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Contributors to Increased Mortality Associated With Care Fragmentation After Emergency General Surgery

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Invited Commentary

Supplemental content

IMPORTANCE Care fragmentation at time of readmission after emergency general surgery (EGS) is associated with high mortality; however, the factors underlying this finding remain unclear.

OBJECTIVE To identify patient and hospital factors associated with increased mortality among patients after EGS readmitted within 30 days of discharge to a nonindex hospital.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort study using the 2014 Healthcare Cost and Utilization Project Nationwide Readmissions Database. Participants were all adult patients (18 years or older) who underwent 1 of the 15 most common EGS procedures in the United States from January 1 to November 30, 2014, and survived to discharge. The dates of analysis were October through December 2019.

EXPOSURES Thirty-day readmission to a hospital other than that of the index surgical procedure. The study examined the association of interventions during readmission, change in hospital resource level, and severity of patient illness during readmission.

MAIN OUTCOMES AND MEASURES Ninety-day inpatient mortality.

RESULTS In total, 71 944 patients who underwent EGS (mean [SD] age, 59.0 [18.3] years; 53.5% [38 487 of 71 944] female) were readmitted within 30 days of discharge, of whom 10 495 (14.6%) were readmitted to a nonindex hospital. Compared with patients readmitted to index hospitals, patients readmitted to nonindex hospitals were more likely to be readmitted to hospitals with low annual EGS volume (33.5% vs 25.6%, $P < .001$) and be in the top half of illness severity profile (37.2% vs 31.2%, $P < .001$). Overall 90-day mortality was higher in the patients readmitted to nonindex hospitals (6.1% vs 4.3%, $P < .001$). When adjusted for baseline patient and hospital characteristics, care fragmentation was independently associated with increased mortality (adjusted odds ratio [aOR], 1.36; 95% CI, 1.17-1.58; $P < .001$). After adjustment for interventions performed during readmission, change in EGS hospital volume level, and severity of patient illness, care fragmentation was no longer independently associated with mortality (aOR, 1.05; 95% CI, 0.88-1.26; $P = .58$). In this complete model, severity of illness was the strongest risk factor of mortality during readmission.

CONCLUSIONS AND RELEVANCE In this cohort study of adult patients who require rehospitalization after EGS, 14.6% are readmitted to a hospital other than where the index procedure was performed. Although the overall mortality rate is higher for this population, the excess mortality appears to be primarily associated with severity of patient illness at time of readmission. These data underscore the need to develop systems of care to rapidly triage patients to hospitals best equipped to manage their condition.

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Unplanned hospital readmission after major surgery is common and continues to be a priority for both hospitals and surgeons as they are increasingly held accountable for postdischarge outcomes by payers and policy makers.[1-3] Although readmissions may ultimately play an important role in patient care by rescuing patients from complications or acute medical issues, care fragmentation at time of readmission is associated with worse outcomes across a variety of surgical specialties. For example, readmission to a hospital different from that where the index operation was performed carries a 48% increased risk of mortality for certain high-risk surgical procedures.[4]

Emergency general surgery (EGS) represents a broad range of acute surgical conditions that together constitute a substantial public health burden, accounting for more than 7% of all inpatient hospitalizations and carrying disproportionately high morbidity and mortality.[5-7] After EGS, patients have high rates of resource use, including readmission. Almost 1 in 5 elderly patients readmitted after EGS procedures experiences fragmentation in care and readmission to a nonindex hospital.[8] Similar to other surgical populations, this pattern is independently associated with higher mortality. Although this phenomenon is well established, what remains unclear is the mechanisms underlying the excess mortality seen with care fragmentation after inpatient surgery.

Identifying contributors to increased mortality because of care fragmentation at time of readmission is important to develop systems and interventions that target these factors and optimize patient outcomes. We hypothesized that 3 key factors contribute to the excess mortality of care fragmentation observed in patients after EGS. First, patients who require additional procedures or surgical interventions during readmission might be adversely affected by care discontinuity (eg, loss of clinical information and familiarity of care teams) at nonindex hospitals. Second, nonindex hospitals might not have the resources or systems necessary to effectively manage the acute medical or surgical needs of readmitted patients after EGS. Third, severity of illness might necessitate that patients be readmitted to nonindex hospitals because they may be too ill to be transported to the index hospital. This study investigated each of these factors as a contributor to mortality during nonindex hospital readmission in a nationally representative all-payer sample of patients who underwent EGS.

