsequent EGS operations within 6 months of an index EGS procedure.

METHODS

Study Population

The Healthcare Cost and Utilization Project maintains the Nationwide Readmissions Database (NRD). Annually, the NRD captures approximately 17 million unweighted, all payer hospital discharges from up to 27 states in the United States.[10] We used the 2010–2015 NRD to identify patients at least 18 years of age who underwent an EGS procedure, were discharged alive, and had 6 months of discharge data available. Given that this is a retrospective observational study, no power analysis was performed to determine sample size a priori.

Despite the breadth of the EGS field, seven procedures account for 80% of EGS volume, complications, death, and cost.[7] As such, we used *ICD-9 Clinical Modification* codes to identify patients who underwent one of the seven procedures: appendectomy (47.0X), cholecystectomy (51.263X), small bowel

Submitted: September 7, 2018, Revised: October 25, 2018, Accepted: November 11, 2018, Published online: November 28, 2018.

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This study was presented at the 77th Annual Meeting of AAST and Clinical Congress of Acute Care Surgery, September 26–29, 2018, in San Diego, California.

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Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (www.jtrauma.com).

DOI: 10.1097/TA.0000000000002151

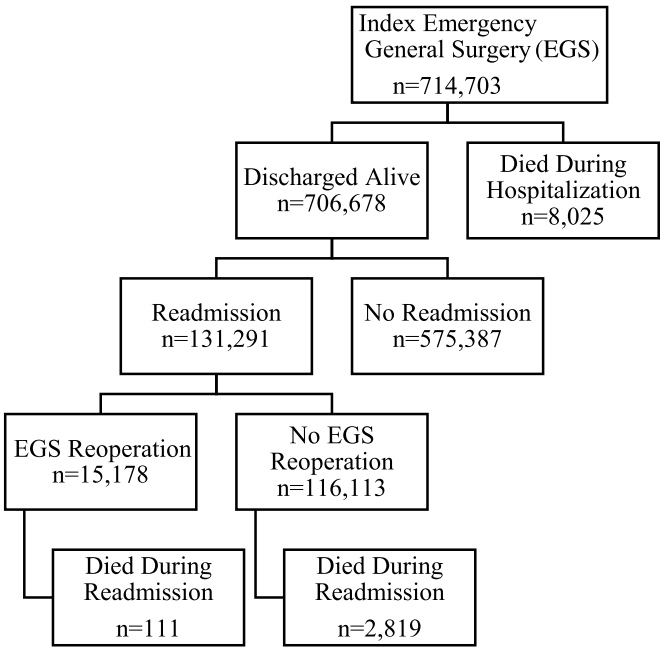

Figure 1. Diagram of study population.

resection (45.6X), large bowel resection (45.7X), control of gastrointestinal (GI) ulcer and bleeding (44.4X), peritoneal adhesiolysis (54.5X), and exploratory laparotomy (54.1X). We used the American Association for the Surgery of Trauma criteria to distinguish EGS procedures from elective procedures. These criteria include procedures that occurred on day 0 or 1 of admission and patients who were admitted urgently, emergently or through the emergency department if admission status was unknown.

Exclusion criteria included patients younger than 18 years of age, patients who died during the index hospitalization, patients with less than 6 months of available data postdischarge, and patients who were treated in hospitals with less than 50 EGS procedures per year, determined a priori. Such low volume EGS centers were excluded to eliminate potential confounding between volume and outcomes.[11–13]

Clinical Factors and Outcomes

We collected the following patient factors: sex (male, female), age, payer (Private, Medicare, Medicaid, self-pay, other), residential zip code median income, and Elixhauser score to capture acute and chronic comorbidities previously shown to be associated with outcomes.[14] Hospital characteristics included hospital bed size (as defined by the nationwide readmission database[10]), ownership (private, public, governmental), academic affiliation, and region (urban or rural). Clinical factors included hospital length of stay and disposition on discharge (home, short-term hospital, skilled nursing facility, home health care, and left against medical advice). The primary outcomes were rate of all cause readmission and rate of undergoing a second EGS procedure within 6 months of an index EGS procedure.

