Hospital variation in mortality after emergent bowel resections: The role of failure-to-rescue

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BACKGROUND: Hospital variation in failure-to-rescue (FTR) rates has partially explained nationwide differences in mortality after elective surgeries. To examine the role of FTR among emergency general surgery, we compared nationwide risk-adjusted mortality, complications, and FTR rates after emergent bowel resections.

METHODS: We identified patients who underwent emergent small or large bowel resections in the 2010 to 2011 Nationwide Inpatient Sample using the American Association for the Surgery of Trauma criteria. We then calculated risk-adjusted mortality rates for each hospital using multivariable logistic regressions and postestimation, which adjusted for patient age, sex, race and ethnicity, payer status, comorbidities, and hospital clustering. After excluding hospitals with fewer than 10 resections per year, we ranked the remaining hospitals by their risk-adjusted mortality rates and divided them into five quintiles. We compared both risk-adjusted complication rates and FTR rates between the top (lowest mortality) and bottom (highest mortality) quintiles.

RESULTS: We identified 21,564 emergent bowel resections, weighted to 105,925 procedures nationwide. The bottom quintile of hospitals had an overall risk-adjusted mortality rate that was 10.9 times higher than that of the top quintile of hospitals (15.3% vs. 1.4%). While risk-adjusted complication rates were similarly high for both the bottom and the top quintiles of hospitals (22.5% vs. 15.7%), the risk-adjusted FTR rates were 10.8 times higher in the bottom quintile of hospitals relative to the top quintile of hospitals (33.4% vs. 3.1%). Using larger hospital volume thresholds yielded similar findings. Furthermore, large variations existed in complication-specific FTR rates (surgical site infection [6.6%] to myocardial infarction [29.4%]).

CONCLUSION: Nationwide hospital variation in risk-adjusted mortality rates exist after emergent bowel resections. As complication rates were similar across hospitals, the significantly higher FTR rates at higher-mortality hospitals may drive this variation in mortality. System-level initiatives addressing the management of postoperative complications may improve patient care and reduce variation in outcomes. (*J Trauma Acute Care Surg.* 2018;84: 702–710. Copyright © American Association for the Surgery of Trauma. All rights reserved.)

LEVEL OF EVIDENCE: Prognostic and epidemiological study, level IV.

KEY WORDS: Emergent bowel resections; failure-to-rescue; mortality; complications.

Emergent bowel resections comprise a significant proportion of all emergency general surgeries (EGS) in the United States.[1] These resections are performed for a variety of common surgical conditions, including acute diverticulitis, perforation, and hemorrhage, and still carry significantly high rates of adverse outcomes.[2] There also likely exists large hospital variations in mortality and complication rates after these resections, warranting system-level quality improvement initiatives to improve patient outcomes.[3]

Failure to rescue (FTR), defined as death after a postoperative complication, has emerged over the past decade both as an indicator of health processes and as an opportunity for quality improvement initiatives aimed at enhancing patient care. FTR plays a key role in explaining hospital-level variation in postoperative mortality for a variety of elective procedures, such as coronary artery bypass grafting, abdominal aortic aneurysm repair, pancreatectomy, and esophagectomy.[4] Accordingly, professional medical and surgical organizations have recently begun using FTR as a quality metric in patient care.[5] However, few studies have both described hospital-level variation in mortality specifically among EGS and investigated the subsequent role of FTR.

In this study, we used the Nationwide Inpatient Sample (NIS) to (1) document contemporary outcomes after emergent bowel resections, (2) examine hospital level variations in postoperative mortality, and (3) characterize the potential role of FTR with outcomes. Considering that emergent procedures have consistently been shown to have higher mortality and complication rates relative to their elective counterparts, we hypothesize that there will be large variations in hospital mortality that may be explained by FTR, and that specific complications will have higher FTR rates.

METHODS

NIS

The Agency for Healthcare Research and Quality NIS is the largest publicly available all-payer inpatient healthcare database in the United States, representing at least 35 million inpatient hospitalizations yearly. Beginning in 2012, the NIS database changed their methodology from including all discharges among a 20% sample of all participating hospitals in the United States to being a 20% sample of discharges among all hospitals. As the underlying unit of analysis in this study occurred at the level of individual hospitals, we used the 2010 and 2011 NIS databases to capture all outcomes after bowel resections occurring at a hospital.

Study Population and Patient and Hospital Characteristics

We used the American Association for the Surgery of Trauma criteria to capture emergent open small- and large-bowel resections.[1,6] We identified these resections using International Classification of Diseases—9th Rev.—Clinical Modification (ICD-9-CM) codes: open small-bowel resections (45.6×) and large bowel resections (45.7×). The data set consisted of patients aged 18 to 105 years with one of the above ICD-9-CM procedure codes who were admitted urgently or emergently or who were admitted through the emergency department if admission type was unknown. We excluded procedures not performed on day 0 or day 1 of admission. To ensure that hospitals performed enough bowel resections for analysis and for hospital confidentiality, we only included those that recorded at least 10 resections annually.

