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In Patients Admitted Emergently With Either Intestinal Fistula, Ulceration, Perforation, Angiodysplasia, or Dieulafoy Lesion, Increased Frailty, Age, Time to Operation, and Hospital Length of Stay Are Mortality Risk Factors

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Abstract

Background: This study aimed to elucidate and quantify mortality risk factors in patients emergently admitted with the intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions.

Methods: The National Inpatient Sample admitted with code ICD-9 569.8 between 2005-2014. Relationships between mortality and all parameters of interest were determined with multivariable logistic regression models.

Results: 53,585 patients were assessed, including 18,361 adults and 35,224 elderly patients who possessed an average age of 50.8 and 78.1 years, respectively. Female patients made up 51.2% of adults and 57.2% of the elderly, while males accounted for 48.8% of adults and

42.8% of elderly patients. Average mortality rate for operated adults was 4.3%, for non-operated adults was 2.5%, for operated elderly was 6.6%, and for non-operated elderly was 7.1%. Time to operation, age, modified frailty index were the most significant risk factors for mortality for the operative group. Every additional day of delay to operative intervention increased the risk of mortality by 3.0% and 3.5% in adult and elderly patients, respectively. Operatively managed adult and elderly patients with intestinal perforation were 3.2 times and 4.0 times more likely to expire relative to those with intestinal fistula, respectively. In the non-operative group, odds of mortality were 3.0 times higher in adults and 3.3 in the elderly compared to fistula. Intestinal ulceration was associated with reduced mortality odds by 62.0% in adults and 65.7% in elderly patients when compared to fistula. Similarly, when compared to fistula, the mortality risk decreased by 61.7% and 82.7% in adult and elderly patients with angiodysplasia, respectively. Lastly, the indication of Dieulafoy intestinal lesion was associated with an 82.4% reduced mortality odds relative to fistula in elderly patients.

In the non-operative group, intestinal perforation increased odds of mortality by 3.0 times in adults and 3.3 times in elderly patients when compared to those with fistula. When comparing mortality odds against those with fistula, adult non-operative patients with intestinal ulceration, angiodysplasia, or Dieulafoy intestinal lesion had lower mortality odds by 57.8%, 59.9%, and 83.5%, respectively. Similarly, non-operative elderly patients displayed reduced mortality odds by 73.7%, 84.8%, and 86.5%, respectively. Each additional day of hospitalization increased the odds of mortality by 1.3% in non-operative adult patients.

Conclusion: Patients emergently admitted for the above pathologies with advanced age or frailty had higher mortality risk than their younger and non-frail counterparts. Other factors such as delayed time to operation and prolonged hospital length of stay increased mortality odds in operatively managed and conservatively managed patients, respectively.

Key Words: Intestinal Fistula, Ulceration, Perforation, Angiodysplasia, or Dieulafoy Lesion, In-hospital mortality, Age, Hospital Length of Stay

Introduction

The International classification of diseases (ICD)-9 code of 569.8 represent a collective of highly prevalent gastrointestinal (GI) diseases including intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, and Dieulafoy lesions. These conditions significantly contribute to morbidity and mortality. Recent investigations indicate that mortality rates are highly variable due to misdiagnosis with an approximate range between 2-30%.[1-7] Irrespective of mortality rate, the prevalence of these diseases leads them to account for 5 of the 12 most common causes of mortality from non-cancerous gastrointestinal (GI) pathology.[8] Intestinal ulceration is one of the most common GI ailments, and has been shown to significantly reduce quality of life [9]. As of 2019, GI pathology accounts for 135.9 billion USD in annual healthcare expenditure in the United States.[8] Of all possible etiologies contributing to this immense cost, angiodysplasia represents the most common cause of small bowel bleeding and the most frequent GI vascular lesion in elderly patients.[10-12] Intestinal fistula is independently responsible for more than 28,845 annual hospitalizations.[13] Moreover, Dieulafoy lesion-associated hospitalizations cost patients an average of 111,914 USD as of 2020.[14] These findings highlight the widespread impact of these conditions in the form of lives, dollars, and suffering.

Intestinal fistula, ulceration, perforation, angiodysplasia, and Dieulafoy lesions have a wide variety of etiologies, some of which have yet to be fully elucidated. Despite the prevalence of these conditions, there has been relatively limited research conducted to identify risk factors for mortality. Analysis of these disorders collectively may provide a more holistic understanding of the overarching variables affecting mortality and morbidity. Identification of shared risk factors is an important step toward the creation of effective prophylactic preventative strategies. Furthermore, enhanced delineation of mortality risk factors implicated across these disorders will enhance clinical prognostication and promote resource allocation toward high-risk patients. Therefore, additional investigations assessing clinical variables are a critical measure towards improving the outcomes of emergently admitted patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. When considering possible overlapping factors, we hypothesize prolonged hospital length of stay, frailty, advanced age, and delayed time to operation significantly contribute to mortality odds in these patient populations.

The principal aim of this 10-year retrospective investigation of 53,585 patients emergently admitted with the

primary diagnosis with these conditions was to elucidate and describe the impact of potential mortality risk factors.

Methods

The retrospective analysis described above utilized results from the National Inpatient Sample (NIS) database for patients emergently admitted with the primary diagnosis ICD-9 code 569.8. ICD-9 569.8 includes the following diagnoses; intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, and Dieulafoy lesions.

The NIS repository is part of a larger group of databases and spreadsheets created by the Healthcare Cost and Utilization Project (HCUP). The development of the NIS is the result of Federal-State-Industry affiliations organized by the Agency for Healthcare Research and Quality. Information regarding inpatient utilization, clinical outcomes, epidemiological trends, and biopsychosocial parameters are included. Furthermore, these results originate from a wide variety of medical centers found across the United States contributing to the highly generalizable nature of conclusions drawn from the database. Investigators using the NIS may conduct sophisticated statistical analyses to better understand the epidemiologic relationships underlying the numerous ailments assessed within the HCUP.

Patient Features

Data regarding patient features collected from the NIS was stratified according to age differences (adult and elderly), clinical outcome (survived and deceased), operation status (operation and no operation), intestine disorder (fistula, ulceration, perforation, angiodysplasia, Dieulafoy lesion), and type of invasive diagnostic or surgical procedure implemented. Additional sub-stratification was completed on the basis of race (White, Black, Hispanic, Asian/Pacific Islander, Native American, Other), income quartile, insurance status (private insurance, Medicare, Medicaid, self-pay, no charge, other), hospital location (rural, urban non-teaching, urban teaching), comorbidities, as well as invasive diagnostic procedure, surgical procedure, invasive or surgical procedure, deceased status, modified frailty index, time to surgical procedure, length of stay, and total charges in dollars.

The Subramaniam 5-item modified frailty index utilizes the following variables to determine frailty; functional health status, diabetes mellitus, history of chronic obstructive pulmonary disease (COPD), history of congestive heart failure, and hypertension requiring medication. Unfortunately, the NIS repository does not specify the duration or severity of comorbidities prior to admission. Nor does the database directly possess all variables required to calculate the 5-item modified frailty index. Therefore, to include frailty we utilized the following data points included in the NIS to estimate the 5-item mortality frailty index. Every category was assigned one point if the comorbidity was indicated. All points were summated to create a modified frailty index scale ranging from 0 to 5, in which 0 indicated not frail and 5 indicated frailest. Results regarding frailty are shown as averages (SD) in the modified frailty index row in Tables 1-5, and 7.

Table 6 indicates the surgical and invasive diagnostic procedures assessed based on the prevalence of utilization and survival status in adult and elderly patients. Surgical procedures included operations on the esophagus, stomach, intestine, appendix, anus, liver, pancreas, hernia, gallbladder and biliary tree, rectum, rectosigmoid, and perirectal tissue, and other abdominal regions. Similarly, invasive diagnostic procedures assessed included those involving the esophagus, stomach, intestine, rectum, rectosigmoid, and perirectal tissue, anus, liver, gallbladder and biliary tract, pancreas, and other abdominal regions. The ICD-9 code relating to each surgical procedure or invasive diagnostic procedure is indicated in Table 6 adjacent to their corresponding intervention.

Statistical Analysis

Following stratification, all data points relevant to a specific variable were utilized to determine the standard deviation (SD), average, and confidence interval (CI) set at 95%. Additionally, chi-square test and T-test were used to further describe associations between categorical and continuous results, respectively. The large sample size (53,585 patients) allowed statistical analyses to be completed in the presence of small changes from normality. Abnormal data points were critically assessed and removed if determined to be potential outliers. Transformation of data through log or square root was found to normalize any potential outliers retained. Mortality was the dependent variable employed in all analyses. Logistic univariable and binary multivariable logistic regression studies were performed to determine associations with mortality. Stepwise backward elimination was performed in a backward logistic regression analysis to determine mortality risk factors whilst controlling for confounding variables. Factors included in the backward logistic regression

included time to operation, age, modified frailty index, hospital length of stay, intestine disorder, female sex, invasive diagnostic procedure, race, income quartile, insurance, and hospital location. The multivariable logistic regression model included all confounding variables, of which all statistically insignificant variables ($p>0.05$) were removed with backward elimination. Confidence intervals (95%), adjusted odds ratios, and p-values are shown in the results of the multivariable logistic regression table as well as the coefficient of determination relative to age and operation status subgroups. Statistical assessments were completed using SPSS version 24 (SPSS Inc., Chicago, Illinois).

Results

3.1 Sex, Age, Race, and Comorbidity Differences

53,585 patients were emergently admitted with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions, between 2005-2014. Of these, adult and elderly patients made up 34.3% (18,361) and 65.7% (35,224) of the total cases, respectively. In the adult group, males accounted for 48.8% (8,954) of admissions, while females accounted for 51.2% (9,407) of admissions. Among the elderly, female and male patients represented 57.2% (20,146) and 42.8% (15,078) of the cases. The mean age of adult male and female patients was 50.09 and 51.52 years, respectively. Elderly male and female patients displayed similar mean ages of 77.43 and 78.54 years, respectively. Regardless of sex, adults displayed similar mortality rates of 3.4% (males) and 3.9% (females). Elderly females displayed the highest mortality rate of 7.5%, elderly males exhibited the second highest mortality rate of 5.9%. Male and female adults were predominantly White, possessed private insurance, and were treated at urban teaching hospitals. Regardless of sex, elderly patients were mainly White, funded by Medicare, and were admitted to urban and nonurban teaching hospitals. Adult males showed higher rates of AIDS, alcohol abuse, drug abuse, liver disease, lymphoma, paralysis, renal failure, Dieulafoy intestinal lesion, and intestinal perforation compared to their female counterparts. Adult females displayed significantly higher rates of deficiency anemia, rheumatoid arthritis, chronic pulmonary disease, depression, uncomplicated diabetes, chronic complicated diabetes, hypothyroidism, fluid/electrolyte disorders, metastatic cancer, other neurological disorder, obesity, psychoses, solid tumor, weight loss, intestinal fistula, intestinal ulceration, and angiodysplasia. Elderly males exhibited higher rates of AIDS, alcohol abuse, chronic pulmonary disease, coagulopathy, uncomplicated diabetes, chronic complications diabetes, liver disease, lymphoma, metastatic cancer, peripheral vascular disorder, renal failure, solid tumor, intestinal ulceration, angiodysplasia, and Dieulafoy lesion of intestine. Elderly females displayed higher rates of deficiency anemia, rheumatoid arthritis, depression, hypertension, hypothyroidism, fluid/electrolyte disorder, obesity, other neurological disorder, psychoses, pulmonary circulation disorder, weight loss, intestinal fistula, and intestinal perforation. Regardless of age, men displayed higher rates of surgical procedures and invasive or surgical procedures. Elderly males also displayed higher rates of invasive diagnostic procedures relative to their female counterparts.