Statistical Analysis

We reported proportions for categorical variables and medians and interquartile ranges (IQRs, 25th percentile to 75th percentile) for continuous variables. We then used *t* test, proportion test, and χ^2 tests to test for statistically significant differences in the means and proportions for continuous and categorical variables, respectively. We calculated readmission rate and rate of recurring EGS. Using multivariable logistic regressions, we identified risk factors associated with requiring a second EGS procedure within 6 months. These regressions controlled for confounding by adjusting for patient sex, age, length of stay, payer, Elixhauser score, hospital ownership and size, and EGS procedure. The model also applied robust standard errors to account for clustering of patients at individual hospitals. Analyses were performed in STATA 14.2 (StataCorp, College Station, TX). This study was determined not to involve human participants and contains no identified patient's data; therefore, it was exempted from the Johns Hopkins Institutional Review Board.

RESULTS

We identified 714,703 patients undergoing one of seven EGS procedures, of which 706,678 survived the index hospitalization and were eligible for analysis (1.1% in-patient mortality rate; range, 0.07% for appendectomies to 10.7% for laparotomies) (Fig. 1). Overall, patients had their index procedure at large hospitals (62.6%), those with no teaching affiliation (53.6%) and in urban areas (94.4%). Cumulative readmission rates rose steadily from 7.9% to 13.8% to 18.6% at 1, 3, and 6 months, respectively (Fig. 2). Patients who were readmitted within 6 months were older (median age in years, 62 vs. 50), had a higher proportion of Medicare recipients (49.7% vs. 27.5%), had more comorbidities (median Elixhauser score, 3 vs. 1), and had longer length of stay during their index hospitalization (median length of stay in days, 5 vs. 3) when compared with patients who were not readmitted (Table 1).

Among those patients who had a readmission within 6 months, 15,178 patients (11.6%) underwent one of the seven EGS procedures on readmission. There was a median of 45 days (IQR, 16–92) to readmission among those who received a second EGS procedure, and 74% of those patients received their second procedure within the first 90 days of follow-up (Table, Supplemental Digital Content 1, http://links.lww.com/TA/B247). Furthermore, 19.3% of those who did not have a second

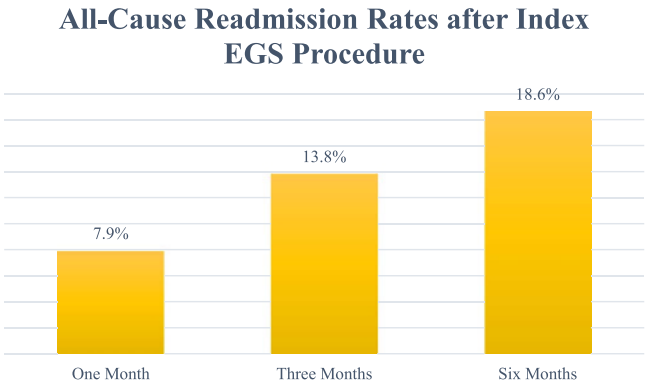

Figure 2. All-cause 1, 3, and 6 month readmission rates.

TABLE 1. Patient Demographics of EGS Patients by 6-Month Readmission Status

	Readmission	No Readmission	All Patients With Index EGS
Total number	131,291	575,387	706,678
Age, median (IQR),	62 (46–75)*	50 (33–65)*	52 (35–68)
Comorbidities, median (IQR)	3 (1–5)*	1 (0–3)*	1 (0–3)
Female, %	55.6%†	57.3%†	57.0%
Payer, %‡			
Private	26.6%	41.9%	39.0%
Medicare	49.7%	27.5%	31.7%
Medicaid	14.5%	15.8%	15.6%
Self-pay	5.1%	9.4%	8.6%
Other/unknown	4.0%	5.4%	5.2%
Length of stay	5 (3–9)*	3 (2–5)	3 (2–6)
Hospital characteristics			
Rural,%	5.6%	5.7%	5.6%
Teaching affiliation, %	47.9%†	46.0%†	46.4%
Hospital bedsize, %‡			
Small	10.0%	10.6%	10.5%
Medium	26.8%	26.9%	26.9%
Large	63.2%	62.5%	62.6%