Key Points

Question What factors are responsible for the increased mortality observed in patients readmitted to a nonindex hospital after emergency general surgery?

Findings In this cohort study of 71 944 patients in the 2014 Nationwide Readmissions Database who underwent emergency general surgery, patients readmitted to a nonindex hospital had a higher overall mortality rate compared with patients readmitted to index hospitals. This excess mortality was primarily explained by severity of patient illness at readmission.

Meaning Because severity of patient illness is not modifiable, there is a need to develop systems that allow for rapid assessment and triage of patients after emergency general surgery to hospitals best equipped to manage their specific condition.

Methods

Data Source and Patient Selection

The 2014 Nationwide Readmissions Database (NRD)[9] from the Healthcare Cost and Utilization Project (HCUP) and Agency for Healthcare Research and Quality was used to conduct this retrospective cohort study. The NRD is an all-age, all-payer database drawn from 22 HCUP State Inpatient Databases. Together, it contains 15 million unweighted discharges, which are then weighted to give a nationally representative sample of 35 million discharges. The data set contains unique patient identifiers that permit longitudinal tracking of patients' readmissions over the course of a calendar year. The study was reviewed by the University of Utah Institutional Review Board and was exempt from formal review and informed consent because patient information was deidentified. All research activities followed regulations within the HCUP and Agency for Healthcare Research and Quality data use agreements.

The study identified all adult patients (18 years or older) with a nonelective index admission who underwent 1 of the following 15 most common EGS procedures in the United States from January 1 to November 30, 2014, and survived to discharge: cholecystectomy, appendectomy, small-bowel resection, incision and drainage, lysis of adhesions, debridement of wound or infection, nontrauma exploratory laparotomy, nontrauma exploratory laparoscopy, colorectal resection, construction of colostomy, construction of ileostomy, inguinal or femoral hernia, other hernia repair, hemorrhoid procedure, and operative management of peptic ulcer disease. These procedures represent more than 90% of EGS procedures performed annually in the United States.[10] Single-level Clinical Classifications Software[11] procedure codes developed by the HCUP were used to identify patients who underwent the above procedures in a nonelective manner in 2014. The dates of analysis were October through December 2019.

Patients were excluded if they were younger than 18 years at the time of index EGS admission, if they died during their index hospital stay, or if they did not experience a readmission. Patients were considered readmitted if they had a nonelective admission to any hospital within 30 days of discharge from the index EGS hospitalization. Nonindex readmission was classified as a readmission to a hospital other than the one where the index EGS procedure was performed. Also excluded were patients who underwent interfacility transfers between 2 acute care hospitals during their readmission hospitalization because it was not possible to obtain characteristics of the initial hospital, including bed size, length of time before transfer, and procedures occurring before transfer. This exclusion criterion also limits misclassification of index and nonindex hospital readmission for those patients who were transferred either from or to their index hospital. Because the NRD does not allow for tracking patients across calendar years, patients admitted in December were excluded to ensure full 30-day follow-up.

Patient and Hospital Characteristics

Demographic data were obtained from the NRD, including age, sex, zip code median (interquartile range [IQR]) income quartile, primary expected payer, and number of chronic conditions. Also examined were hospital characteristics, such as ownership, bed size, rural location, and teaching hospital status. In addition, the study examined the proportion of complex or advanced presentations for 9 common EGS diseases, with severity scales defined by The American Association for the Surgery of Trauma (AAST). Simple disease was defined as AAST class 1 to 3, and complex disease was defined as AAST class 4 to 5.[12] Relevant *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes are listed in eTable 1 in the Supplement.

Patients requiring interventions were classified using the *ICD-9* procedure class variable in the NRD. Classification included none, procedure only (if the procedure would have occurred outside of an operating room), or operating room with or without procedure (if an operating room was required).