We collected the following patient factors and analyzed them in categorical groups: sex (male, female), race and ethnicity (white, black, Hispanic, other/missing), age (18–44, 45–64, 65+), Elixhauser score (0–1, 2–4, 5+) using ICD-9-CM codes to capture acute and chronic comorbidities that have been shown to be significantly associated with in-hospital mortality, and payer (private, Medicare, Medicaid, self-pay).[7] Hospital characteristics included number of beds (≤200, 201–400, >400), region (urban, rural), and affiliation (teaching, nonteaching).

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TABLE 1. Demographics of Patients Undergoing EGS Procedures

	All Patients	First Quintile (Lowest Mortality)	Second Quintile	Third Quintile	Fourth Quintile	Fifth Quintile (Highest Mortality)	*p*
Patients (N)	21,564	3,570 (16.6%)	4,203 (19.5%)	4,839 (22.4%)	4,720 (21.9%)	4,232 (19.6%)	
Sex, %							<0.001
Male	44.6%	45.7%	44.5%	46.8%	45.9%	50.0%	
Female	53.4%	54.3%	55.5%	53.2%	54.2%	50.0%	
Race and ethnicity, %							<0.001
White	71.5%	75.4%	72.1%	72.0%	72.7%	65.6%	
Black	13.3%	7.7%	11.4%	12.0%	15.6%	19.0%	
Hispanic ethnicity	6.1%	5.1%	5.4%	6.5%	5.5%	7.7%	
Other/missing	9.1%	11.8%	11.1%	9.5%	6.2%	7.7%	
Age, %							<0.001
18–44	16.6%	14.0%	14.6%	15.8%	17.4%	20.7%	
45–64	35.6%	36.4%	36.2%	35.5%	35.1%	34.9%	
65+	47.9%	49.6%	49.2%	48.8%	47.5%	44.5%	
Comorbidities, %							<0.001
0–1	29.4%	28.4%	28.2%	17.3%	29.9%	33.2%	
2–4	48.9%	48.2%	48.4%	47.0%	50.1%	50.8%	
5+	21.7%	23.4%	23.4%	25.7%	20.0%	16.0%	
Payer, %							<0.001
Private	32.9%	35.8%	33.1%	32.5%	32.4%	31.0%	
Medicare	48.3%	50.1%	50.0%	48.3%	47.7%	45.9%	
Medicaid	8.1%	6.0%	6.4%	7.6%	79.0%	12.1%	
Self pay	10.8%	8.1%	10.5%	11.7%	12.0%	10.9%	
Hospital beds, %							<0.001
≤200 beds	9.0%	12.9%	10.1%	10.5%	6.5%	5.7%	
201–400 beds	21.9%	26.0%	31.6%	12.7%	23.2%	17.9%	
>400 beds	66.7%	58.1%	56.5%	76.8%	66.1%	73.3%	
Missing	2.4%	3.0%	1.8%	0.0%	4.1%	3.1%	
Region, %							<0.001
Rural	7.6%	9.7%	8.1%	6.0%	6.2%	8.6%	
Urban	90.1%	87.3%	90.1%	94.1%	89.7%	88.3%	
Missing	2.4%	3.0%	1.8%	0.0%	4.1%	3.1%	
Affiliation, %							<0.001
Teaching	45.4%	61.4%	42.8%	48.3%	43.1%	33.7%	
Nonteaching	52.2%	35.6%	55.3%	51.7%	52.8%	63.2%	
Missing	2.4%	3.0%	1.8%	0.0%	4.1%	3.1%	

Risk-Adjusted Outcomes

We calculated both unadjusted and risk-adjusted rates for mortality, complications, and failure-to-rescue. For overall unadjusted outcomes, we determined mortality when the disposition at discharge was "expired," used previously published ICD-9-CM codes[2,8] to identify the presence of at least one of eight common EGS complications (acute renal failure, pulmonary failure, surgical site infection [SSIs], gastrointestinal bleed, pneumonia, hemorrhage, myocardial infarction, and deep vein thrombosis/pulmonary embolism), and calculated FTR rates from the proportion of patients who died among those experiencing either a specific complication or any complication.