Table 1. Characteristics of emergently admitted patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were stratified according to sex categories, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		Male	Female	p	Male	Female	p
All Cases		8,954 (48.8%)	9,407 (51.2%)		15,078 (42.8%)	20,146 (57.2%)	
Race	**White**	5,110 (66.9%)	5,627 (70.4%)	**<0.001**	10,488 (80.3%)	13,486 (79.0%)	**0.048**
	Black	1,242 (16.3%)	1,280 (16.0%)		1,287 (9.9%)	1,758 (10.3%)	
	Hispanic	841 (11.0%)	679 (8.5%)		765 (5.9%)	1,128 (6.6%)	
	Asian/Pacific Islander	163 (2.1%)	149 (1.9%)		229 (1.8%)	296 (1.7%)	
	Native American	57 (0.7%)	54 (0.7%)		51 (0.4%)	82 (0.5%)	
	Other	227 (3.0%)	206 (2.6%)		243 (1.9%)	329 (1.9%)	

Income Quartile	Quartile 1	2,493 (28.6%)	2,662 (28.9%)	0.930	3,704 (25.0%)	5,062 (25.5%)	0.170
	Quartile 2	2,279 (26.2%)	2,434 (26.4%)		3,846 (25.9%)	5,219 (26.3%)	
	Quartile 3	2,120 (24.3%)	2,216 (24.0%)		3,762 (25.4%)	5,036 (25.4%)	
	Quartile 4	1,819 (20.9%)	1,908 (20.7%)		3,526 (23.8%)	4,520 (22.8%)	
Insurance	Private Insurance	4,280 (47.9%)	4,534 (48.3%)	<0.001	1,263 (8.4%)	1,232 (6.1%)	<0.001
	Medicare	1,825 (20.4%)	2,095 (22.3%)		13,464 (89.4%)	18,454 (91.7%)	
	Medicaid	1,413 (15.8%)	1,765 (18.8%)		127 (0.8%)	249 (1.2%)	
	Self-Pay	840 (9.4%)	598 (6.4%)		49 (0.3%)	65 (0.3%)	
	No Charge	91 (1.0%)	70 (0.7%)		2 (0.0%)	6 (0.0%)	
	Other	483 (5.4%)	321 (3.4%)		150 (1.0%)	111 (0.6%)	
Hospital Location	Rural	807 (9.0%)	846 (9.0%)	0.920	1,613 (10.7%)	2,195 (10.9%)	0.240
	Urban: Non-Teaching	3,364 (37.6%)	3,508 (37.3%)		6,605 (43.8%)	8,968 (44.5%)	
	Urban: Teaching	4,783 (53.4%)	5,053 (53.7%)		6,860 (45.5%)	8,983 (44.6%)	
Comorbidities	AIDS	90 (1.0%)	33 (0.4%)	<0.001	8 (0.1%)	2 (0.0%)	0.023
	Alcohol Abuse	697 (7.8%)	303 (3.2%)	<0.001	477 (3.2%)	162 (0.8%)	<0.001
	Deficiency Anemias	1,629 (18.2%)	2,206 (23.5%)	<0.001	3,433 (22.8%)	4,852 (24.1%)	0.004
	Rheumatoid Arthritis	152 (1.7%)	448 (4.8%)	<0.001	318 (2.1%)	915 (4.5%)	<0.001
	Chronic Blood Loss	793 (8.9%)	859 (9.1%)	0.520	3,054 (20.3%)	4,032 (20.0%)	0.580
	Congestive Heart Failure	705 (7.9%)	716 (7.6%)	0.510	4,080 (27.1%)	5,351 (26.6%)	0.300
	Chronic Pulmonary Disease	1,211 (13.5%)	1,826 (19.4%)	<0.001	4,139 (27.5%)	5,245 (26.0%)	0.003
	Coagulopathy	631 (7.0%)	652 (6.9%)	0.760	1,352 (9.0%)	1,422 (7.1%)	<0.001
	Depression	668 (7.5%)	1,455 (15.5%)	<0.001	858 (5.7%)	2,108 (10.5%)	<0.001
	Diabetes, Uncomplicated	1,386 (15.5%)	1,670 (17.8%)	<0.001	4,037 (26.8%)	4,970 (24.7%)	<0.001
	Diabetes, Chronic Complications	289 (3.2%)	369 (3.9%)	0.011	779 (5.2%)	885 (4.4%)	0.001
	Drug Abuse	403 (4.5%)	309 (3.3%)	<0.001	47 (0.3%)	53 (0.3%)	0.400
	Hypertension	3,714 (41.5%)	3,952 (42.0%)	0.460	10,013 (66.4%)	13,816 (68.6%)	<0.001
	Hypothyroidism	308 (3.4%)	1,099 (11.7%)	<0.001	1,418 (9.4%)	4,123 (20.5%)	<0.001
	Liver Disease	695 (7.8%)	535 (5.7%)	<0.001	577 (3.8%)	621 (3.1%)	<0.001
	Lymphoma	122 (1.4%)	63 (0.7%)	<0.001	281 (1.9%)	237 (1.2%)	<0.001
	Fluid/Electrolyte Disorders	2,487 (27.8%)	3,019 (32.1%)	<0.001	4,033 (26.7%)	6,670 (33.1%)	<0.001
	Metastatic Cancer	531 (5.9%)	682 (7.2%)	<0.001	717 (4.8%)	793 (3.9%)	<0.001
	Other Neurological Disorders	381 (4.3%)	552 (5.9%)	<0.001	1,046 (6.9%)	1,464 (7.3%)	0.230
	Obesity	782 (8.7%)	1,308 (13.9%)	<0.001	786 (5.2%)	1,333 (6.6%)	<0.001
	Paralysis	197 (2.2%)	137 (1.5%)	<0.001	251 (1.7%)	301 (1.5%)	0.200
	Peripheral Vascular Disorders	505 (5.6%)	516 (5.5%)	0.650	2,202 (14.6%)	2,411 (12.0%)	<0.001
	Psychoses	360 (4.0%)	555 (5.9%)	<0.001	209 (1.4%)	430 (2.1%)	<0.001
	Pulmonary Circulation Disorders	173 (1.9%)	210 (2.2%)	0.160	642 (4.3%)	1,127 (5.6%)	<0.001
	Renal Failure	1,068 (11.9%)	995 (10.6%)	0.004	4,167 (27.6%)	4,001 (19.9%)	<0.001
	Solid Tumor	274 (3.1%)	352 (3.7%)	0.011	746 (4.9%)	593 (2.9%)	<0.001
	Peptic Ulcer	9 (0.1%)	7 (0.1%)	0.550	9 (0.1%)	14 (0.1%)	0.720
	Valvular Disease	393 (4.4%)	454 (4.8%)	0.160	2,368 (15.7%)	3,280 (16.3%)	0.150
	Weight Loss	1,146 (12.8%)	1,315 (14.0%)	0.019	1,395 (9.3%)	2,088 (10.4%)	0.001

Intestine Disorder	Fistula of Intestine	2,079 (23.2%)	2,507 (26.7%)		1,054 (7.0%)	1,736 (8.6%)	
	Ulceration of Intestine	1,176 (13.1%)	1,251 (13.3%)		1,433 (9.5%)	1,822 (9.0%)	
	Perforation of Intestine	3,602 (40.2%)	3,442 (36.6%)	**<0.001**	3,137 (20.8%)	5,000 (24.8%)	**<0.001**
	Angiodysplasia	1,950 (21.8%)	2,089 (22.2%)		9,114 (60.4%)	11,174 (55.5%)	
	Dieulafoy Lesion of Intestine	147 (1.6%)	118 (1.3%)		340 (2.3%)	414 (2.1%)	
Invasive Diagnostic Procedure		3,005 (33.6%)	3,129 (33.3%)	0.670	7,364 (48.8%)	9,191 (45.6%)	**<0.001**
Surgical Procedure		5,653 (63.1%)	5,526 (58.7%)	**<0.001**	9,542 (63.3%)	11,662 (57.9%)	**<0.001**
Invasive or Surgical Procedure		6,978 (77.9%)	7,020 (74.6%)	**<0.001**	12,263 (81.3%)	15,536 (77.1%)	**<0.001**
Deceased		302 (3.4%)	364 (3.9%)	0.070	884 (5.9%)	1,511 (7.5%)	**<0.001**
		Mean (SD)	**Mean (SD)**	**p**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years		50.09 (11.53)	51.52 (10.58)	**<0.001**	77.43 (7.39)	78.54 (7.71)	**<0.001**
Modified Frailty Index Score		1.17 (1.11)	1.27 (1.14)	**<0.001**	2.00 (1.18)	1.88 (1.15)	**<0.001**
Time to Invasive Diagnostic Procedure, Days		2.13 (4.03)	2.42 (5.05)	**0.026**	1.95 (2.68)	2.15 (4.16)	**<0.001**
Time to Surgical Procedure, Days		2.25 (7.04)	2.31 (6.02)	0.640	2.11 (2.97)	2.15 (3.66)	0.340
Length of Stay, Days		9.67 (14.00)	10.02 (13.40)	0.090	7.11 (9.02)	7.51 (9.07)	**<0.001**
Total Charges, Dollars		74,519 (119,253)	73,564 (112,763)	0.580	54,728 (86,095)	54,045 (82,440)	0.460

*Bold indicates result is statistically significant

3.2 Mortality

Adult patients displayed a lower mortality rate of 3.6%, compared to 6.8% of elderly patients who died in the hospital. Surviving adult patients were approximately 4 years younger than deceased adults. Similarly, deceased elderly patients were 3 years older than their surviving counterparts. Differences in comorbidities were analyzed in Table 2 based on survival and age. Deceased adult patients displayed higher rates of surgical procedures, modified frailty index, time to an invasive diagnostic procedure or surgical procedure, hospital length of stay, and total charges in dollars. Expired elderly patients displayed longer time to invasive diagnostic procedures, hospital length of stay, and higher total charges in dollars.