*Difference between readmission and no readmission group reached statistical significance using *t* test with *p* value cutoff <0.05.
†Difference between readmission and no readmission group reached statistical significance using probability test with *p* value cutoff <0.05.
‡Difference between readmission and no readmission group reached statistical significance using χ^2 test with *p* value cutoff of <0.05.

procedure presented to a different hospital relative to the index hospitalization, while only 9.6% of those who received a second procedure presented to a different hospital.

The two most common index EGS procedures among all patients were cholecystectomy (43.8%) and appendectomy (30.4%). However, the index EGS procedure varied between those patients who were readmitted and did not undergo a second EGS procedure versus their counterparts who did undergo a second EGS procedure. Specifically, the most common index procedure among readmitted patients who did not undergo a second EGS procedure included cholecystectomy (35.6%), relative to control of GI ulcer and bleed (36.5%) for those who did have a second procedure (Fig. 3).

Among the readmitted patients who underwent a second EGS procedure, the most common second procedures included control GI ulcer and bleed (35.8%) and peritoneal adhesiolysis (25.0%) (Figure, Supplemental Digital Content 2, http://links.lww.com/TA/B248). Even further, the second EGS procedure varied by type of index procedure. For example, patients who initially underwent a large bowel resection were most likely to undergo peritoneal adhesiolysis (42.7%) or a second large bowel resection (39.9%). This differs substantially from those who initially underwent control of GI ulcer and bleed, who were almost exclusively undergoing a second control of GI ulcer and bleed (92.6%) (Table 2).

A multivariable logistic regression model was used to identify risk factors associated with repeat EGS procedure within 6 months of an index procedure after controlling for patient factors, clinical factors, and hospital clustering (Table 3). The following patient and hospital factors were associated with having a second EGS procedure within 6 months of the index EGS procedure: male sex (adjusted odds ratio [aOR], 1.06 [95% confidence interval, 1.01–1.10]), being treated at small hospitals (aOR, 1.16 [1.07–1.24]), at private, nonprofit hospitals (aOR, 1.09 [1.02–1.17]) or private, investor-owned hospitals (aOR, 1.09 [1.00–1.85]), and being discharged to a short-term

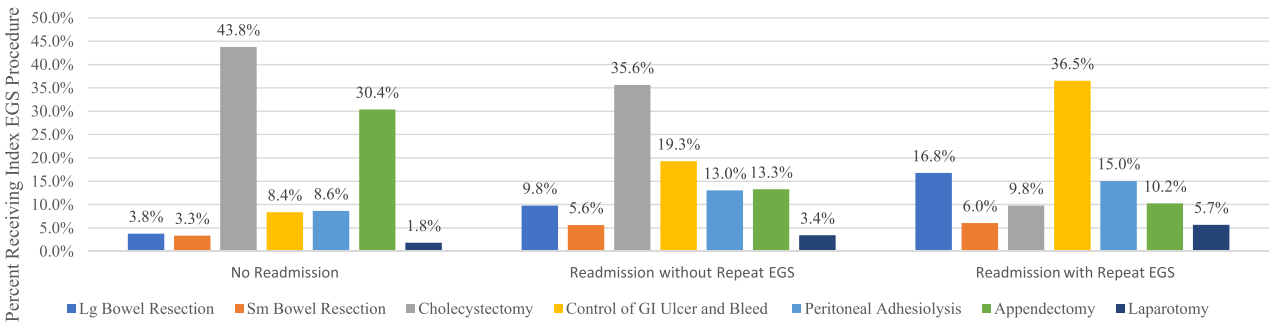

Figure 3. Proportion of index EGS procedure by readmission status (no readmission, readmission without repeat EGS, readmission with repeat EGS).