To determine risk-adjusted mortality rates, we used logistic regression and postestimation, as previously described.[4] We first performed a multivariable logistic regression to calculate the probability of mortality for each patient; the regression adjusted for gender, age, race, payer, Elixhauser score, and bowel resection (small vs. large), and accounted for hospital clustering. We then summed these probabilities across all patients within a hospital, calculated each hospital's observed to expected ratio of mortality, and then multiplied this ratio by the overall mortality rate to determine the hospital's risk-adjusted mortality rate. Next, we ranked hospitals by their risk-adjusted mortality rate and divided them into five equal quintiles, where the first quintile represented the top 20% of hospitals with the lowest risk-adjusted mortality rates and the fifth quintile represented the bottom 20% of hospitals with the highest risk-adjusted mortality rates. Finally, we aggregated patients operated on by all hospitals within each of the five quintiles to obtain overall quintile-specific risk-adjusted mortality rates, for the remaining analyses. We similarly calculated overall risk-adjusted complication rates and FTR rates for each quintile.

Statistical Analysis

We used χ^2 tests to evaluate unadjusted differences in patient and hospital characteristics between all five quintiles, and

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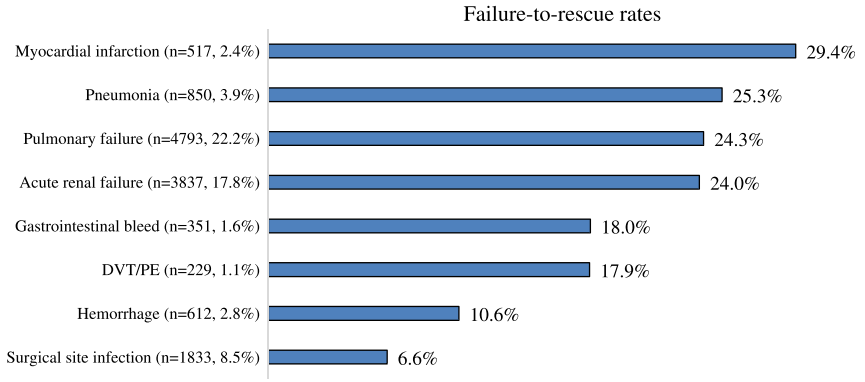

Figure 1. Incidence and rates of FTR of individual complications. While myocardial infarction and pneumonia were two of the least common complications, they had the highest FTR rates. Hemorrhage and SSIs had the lowest FTR rates.

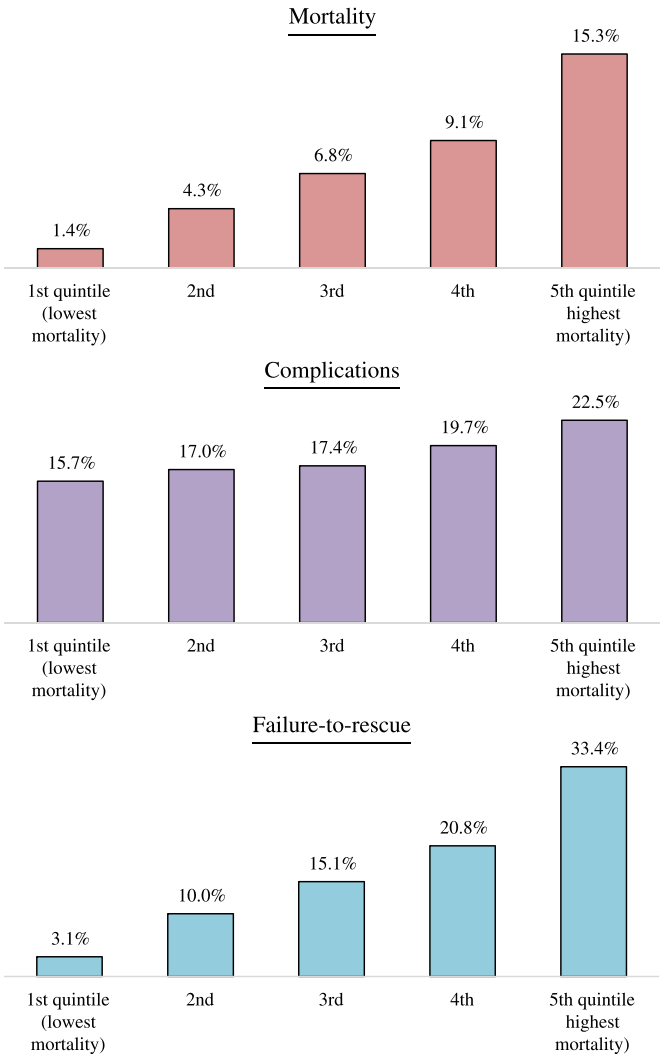

Figure 2. Risk-adjusted mortality, complications, and FTR rates by hospital quintiles. While patients operated on by hospitals with the highest mortality rates had greater complication rates relative to patients from other hospitals, they experienced far greater FTR rates.