Table 2. Characteristics of emergently admitted patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were classified according to outcome categories, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	p	Survived	Deceased	p
All Cases		17,697 (96.4%)	666 (3.6%)		32,815 (93.2%)	2,395 (6.8%)	
Sex, Female		9,037 (51.1%)	364 (54.7%)	0.070	18,624 (56.8%)	1,511 (63.1%)	**<0.001**
Race	White	10,331 (68.6%)	398 (70.6%)		22,292 (79.3%)	1,674 (82.9%)	
	Black	2,431 (16.1%)	92 (16.3%)		2,898 (10.3%)	147 (7.3%)	
	Hispanic	1,472 (9.8%)	48 (8.5%)	0.540	1,777 (6.3%)	114 (5.6%)	**<0.001**
	Asian/Pacific Islander	306 (2.0%)	6 (1.1%)		493 (1.8%)	31 (1.5%)	
	Native American	106 (0.7%)	5 (0.9%)		128 (0.5%)	5 (0.2%)	
	Other	418 (2.8%)	15 (2.7%)		524 (1.9%)	49 (2.4%)	
Income Quartile	Quartile 1	4,962 (28.7%)	196 (30.4%)		8,154 (25.2%)	609 (26.1%)	
	Quartile 2	4,516 (26.1%)	195 (30.2%)	**0.016**	8,452 (26.1%)	609 (26.1%)	0.640
	Quartile 3	4,208 (24.3%)	128 (19.8%)		8,224 (25.4%)	569 (24.4%)	
	Quartile 4	3,601 (20.8%)	126 (19.5%)		7,497 (23.2%)	548 (23.5%)	

Insurance	**Private Insurance**	8,552 (48.4%)	261 (39.2%)	**<0.001**	2,308 (7.0%)	186 (7.8%)	**<0.001**
	Medicare	3,742 (21.2%)	180 (27.1%)		29,777 (90.9%)	2,128 (89.0%)	
	Medicaid	3,026 (17.1%)	149 (22.4%)		347 (1.1%)	29 (1.2%)	
	Self-Pay	1,396 (7.9%)	44 (6.6%)		99 (0.3%)	15 (0.6%)	
	No Charge	155 (0.9%)	6 (0.9%)		7 (0.0%)	1 (0.0%)	
	Other	781 (4.4%)	25 (3.8%)		229 (0.7%)	32 (1.3%)	
Hospital Location	**Rural**	1,604 (9.1%)	49 (7.4%)	0.200	3,454 (10.5%)	354 (14.8%)	**<0.001**
	Urban: Non-Teaching	6,633 (37.5%)	242 (36.3%)		14,550 (44.3%)	1,018 (42.5%)	
	Urban: Teaching	9,460 (53.5%)	375 (56.3%)		14,811 (45.1%)	1,023 (42.7%)	
Comorbidities	**AIDS**	116 (0.7%)	7 (1.1%)	0.220	9 (0.0%)	1 (0.0%)	0.510
	Alcohol Abuse	962 (5.4%)	38 (5.7%)	0.760	599 (1.8%)	40 (1.7%)	0.580
	Deficiency Anemias	3,741 (21.1%)	96 (14.4%)	**<0.001**	7,879 (24.0%)	404 (16.9%)	**<0.001**
	Rheumatoid Arthritis	571 (3.2%)	29 (4.4%)	0.110	1,157 (3.5%)	76 (3.2%)	0.370
	Chronic Blood Loss	1,638 (9.3%)	14 (2.1%)	**<0.001**	6,983 (21.3%)	101 (4.2%)	**<0.001**
	Congestive Heart Failure	1,350 (7.6%)	72 (10.8%)	**0.003**	8,826 (26.9%)	600 (25.1%)	**0.049**
	Chronic Pulmonary Disease	2,913 (16.5%)	124 (18.6%)	0.140	8,764 (26.7%)	614 (25.6%)	0.250
	Coagulopathy	1,118 (6.3%)	163 (24.5%)	**<0.001**	2,433 (7.4%)	339 (14.2%)	**<0.001**
	Depression	2,080 (11.8%)	41 (6.2%)	**<0.001**	2,829 (8.6%)	137 (5.7%)	**<0.001**
	Diabetes, Uncomplicated	2,966 (16.8%)	92 (13.8%)	**0.045**	8,648 (26.4%)	356 (14.9%)	**<0.001**
	Diabetes, Chronic Complications	641 (3.6%)	17 (2.6%)	0.150	1,600 (4.9%)	63 (2.6%)	**<0.001**
	Drug Abuse	691 (3.9%)	20 (3.0%)	0.240	94 (0.3%)	6 (0.3%)	0.750
	Hypertension	7,446 (42.1%)	217 (32.6%)	**<0.001**	22,601 (68.9%)	1,218 (50.9%)	**<0.001**
	Hypothyroidism	1,381 (7.8%)	24 (3.6%)	**<0.001**	5,256 (16.0%)	283 (11.8%)	**<0.001**
	Liver Disease	1,155 (6.5%)	74 (11.1%)	**<0.001**	1,124 (3.4%)	74 (3.1%)	0.380
Comorbidities	**Lymphoma**	172 (1.0%)	13 (2.0%)	**0.013**	458 (1.4%)	60 (2.5%)	**<0.001**
	Fluid/Electrolyte Disorders	5,166 (29.2%)	339 (50.9%)	**<0.001**	9,477 (28.9%)	1,218 (50.9%)	**<0.001**
	Metastatic Cancer	1,041 (5.9%)	169 (25.4%)	**<0.001**	1,192 (3.6%)	318 (13.3%)	**<0.001**
	Other Neurological Disorders	880 (5.0%)	52 (7.8%)	**0.001**	2,290 (7.0%)	218 (9.1%)	**<0.001**
	Obesity	2,041 (11.5%)	49 (7.4%)	**0.001**	2,043 (6.2%)	75 (3.1%)	**<0.001**
	Paralysis	315 (1.8%)	19 (2.9%)	**0.042**	502 (1.5%)	50 (2.1%)	**0.034**
	Peripheral Vascular Disorders	957 (5.4%)	65 (9.8%)	**<0.001**	4,266 (13.0%)	346 (14.4%)	**0.043**
	Psychoses	888 (5.0%)	27 (4.1%)	0.260	585 (1.8%)	54 (2.3%)	0.100
	Pulmonary Circulation Disorders	360 (2.0%)	23 (3.5%)	**0.012**	1,660 (5.1%)	107 (4.5%)	0.200
	Renal Failure	1,941 (11.0%)	121 (18.2%)	**<0.001**	7,664 (23.4%)	499 (20.8%)	**0.005**
	Solid Tumor	575 (3.2%)	51 (7.7%)	**<0.001**	1,191 (3.6%)	148 (6.2%)	**<0.001**
	Peptic Ulcer	16 (0.1%)	0 (0%)	0.999	21 (0.1%)	2 (0.1%)	0.670
	Valvular Disease	823 (4.7%)	24 (3.6%)	0.210	5,454 (16.6%)	190 (7.9%)	**<0.001**
	Weight Loss	2,295 (13.0%)	164 (24.6%)	**<0.001**	3,051 (9.3%)	428 (17.9%)	**<0.001**
Intestine Disorder	**Fistula of Intestine**	4,512 (25.5%)	76 (11.4%)	**<0.001**	2,664 (8.1%)	125 (5.2%)	**<0.001**
	Ulceration of Intestine	2,414 (13.6%)	13 (2.0%)		3,215 (9.8%)	38 (1.6%)	
	Perforation of Intestine	6,511 (36.8%)	532 (79.9%)		6,145 (18.7%)	1,986 (82.9%)	
	Angiodysplasia	3,997 (22.6%)	44 (6.6%)		20,048 (61.1%)	236 (9.9%)	
	Dieulafoy Lesion of Intestine	263 (1.5%)	1 (0.2%)		743 (2.3%)	10 (0.4%)	

Invasive Diagnostic Procedure	6,010 (34.0%)	122 (18.3%)	**<0.001**	16,176 (49.3%)	373 (15.6%)	**<0.001**
Surgical Procedure	10,693 (60.4%)	484 (72.7%)	**<0.001**	19,789 (60.3%)	1,404 (58.6%)	0.100
Invasive or Surgical Procedure	13,501 (76.3%)	496 (74.5%)	0.280	26,308 (80.2%)	1,478 (61.7%)	**<0.001**
	Mean (SD)	**Mean (SD)**	**p**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years	50.69 (11.13)	54.58 (8.74)	**<0.001**	77.87 (7.51)	80.67 (8.20)	**<0.001**
Modified Frailty Index Score	1.21 (1.13)	1.53 (1.01)	**<0.001**	1.94 (1.17)	1.76 (1.12)	**<0.001**
Time to Invasive Diagnostic Procedure, Days	2.24 (4.49)	4.24 (7.79)	**0.015**	2.02 (2.96)	3.78 (13.77)	**0.026**
Time to First Surgical Procedure, Days	2.20 (6.27)	4.05 (11.00)	**0.001**	2.15 (3.27)	1.86 (4.49)	**0.025**
Length of Stay, Days	9.63 (12.91)	15.41 (26.69)	**<0.001**	7.20 (8.67)	9.20 (13.01)	**<0.001**
Total Charges, Dollars	70,770 (109,766)	159,988 (207,527)	**<0.001**	51,193 (77,291)	97,572 (141,687)	**<0.001**

*Bold indicates result is statistically significant

3.3 Operation vs. No Operation

Table 3 illustrates differences between adult and elderly patients based on operation status. Adult and elderly patients displayed similar operation rates of 60.9% (11,186) and 60.2% (21,206), respectively. Age was not significantly different between surgically managed and conservatively managed adult patients. Elderly patients who underwent an operation were 1 year younger than non-operatively treated elderly patients. Regardless of operation status, adult patients were primarily White, admitted to urban teaching hospitals, and funded by private insurance. Similarly, elderly patients were predominantly White, funded by Medicare, and admitted to nonteaching and teaching hospitals. Regardless of age, patients who underwent operations displayed higher rates of alcohol abuse, coagulopathy, lymphoma, fluid/electrolyte disorder, weight loss, Dieulafoy intestinal lesion, and intestinal perforation. Surgically managed patients also exhibited longer time to invasive diagnostic procedures, lower modified frailty index, longer hospital length of stay, and larger total charges in dollars. Operatively treated adults displayed higher mortality rates and lower rates of invasive diagnostic procedures. Elderly patients exhibited no difference in mortality and invasive diagnostic procedures based on operation status.