TABLE 2. Type of EGS Procedure on Readmission Stratified by Index EGS Procedure Type

		Index EGS Procedure n, %						
		Large Bowel Resection	Small Bowel Resection	Cholecystectomy	Control of GI Ulcer and Bleed	Peritoneal Adhesiolysis	Appendectomy	Laparotomy
EGS Procedure on Readmission (n, %)	Large bowel resection	1,016 (39.9)	49 (5.4)	112 (7.6)	43 (0.8)	129 (5.7)	285 (18.4)	93 (10.8)
	Small bowel resection	195 (7.7)	462 (50.4)	91 (6.1)	37 (0.7)	217 (9.5)	76 (4.9)	48 (5.6)
	Cholecystectomy	82 (3.2)	58 (6.3)	475 (32.1)	162 (2.9)	164 (7.2)	324 (20.9)	37 (4.3)
	Control of GI ulcer and bleed	33 (1.3)	20 (2.2)	149 (10.1)	5,130 (92.6)	69 (3.0)	32 (2.1)	7 (0.8)
	Peritoneal adhesiolysis	1,087 (42.7)	231 (25.2)	297 (20.1)	112 (2.0)	1,549 (67.9)	371 (23.9)	147 (17.1)
	Appendectomy	24 (0.9)	20 (2.2)	230 (15.5)	14 (0.3)	37 (1.6)	261 (16.8)	18 (2.1)
	Laparotomy	107 (4.2)	76 (8.3)	127 (8.6)	44 (0.8)	118 (5.2)	204 (13.1)	509 (59.3)
	Total (n)	2,544 (100)	916 (100)	1,481 (100)	5,542 (100)	2,283 (100)	1,553 (100)	859 (100)

hospital (aOR, 1.35 [1.04–1.74]) or with home health care (aOR, 1.19 [1.13–1.25]) (Table 3).

Patients undergoing certain index EGS procedures were associated with higher odds of undergoing a second EGS procedure. All index procedures, when compared with index cholecystectomy, had increased odds of repeat EGS within 6 months. The following procedures are listed in order of greatest to smallest increased odds of repeat EGS: control of GI ulcer and bleeding (aOR, 9.38 [8.75–10.05]), laparotomy (aOR, 7.62 [6.92–8.40]), large bowel resection (aOR, 6.94 [6.44–7.47]), peritoneal adhesiolysis (aOR, 4.90 [4.56–5.26]), small bowel resection (aOR, 4.67 [4.25–5.13]), and appendectomy (aOR, 2.07 (1.93–2.22]).

Self-pay patients (aOR, 0.80 [0.72–0.89]), Medicare patients (aOR, 0.90 [0.84–0.96]), Medicaid patients (aOR, 0.83 [0.77–0.89]), and those discharged to skilled nursing facilities (aOR, 0.71 [0.66–0.76]) had decreased odds of repeat EGS. Slight decrease in odds of repeat EGS was also found among older patients (aOR, 1.00 [0.99–1.00]), patients with more comorbidities (aOR, 0.93 [0.92–0.94]), patients with longer lengths of stay (aOR, 0.98 [0.98–0.99]), and patients in the lowest income quartile relative to the highest (aOR, 0.93 [0.88–1.00]) (Table 3).

DISCUSSION

While EGS procedures continue to rise in the United States, there exists limited literature on the long-term outcomes of these procedures, especially with respect to patients undergoing a second EGS procedure postdischarge. In this study, we found that the cumulative readmission rates among patients receiving one of seven common EGS procedures rose from 7.9% to 13.8% to 18.6% at 1, 3, and 6 months, respectively. Furthermore, at least half of all second EGS procedures occur within 6 weeks of discharge from the index EGS procedure, our data suggest that certain patients undergoing higher-risk EGS procedures are more likely to require a second EGS procedure. These findings can appropriately inform clinical practices for surgeons taking care of patients undergoing various EGS procedures, warranting further discussion.