TABLE 2. Predictors of Both Overall Complications and FTR Among Patients Undergoing Small or Large Bowel Resections

	*Complications	**FTR
Quintile		
First (lowest mortality)	Reference	Reference
Second	1.18 (1.03–1.36)	3.23 (2.29–4.54)
Third	1.27 (1.10–1.46)	5.44 (3.92–7.53)
Fourth	1.44 (1.25–1.65)	7.24 (5.24–10.02)
Fifth (highest mortality)	1.68 (1.46–1.94)	12.98 (9.38–17.95)
Sex		
Male	Reference	Reference
Female	0.75 (0.70–0.80)	0.98 (0.86–1.11)
Race and ethnicity		
White	Reference	Reference
Black	1.12 (1.01–1.23)	0.86 (0.70–1.04)
Hispanic ethnicity	0.91 (0.79–1.04)	0.99 (0.74–1.32)
Other/missing	1.04 (0.92–1.17)	1.06 (0.83–1.34)
Age, y		
18–44	0.63 (0.56–0.71)	0.53 (0.38–0.73)
45–64	0.75 (0.68–0.82)	0.73 (0.60–0.87)
65+	Reference	Reference
Comorbidities		
0–1	Reference	Reference
2–4	2.86 (2.63–3.10)	1.55 (1.21–1.99)
5+	7.90 (7.15–8.73)	2.07 (1.60–2.68)
Payer		
Private	Reference	Reference
Medicare	1.28 (1.16–1.41)	1.44 (1.18–1.76)
Medicaid	1.38 (1.22–1.56)	1.33 (0.99–1.78)
Self-pay	1.15 (1.02–1.29)	1.33 (0.99–1.79)
Complication		
Large-bowel resection	Reference	Reference
Small-bowel resection	1.12 (1.05–1.19)	1.00 (0.88–1.14)

Area under the receiver's operator curve: complications (72%), failure-to-rescue (79%).

*This multivariable logistic regression included all patients, adjusted for hospital quintiles, sex, race and ethnicity, age, number of comorbidities, payer, and small verse large bowel resection, and accounted for correlations of outcomes within individual hospitals.

**This multivariable logistic regression only included patients experiencing complications and additionally adjusted for all eight recorded complications.

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described continuous variables using medians and interquartile ranges (IQR, 25th percentile to 75th percentile). We then compared risk-adjusted outcomes between the top and bottom quintiles and repeated these analyses specifically among hospitals with or without teaching affiliations. Next, we performed two multivariable logistic regressions to assess statistically-significant differences in risk-adjusted complication rates and FTR rates between the top and bottom quintiles, and then calculated the area under the receiver's operator curve. Both regressions controlled for sex, age, race, payer, Elixhauser score, and bowel resection (small vs. large), accounted for hospital clustering, and presented outcomes as an adjusted odds ratio (aOR) with 95% confidence intervals (CIs). The regression with FTR as an outcome additionally adjusted for each of the eight studied complications. We then performed a sensitivity test by repeating our analyses using higher annual hospital volume thresholds. Finally, to begin evaluating why these variations in FTR may exist across hospitals, we assessed annual hospital volumes, the overall proportion of geriatric patients, and the incidence of each of the eight complications cross each of the five hospital quintiles. Analyses were performed in STATA 14.2 (StataCorp, College Station, TX). This study was exempted from the Johns Hopkins Institutional Review Board.

RESULTS

After applying our inclusion and exclusion criteria, we identified a total of 21,564 emergent bowel resections (59.6% large-bowel resections, 40.4% small-bowel resections), weighted to 105,925 resections nationwide (see Figure, Supplement Digital Content 1, http://links.lww.com/TA/B84). The majority of patients were female (53.4%) and white (71.5%). Nearly half were at least 65 years old (47.9%), had two to four comorbidities (48.9%), and had Medicare insurance (48.3%). Patients mostly had their resections at hospitals with >400 beds (66.7%), within urban regions (90.1%), and among those with nonteaching affiliations (52.2%). Demographics differed by hospital quintiles (Table 1).

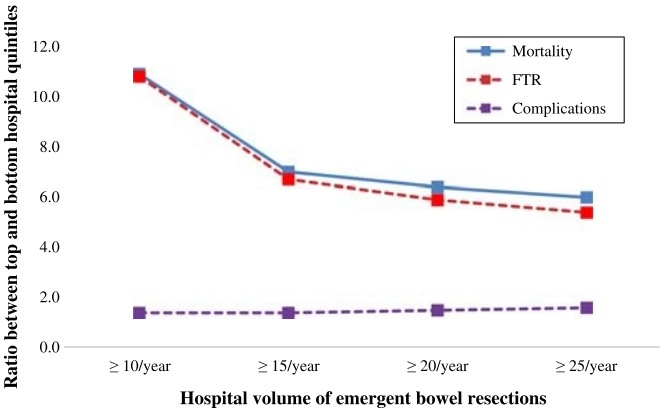

Figure 3. Ratio between risk-adjusted outcomes among the top (lowest mortality) and bottom (highest mortality) quintile of hospitals when using greater hospital volume thresholds. Even with using greater hospital volume thresholds, risk-adjusted complication rates continued to vary minimally between the top and bottom quintile while risk-adjusted FTR rates continually varied significantly.