Table 3. Characteristics of emergently admitted patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were stratified according to operation status, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		No Operation	**Operation**	**p**	**No Operation**	**Operation**	**p**
All Cases		7,190 (39.1%)	11,186 (60.9%)		14,020 (39.8%)	21,206 (60.2%)	
Sex, Female		3,881 (54.0%)	5,526 (49.4%)	**<0.001**	8,484 (60.5%)	11,662 (55.0%)	**<0.001**
Race	**White**	4,082 (67.0%)	6,657 (69.7%)	**<0.001**	9,400 (78.7%)	14,574 (80.1%)	**0.004**
	Black	1,113 (18.3%)	1,410 (14.8%)		1,312 (11.0%)	1,734 (9.5%)	
	Hispanic	585 (9.6%)	935 (9.8%)		744 (6.2%)	1,149 (6.3%)	
	Asian/Pacific Islander	108 (1.8%)	204 (2.1%)		203 (1.7%)	322 (1.8%)	
	Native American	40 (0.7%)	71 (0.7%)		52 (0.4%)	81 (0.4%)	
	Other	163 (2.7%)	270 (2.8%)		230 (1.9%)	343 (1.9%)	
Income Quartile	**Quartile 1**	2,109 (29.9%)	3,051 (28.0%)	**0.020**	3,610 (26.2%)	5,156 (24.7%)	**0.018**
	Quartile 2	1,854 (26.3%)	2,860 (26.2%)		3,585 (26.0%)	5,481 (26.3%)	
	Quartile 3	1,664 (23.6%)	2,677 (24.6%)		3,430 (24.9%)	5,368 (25.7%)	
	Quartile 4	1,416 (20.1%)	2,313 (21.2%)		3,173 (23.0%)	4,874 (23.3%)	

Insurance	**Private Insurance**	3,173 (44.2%)	5,647 (50.6%)	**<0.001**	917 (6.6%)	1,578 (7.5%)	**0.001**
	Medicare	1,809 (25.2%)	2,114 (18.9%)		12,759 (91.2%)	19,161 (90.5%)	
	Medicaid	1,356 (18.9%)	1,823 (16.3%)		144 (1.0%)	232 (1.1%)	
	Self-Pay	487 (6.8%)	953 (8.5%)		46 (0.3%)	68 (0.3%)	
	No Charge	55 (0.8%)	106 (1.0%)		2 (0.0%)	6 (0.0%)	
	Other	294 (4.1%)	513 (4.6%)		127 (0.9%)	134 (0.6%)	
Hospital Location	**Rural**	605 (8.4%)	1,049 (9.4%)	**<0.001**	1,654 (11.8%)	2,154 (10.2%)	**<0.001**
	Urban: Non-Teaching	2,505 (34.8%)	4,376 (39.1%)		6,078 (43.4%)	9,495 (44.8%)	
	Urban: Teaching	4,080 (56.7%)	5,761 (51.5%)		6,288 (44.9%)	9,557 (45.1%)	
Comorbidities	**AIDS**	43 (0.6%)	80 (0.7%)	0.340	3 (0.0%)	7 (0.0%)	0.750
	Alcohol Abuse	360 (5.0%)	640 (5.7%)	**0.037**	207 (1.5%)	432 (2.0%)	**<0.001**
	Deficiency Anemias	1,612 (22.4%)	2,236 (19.9%)	**<0.001**	3,360 (24.0%)	4,925 (23.2%)	0.110
	Rheumatoid Arthritis	258 (3.6%)	342 (3.1%)	**0.048**	482 (3.4%)	751 (3.5%)	0.610
	Chronic Blood Loss	793 (11.0%)	859 (7.7%)	**<0.001**	3,330 (23.8%)	3,757 (17.7%)	**<0.001**
	Congestive Heart Failure	598 (8.3%)	825 (7.4%)	**0.020**	3,978 (28.4%)	5,454 (25.7%)	**<0.001**
	Chronic Pulmonary Disease	1,235 (17.2%)	1,803 (16.1%)	0.060	3,787 (27.0%)	5,598 (26.4%)	0.200
	Coagulopathy	391 (5.4%)	892 (8.0%)	**<0.001**	909 (6.5%)	1,865 (8.8%)	**<0.001**
	Depression	983 (13.7%)	1,140 (10.2%)	**<0.001**	1,269 (9.1%)	1,697 (8.0%)	**0.001**
	Diabetes, Uncomplicated	1,297 (18.0%)	1,761 (15.7%)	**<0.001**	3,782 (27.0%)	5,226 (24.6%)	**<0.001**
	Diabetes, Chronic Complications	275 (3.8%)	383 (3.4%)	0.150	691 (4.9%)	973 (4.6%)	0.140
	Drug Abuse	281 (3.9%)	431 (3.9%)	0.850	42 (0.3%)	58 (0.3%)	0.650
	Hypertension	3,102 (43.1%)	4,565 (40.8%)	**0.002**	9,558 (68.2%)	14,271 (67.3%)	0.090
	Hypothyroidism	605 (8.4%)	802 (7.2%)	**0.002**	2,344 (16.7%)	3,197 (15.1%)	**<0.001**
	Liver Disease	509 (7.1%)	722 (6.5%)	0.100	478 (3.4%)	720 (3.4%)	0.940
	Lymphoma	41 (0.6%)	144 (1.3%)	**<0.001**	160 (1.1%)	358 (1.7%)	**<0.001**
	Fluid/Electrolyte Disorders	1,866 (26.0%)	3,640 (32.5%)	**<0.001**	3,787 (27.0%)	6,917 (32.6%)	**<0.001**
Comorbidities	**Metastatic Cancer**	506 (7.0%)	707 (6.3%)	0.060	643 (4.6%)	867 (4.1%)	**0.024**
	Other Neurological Disorders	429 (6.0%)	504 (4.5%)	**<0.001**	1,095 (7.8%)	1,415 (6.7%)	**<0.001**
	Obesity	823 (11.4%)	1,267 (11.3%)	0.800	796 (5.7%)	1,323 (6.2%)	**0.030**
	Paralysis	132 (1.8%)	202 (1.8%)	0.880	247 (1.8%)	305 (1.4%)	**0.017**
	Peripheral Vascular Disorders	369 (5.1%)	653 (5.8%)	**0.042**	1,904 (13.6%)	2,709 (12.8%)	**0.028**
	Psychoses	394 (5.5%)	521 (4.7%)	**0.012**	256 (1.8%)	383 (1.8%)	0.890
	Pulmonary Circulation Disorders	128 (1.8%)	255 (2.3%)	**0.021**	734 (5.2%)	1,035 (4.9%)	0.140
	Renal Failure	907 (12.6%)	1,156 (10.3%)	**<0.001**	3,335 (23.8%)	4,833 (22.8%)	**0.030**
	Solid Tumor	260 (3.6%)	366 (3.3%)	0.210	525 (3.7%)	814 (3.8%)	0.650
	Peptic Ulcer	8 (0.1%)	8 (0.1%)	0.370	12 (0.1%)	11 (0.1%)	0.230
	Valvular Disease	371 (5.2%)	476 (4.3%)	**0.004**	2,493 (17.8%)	3,155 (14.9%)	**<0.001**
	Weight Loss	874 (12.2%)	1,587 (14.2%)	**<0.001**	1,079 (7.7%)	2,404 (11.3%)	**<0.001**
Intestine Disorder	**Fistula of Intestine**	2,719 (37.8%)	1,872 (16.7%)	**<0.001**	1,577 (11.2%)	1,213 (5.7%)	**<0.001**
	Ulceration of Intestine	1,567 (21.8%)	861 (7.7%)		1,797 (12.8%)	1,458 (6.9%)	
	Perforation of Intestine	1,053 (14.6%)	5,998 (53.6%)		1,974 (14.1%)	6,163 (29.1%)	
	Angiodysplasia	1,794 (25.0%)	2,247 (20.1%)		8,565 (61.1%)	11,725 (55.3%)	
	Dieulafoy Lesion of Intestine	57 (0.8%)	208 (1.9%)		107 (0.8%)	647 (3.1%)	

Invasive Diagnostic Procedure	2,820 (39.2%)	3,315 (29.6%)	**<0.001**	6,595 (47.0%)	9,961 (47.0%)	0.900
Deceased	182 (2.5%)	484 (4.3%)	**<0.001**	991 (7.1%)	1,404 (6.6%)	0.100
	Mean (SD)	**Mean (SD)**	**p**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years	50.69 (11.00)	50.91 (11.13)	0.180	78.70 (7.82)	77.64 (7.41)	**<0.001**
Modified Frailty Index Score	1.27 (1.15)	1.19 (1.12)	**<0.001**	1.96 (1.18)	1.91 (1.15)	**<0.001**
Time to Invasive Diagnostic Procedure, Days	1.98 (2.42)	2.54 (5.85)	**<0.001**	1.91 (1.88)	2.16 (4.37)	**<0.001**
Length of Stay, Days	6.06 (8.04)	12.28 (15.85)	**<0.001**	5.14 (5.40)	8.79 (10.56)	**<0.001**
Total Charges, Dollars	36,733 (53,063)	98,017 (137,169)	**<0.001**	31,101 (40,017)	69,678 (100,358)	**<0.001**

*Bold indicates result is statistically significant

3.4 Intestinal Disorder Differences, Adults

Table 4 illustrates differences amongst adults with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesion. Intestinal perforation was the most common intestinal disorder, accounting for 38.4% of all cases in adults. Fistula, angiodysplasia, ulceration, and Dieulafoy lesions resulted in 25.0%, 22.0%, 13.2%, and 1.4% of adult cases, respectively. Intestinal perforation led to the highest mortality rate of 7.6% in emergently admitted adults. Fistula, angiodysplasia, ulceration, and Dieulafoy lesions resulted in relatively lower mortality rates of 1.7%, 1.1%, 0.5%, and 0.4%, respectively. All comorbidities analyzed, except paralysis, revealed significant associations with intestinal fistula, ulceration, perforation, angiodysplasia, and Dieulafoy lesion. Adult patients with intestinal ulceration or angiodysplasia underwent invasive diagnostic procedures at significantly higher rates than adults with intestinal fistula, perforation, and Dieulafoy lesions. Similarly, adults with intestinal perforation and Dieulafoy lesions underwent surgical procedures more frequently than adults with intestinal fistula, ulceration, and angiodysplasia. The mean ages of adults with angiodysplasia, Dieulafoy lesion, ulceration, perforation, and fistula were 55.85, 51.77, 50.29, 49.38, and 48.85 years, respectively. The modified frailty index was highest in adult patients with angiodysplasia (1.79) and lowest in intestinal perforation (0.96). Time to invasive diagnostic procedures and surgical procedures was significantly longer in patients with intestinal fistula compared to intestinal ulceration, perforation, angiodysplasia, or Dieulafoy lesion. Hospital length of stay and total charges in dollars were largest in adult patients with intestinal fistula or intestinal perforation.

Table 4. Characteristics of emergently admitted adult patients with the primary EGS diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were stratified based on sub-diagnosis, NIS 2005-2014.