Patients undergoing emergent procedures represent a sicker and more acutely ill population relative to those undergoing elective procedures. Even further, the life-saving measures of an emergent intervention eliminate the opportunity for preoperative optimization of comorbidities. It follows that these patients have high postoperative morbidity and mortality rates. Many among those discharged alive will subsequently experience a surgical complication requiring a readmission. The findings of this study are consistent with previously published 30-day readmission rates (6–15%) among EGS patients.[6,9,15,16] The current analysis provides further granularity in that it shows cumulative readmission rates continue to rise beyond the initial 30 days.

Even further, this study suggests that not all EGS readmissions are the same. Of the total 131,291 readmissions, there was a subset of patients (n = 15,178, 11.6%) who underwent one of seven EGS procedures at the time of readmission. Control of GI ulcer and bleeding and laparotomy were associated with ninefold and eightfold increase in odds respectively (the two highest odds) of undergoing a second EGS procedure. Of the seven readmission EGS procedures, more than half of patients underwent control of GI ulcer and bleed and peritoneal adhesiolysis. This may point to a clinically relevant framework with which to identify patients at risk of requiring future EGS procedures. Of the patients who initially underwent a control of GI ulcer and bleed and had a subsequent operation, 93% underwent a reoperation of a control of GI ulcer and bleed. This trend warrants the question of whether there are preventable behaviors, such as non-steroidal anti-inflammatory drug overuse, or unidentified, reversible acid hypersecretory states, which may provide opportunities to reduce the likelihood of requiring a future reoperation. This trend is different, for example, among patients receiving an index large bowel resection. Among these patients receiving a second operation, 43% underwent a peritoneal adhesiolysis and 40% underwent a second large bowel resection. In this clinical scenario, a subset of patients may require further intervention given the natural disease course of the index procedure itself, namely, adhesiolysis for obstructive symptoms following a large abdominal procedure. Careful attention in the outpatient setting for common complications of morbid procedures and also for opportunities to change health behaviors may present the opportunity to plan elective safer procedures or may potentially prevent the need for reoperation all together.

A smaller proportion of those who underwent a second EGS procedure (9.6%) presented to a different hospital on readmission compared with those who were readmitted without a second EGS procedure (19.3%). This suggests that patients with the highest acute care need are more likely to receive care at the

TABLE 3. Multivariate Logistic Regression for Repeat EGS Within 6 Months of Index EGS Procedure

	Repeat EGS	
	aOR (95% CI)	***p***
Male	1.06 (1.01–1.10)	0.013
Age	1.00 (0.99–1.00)	0.000
Comorbidities	0.93 (0.92–0.94)	0.000
Payer		
Private	Reference	
Medicare	0.90 (0.84–0.96)	0.001
Medicaid	0.83 (0.77–0.89)	0.000
Self-pay	0.80 (0.72–0.89)	0.000
Other/unknown	1.00 (0.91–1.12)	0.889
Income quartile		
1	0.93 (0.86–1.00)	0.040
2	1.02 (0.96–1.09)	0.465
3	0.99 (0.99–1.06)	0.801
4	Reference	
Length of stay	0.98 (0.98–0.99)	0.000
EGS		
Cholecystectomy	Reference	
Large bowel resection	6.94 (6.44–7.47)	0.000
Small bowel resection	4.67 (4.25–5.13)	0.000
Control of GI ulcer and bleed	9.38 (8.75–10.05)	0.000
Peritoneal adhesiolysis	4.90 (4.56–5.26)	0.000
Appendectomy	2.07 (1.93–2.22)	0.000
Laparotomy	7.62 (6.92–8.40)	0.000
Discharge		
Home	Reference	
Short-term hospital	1.35 (1.04–1.74)	0.022
Skilled nursing facility	0.71 (0.66–0.76)	0.000
Home health care	1.19 (1.13–1.25)	0.000
Against medical advice	0.82 (0.63–1.08)	0.160
Hospital ownership		
Public	Reference	
Private, nonprofit	1.09 (1.02–1.17)	0.000
Private, investor-owned	1.09 (1.00–1.85)	0.044
Hospital bed size		
Small	1.16 (1.07–1.24)	0.000
Medium	1.02 (0.97–1.08)	0.445
Large	Reference	