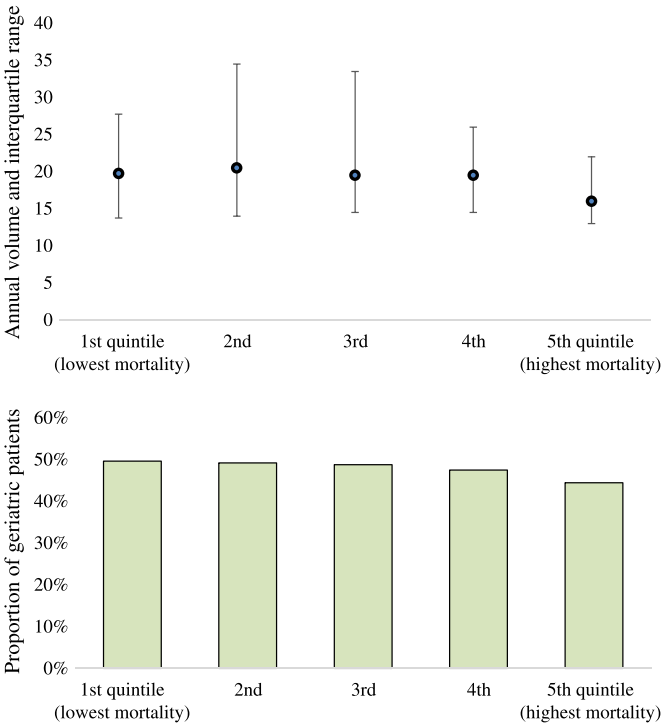

Figure 4. Minimal variation in annual volume of geriatric patient population across hospital quintiles. There existed minimal variation in the annual hospital volume of emergent bowel resections or the proportion of geriatric patients served across each of the five hospital quintiles.

We identified 457 hospitals performing at least 10 emergent bowel resections annually (median, 19/year; IQR, 14/year to 29/year), and there was an overall unadjusted mortality rate of 7.7%, complication rate of 38.3%, and FTR rate of 17.2%. There existed both a wide range in the incidences of complications and complication-specific FTR rates (Fig. 1). The most common complications were pulmonary failure (22.2%), acute renal failure (17.8%), and SSI (8.5%), where the least common included myocardial infarction (2.4%), gastrointestinal bleed (1.6%), and deep vein thrombosis or pulmonary embolism (1.1%). However, myocardial infarction had the greatest FTR rate (29.4%), followed by pneumonia (25.3%) and pulmonary failure (24.3%).

Risk-adjusted mortality rates by hospital varied significantly (median, 6.9%; IQR, 3.6% to 9.9%). Among patients operated on by hospitals in either the top or bottom quintile of hospitals, the risk-adjusted mortality rate varied further by 10.9-fold (1.4% vs. 15.3%, respectively), whereas the risk-adjusted complications rate varied by 1.4-fold (15.7% vs. 22.5%) (Fig. 2). When assessing patients experiencing complications, the risk-adjusted FTR rate varied by 10.8-fold (3.1% vs. 33.4%) between the top and bottom quintiles of hospitals. Repeating these analyses by hospital teaching affiliation revealed that there were lower rates of FTR and overall variation in risk-adjusted outcomes among hospitals with

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teaching affiliations (mortality, 7.5-fold; complications, 1.5-fold; FTR, 6.7-fold) relative to outcomes of hospitals without teaching affiliations (mortality, 18.0-fold; complications, 1.4-fold; FTR, 15.9-fold).

Two multivariable logistic regressions assessed the association between the quintiles of hospitals with both complications and FTR (Table 2). Relative to patients operated on by hospitals in the first quintile (lowest mortality), there were small incremental increases in the adjusted odds of complications among the remaining hospital quintiles: second (aOR, 1.18; 95% CI, 1.03–1.36]), third (aOR, 1.27; 95% CI, 1.10–1.46), fourth (aOR, 1.44; 95% CI, 1.25–1.65), and fifth (highest mortality: aOR, 1.68; 95% CI, 1.46–1.94). In contrast, relative to patients operated on by hospitals in the 1st (lowest mortality) quintile, there were increasingly greater odds of FTR across the hospital quintiles: second (aOR, 3.23; 95% CI, 2.29–4.54), third (aOR, 5.44; 95% CI, 3.92–7.53), fourth (aOR, 7.24; 95% CI, 5.24–10.02), and fifth (highest mortality: aOR, 12.98; 95% CI, 9.38–17.95). Other notable predictors of both complications and FTR were older age, greater number of comorbidities, and nonprivate insurance. Additionally, black relative to white patients were associated with greater complications.