Hospital annual EGS volume quartile was used as a proxy measure of hospital resources. Hospital volume has been shown to be closely associated with the presence of complex resources,[13] and annual EGS volume in particular has been shown to be associated with quality of care.[14] We defined annual EGS volume at each hospital by the total number of EGS cases during 2014. Quartiles of annual EGS volume were then calculated with cutoff points as follows: quartile 1 (≤732 cases), quartile 2 (733-1270 cases), quartile 3 (1271-2071 cases), and quartile 4 (≥2072 cases). Patients were identified who experienced a change in resource level during their readmission: first from a quartile 1 hospital during index admission to a quartile 3 or 4 hospital during readmission, representing an increase in hospital resources, and then from a quartile 3 or 4 index hospital to a quartile 1 hospital on readmission, representing a decrease in hospital resources. These classifications were chosen to capture only patients who underwent the largest changes in resource level between admissions; all others were classified as no change.

Patient severity of illness was measured using the NRD variable risk of mortality. This categorical variable uses the 3M All Patient Refined DRG Classification System to classify patients into clinically meaningful groups based on diagnosis related groups (DRGs) and illness severity and then derive an estimated risk of mortality: 1 corresponds to the lowest predicted risk of death during admission, and 4 corresponds to an extreme risk of mortality.

The primary outcome of interest was all-cause mortality during inpatient hospitalization up to 90 days after readmission. Secondary outcomes included readmission length of stay and total readmission hospital charges.

Statistical Analysis

Hospital-level sampling weights for the initial hospital or readmission hospital that were provided by the NRD were used for all analyses. Summaries and comparisons of most patient characteristics, the index hospital characteristics, and EGS conditions (at the initial hospital) were evaluated using sampling weights for the initial admission hospital. Patient characteristics at readmission, characteristics of the readmission hospitals, and the readmission interventions were evaluated with the readmission hospital's sampling weights. Models for 90-day mortality were also weighted based on the readmission hospital.

First, the rate of 30-day readmission after discharge from index EGS surgical admissions to both index and nonindex hospitals was calculated. Differences were then assessed in patient and hospital characteristics using χ^2 test and Wilcoxon rank sum test for categorical and continuous variables as appropriate.

Univariable logistic regression of 90-day in-hospital mortality for all risk factors of interest used sampling weights based on the readmission hospital's characteristics. A multivariable logistic regression model was then constructed using an indicator of readmission to a nonindex hospital and the following base variables: age, sex, primary expected payer, number of chronic conditions, and ownership type for the readmission hospital. The 3 variables of interest were then added sequentially (readmission interventions, hospital annual EGS volume change, and readmission severity of illness) to evaluate the change in mortality prediction. The discriminatory power of the 4 multivariable models was assessed using the area under the curve.

All analyses were conducted with R, version 3.6.1 (R Project for Statistical Computing), specifically using the survey package for weighting. Statistical significance was set at 2-sided $P < .05$.

Results

Study Population

Of the 399 786 index admissions for EGS procedures, 379 886 patients survived their initial hospitalization, and 34 641 patients (9.1%) were readmitted within 30 days of discharge. A total of 996 patients were excluded because of interfacility transfer during readmission, leaving 33 645 eligible readmissions in the study population. This number represents 71 944 weighted admissions (mean [SD] age, 59.0 [18.3] years; 53.5% [38 487 of 71 944] female), of which 10 495 (14.6%) were for patients who were readmitted to a hospital other than the one where their index procedure was performed (eFigure in the Supplement). The most common procedures were cholecystectomy, debridement of wound, lysis of adhesions, and colorectal resection, which together accounted for 78.4% of all procedures (eTable 2 in the Supplement).

Patient Characteristics

Compared with patients who were readmitted to the index hospital, those who were readmitted to nonindex hospitals had a slightly higher proportion of male individuals, patients in the lower 2 zip code median income quartiles, and publicly insured individuals (**Table 1**). Patients who underwent nonindex readmission were also more likely to have initially been treated at a small (19.4% vs 14.0%, $P < .001$) or nonteaching (41.5% vs 35.5%, $P < .001$) hospital or one in the lowest quartile of annual EGS volume (35.7% vs 25.6%, $P < .001$). Pa-

Table 1. Characteristics of Readmitted Patients and Index Hospitals[a]