		Disorder of Intestine - Adult					p
		Fistula	Ulceration	Perforation	Angiodysplasia	Dieulafoy	
All Cases		4,591 (25.0%)	2,428 (13.2%)	7,051 (38.4%)	4,051 (22.0%)	265 (1.4%)	
Sex, Female		2,507 (54.7%)	1,251 (51.5%)	3,442 (48.9%)	2,089 (51.7%)	118 (44.5%)	**<0.001**
Race	**White**	2,749 (70.6%)	1,432 (69.3%)	4,366 (73.2%)	2,051 (58.8%)	141 (61.8%)	**<0.001**
	Black	561 (14.4%)	303 (14.7%)	691 (11.6%)	924 (26.5%)	44 (19.3%)	
	Hispanic	396 (10.2%)	199 (9.6%)	559 (9.4%)	349 (10.0%)	17 (7.5%)	
	Asian/Pacific Islander	52 (1.3%)	55 (2.7%)	135 (2.3%)	59 (1.7%)	11 (4.8%)	
	Native American	26 (0.7%)	14 (0.7%)	44 (0.7%)	23 (0.7%)	4 (1.8%)	
	Other	108 (2.8%)	64 (3.1%)	170 (2.8%)	80 (2.3%)	11 (1.8%)	
Income Quartile	**Quartile 1**	1,338 (29.9%)	606 (25.5%)	1,866 (27.2%)	1,283 (32.4%)	67 (26.0%)	**<0.001**
	Quartile 2	1,202 (26.8%)	588 (24.7%)	1,828 (26.6%)	1,032 (26.1%)	64 (24.8%)	
	Quartile 3	1,017 (22.7%)	612 (25.7%)	1,702 (24.8%)	940 (23.7%)	70 (27.1%)	
	Quartile 4	924 (20.6%)	573 (24.1%)	1,470 (21.4%)	705 (17.8%)	57 (22.1%)	

Insurance	Private Insurance	1,947 (42.5%)	1,284 (53.1%)	3,823 (54.4%)	1,644 (40.8%)	122 (46.0%)	<0.001
	Medicare	1,015 (22.1%)	510 (21.1%)	954 (13.6%)	1,380 (34.2%)	64 (24.2%)	
	Medicaid	1,056 (23.0%)	335 (13.9%)	1,120 (15.9%)	630 (15.6%)	38 (14.3%)	
	Self-Pay	306 (6.7%)	175 (7.2%)	707 (10.1%)	227 (5.6%)	25 (9.4%)	
	No Charge	34 (0.7%)	14 (0.6%)	80 (1.1%)	32 (0.8%)	1 (0.4%)	
	Other	228 (5.0%)	100 (4.1%)	343 (4.9%)	121 (3.0%)	15 (5.7%)	
Hospital Location	Rural	259 (5.6%)	182 (7.5%)	845 (12.0%)	354 (8.8%)	14 (5.3%)	<0.001
	Urban: Non-Teaching	1,243 (27.1%)	1,104 (45.5%)	2,865 (40.6%)	1,573 (38.9%)	96 (36.2%)	
	Urban: Teaching	3,089 (67.3%)	1,142 (47.0%)	3,341 (47.4%)	2,114 (52.3%)	155 (58.5%)	
Comorbidities	AIDS	12 (0.3%)	17 (0.7%)	62 (0.9%)	30 (0.7%)	2 (0.8%)	0.002
	Alcohol Abuse	115 (2.5%)	107 (4.4%)	364 (5.2%)	397 (9.8%)	17 (6.4%)	<0.001
	Deficiency Anemias	1,189 (25.9%)	464 (19.1%)	1,135 (16.1%)	997 (24.7%)	53 (20.0%)	<0.001
	Rheumatoid Arthritis	127 (2.8%)	99 (4.1%)	212 (3.0%)	155 (3.8%)	7 (2.6%)	0.005
	Chronic Blood Loss	59 (1.3%)	299 (12.3%)	97 (1.4%)	1,146 (28.4%)	51 (19.2%)	<0.001
	Congestive Heart Failure	157 (3.4%)	148 (6.1%)	280 (4.0%)	800 (19.8%)	38 (14.3%)	<0.001
	Chronic Pulmonary Disease	686 (14.9%)	373 (15.4%)	1,055 (14.3%)	927 (22.9%)	47 (17.7%)	<0.001
	Coagulopathy	162 (3.5%)	103 (4.2%)	514 (7.3%)	481 (11.9%)	23 (8.7%)	<0.001
	Depression	693 (15.1%)	301 (12.4%)	596 (8.5%)	507 (12.5%)	26 (9.8%)	<0.001
	Diabetes, Uncomplicated	778 (16.9%)	415 (17.1%)	734 (10.4%)	1,077 (26.7%)	54 (20.4%)	<0.001
	Diabetes, Chronic Complications	87 (1.9%)	103 (4.2%)	105 (1.5%)	340 (8.4%)	23 (8.7%)	<0.001
	Drug Abuse	195 (4.2%)	94 (3.9%)	292 (4.1%)	125 (3.1%)	6 (2.3%)	0.021
	Hypertension	1,600 (34.9%)	1,141 (47.0%)	2,307 (32.7%)	2,481 (61.4%)	138 (52.1%)	<0.001
	Hypothyroidism	362 (7.9%)	199 (8.2%)	447 (6.3%)	371 (9.2%)	28 (10.6%)	<0.001
	Liver Disease	156 (3.4%)	122 (5.0%)	255 (3.6%)	671 (16.6%)	27 (10.2%)	<0.001
	Lymphoma	24 (0.5%)	17 (0.7%)	119 (1.7%)	23 (0.6%)	2 (0.8%)	<0.001
	Fluid/Electrolyte Disorders	1,409 (30.7%)	599 (24.7%)	2,473 (35.1%)	963 (23.8%)	62 (23.4%)	<0.001
Comorbidities	Metastatic Cancer	401 (8.7%)	53 (2.2%)	692 (9.8%)	64 (1.6%)	3 (1.1%)	<0.001
	Other Neurological Disorders	198 (4.3%)	146 (6.0%)	306 (4.3%)	266 (6.6%)	17 (6.4%)	<0.001
	Obesity	637 (13.9%)	253 (10.4%)	700 (9.9%)	456 (11.3%)	44 (16.6%)	<0.001
	Paralysis	85 (1.9%)	38 (1.6%)	129 (1.8%)	72 (1.8%)	10 (3.8%)	0.160
	Peripheral Vascular Disorders	93 (2.0%)	207 (8.5%)	322 (4.6%)	379 (9.4%)	21 (7.9%)	<0.001
	Psychoses	276 (6.0%)	131 (5.4%)	321 (4.6%)	177 (4.4%)	10 (3.8%)	0.001
	Pulmonary Circulation Disorders	47 (1.0%)	38 (1.6%)	114 (1.6%)	168 (4.2%)	16 (6.0%)	<0.001
	Renal Failure	306 (6.7%)	271 (11.2%)	385 (5.5%)	1,047 (25.9%)	54 (20.4%)	<0.001
	Solid Tumor	224 (4.9%)	43 (1.8%)	284 (4.0%)	71 (1.6%)	4 (1.5%)	<0.001
	Peptic Ulcer	6 (0.1%)	6 (0.2%)	2 (0.0%)	1 (0.0%)	1 (0.4%)	0.004
	Valvular Disease	63 (1.4%)	112 (4.6%)	132 (1.9%)	509 (12.6%)	31 (11.7%)	<0.001
	Weight Loss	1,185 (25.8%)	115 (4.7%)	977 (13.9%)	168 (4.2%)	16 (6.0%)	<0.001
Invasive Diagnostic Procedure		463 (10.1%)	2,024 (83.4%)	964 (13.7%)	2,514 (62.2%)	170 (64.2%)	<0.001
Surgical Procedure		1,872 (40.8%)	861 (35.5%)	5,998 (85.1%)	2,247 (55.6%)	208 (78.5%)	<0.001
Invasive or Surgical Procedure		2,029 (44.2%)	2,337 (96.3%)	6,057 (85.9%)	3,326 (82.3%)	257 (97.0%)	<0.001
Deceased		76 (1.7%)	13 (0.5%)	532 (7.6%)	44 (1.1%)	1 (0.4%)	<0.001
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p

Age, Years	48.85 (11.37)	50.29 (11.17)	49.38 (11.43)	55.85 (8.15)	51.77 (11.20)	**<0.001**
Modified Frailty Index Score	1.14 (1.03)	1.12 (1.11)	0.96 (0.98)	1.79 (1.26)	1.48 (1.29)	**<0.001**
Time to Invasive Diagnostic Procedure, Days	7.05 (13.37)	1.87 (2.17)	2.49 (4.66)	1.77 (1.69)	1.18 (1.26)	**<0.001**
Time to Surgical Procedure, Days	6.48 (13.29)	2.15 (5.97)	0.99 (3.29)	2.37 (2.64)	1.82 (2.43)	**<0.001**
Length of Stay, Days	13.87 (20.25)	4.93 (5.02)	11.59 (12.40)	5.49 (6.53)	5.31 (5.28)	**<0.001**
Total Charges, Dollars	87,350 (142,390)	34,868 (41,939)	98,398 (130,679)	41,846 (62,248)	49,810 (56,935)	**<0.001**

*Bold indicates result is statistically significant

3.5 Intestinal Disorder Differences, Elderly

Elderly patient characteristics and outcomes were compared based on the diagnosis of intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesion. Angiodysplasia was the predominant intestinal diagnosis involved in 57.6% of all elderly patients, while perforation, ulceration, fistula, and Dieulafoy lesion accounted for 23.1%, 9.2%, 7.9%, and 2.1%, respectively. Elderly patients with intestinal perforation exhibited a significantly higher rate of mortality (24.4%) in comparison to fistula (4.5%), Dieulafoy lesion (1.3%), ulceration (1.2%), and angiodysplasia (1.2%). All comorbidities analyzed demonstrated statistical correlation with the intestinal disorders, except AIDS and rheumatoid arthritis. The mean ages of elderly patients diagnosed with intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesion ranged from 74.61 to 79.14 years. The rate of invasive diagnostic procedures was highest in patients with intestinal ulceration (79.9%), angiodysplasia (59.7%), and Dieulafoy lesions (62.6%). Surgical management was utilized most frequently in patients with Dieulafoy lesion (85.8%), followed by perforation (75.7%), angiodysplasia (57.8%), ulceration (44.8%), and fistula (43.5%). Elderly patients diagnosed with angiodysplasia and Dieulafoy lesions possessed the highest frailty, with modified frailty indices of 2.11 and 2.06, respectively. Time to invasive diagnostic and surgical procedure was longest in elderly patients with intestinal fistula. Hospital length of stay and total charges in dollars were significantly larger in patients with intestinal fistula and perforation.

Table 5. Characteristics of emergently admitted elderly patients with the primary EGS diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were stratified according to sub-diagnosis, NIS 2005-2014.

