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Longer stay in Hospital is the Risk Factor for Mortality whereas Surgery is the Protective Factor in Patients with Blood in Stool

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Abstract

Background: While blood in stool is often self-limited, acute gastrointestinal (GI) bleeding can be a medical emergency, and few large-scale studies have analyzed the demographics and outcomes of those seeking emergent evaluation of bloody stools. The aim of this study was to evaluate independent predictors of in-hospital mortality for patients admitted emergently with the primary diagnosis of blood in stool over a ten-year span.

Methods: National Inpatient Sample Database data was extracted regarding adult (18-64 years of age) and elderly patient populations with the primary diagnosis of blood in stool between 2005-2014. Data regarding general demographics (i.e. age, sex, race, income, insurance payer, hospital location, comorbidities), hospital course (i.e. invasive diagnostic and/or surgical procedure status, hospital length of stay, days to operation), and outcomes were analyzed. The relationship between mortality and predictors was evaluated using multivariable logistic regression and generalized additive models.

Results: Data from 72,253 patients was collected, of which, 1,523 patients died (2.1%). The mean age was 65 years, and 49% of patients were male. Mortality was significantly associated with being older (OR=1.02; 95% CI=1.01-1.03; P<0.001), being male (OR=1.48; 95% CI=1.33-1.65; P<0.001), longer hospital length of stay (HLOS; OR=1.01; 95% CI=1.001-1.02; P<0.001) and having bacterial infections (OR=2.09; 95% CI=1.78-2.44;

P<0.001). Comorbidities associated with a greater than two-fold odds of mortality included respiratory, cardiac, and liver diseases, fluid and electrolyte disorders, and trauma, burns, and poisons. A nonlinear relationship between HLOS and mortality was observed, with the lowest mortality rate at day 3 and significantly increased mortality for the days following. Patients who underwent invasive diagnostic testing and/or surgery had lower odds of mortality.

Conclusion: From 2005-2014 the mortality among patients presenting emergently with blood in stool was 2.1%. Male sex, increased age and HLOS, bacterial infections, and previously mentioned comorbidities were risk factors for such patients, while invasive diagnostic testing and/or surgery were protective factors. HLOS longer than 3 days was also associated with increased odds of mortality.

Keywords: Melena, blood in stool, GI bleeding, in-hospitalization mortality, hospital length of stay.

Introduction

Blood in stool is due to bleeding in the upper or lower gastrointestinal tract and can signal benign or more serious pathologies. Upper GI bleeding, usually manifesting as bright red blood in vomit or black tarry stools (melena), originates from the esophagus, stomach, or duodenum and has an annual incidence of approximately 47/100,000[1]. Lower GI bleeding, which occurs in the colon, rectum, or anus, presents as bright red stools or melena and has an annual incidence of around 36/100,000[2]. Common causes of lower GI bleeding include diverticulosis, hemorrhoids, ischemic pathologies, inflammatory bowel disease, and post-polypectomy. While incidence of upper GI bleeds has decreased, in large part due to improved Helicobacter pylori management and use of proton pump inhibitors, incidence of lower GI bleeding may be increasing and may confer a higher risk of recurrent bleeds and death[1]. Regardless of site of origin, 80-85% of cases of blood in stool are self-limited and amenable to elective evaluation.[2] However, emergent admission is warranted in cases of recurrent or severe bleeding, hemodynamic changes, and presence of comorbid conditions, and the mortality rate is 2-4%[3]. The primary symptom of blood in stool evidently encompasses a vast scope of pathologies and outcomes – thus, improved delineation of risk factors for mortality among patients with acute GI bleeding is needed for improved clinical management.

Hospital length of stay (HLOS) is an important quality metric for many health systems, with many published and ongoing efforts aimed at delineating its impact on patient outcomes. Exceedingly long hospital stays can strain a hospital's capacity to meet patient demands, leading to ICU and emergency department crowding and increased risk of infections[4]. Previous studies have found that prolonged HLOS is been associated with increased odds of mortality, as well as hospital readmission[5–7]. In particular, Cook et al. found that clinically significant GI bleeds were associated with increased length of ICU stay and increased mortality[8]. This study aimed to further evaluate independent predictors of in-hospital mortality for patients admitted emergently with the primary diagnosis of blood in stool.

Methods

Data analyzed and reported in this study were obtained through the National Inpatient Sample (NIS), the largest publicly available inpatient healthcare database developed for the Healthcare Cost and Utilization Project (HCUP). The NIS contains information on all hospital stays from 1988-2019, regardless of insurance method utilized. This retrospective cohort study analyzed data from the NIS-2005-2014 regarding adult and elderly patients admitted to the Emergency Department with a primary diagnosis of blood in stool. ICD-9-CM diagnosis code of 578.1 was used as the first inclusion criteria, which represents both melena and hematochezia[9]. Other inclusion criteria were having this code recoded as the primary diagnosis (DX1 variable in the NIS database), age of 18 years or older, and emergency admission of the patient. The following characteristics were obtained and analyzed for such patients: age, sex, race, income quartile, insurance payer, hospital location, associated comorbidities, invasive diagnostic and/or surgical procedure status, hospital length of stay (HLOS), and days to operation. ICD-9 codes for surgical procedures and invasive diagnostic procedures data were also collected (Supplementary Table 1).