Variable	Index readmission (n = 61 449)	Nonindex readmission (n = 10 495)	P value
Patient characteristics			
Age, y	(n = 61 448)	(n = 10 495)	
18-49	18 379 (29.9)	3180 (30.3)	.14
50-64	17 712 (28.8)	2836 (27.0)	
65-75	12 302 (20.0)	2146 (20.4)	
>75	13 055 (21.2)	2333 (22.2)	
Female sex	33 130 (53.9)	5357 (51.0)	<.001
Zip code median income quartile	(n = 60 590)	(n = 10 321)	
1, Lowest	17 355 (28.6)	3166 (30.7)	.005
2	16 762 (27.7)	2938 (28.5)	
3	13 982 (23.1)	2336 (22.6)	
4, Highest	12 491 (20.6)	1881 (18.2)	
Primary expected payer	(n = 61 391)	(n = 10 483)	
Private	15 923 (25.9)	2082 (19.9)	<.001
Medicare	30 126 (49.1)	5684 (54.2)	
Medicaid	10 249 (16.7)	1867 (17.8)	
Self-pay	2684 (4.4)	493 (4.7)	
No charge	545 (0.9)	70 (0.7)	
Other	1864 (3.0)	287 (2.7)	
No. of chronic conditions, median (IQR)	5 (3-8)	6 (3-8)	<.001
Illness severity at index admission	(n = 61 445)	(n = 10 494)	
1, Mild	24 523 (39.9)	3723 (35.5)	<.001
2, Moderate	16 326 (26.6)	3016 (28.7)	
3, Major	14 779 (24.1)	2647 (25.2)	
4, Extreme	5817 (9.5)	1108 (10.6)	
Index hospital characteristics			
Ownership	(n = 61 449)	(n = 10 495)	
Government nonfederal	7201 (11.7)	1294 (12.3)	<.001
Private	9468 (15.4)	1990 (19.0)	
Private nonprofit	44780 (72.9)	7211 (68.7)	
Bed size	(n = 61 449)	(n = 10 495)	
Small	8595 (14.0)	2032 (19.4)	<.001
Medium	17 407 (28.3)	2950 (28.1)	
Large	35 447 (57.7)	5513 (52.5)	
Rural location	801 (1.3)	271 (2.6)	<.001
Teaching hospital	39 635 (64.5)	6136 (58.5)	<.001
Annual EGS volume quartile	(n = 61 449)	(n = 10 495)	
1, Lowest	15 755 (25.6)	3745 (35.7)	<.001
2	15 176 (24.7)	2272 (21.7)	
3	14 049 (22.9)	2176 (20.7)	
4, Highest	16 469 (26.8)	2302 (21.9)	

Abbreviations: EGS, emergency general surgery; IQR, interquartile range.

[a] Weighted by the initial admission sampling weights. The Nationwide Readmissions Database uses weights to calculate the reported national estimates. The totals of the counts shown for categorical variables may not sum to the total cohort denominator because of rounding of weighted estimates and/or missing values within the variable.

tients admitted to nonindex hospitals also had more chronic conditions (median [IQR], 6 [3-8] vs 5 [3-8]; $P < .001$) and had a longer time from discharge to readmission date (median [IQR], 18 [11-24] vs 16 [10-22] days; $P < .001$). At both index and readmission hospitalizations, the nonindex readmission group had an overall higher illness severity profile. At the time of readmission, 37.2% of the nonindex readmission group were in the top 2 categories of illness severity compared with 31.2% of the index readmission group ($P < .001$) (**Table 2**). Complexity of 9 common EGS diagnoses was examined, with no statistically significant difference in the total proportion of complex cases between groups (11.8% for the index readmission group vs 12.4% for the nonindex readmission group, $P = .25$) (eTable 3 in the Supplement).

Readmission Interventions and Hospital Resources

The proportion of patients who underwent a non-operating room therapeutic procedure or operative intervention was similar between index and nonindex readmission groups (**Table 3**). Of patients readmitted to a nonindex hospital, 50.5% of those initially admitted to a quartile 1 (low-volume) hospital were subsequently readmitted to either a quartile 3 or 4 hospital, representing an increase in resources. In contrast, 37.0% of patients admitted to a quartile 3 or 4 hospital were subsequently readmitted to a low-volume EGS hospital (eTable 4 in the Supplement). Comparing the 2 patient groups, a higher proportion of patients in the nonindex readmission group were readmitted to hospitals with a low annual EGS volume (33.5% vs 25.6%, $P < .001$) (Table 2).