		Disorder of Intestine - Elderly					p
		Fistula	Ulceration	Perforation	Angiodysplasia	Dieulafoy	
All Cases		2,790 (7.9%)	3,255 (9.2%)	8,137 (23.1%)	20,290 (57.6%)	754 (2.1%)	
Sex, Female		1,736 (62.2%)	1,822 (56.0%)	5,000 (61.4%)	11,174 (55.1%)	414 (54.9%)	**<0.001**
Race	**White**	1,942 (80.6%)	2,173 (78.5%)	5,693 (83.0%)	13,630 (78.1%)	536 (81.1%)	**<0.001**
	Black	191 (7.9%)	257 (9.3%)	472 (6.9%)	2,061 (11.8%)	65 (9.8%)	
	Hispanic	182 (7.6%)	183 (6.6%)	384 (5.6%)	1,116 (6.4%)	28 (4.2%)	
	Asian/Pacific Islander	33 (1.4%)	92 (3.3%)	137 (2.0%)	242 (1.4%)	21 (3.2%)	
	Native American	9 (0.4%)	8 (0.3%)	34 (0.5%)	80 (0.5%)	2 (0.3%)	
	Other	53 (2.2%)	55 (2.0%)	140 (2.0%)	316 (1.8%)	9 (1.4%)	
Income Quartile	**Quartile 1**	758 (27.6%)	779 (24.4%)	2,005 (25.1%)	5,055 (25.3%)	169 (22.8%)	**0.001**
	Quartile 2	716 (26.1%)	801 (25.0%)	2,191 (27.5%)	5,178 (25.9%)	180 (24.3%)	
	Quartile 3	652 (23.7%)	831 (26.0%)	1,926 (24.1%)	5,174 (25.9%)	215 (29.0%)	
	Quartile 4	621 (22.6%)	787 (24.6%)	1,858 (23.3%)	4,603 (23.0%)	178 (24.0%)	
Insurance	**Private Insurance**	217 (7.8%)	259 (8.0%)	683 (8.4%)	1,285 (6.3%)	51 (6.8%)	**<0.001**
	Medicare	2,495 (89.7%)	2,918 (89.7%)	7,220 (88.9%)	18,604 (91.8%)	683 (90.7%)	
	Medicaid	32 (1.2%)	40 (1.2%)	97 (1.2%)	199 (1.0%)	8 (1.1%)	
	Self-Pay	10 (0.4%)	13 (0.4%)	40 (0.5%)	50 (0.2%)	1 (0.1%)	
	No Charge	0 (0%)	2 (0.1%)	2 (0.0%)	4 (0.0%)	0 (0%)	
	Other	28 (1.0%)	22 (0.7%)	80 (1.0%)	121 (0.6%)	10 (1.3%)	

Hospital Location	Rural	247 (8.9%)	330 (10.1%)	1,217 (15.0%)	1,952 (9.6%)	62 (8.2%)	
	Urban: Non-Teaching	981 (32.2%)	1,554 (47.7%)	3,592 (44.1%)	9,152 (45.1%)	294 (39.0%)	**<0.001**
	Urban: Teaching	1,562 (56.0%)	1,371 (42.1%)	3,328 (40.9%)	9,186 (45.3%)	398 (52.8%)	
Comorbidities	AIDS	0 (0%)	0 (%)	3 (0.0%)	7 (0.0%)	0 (0%)	0.660
	Alcohol Abuse	27 (1.0%)	52 (1.6%)	125 (1.5%)	427 (2.1%)	8 (1.1%)	**<0.001**
	Deficiency Anemias	878 (31.5%)	688 (21.1%)	1,736 (21.3%)	4,838 (23.8%)	145 (19.2%)	**<0.001**
	Rheumatoid Arthritis	93 (3.3%)	128 (3.9%)	320 (3.9%)	668 (3.3%)	24 (3.2%)	0.053
	Chronic Blood Loss	61 (2.2%)	565 (17.4%)	169 (2.1%)	6,131 (30.2%)	161 (21.4%)	**<0.001**
	Congestive Heart Failure	355 (12.7%)	646 (19.8%)	1,428 (17.5%)	6,765 (33.3%)	238 (31.6%)	**<0.001**
	Chronic Pulmonary Disease	599 (21.5%)	687 (21.1%)	1,841 (22.6%)	6,096 (30.0%)	162 (21.5%)	**<0.001**
	Coagulopathy	111 (4.0%)	203 (6.2%)	731 (9.0%)	1,649 (8.1%)	80 (10.6%)	**<0.001**
	Depression	314 (11.3%)	271 (8.3%)	564 (6.9%)	1,765 (8.7%)	52 (6.9%)	**<0.001**
	Diabetes, Uncomplicated	662 (23.7%)	771 (23.7%)	1,338 (16.4%)	6,028 (29.7%)	209 (27.7%)	**<0.001**
	Diabetes, Chronic Complications	101 (3.6%)	158 (4.9%)	186 (2.3%)	1,175 (5.8%)	44 (5.8%)	**<0.001**
	Drug Abuse	15 (0.5%)	10 (0.3%)	31 (0.4%)	42 (0.2%)	2 (0.3%)	**0.010**
	Hypertension	1,696 (60.8%)	2,295 (70.5%)	4,674 (57.4%)	14,609 (72.0%)	555 (73.6%)	**<0.001**
	Hypothyroidism	451 (16.2%)	510 (15.7%)	1,067 (13.1%)	3,386 (16.7%)	127 (16.8%)	**<0.001**
	Liver Disease	48 (1.7%)	71 (2.2%)	152 (1.9%)	896 (4.4%)	31 (4.1%)	**<0.001**
	Lymphoma	29 (1.0%)	36 (1.1%)	216 (2.7%)	226 (1.1%)	11 (1.5%)	**<0.001**
	Fluid/Electrolyte Disorders	1,006 (36.1%)	982 (30.2%)	3,653 (44.9%)	4,861 (24.0%)	202 (26.8%)	**<0.001**
	Metastatic Cancer	303 (10.9%)	65 (2.0%)	836 (10.3%)	293 (1.4%)	13 (1.7%)	**<0.001**
	Other Neurological Disorders	167 (6.0%)	222 (6.8%)	632 (7.8%)	1,431 (7.1%)	58 (7.7%)	**0.021**
Comorbidities	Obesity	279 (10.0%)	198 (6.1%)	441 (5.4%)	1,156 (5.7%)	45 (6.0%)	**<0.001**
	Paralysis	44 (1.6%)	64 (2.0%)	110 (1.4%)	324 (1.6%)	10 (1.3%)	0.180
	Peripheral Vascular Disorders	180 (6.5%)	552 (17.0%)	881 (10.8%)	2,896 (14.3%)	104 (13.8%)	**<0.001**
	Psychoses	76 (2.7%)	64 (2.0%)	204 (2.5%)	282 (1.4%)	13 (1.7%)	**<0.001**
	Pulmonary Circulation Disorders	77 (2.8%)	104 (3.2%)	246 (3.0%)	1,296 (6.4%)	46 (6.1%)	**<0.001**
	Renal Failure	347 (12.4%)	658 (20.2%)	1,169 (14.4%)	5,747 (28.3%)	247 (32.8%)	**<0.001**
	Solid Tumor	218 (7.8%)	80 (2.5%)	451 (5.5%)	578 (2.8%)	12 (1.6%)	**<0.001**
	Peptic Ulcer	1 (0.0%)	10 (0.3%)	6 (0.1%)	3 (0.0%)	3 (0.4%)	**<0.001**
	Valvular Disease	106 (3.8%)	319 (9.8%)	481 (5.9%)	4,591 (22.6%)	151 (20.0%)	**<0.001**
	Weight Loss	826 (29.6%)	210 (6.5%)	1,523 (18.7%)	875 (4.3%)	49 (6.5%)	**<0.001**
Invasive Diagnostic Procedure		287 (10.3%)	2,600 (79.9%)	1,088 (13.4%)	12,109 (59.7%)	472 (62.6%)	**<0.001**
Surgical Procedure		1,213 (43.5%)	1,458 (44.8%)	6,163 (75.7%)	11,725 (57.8%)	647 (85.8%)	**<0.001**
Invasive or Surgical Procedure		1,308 (46.9%)	3,130 (96.2%)	6,222 (76.5%)	16,404 (80.8%)	737 (97.7%)	**<0.001**
Deceased		125 (4.5%)	38 (1.2%)	1,986 (24.4%)	236 (1.2%)	10 (1.3%)	**<0.001**
		Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years		74.61 (7.09)	76.99 (7.46)	77.94 (8.10)	78.72 (7.32)	79.14 (7.58)	**<0.001**
Modified Frailty Index Score		1.75 (1.05)	1.73 (1.11)	1.63 (1.08)	2.11 (1.19)	2.06 (1.18)	**<0.001**
Time to Invasive Diagnostic Procedure, Days		7.62 (11.22)	1.91 (1.80)	3.77 (10.78)	1.83 (1.65)	1.62 (1.66)	**<0.001**
Time to Surgical Procedure, Days		5.16 (8.13)	2.16 (2.56)	1.06 (2.54)	2.37 (2.71)	2.26 (2.36)	**<0.001**
Length of Stay, Days		13.46 (16.40)	5.56 (4.75)	11.26 (11.66)	5.26 (5.47)	5.82 (4.91)	**<0.001**
Total Charges, Dollars		85,111 (128,100)	37,455 (43,199)	97,204 (119,098)	36,113 (51,621)	46,129 (62,315)	**<0.001**

*Bold indicates result is statistically significant

3.6 Surgical and Invasive Diagnostic Procedures

Table 6 illustrates a stratified analysis of survival following surgical and invasive diagnostic procedures in elderly and adult patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions. In adult patients, the most common operations involved the intestine (60.0%), other abdominal regions (22.5%), and stomach (5.5%). Similarly, elderly patients most frequently underwent operations on the intestine (69.3%), other abdominal regions (12.2%), and stomach (9.8%). The operations associated with the largest mortality rate in adult patients involved the gallbladder and biliary tract (7.8%), other abdominal regions (6.7%), pancreas (6.3%), hernia (5.9%), esophagus (5.3%), stomach (4.6%), intestine (4.3%), appendix (4.1%), liver (3.1%), anus (2.8%), rectum, rectosigmoid, and perirectal tissue (2.7%). Elderly patient mortality rates were highest following operations on the pancreas (40.0%), gallbladder and biliary tract (19.6%), other abdominal regions (15.9%), hernia (12.5%), appendix (10.5%), intestine (6.9%), liver (6.9%), stomach (5.1%), rectum, rectosigmoid, and perirectal tissue (4.5%), anus (2.2%), and esophagus (1.4%).

Invasive intestinal diagnostic procedures accounted for the vast majority of procedures in adults (83.5%) and elderly patients (92.8%). Adult mortality was highest following invasive diagnostic procedures on the liver (13.6%), gallbladder and biliary tract (11.1%), other abdominal regions (5.4%), anus (4.8%), intestine (1.4%), and rectum, rectosigmoid, and perirectal tissue (1.0%). No adult mortality was recorded following invasive diagnostic procedures on the esophagus, stomach, or pancreas. Mortality rates were highest in elderly patients following invasive diagnostic procedures on other abdominal regions (15.6%), liver (14.4%), anus (12.5%), pancreas (9.1%), stomach (6.2%), rectum, rectosigmoid, and perirectal tissue (3.1%), and intestine (1.8%). No elderly death was recorded after an invasive diagnostic procedure on the esophagus or gallbladder and biliary tract.

Table 6. Characteristics of emergently admitted patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Data were stratified according to surgical procedure, NIS 2005-2014.