As our primary analysis evaluated hospitals that performed 10 resections or more per year, we repeated our analysis using increasingly larger hospital volume thresholds: 15 or more, 20 or more, and 25 or more resections per year. Risk-adjusted complication rates continued to vary minimally between the top and bottom quintile of hospitals (Fig. 3). However, risk-adjusted FTR rates continually varied significantly between the top and bottom quintiles, closely following the same trends as risk-adjusted mortality rates. Finally, to begin assessing whether certain surgical or hospital characteristics may explain these variations in FTR rates, we did not observe much variation across hospital quintiles with regards to annual hospital volumes or the overall proportion of geriatric patients served (Fig. 4), or with the incidence of each of the eight complications (see Figure, Supplement Digital Content 2, http://links.lww.com/TA/B85).

DISCUSSION

In this retrospective nationwide study of emergent bowel resections, rates of failure-to-rescue but not rates of complications contributed significantly to variations in hospital mortality, even at higher volume hospitals. There existed a 10.9-fold variation in mortality rates among hospitals performing at least ten emergent bowel resections annually. However, complication rates remained relatively similar across hospitals, only differing by 1.4-fold, whereas rates of FTR varied 10.8-fold between low mortality and high mortality hospitals. When attempting to assess clinical factors that may explain these variations in FTR, we could not identify any glaring differences across hospital quintiles with regard to annual hospital volumes, the proportion of geriatric patients served, or the incidence of specific complications. As the annual incidence of emergent bowel resections will likely grow in the United States, secondary to both the aging population and the burden of chronic diseases and comorbidities, these findings suggest that addressing FTR can serve as a quality improvement marker for reducing surgical morbidity and mortality after these procedures.[9]

Previous studies have documented the role of FTR in characterizing variations in hospital mortality. Among the Medicare population, Ghaferi et al.[4] found that rates of FTR ranged 2.5-fold between high mortality and low mortality hospitals for six common elective procedures, including esophagectomy, coronary artery bypass grafting, and abdominal aortic aneurysm repair. Specifically for colectomies, Ko et al.[10] found an overall FTR rate of 8.1% among patients undergoing either elective or emergent resections, and Henneman et al.[11] determined a threefold difference in FTR rates between high mortality and low mortality hospitals among patients undergoing resections for colorectal cancer. Our study represents one of the first, to our knowledge, to look exclusively at emergent bowel resections, which subsequently underscores why we determined a greater FTR rate than that reported in prior studies. Emergent procedures limit opportunities to optimize comorbidities in patients and their physiological reserve to handle the postoperative care.[12–15] Furthermore, colitis, sigmoiditis, perforations, or other complications can prompt the patient to enter a systemic inflammatory state, which has been associated with worse postoperative outcomes.[16–18] The marked incidence of adverse outcomes observed in this study highlights the need for quality improvement programs.

The wide variation in hospital rates of FTR underscores the now well-founded understanding that postoperative complications and mortality are not linear events. Two identical patients experiencing a complication after an emergent bowel resection may have dissimilar outcomes solely from presenting to different hospitals. The causes for this nationwide variation in FTR rates are likely multifactorial. A few reasons may include differences in the timely identification of postoperative complications, the availability of prompt radiograph services, and surgical staff. One nationwide study found that teaching status, hospitals with greater than 200 beds, high hospital technology, and increased nurse-to-patient ratios were associated with lower FTR rates after pancreatectomy.[19] Similarly, we found that hospitals with teaching affiliations had lower rates of and reduced variations in outcomes, suggesting that greater resources at teaching affiliations may help rescue patients. However, the same prior study evaluating pancreatectomies found that these larger, hospital-level factors only partially explained nationwide variations in FTR, and that a better understanding of "microsystems within hospitals" may further describe such variations. Profit et al., Sakamoto et al., and Fan et al.[20–22] corroborate this thought process by showing how team culture can be associated with complications and their subsequent care. Studying hospital-specific causes and actionable tasks related to FTR within individual centers, in addition to nationwide studies, may help rescue patients experience postoperative complications.