Outcomes

Patients undergoing EGS who were readmitted to nonindex hospitals had higher all-cause mortality during inpatient hospitalization than those who were readmitted to the hospital where their initial operation was performed (6.1% vs 4.3%, $P < .001$). Readmission length of stay did not differ between the 2 groups; however, hospital charges were higher in the nonindex readmission group (median [IQR], $30 760 [$16 398-$59 409] vs $28 845 [$16 253-$53 642]; $P = .002$). Univariable regression analysis of risk factors for in-hospital mortality is summarized in eTable 5 in the Supplement.

To investigate contributors to 90-day mortality with nonindex readmission, a series of 4 stepwise multivariable logistic regression models was examined using an additive approach to test the association of each variable in our hypothesis (**Table 4**). When only relevant patient and readmission hospital characteristics were examined, readmission to a nonindex hospital increased the odds of mortality by 36% (adjusted odds ratio [aOR], 1.36; 95% CI, 1.17-1.58; $P < .001$) (model 1), adjusted for age, sex, primary expected payer, number of chronic conditions, and ownership type for the readmission hospital. The addition of first readmission interventions (model 2) and subsequently hospital annual EGS volume change (model 3) had a small overall association with nonindex readmission. When readmission severity of illness was added to the model (model 4), nonindex readmission was no longer a statistically significant risk factor for 90-day mortality (aOR, 1.05; 95% CI, 0.88-1.26; $P = .58$). In this complete model, readmission severity of illness was the primary contributor to 90-day mortality. Neither increase nor decrease in hospital annual EGS volume was a statistically significant risk factor for mortality, and therapeutic procedures had a modest association (aOR, 1.45; 95% CI, 1.23-1.72; $P < .001$). The area under the curve of the models increased from 0.733 for model 1 to 0.868 for model 4. Sensitivity analysis that included interfacility transfers showed preservation of the patterns described above (eTable 6 in the Supplement).

Table 2. Readmission Patient and Hospital Characteristics[a]

Variable	Index readmission (n = 61 452)	Nonindex readmission (n = 10 433)
Patient characteristics		
Time to readmission, median (IQR), d	16 (10-22)	18 (11-24)
Illness severity at readmission	(n = 61 426)	(n = 10 430)
1, Mild	23 383 (38.1)	3476 (33.3)
2, Moderate	18 889 (30.8)	3071 (29.4)
3, Major	13 858 (22.6)	2565 (24.6)
4, Extreme	5296 (8.6)	1318 (12.6)
Readmission hospital characteristics		
Ownership	(n = 61 452)	(n = 10 430)
Government nonfederal	7201 (11.7)	1447 (13.9)
Private	9470 (15.4)	1812 (17.4)
Private nonprofit	44 781 (72.9)	7174 (68.8)
Bed size	(n = 61 452)	(n = 10 430)
Small	8594 (14.0)	1891 (18.1)
Medium	17 405 (28.3)	2967 (28.4)
Large	35 453 (57.7)	5575 (53.4)
Rural location	802 (1.3)	331 (3.2)
Teaching hospital	39 634 (64.5)	6311 (60.5)
Annual EGS volume quartile	(n = 61 453)	(n = 10 384)
1, Lowest	15 755 (25.6)	3478 (33.5)
2	15 179 (24.7)	2436 (23.5)
3	14 050 (22.9)	2125 (20.5)
4, Highest	16 469 (26.8)	2345 (22.6)

Abbreviations: EGS, emergency general surgery; IQR, interquartile range.

[a] Weighted by readmission sampling weights. $P < .001$ for all comparisons. The Nationwide Readmissions Database uses weights to calculate the reported national estimates. The totals of the counts shown for categorical variables may not sum to the total cohort denominator because of rounding of weighted estimates and/or missing values within the variable.

Discussion

Care fragmentation during readmission has been shown to be associated with increased mortality across a wide spectrum of surgical subspecialties, yet our understanding of mechanisms underlying this finding remains largely speculative.[4,15-19] In this national study of adult readmissions after common EGS procedures, we found that 14.6% of patients were readmitted to hospitals other than those of their initial surgery and that these patients experienced higher rates of in-hospital mortality. This excess mortality was primarily explained by severity of patient illness at time of readmission.