Surgical Procedure (ICD 9)	Adults, N (%)				Elderly, N (%)			
	Procedures	Survived	Deceased	p	Procedures	Survived	Deceased	p
Operations on Esophagus (42.01-42.19, 42.31-42.99)	76 (0.5%)	72 (94.7%)	4 (5.3%)	0.360	214 (0.8%)	211 (98.6%)	3 (1.4%)	**<0.001**
Operations on Stomach (43.0-44.03, 44.21-44.99)	911 (5.5%)	869 (95.4%)	42 (4.6%)	0.100	2,677 (9.8%)	2,541 (94.9%)	136 (5.1%)	**<0.001**
Operations on Intestine (45.00-45.03, 45.30-46.99)	9,926 (60.0%)	9,496 (95.7%)	430 (4.3%)	**<0.001**	18,838 (69.3%)	17,532 (93.1%)	1,306 (6.9%)	0.300
Operations on Appendix (47.01-47.99)	690 (4.2%)	662 (95.9%)	28 (4.1%)	0.540	344 (1.3%)	308 (89.5%)	36 (10.5%)	**0.007**
Operations on Rectum, Rectosigmoid, and Perirectal Tissue (48.0-48.1, 48.31-48.99)	329 (2.0%)	320 (97.3%)	9 (2.7%)	0.380	762 (2.8%)	728 (95.5%)	34 (4.5%)	**0.009**
Operations on Anus (49.01-49.12, 49.31-49.99)	36 (0.2%)	35 (97.2%)	1 (2.8%)	0.999	46 (0.2%)	45 (97.8%)	1 (2.2%)	0.370
Operations on Liver (50.0, 50.21-50.99)	32 (0.2%)	31 (96.9%)	1 (3.1%)	0.999	29 (0.1%)	27 (93.1%)	2 (6.9%)	0.999
Operations on Gallbladder and Biliary Tract (51.01-51.04, 51.21-51.99)	218 (1.3%)	201 (92.2%)	17 (7.8%)	**0.001**	317 (1.2%)	255 (80.4%)	62 (19.6%)	**<0.001**
Operations on Pancreas (52.01-52.09, 52.21-52.99)	16 (0.1%)	15 (93.8%)	1 (6.3%)	0.450	10 (0.04%)	6 (60.0%)	4 (40.0%)	**0.003**
Operations on Hernia (53.00-53.9)	575 (3.5%)	541 (94.1%)	34 (5.9%)	**0.003**	617 (2.3%)	540 (87.5%)	77 (12.5%)	**<0.001**
Operations on Other Operations on Abdominal Region (54.0-54.19, 54.3-54.99)	3,724 (22.5%)	3,474 (93.3%)	250 (6.7%)	**<0.001**	3,326 (12.2%)	2,797 (84.1%)	529 (15.9%)	**<0.001**

Invasive Diagnostic Procedure (ICD 9)	Procedures	Survived	Deceased	p	Procedures	Survived	Deceased	p
Invasive Diagnostic Procedure on Esophagus (42.21-42.29)	14 (0.2%)	14 (100%)	0 (0%)	0.999	27 (0.2%)	27 (100%)	0 (0%)	0.260
Invasive Diagnostic Procedure on Stomach (44.11-44.19)	28 (0.4%)	28 (100%)	0 (0%)	0.630	65 (0.4%)	61 (93.8%)	4 (6.2%)	0.999
Invasive Diagnostic Procedure on Intestine (45.11-45.29)	5,363 (83.5%)	5,286 (98.6%)	77 (1.4%)	**<0.001**	15,808 (92.8%)	15,529 (98.2%)	279 (1.8%)	**<0.001**
Invasive Diagnostic Procedure on Rectum, Rectosigmoid, and Perirectal Tissue (48.21-48.29)	299 (4.7%)	296 (99.0%)	3 (1.0%)	**0.011**	458 (2.7%)	444 (96.9%)	14 (3.1%)	**0.001**
Invasive Diagnostic Procedure on Anus (49.21-49.29)	21 (0.3%)	20 (95.2%)	1 (4.8%)	0.540	32 (0.2%)	28 (87.5%)	4 (12.5%)	0.280
Invasive Diagnostic Procedure on Liver (50.11-50.19)	81 (1.3%)	70 (86.4%)	11 (13.6%)	**<0.001**	90 (0.5%)	77 (85.6%)	13 (14.4%)	**0.004**
Invasive Diagnostic Procedure on Gallbladder and Biliary Tract (51.10-51.19)	9 (0.1%)	8 (88.9%)	1 (11.1%)	0.280	13 (0.08%)	13 (100%)	0 (0%)	0.999
Invasive Diagnostic Procedure on Pancreas (52.11-52.19)	3 (0.05%)	3 (100%)	0 (0%)	0.999	11 (0.06%)	10 (90.9%)	1 (9.1%)	0.540
Invasive Diagnostic Procedure on Other Operations on Abdominal Region (54.21-54.29)	607 (9.4%)	574 (94.6%)	33 (5.4%)	**0.015**	538 (3.2%)	454 (84.4%)	84 (15.6%)	**<0.001**

*Bold indicates result is statistically significant

3.7 Mortality Risk Factors

Table 7 illustrates a multivariable logistic regression analysis evaluating associations between mortality and parameters of interest in emergently admitted operative and non-operative patients studied. For the operative group, time to operation, age, modified frailty index were the most significant risk factors for mortality. Every additional day of delay to operative intervention increased the risk of mortality by 3.0% and 3.5% in adult and elderly patients, respectively. Regarding age, each additional year increased the mortality odds by 3.4% in operated adults and 4.7% in operated elderly patients. Additionally, a higher modified frailty index was associated with a 40.8% and 10.4% increase in mortality odds for operatively managed adult and elderly patients, respectively. Fistula of the intestine was chosen as the reference category for comparison between all intestinal disorders studied. Of all these conditions, intestinal perforation was most strongly associated with mortality. Death of operatively managed adult and elderly patients with intestinal perforation was 3.2 times and 4.0 times more likely relative to those with intestinal fistula, respectively. The presence of intestinal ulceration was associated with reduced mortality odds by 62.0% in adults and 65.7% in elderly patients when compared to fistula. Similarly, when compared to fistula the mortality risk decreased by 61.7% and 82.7% in adult and elderly patients with angiodysplasia, respectively. Lastly, the presence of Dieulafoy intestinal lesion was associated with an 82.4% reduced mortality odds relative to fistula in elderly patients, but showed no significant relationship with mortality in operatively treated adult patients.

In the non-operative group, the most significant mortality-associated variables were age, modified frailty index and hospital length of stay. Each additional year increased mortality odds by 3.6% and 4.6% in adult and elderly patients, respectively. Frailty was associated with a 38.6% increase in mortality odds in adults and 9.1% increase in mortality odds in elderly patients. Hospital length of stay was not a significant mortality factor in non-operative elderly patients, however, each additional day of hospitalization increased mortality by 1.3% in non-operative adults. Intestinal perforation displayed robust associations, increasing mortality odds by 3.0 times in adults and 3.3 times in elderly patients when compared to those with fistula. When comparing mortality odds against those with fistula, adult non-operative patients with intestinal ulceration, angiodysplasia, or Dieulafoy intestinal lesion displayed reduced mortality odds by 57.8%, 59.9%, and 83.5%, respectively. Similarly, non-operative elderly patients with intestinal ulceration, angiodysplasia, or Dieulafoy intestinal lesion displayed reduced mortality odds by 73.7%, 84.8%, and 86.5%, respectively.

Table 7. Backward logistic regression analysis evaluating associations between mortality and different factors in emergently admitted operative and non-operative patients with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions (ICD-9 569.8). Mortality was the dependent variable. NIS 2005-2014.

		Adults Managed with Operation		Elderly Managed with Operation		Adults Managed with No Operation		Elderly Managed with No Operation	
		N = 9,891	R^2 = 0.106	N = 18,824	R^2 = 0.248	N = 11,175	R^2 = 0.108	N = 21,193	R^2 = 0.248
		OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Time to Operation, Days		1.030 (1.020, 1.039)	<0.001	1.035 (1.021, 1.048)	<0.001	Not Applicable			
Age, Years		1.034 (1.022, 1.046)	<0.001	1.047 (1.038, 1.055)	<0.001	1.036 (1.025, 1.047)	<0.001	1.046 (1.038, 1.054)	<0.001
Modified Frailty Index Score		1.408 (1.284, 1.545)	<0.001	1.104 (1.044, 1.167)	<0.001	1.386 (1.272, 1.511)	<0.001	1.091 (1.035, 1.149)	0.001
Hospital Length of Stay, Days		*				1.013 (1.009, 1.017)	<0.001	*	
Intestinal Disorders	Fistula [Ref]		<0.001		<0.001		<0.001		<0.001
	Ulceration	0.380 (0.174, 0.828)	0.015	0.343 (0.214, 0.550)	<0.001	0.422 (0.204, 0.872)	0.020	0.263 (0.168, 0.413)	<0.001
	Perforation	3.296 (2.330, 4.664)	<0.001	4.025 (3.046, 5.320)	<0.001	3.082 (2.261, 4.200)	<0.001	3.344 (2.609, 4.286)	<0.001
	Angiodysplasia	0.383 (0.231, 0.634)	<0.001	0.173 (0.126, 0.239)	<0.001	0.401 (0.249, 0.646)	<0.001	0.152 (0.113, 0.204)	<0.001
	Dieulafoy Lesions	0.180 (0.024, 1.322)	0.090	0.176 (0.080, 0.389)	<0.001	0.165 (0.023, 1.212)	0.080	0.135 (0.061, 0.295)	<0.001

*Removed via Backward Elimination

Discussion

4.1 Age and Mortality

Our study demonstrated that patients admitted emergently with the primary diagnosis of either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions collectively have a mortality rates of 3.6% and 6.8% in adult and elderly patients, respectively. Higher mortality rates in elderly patients relative to their adult counterparts were observed in both surgically and non-surgically managed patients. These results indicate that elderly patients have approximately two-fold higher mortality risk than adult patients. Previous investigations analyzing the relationship between age, mortality, and in patients with these diagnoses have revealed variable conclusions.

While numerous studies have attempted to describe the relationships observed above, significant variations in etiology and study design limit the applicability of their results. Nevertheless, the following information highlights a large body of literature assessing age as a potential mortality risk factor. Intestinal bleeding, frequently observed in patients with intestinal ulceration, occurs at significantly higher rates in elderly patients. Additionally, strong associations have been identified between advanced age and mortality in patients with gastrointestinal bleeding and ulceration.[15-17] Similarly, older age was associated with higher mortality in patients with postoperative enteric fistula.[18,19] While the etiology of angiodysplasia has yet to be fully elucidated, studies have indicated that degenerative changes may contribute to disease progression, and correspondingly higher rates of angiodysplasia are seen in patients of advanced age.[20-23] Furthermore, advanced age has been identified as a significant predictor of higher rebleeding rates in patients with angiodysplasia.[24] When analyzing mortality risk factors involved in perforation peritonitis, numerous investigations have demonstrated that advanced age independently increases mortality risk.[25-30] The strong associations between age and mortality revealed throughout these studies indicate that age-associated degeneration may contribute to disease complication and mortality, however, additional studies have revealed contradictory results.