Statistical Analysis

For numerical attributes, mean (SD) and confidence interval of 95% was determined. The data was stratified according to sex, age range (adult vs. elderly), and outcome categories, as well as invasive diagnostic and surgery status. A backwards multivariable logistic regression analysis was also conducted to predict risk factors of mortality. To test the linearity vs. non-linearity of the relationship between hospital length of stay (HLOS) and mortality, a generalized additive model (GAM) was built. EDF>1 in GAM denotes non-linear relationship between the dependent and

independent variables. P values less than 0.05 were considered statistically significant and were reported. For such analyses, SPSS version 24 (SPSS Inc., Chicago, IL) and R software (Foundation for Statistical Computing, Vienna, Austria) were utilized.

Data are available upon reasonable request. All data relevant to the study are included in the article or provided separately as supplementary information. Data will be shared with investigators whose proposed use of data has been approved by an independent review committee identified for this purpose. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of New York Medical College (protocol code 14177 approved on Jun 2019).

Results

Baseline demographics of emergently admitted patients with chief complaint of blood in stool

From 2005-2014, a total number of 72,253 patients were admitted with a primary diagnosis of blood in stool. The mean age of admitted patients was 65.0 years - most adult patients between the ages of 18-64 years of age were male (57.1%) while most patients within the elderly population (65+ years) were female (55.2%). Most patients between 18-64 years of age were funded by private insurance (42.1%), while a vast majority of patients 65+ years of age were Medicare recipients (90.8%). Regardless of age or sex, most patients presented to urban teaching hospitals and underwent invasive diagnostic and/or surgical procedures.

Differences by Sex

Among the 72,253 patients emergently admitted with a primary diagnosis of blood in stool, the mean (SD) age of the 1,523 patients who died was 68.53 (7.85) years. Of these patients, 824 (54.1%) were male (Table 1). The most prominent comorbidities were hypertension, alcohol abuse, uncomplicated diabetes, chronic pulmonary disease, and chronic blood loss. Males showed higher rates of alcohol abuse (particularly those between the ages of 18-64), as well as coagulopathy, liver disease, renal failure, and drug abuse. Females indicated higher rates of deficiency anemias, rheumatoid arthritis, chronic pulmonary disease, hypothyroidism, and fluid/electrolyte disorders. Notably, the incidence of hypertension was higher among men between the ages of 18-64, while this higher incidence shifted towards women in the 64+ age category (Table 1).

Table 1. Characteristics of emergency admitted patients with the primary diagnosis of blood in stool (NIS 2005-2014). Data was stratified according to sex categories.

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		Male	Female	p	Male	Female	p
All Cases		13,828 (57.1%)	10,395 (42.9%)		21,533 (44.8%)	26,497 (55.2%)	
Race	White	7,409 (62.3%)	5,664 (63.8%)	<0.001	14,777 (79.1%)	17,507 (76.9%)	<0.001
	Black	2,314 (19.4%)	1,796 (20.2%)		1,882 (10.1%)	2,833 (12.4%)	
	Hispanic	1,341 (11.3%)	914 (10.3%)		1,125 (6.0%)	1,389 (6.1%)	
	Asian/Pacific Islander	382 (3.2%)	208 (2.3%)		435 (2.3%)	506 (2.2%)	
	Native American	107 (0.9%)	82 (0.9%)		79 (0.4%)	113 (0.5%)	
	Other	345 (2.9%)	208 (2.3%)		388 (2.1%)	415 (1.8%)	
Income Quartile	Quartile 1	4,240 (31.5%)	3,132 (30.8%)	0.029	5,321 (25.2%)	6,818 (26.2%)	<0.001
	Quartile 2	3,420 (25.4%)	2,641 (26.0%)		5,548 (26.2%)	6,933 (26.6%)	
	Quartile 3	3,153 (23.4%)	2,499 (24.6%)		5,377 (25.4%)	6,744 (25.9%)	
	Quartile 4	2,650 (19.7%)	1,882 (18.5%)		4,890 (23.1%)	5,577 (21.4%)	
Insurance	Private Insurance	5,853 (42.5%)	4,337 (41.8%)	<0.001	1,698 (7.9%)	1,523 (5.8%)	<0.001
	Medicare	2,967 (21.5%)	2,408 (23.2%)		19,227 (89.4%)	24,381 (92.1%)	
	Medicaid	2,283 (16.6%)	2,114 (20.4%)		223 (1.0%)	297 (1.1%)	
	Self-Pay	1,694 (12.3%)	997 (9.6%)		102 (0.5%)	129 (0.5%)	
	No Charge	188 (1.4%)	118 (1.1%)		8 (0.0%)	10 (0.0%)	
	Other	791 (5.7%)	394 (3.8%)		257 (1.2%)	122 (0.5%)	