Logistic regression accounted for hospital clustering and adjusted for patient age, number of comorbidities, and length of stay of index hospitalization as continuous variables and sex, payer, hospital ownership, hospital size, and index EGS procedure as categorical variables.

same institution, which may be beneficial in that care discontinuity has been shown to independently contribute to mortality.[17] Since 90% of the patients requiring a future EGS return to the same hospital and 72% receive the second procedure within the 90-day global follow-up period, there is an opportunity to identify the patients at highest risk for reoperation in a nonemergency setting. We were able to identify that males treated at private, nonprofit, investor-owned hospitals, or small hospitals who were discharged to short-term hospitals or with home health care were at increased odds of requiring an EGS procedure within 6 months of discharge. Importantly, this risk profile is different from previous studies that identified risk factors associated with 30-day readmission, which included increased risk for those who left against medical advice and those with public health insurance.[6] In fact, patients in the lowest income quartile and Medicare, Medicaid, and self-pay patients were at lower risk of reoperation when controlling for other factors. This suggests that patients who are sicker at the time of the index hospitalization, as measured by morbidity of index procedure and need for assistance on discharge, are more of a predictor of future EGS need rather than social determinants of health, such as income and health insurance status, which contribute to global EGS readmission.

There are important limitations to this study. First, we were only able to study all-cause readmission and could not absolutely determine whether the readmission was because of the index EGS procedure. We sought to address this by capturing all-cause readmissions at three different durations (1, 3, and 6 months), where readmissions within 1 month would more likely be because of the index procedure than those during the 6-month postoperative period. Second, the current analysis is likely a slight underestimate of readmission and reoperation rates given that this data set does not report outpatient mortality, that we used only the seven most burdensome EGS procedures, and that patients may have been readmitted in a different state, which would not have been captured in this database. In addition, the database does not allow for analysis of differences in outpatient follow-up, indication for surgical intervention, surgical technique, hospital practice patterns, surgeon volume, and various clinically important patient characteristics such as past surgical history.

CONCLUSION

Emergency general surgery accounts for a large burden of surgical morbidity and mortality. Understanding long-term readmissions and repeat EGS procedures can inform quality improvement initiatives. In this study, the cumulative readmission rate rose from 7.9% to 13.8% to 18.6% at 1, 3, and 6 months among patients who underwent an EGS procedure. Of those readmitted, one in nine undergo a second EGS procedure. As half of these patients presented within 6 weeks of hospital discharge and 90% presented to the same hospital, there is a unique opportunity to identify the highest-risk EGS patients. Sicker patients, as suggested by index procedure type and discharge type, were shown to be at higher odds of requiring a second procedure. Future prospective studies will be able to further distinguish between recurring procedures caused by the natural disease course from preventable etiologies.

AUTHORSHIP

N.L., A.M., H.E., J.K.C., M.H., F.J., B.A.J., A.B.N., D.T.E., J.D.J., and J.V.S. contributed to the study conception and design. A.M. and J.K.C. contributed to the acquisition of data. N.L., A.M., H.E., J.K.C., M.H., F.J., B.A.J., A.B.N., D.T.E., J.D.J., and J.V.S. contributed to the analysis and interpretation of data. N.L. and J.V.S. contributed to the drafting of article. N.L., A.M., H.E., J.K.C., M.H., F.J., B.A.J., A.B.N., D.T.E., J.D.J., and J.V.S. contributed to the critical revision of the article.

DISCLOSURE

The authors declare no conflicts of interest.

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