In contrast to the findings described above, Klucinski et al. and Mawdsley et al. both illustrated that age does not significantly impact mortality in patients with a fistula of the small intestine.[31,32] However, in patients with bowel perforation, Tan et al. reported that age was not a significant predictor of mortality.[33] Furthermore, these results are supported by Tung et al. and Gedik et al. who independently demonstrated no association between age and mortality in patients with enteric perforation but in the setting of gynecologic oncology and typhoid-associated perforations.[34,35] Multiple large retrospective studies showed no statistically significant relationship between age, mortality, and intestinal ulceration in patients with upper gastrointestinal bleeding.[36,37] Similarly, several investigations have reported no correlation between advanced age and higher

rates of rebleeding Dieulafoy lesions.[38-40] Clearly, the large volume of literature demonstrating conflicting findings regarding the association between age and mortality in these patient populations indicates that the relationship is not fully elucidated.

We hypothesize that age serves as a proxy marker for the true mortality-related variables, which could explain the lack of a clear consensus in extant literature. While the predictive value of age itself may be limited, it may be used as an immediately available factor to prognosticate patient outcomes until additional variables can be identified on an individual patient basis. Previous studies have determined frailty to be a more accurate predictor of mortality relative to chronologic age in patients undergoing emergency general surgery.[41] We recommend similar investigations into the comparison of age versus frailty as mortality-predicting factors in patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions.

4.2 Modified Frailty Index and Mortality

Frailty has increasingly been identified as an independent predictor of prolonged hospital length of stay (HLOS), mortality, and inferior surgical outcomes in a wide variety of medical ailments.[42-48] In addition to independently predicting mortality, frailty is significantly associated with loss of independence following high-risk gastrointestinal surgery.[49] These relationships have been further corroborated in low-risk emergency general surgery (EGS) where frailty has an even greater relationship to mortality relative to high-risk EGS.[50] The relationship between frailty and intestinal fistula has been demonstrated as a strong predictor of post-surgical infections and Clavien Dindo grade IV complications.[51,52] Relatively limited research has analyzed the relationship between mortality and frailty in patients with Dieulafoy lesions. The relative scarcity of research into this topic likely relates to the relatively low prevalence of Dieulafoy lesions. Further research should be conducted to classify these relationships. Nevertheless, frailty has been thoroughly investigated as a major mortality risk factor in patients with gastrointestinal pathology.

Our results are consistent with prior literature indicating that the 5-item modified frailty index may be employed to better predict mortality in non-operatively and operatively managed patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. More specifically, a higher modified frailty index was associated with a 40.8% and 10.8% increase in mortality odds for operatively managed adult and elderly patients, respectively. Similarly in the non-operative setting, frailty was associated with a 38.6% increase in mortality odds in adults and 9.1% in elderly patients. These findings were based upon our estimated 5-item modified frailty index created with the available variables within the NIS database to enumerate the Subramaniam 5-item modified frailty index.[44] The methods utilized to estimate are described in greater detail in the methods section.

Our conclusions, as well as the supporting literature, strongly suggest that frailty should be employed as a prognostic factor for patients emergently admitted with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. Besides prognostication, clinical interventions need to be further studied to assess what steps can be employed to mitigate the increased risk of mortality in frail patients.

Of the variables included in the 5-item modified frailty index, glycemic control has been identified as a key variable involved in gastrointestinal rebleeding events and mortality.[53,54] We recommend future investigations assess the impact of improved glycemic control on mortality in frail patients with any of the highly prevalent diagnoses investigated in this study. Additionally, previous research has revealed the utility of multimodal prehabilitation involving comprehensive geriatric co-management with interventions attempting to improve nutritional status, medication management, and psychological status in frail patients undergoing elective surgery.[55] The British Geriatrics Society and Centre for Perioperative Care have also dispersed recommendations for perioperative care in frail patients including limiting the use of urinary catheters, postoperative opioids, and anticholinergic agents.[56] These recommendations warrant further investigation as tools to reduce mortality risk in emergently managed frail patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions.

4.3 Hospital Length of Stay and Mortality

Prolonged HLOS has significant and widespread negative implications on hospital systems, patients, and healthcare workers. For patients, the potential consequences of prolonged HLOS include, but are not limited to, increased risk of mortality, hospital-acquired infections, and psychiatric disturbances.[57-62] Healthcare providers are also affected by prolonged HLOS as they experience increased frustration, guilt, and pressure to reduce discharge delays. These outcomes are further complicated by the diversion of their primary focus from medical care to discharging patients.[57,63]

From a health system perspective, numerous investigations have demonstrated that prolonged HLOS reduces the availability of hospital resources and significantly increases healthcare costs.[57,59,64] These factors highlight the critical nature of HLOS as a pivotal variable affecting a wide range of healthcare outcomes.

Various investigations across a variety of medical ailments have revealed significant correlations between HLOS and mortality in acute patient care settings.[65-69] In patients emergently treated for gastrointestinal disease, prolonged HLOS has been shown to increase mortality risk in those with acute pancreatitis, colorectal cancer, *C. difficile*, acute appendicitis, ventral hernia, and hemorrhoids.[70-75] Undoubtedly, HLOS has been shown to significantly impact mortality outcomes in emergently treated patients with gastrointestinal pathology. Our investigation further characterizes the relationship between HLOS and survival in patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. Characterizing the relationship between HLOS and survival is imperative prior to identifying variables that may contribute to the correlation for future utilization as clinical intervention targets.

Our results demonstrate that every additional day of hospitalization increases mortality risk by 1.3% in non-operatively managed adult patients diagnosed with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. This finding is supported by previous investigations that exhibited significant associations between prolonged HLOS and mortality in patients with gastrointestinal bleeding, intestinal fistulas, intestinal perforation, gastrointestinal varices, gastroparesis, and gastrointestinal ulcers.[76-82] In addition to significant correlations with mortality, prolonged HLOS has been shown to increase the risk of 30-day readmissions in patients with angiodysplasia.[83] Similarly, patients with Dieulafoy lesions and prolonged HLOS possess higher mortality risk and larger hospital costs.[13] Our data and the supporting literature strongly indicate that increased HLOS contributes to morbidity and mortality in emergently treated patients with any of the investigated intestinal diagnoses. While this relationship is clearly shown by the aforementioned results, further investigation is required to determine if there is a causal relationship. Unfortunately, assessing for causality is outside the scope of this study as the NIS dataset does not provide the necessary information to adequately do so.

Previous investigations have hypothesized that the relationship between mortality and prolonged HLOS may be attributed to higher acuity patients requiring additional hospitalization, higher risk of gastrointestinal bleeding events, and increased nosocomial infections.[84] Patients emergently admitted for either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions have hospitalization lengths approximately ranging between 6-16 days, depending on the sub-diagnosis.[13,33,83,85-88] This length of admission increases the risk of hospital-acquired infections which occur at significantly higher rates after 7 days of hospitalization.[89] It is important to note that prolonged HLOS and hospital-acquired infections both independently increase the risk of gastrointestinal bleeding.[90,91] These hypotheses should be further analyzed within interventional studies to determine the potential causal relationship between HLOS and mortality in patients diagnosed with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions.

While the exact pathophysiologic mechanism between HLOS and mortality has yet to be explicated, strategies to reduce and predict HLOS should be employed without delay. A previous investigation identified the albumin hemoglobin index as a novel preoperative marker for predicting mortality and HLOS in infants undergoing gastrointestinal surgeries.[92] Additionally, conservative treatment strategies, laparoscopic surgery, and enhanced recovery program use have been shown to successfully reduce HLOS in patients with duodenal ulcers and intestinal perforation.[86,93-95] Further research is required to determine the impact of shortening HLOS relative to mortality, morbidity, and healthcare cost in patients emergently treated for either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions. Nevertheless, HLOS can be utilized by clinicians immediately as an additional marker for prognostication, particularly in these patient populations.

4.4 Time to Operation and Mortality

Our results indicate that every one-day delay in surgical intervention in elderly and adult patients emergently admitted with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions resulted in an increased mortality odds of 3.5% and 3.0%, respectively. Prior investigations have revealed similar reductions in survival in individuals with intestinal perforation whose time to operation (TTO) was prolonged.[96-99] Similarly, increases in mortality odds have been observed in patients with delayed TTO who were treated for colorectal cancer, paralytic ileus, small bowel obstruction, and empyema.[61,100-102] In addition to reducing survival odds, delayed intervention has also been associated with increased HLOS and healthcare

costs in cases of angiodysplasia.[103] Lastly, a large-scale retrospective analysis identified delayed TTO as a key risk factor for *C. difficile* infection in patients undergoing general surgery operations [104]. The supporting literature and our results indicate that TTO is a significant contributor to survival odds for patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions. Quality improvement programs geared toward reducing TTO in these patient populations should be further studied to determine their impact on survival, resource utilization, and healthcare cost-effectiveness.

Regardless of the mechanism by which TTO influences the associations described above, it is critical to identify the clinical and operational variables influencing TTO. Previously identified factors contributing to delayed TTO include equipment failure, surgeon unavailability, patient clinical condition, community practice setting, and instrument availability.[105-108] Improving operating room efficiency through targeted multidisciplinary planning has been shown to significantly reduce non-operative time, anesthesia time, and turnover time in neurosurgical operations under 2 hours.[107] We recommend extrapolation of this study design to gastrointestinal operations in patients emergently admitted with any one of the investigated intestinal diagnoses with the additional assessment of mortality impact.

Strengths

The conclusions drawn from this investigation are based upon a large data set obtained from the National Inpatient Sample. Utilization of a national database significantly improves the generalizability of our findings as a result of the diversity of patients included in the study. Furthermore, the inclusion of 53,585 patients over a ten-year period from multiple healthcare settings reduces the impact of confounding variables further contributing to the predictive accuracy of our results. Our investigation also highlights areas of future research that may verify and explain the associations found therein. In addition to future research, the relationships described throughout this study may be utilized by clinicians to better prognosticate clinical outcomes of patients with either intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions.

Limitations

The retrospective nature of this investigation elicits several key limitations. Namely, the National Inpatient Sample (NIS) does not contain information regarding the etiology, chronicity, or severity of the diagnoses investigated. Furthermore, the NIS does not contain information regarding operative techniques employed, medical treatment patterns, and relative control of comorbidities. Further assessment of the mortality factors identified in relation to these additional parameters may provide insight into the pathophysiology involved. Lastly, the NIS does not contain all variables required to determine the 5-item modified frailty index. Therefore, we estimated the 5-item modified frailty index based on the procedure described in the methods section. This estimation may impact the applicability of the conclusions drawn regarding frailty.

Conclusion

Overall patients emergently admitted for either intestinal fistula, intestinal ulceration, intestinal perforation, angiodysplasia, or Dieulafoy lesions with advanced age or increased modified frailty index had higher mortality risk than adults and non-frail patients. Delayed time to operation strongly increases mortality odds in operatively managed patients with all of the above diagnoses. Non-operatively managed adult patients with intestinal fistula, ulceration, perforation, angiodysplasia, or Dieulafoy lesions exhibit higher mortality rates with prolonged hospital length of stay. Compared to intestinal fistula, intestinal perforation increases mortality odds, while intestinal ulceration and angiodysplasia lower mortality odds in adult and elderly patients regardless of operation status. Additional research is required to determine the most appropriate interventions to mitigate the identified risk factors.

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Conflict of Interest Disclosure Statement

The authors have no conflict of interest to declare.

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