Recently, numerous quality and improvement initiatives related to FTR have emerged to improve surgical outcomes.[23,24] Specifically, the Enhanced Recovery After Surgery (ERAS) protocols were initially designed for and focused toward colorectal surgery.[25] A multicenter implementation of an ERAS program among patients undergoing elective colorectal resections successfully altered processes of care and reduced postoperative complication rates.[25] A recent review also found that ERAS protocols resulted in "major improvements in clinical outcomes and costs."[26] However, ERAS protocols may provide more guidance

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geared towards elective but not emergent resections. There also exists suboptimal dissemination and implementation of ERAS protocols, in addition to other evidence-based process measures, for a variety of reasons. Examples include resistance to change, lack of time and staff, and inadequate collaboration and coordination among departments.[27,28] Factors associated with successful ERAS protocols include good leadership, local champions, and standardized order sets and care processes.[26,29] Ensuring the appropriate dissemination and implementation of these programs, tailored toward a hospital's unique needs, will likely benefit patients undergoing emergent bowel resections and other emergency surgeries. Our findings may further inform these protocols and other interventions by identifying that pulmonary failure, acute renal failure, and SSIs were a few of the most frequent postoperative complications after emergent bowel resections, and that they all carried high FTR rates.

One of the most pressing discussions in healthcare has focused on providing high-quality, low-cost surgical care. Towards this effort, many organizations have begun recording FTR as a processes metric to improve patient outcomes, including the National Quality Forum, which has been termed the "gold standard" for healthcare measurement in the United States.[5,30] The challenge, however, with hospital-level metrics often centers on attribution, where diffusion of responsibility can minimize appropriate changes in clinical practices to improve surgical outcomes.[30] Numerous case series have described how providing anonymous, confidential feedback to surgeons have reduced variations in and led to improvements of clinical outcomes and costs for elective procedures.[31,32] Pradarelli et al.[33] studied 575,831 Medicare patients undergoing one of four elective procedures and found "substantial variations" in costs associated with FTR between hospitals. We believe that these variations likely increase when analyzing emergent procedures and therefore offer an opportunity for quality improvement.[34] While emergent procedures carry challenges not intrinsic to elective procedures, similar surgeon-level notifications deserve research and attention to potentially reduce outcomes among emergent procedures.

We acknowledge several limitations in this study. First, as with all administrative databases, there are either missing variables or those not captured that may be essential for our study (i.e. physiologic derangement, prior surgical history, time of operation, operative technique). Second, while we used the American Association for the Surgery of Trauma criteria to identify emergent bowel resections, we may not have captured all eligible procedures. Third, geriatric patients experience a disproportionate proportion of adverse events after EGS procedures. While our analyses adjusted for patient age, we did not use other proxies of frailty that may additionally address confounding. Fourth, we did not assess healthcare costs, which can have significant variation within and between hospitals.[34] Fifth, we could not determine from the database whether a few patients died, not because of failure-to-rescue, but because of withdrawal-of-care. Some of these patients, however, may have passed away at a palliative and hospice center and subsequently not have counted against a hospital's FTR rate (which was determined using in-hospital mortality). Sixth, our large sample size curbed our ability to use a χ^2 test, such as the Hosmer-Lemeshow test, to evaluate our models.[35,36] Finally, we may not have recorded all major postoperative complications after EGS procedures, but did record the eight that have been most studied.

CONCLUSION

In this retrospective nationwide study of emergent bowel resections, rates of failure-to-rescue and not of complications contributed significantly to variations in hospital mortality. There existed a 10.9-fold variation in mortality rates among hospitals performing at least ten emergent bowel resections annually. However, complication rates remained relatively similar across hospitals, only differing by 1.4-fold, while rates of FTR varied 10.8-fold between low mortality and high mortality hospitals. Quality improvement programs and process measures that are tailored towards individual institutions can address FTR to both reduce variations in and improve outcomes after emergent bowel resections.

AUTHORSHIP

A.M., D.E., J.V.S. participated in the study design. A.M. participated in the data acquisition. A.M., D.E., K.S., M.C.M., B.J., J.V.S. participated in the analysis or interpretation of data. A.M. participated in the article draft. A.M., D.E., K.S., M.C.M., B.J., J.V.S. participated in the critical revision and final approval of the article.

DISCLOSURES

The authors declare no disclosures or conflicts of interest.

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DISCUSSION

Dr. Andrew B. Peitzman (Pittsburgh, Pennsylvania): Thank you, Dr. Coimbra and Dr. Spain. I appreciate the opportunity to discuss this well-written and nicely-presented paper.

Multiple descriptive studies have documented failure to rescue in surgical populations since Silber's seminal paper in 1992. The populations generally studied have included high-risk surgical procedures such as coronary artery bypass, esophagectomy, and pancreatectomy.

Recent data have corroborated that emergency general surgery procedures carry greater risk than the same operation performed electively.

In fact, emergency general surgical procedures comprise only 14 percent of the NSQIP database but over 50 percent of the mortality.

As mentioned, Scott and co-authors have documented that seven procedures, including colon and small bowel resection, account for 80 percent of the EGS cases, 80 percent of the complications, and 80 percent of the mortality.

The authors have specifically addressed failure to rescue following urgent, small or large bowel resection using the Nationwide Inpatient Sample.

The findings from this study confirm the high risk of emergency bowel resection with a 7 percent overall mortality, far higher than reported for elective resection.