The results of this study highlight the critical role that severity of illness plays in the outcomes of patients after EGS.

Table 3. Readmission Interventions[a]

Readmission intervention	No. (%) Index readmission (n = 61 452)	No. (%) Nonindex readmission (n = 10 433)	*P* value
None	27 235 (44.3)	4681 (44.9)	.72
Non-operating room procedure only	23 495 (38.2)	3989 (38.2)	
Operating room with or without procedure	10 722 (17.4)	1763 (16.9)	

[a] Weighted by readmission sampling weights.

Table 4. Ninety-Day In-Hospital Mortality Multivariable Logistic Regression Models[a]

Variable	Model 1	*P* value	Model 2	*P* value	Model 3	*P* value	Model 4	*P* value
Nonindex readmission	1.36 (1.17-1.58)	<.001	1.38 (1.18-1.60)	<.001	1.31 (1.09-1.57)	.005	1.05 (0.88-1.26)	.58
Age	1.03 (1.03-1.04)	<.001	1.03 (1.03-1.04)	<.001	1.03 (1.03-1.04)	<.001	1.01 (1.01-1.02)	<.001
Female sex	0.96 (0.85-1.07)	.44	0.96 (0.86-1.08)	.53	0.96 (0.85-1.08)	.50	1.04 (0.92-1.17)	.51
Primary expected payer								
Private	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Medicare	1.36 (1.09-1.69)	.006	1.35 (1.09-1.68)	.007	1.35 (1.09-1.68)	.007	1.12 (0.90-1.39)	.31
Medicaid	0.93 (0.72-1.19)	.56	0.96 (0.74-1.23)	.72	0.94 (0.73-1.21)	.64	0.90 (0.69-1.16)	.41
Self-pay	0.87 (0.53-1.42)	.58	0.93 (0.57-1.52)	.77	0.93 (0.57-1.52)	.77	0.92 (0.53-1.60)	.77
No charge	0.55 (0.18-1.67)	.29	0.64 (0.21-1.94)	.43	0.64 (0.21-1.94)	.43	0.89 (0.28-2.85)	.84
Other	0.75 (0.45-1.25)	.26	0.75 (0.45-1.26)	.28	0.75 (0.45-1.25)	.27	0.82 (0.48-1.41)	.47
No. of chronic conditions	1.10 (1.08-1.12)	<.001	1.09 (1.07-1.11)	<.001	1.09 (1.07-1.11)	<.001	1.04 (1.02-1.06)	<.001
Readmission hospital ownership								
Government nonfederal	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Private	0.81 (0.64-1.01)	.07	0.84 (0.67-1.04)	.12	0.84 (0.68-1.05)	.13	0.81 (0.64-1.02)	.07
Private nonprofit	1.00 (0.84-1.18)	.98	1.00 (0.85-1.18)	>.99	1.00 (0.85-1.18)	>.99	0.90 (0.77-1.06)	.23
Readmission intervention								
None			1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-operating room procedure only			2.82 (2.42-3.30)	<.001	2.82 (2.42-3.30)	<.001	1.45 (1.23-1.72)	<.001
Operating room with or without procedure			2.35 (1.95-2.82)	<.001	2.33 (1.94-2.81)	<.001	1.13 (0.93-1.38)	.21
Hospital annual EGS volume change								
No change					1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Decrease					1.01 (0.70-1.46)	.95	1.25 (0.83-1.87)	.28
Increase					1.30 (0.94-1.80)	.12	1.23 (0.86-1.76)	.27
Readmission illness severity								
1, Minor							1 [Reference]	1 [Reference]
2, Moderate							3.73 (2.51-5.56)	<.001
3, Major							10.33 (7.03-15.17)	<.001
4, Extreme							58.73 (39.80-86.65)	<.001
AUC	0.733	NA	0.763	NA	0.764	NA	0.868	NA

Abbreviations: AUC, area under the curve; EGS, emergency general surgery; NA, not applicable.

[a] Weighted by readmission sampling weights.