The study also validates the principle that a patient will generally tolerate an operation but not the first complication. Their extensive data also demonstrate ten times the mortality in low- versus high-performing hospitals, despite comparable complication rates.

So my questions for the authors are, how do we avoid the first complication in this patient population? Second, what do you recommend in our acute care surgery practices or hospital structures to rescue our patients after their first complication? Has this observation that you presented changed how your hospital provides care for these patients?

Very nice presentation. Thank you.

Dr. Hasan B. Alam (Ann Arbor, Michigan): Yes, very quick question. So if you look at your data – and I think I completely believe that – it's not that the centers of excellence have lower complication rates, per se, they do have complications rates which are slightly lower but not dramatically, once the patient has a complication they don't go on to die. So we are much better at salvaging those patients and getting them through a complication.

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And so the broader question is do you think it is now time for us to regionalize non-trauma general surgery emergency care like we have done for trauma, with standardized protocol policies, expectations, rather than every center trying to micromanage their own environment?

Dr. Patrick Reilly (Philadelphia, Pennsylvania): Can you just comment what your precedence rate was for complications before mortality? Dan Holena from our institution has suggested that using big databases, if you have a lot of patients, who die without a listed complication in the database it actually isn't very accurate and could affect your results.

Dr. Ajai K. Malhotra (Burlington, Vermont): Malhotra, Burlington. Very well presented. Nicely analyzed. But it is implying that the failure to rescue is actually a bad thing.

Is it possible that smaller hospitals where the patient's wishes and the family wishes were taken into account and when the complication actually happened it was a choice not to rescue as opposed to a failure to rescue?

Dr. Jay J. Doucet (San Diego, California): So NIS in the years you looked at it tells you some things about the hospital, its teaching status, what part of the country it's in and what the bed size is.

Do you have any more data on what these bigger hospitals are like? Are they actually, in fact, centers of excellence?

Dr. David J. Dries (Saint Paul, Minnesota): I rise to support the last comment. Three important recent papers support the positive impact of resident participation in the care of our patients. The role of our Acute Surgery centers in teaching is good for our patients as well as our trainees. Thank you.

J Am Coll Surg. 2016;222:30-40, Ann Surg. 2017;265:502–513, and JAMA. 2017;317:2105-2113.

Dr. Ambar Mehta (Baltimore, Maryland): Thank you, Dr. Peitzman for the introduction and for all the questions for everyone. I will try to get through them all.

So the first question was how to avoid the first complication. I think learning to, figuring out how to avoid the first complication requires understanding why it occurred in the first place.

As we all know, emergent procedures have a higher complication rate, in general, relative to elective procedures.

And a few studies have shown that EGS-specific services or mentorship programs can reduce the overall complication rate for emergency surgeries. However, we still require more targeted interventions to reduce the overall complication rate, I believe, in the emergent setting.

For the second question regarding recommendations on how to rescue patients, I believe a recent study, in the past five years, looked at hospital characteristic associated with failure to rescue in the Medicare population and they found that several hospital characteristics were associated with more likely to rescue a patient such as having more than 20 ICU beds, having a greater nurse-to-patient ratio, and a few other factors.

But they realized that these hospital characteristics did not fully explain the variation in failure to rescue rates that they observed. And so they concluded that microsystems and working on teamwork and protocols on the floor with the actual team explains a large variation.

And so I think recommendations for rescuing patients I think requires taking a hospital centered approach and tailing it towards individual centers.

Regarding how has this information changed practices at the current hospital where I go to school, I think this study commented on the nationwide variation of failure to rescue.

And I think it now then asks the next question of can we look at our own outcomes and see how big of an issue is failure to rescue and can we analyze those patients on a case-by-case basis to learn where we can improve.

Regarding the questions from the audience, one of them was, the first one was should we regionalize non-trauma EGS procedures. I think regionalization has definitely shown benefits in the trauma setting.

I think copying a model of that idea for non-trauma EGS procedures may work but it would definitely require studies and multi-center programs to see if it is actually beneficial for patients.

Regarding – I did not catch the second question but I believe it was about capturing patients who died but did not have a complication. I did check this in our database and it was a very low number of patients, so I cannot recall it on the top of my head but I'm more than happy to look into it.

To clarify, though, we did not include those patients as failure to rescue. We made sure that all patients has a complication and then assessed whether those patients had died.

Regarding the patients' wishes not to continue – patients' family wishes not to continue patient care after a patient has undergone a complication. That's a really great point. Unfortunately, we can't answer that or look at that in a nationwide database.

And, finally, the question regarding teaching affiliation with associations. In our paper we do incorporate the full regression results where we look at how are certain hospital factors associated with both complications and failure to rescue.

From my recollection academic teaching status was not associated with complications or higher rates of failure to rescue. Thank you.

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