In contrast to elective surgical conditions, EGS conditions span a wide range of physiologic severity within each condition. For example, a patient with perforated diverticulitis might present with a small abscess and minimal abdominal pain or alternatively may be seen in septic shock with feculent peritonitis. This finding requires more extensive risk adjustment than is typically feasible using common comorbidity indexes. The externally validated and widely used 3M All Patient Refined DRG Classification System was used to provide clinically based risk adjustment for patient severity of illness at time of readmission. Our results show that severity of illness at time of readmission not only was the most important contributor to mortality but also, once accounted for, eliminated the independent association of nonindex readmission.

Previous studies examining care fragmentation after surgery support our findings that severity of illness is associated with nonindex hospital readmission and subsequent mortality. Age, comorbid medical issues, and geographic distance from the patient's home to the index hospital are all associated with increased risk of nonindex readmission.[4,8,20] In a study of elderly patients who underwent EGS, Havens et al[8] showed that individuals having diagnosis categories with a higher likelihood of clinical severity—including resuscitation and vascular procedures—are more likely to be readmitted to nonindex hospitals. Although the NRD does not provide sufficient information to examine the role of geographic proximity in nonindex readmission, prior literature suggests that patients with acute or severe illness may logically choose to present to the closest hospital rather than that of their index surgery.[4,20] The results of the present study are consistent with these previous studies and support their findings identifying patient acuity as a strong risk factor for mortality associated with care fragmentation.

Another hypothesis surrounding the excess mortality associated with care discontinuity after surgery is that loss of clinical information or care team unfamiliarity may contribute to worse clinical outcomes.[21] In a study of care discontinuity after major operations, such as coronary artery bypass grafting, arterial bypass, joint replacement, and esophagectomy, Brooke et al[15] found a dose-dependent reduction in mortality after readmission as the degree of continuity increased at the hospital and clinician level. Similar patterns have been observed in patients undergoing colorectal surgery.[22,23] Therefore, we hypothesized that the need for operative procedures during readmission could influence patient mortality and were surprised when we did not observe a statistically significant association with 90-day mortality. There was also no evidence of effect modification between interventions and nonindex hospital location, suggesting that the unfamiliarity of the operative team did not play a role in patient mortality after EGS procedures.

Clinically, the results of this study speak to the importance of considering patient physiology in EGS triage, particularly in the case of readmission. Nationally representative data demonstrate that more than 90% of all EGS cases may be safely performed at low-volume hospitals.[14] Our study findings add to this understanding and support that, if patients subsequently experience serious complications that result in physiologic instability or septic shock, then expediting readmission to an optimally resourced center is most appropriate regardless of the discontinuity in surgeon or hospital care. Physiologic criteria are commonly used to triage patients with major trauma to designated level I or II trauma centers, and a similar approach could be useful to rapidly identify and triage severely ill patients after EGS to appropriate hospitals.[24-26] Development of regional networks with telemedicine capabilities to encourage cooperation and support between low-resource and high-resource centers is another strategy worthy of consideration.

Limitations

These results must be interpreted in the context of several important limitations. The NRD is an administrative database with limited information on hospital characteristics, including advanced clinical resources and geographic location. As an administrative database, it does not contain physiologic data for detailed risk adjustment; however, we attempted to account for this limitation by using a DRG-based assessment of illness severity in addition to comorbid illnesses. We did not have detailed information on the indications for readmissions or the factors underlying patient decisions to return to nonindex hospitals. Insurance coverage, geographic proximity, established relationships with other physicians, or dissatisfaction with care might all play a role. Finally, we were unable to infer what proportions of deaths were preventable should the patient have been readmitted to either their index hospital or a center with higher resources. For patients who experience serious complications after surgery at a small or limited-resource hospital, treatment at a center with advanced resources may be necessary for appropriate management.

Conclusions

In this cohort study, 14.6% of adult patients in the US who were readmitted after an EGS procedure received care at a hospital different from that of their initial surgery and experienced a higher risk of mortality than those readmitted to their index hospital. The excess mortality risk associated with care fragmentation appears to be largely associated with severity of patient illness. Because this factor is not modifiable, adequate systems must be in place to rapidly assess and triage patients to the most appropriate hospital. Developing systems of coordinated care for patients after EGS—including strategies for rapid evaluation, triage, and, when necessary, transfer—has potential to improve outcomes in this high-risk population.

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