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		Male	Female	p	Male	Female	p
All Cases		13,828 (57.1%)	10,395 (42.9%)		21,533 (44.8%)	26,497 (55.2%)	
Hospital Location	Rural	1,324 (9.6%)	1,005 (9.7%)	0.130	3,014 (14.0%)	3,655 (13.8%)	0.380
	Urban: Non-Teaching	4,815 (34.8%)	3,741 (36.0%)		8,652 (40.2%)	10,811 (40.8%)	
	Urban: Teaching	7,689 (55.6%)	5,649 (54.3%)		9,867 (45.8%)	12,031 (45.4%)	
Comorbidities	AIDS	159 (1.1%)	45 (0.4%)	**<0.001**	16 (0.1%)	1 (0.0%)	**<0.001**
	Alcohol Abuse	2,816 (20.4%)	901 (8.7%)	**<0.001**	1,001 (4.6%)	298 (1.1%)	**<0.001**
	Deficiency Anemias	3,059 (22.1%)	2,650 (25.5%)	**<0.001**	5,365 (24.9%)	6,775 (25.6%)	0.100
	Rheumatoid Arthritis	176 (1.3%)	555 (5.3%)	**<0.001**	416 (1.9%)	1,196 (4.5%)	**<0.001**
	Chronic Blood Loss	2,157 (15.6%)	1,609 (15.5%)	0.800	3,943 (18.3%)	4,864 (18.4%)	0.900
	Congestive Heart Failure	1,230 (8.9%)	930 (8.9%)	0.890	5,554 (25.8%)	6,832 (25.8%)	0.980
	Chronic Pulmonary Disease	2,015 (14.6%)	2,214 (21.3%)	**<0.001**	5,327 (24.7%)	6,157 (23.2%)	**<0.001**
	Coagulopathy	1,489 (10.8%)	916 (8.8%)	**<0.001**	1,758 (8.2%)	1,571 (5.9%)	**<0.001**
	Depression	1,329 (9.6%)	1,801 (17.3%)	**<0.001**	1,468 (6.8%)	3,039 (11.5%)	**<0.001**
	Diabetes, Uncomplicated	2,649 (19.2%)	2,078 (20.0%)	0.110	5,720 (26.6%)	6,574 (24.8%)	**<0.001**
	Diabetes, Chronic Complications	560 (4.0%)	436 (4.2%)	0.580	1,150 (5.3%)	1,197 (4.5%)	**<0.001**
	Drug Abuse	872 (6.3%)	448 (4.3%)	**<0.001**	103 (0.5%)	68 (0.3%)	**<0.001**
	Hypertension	6,900 (49.9%)	4,892 (47.1%)	**<0.001**	14,692 (69.5%)	19,406 (73.2%)	**<0.001**
	Hypothyroidism	543 (3.9%)	1,256 (12.1%)	**<0.001**	2,196 (10.2%)	5,813 (21.9%)	**<0.001**
	Liver Disease	2,667 (19.3%)	1,379 (13.3%)	**<0.001**	1,123 (5.2%)	991 (3.7%)	**<0.001**
	Lymphoma	122 (0.9%)	64 (0.6%)	**0.019**	343 (1.6%)	272 (1.0%)	**<0.001**
	Fluid/Electrolyte Disorders	3,101 (22.4%)	2,655 (25.5%)	**<0.001**	5,469 (25.4%)	7,916 (29.9%)	**<0.001**
	Metastatic Cancer	435 (3.1%)	365 (3.5%)	0.120	878 (4.1%)	701 (2.6%)	**<0.001**
	Other Neurological Disorders	787 (5.7%)	713 (6.9%)	**<0.001**	1,902 (8.8%)	2,676 (10.1%)	**<0.001**
	Obesity	1,336 (9.7%)	1,457 (14.0%)	**<0.001**	1,213 (5.6%)	1,786 (6.7%)	**<0.001**
	Paralysis	316 (2.3%)	197 (1.9%)	**0.037**	485 (2.3%)	614 (2.3%)	0.640
	Peripheral Vascular Disorders	597 (4.3%)	493 (4.7%)	0.110	2,733 (12.7%)	2,685 (10.1%)	**<0.001**
	Psychoses	641 (4.6%)	703 (6.8%)	**<0.001**	360 (1.7%)	608 (2.3%)	**<0.001**
	Pulmonary Circulation Disorders	261 (1.9%)	282 (2.7%)	**<0.001**	892 (4.1%)	1,416 (5.3%)	**<0.001**
	Renal Failure	1,725 (12.5%)	1,111 (10.7%)	**<0.001**	5,829 (27.1%)	5,432 (20.5%)	**<0.001**
	Solid Tumor	345 (2.5%)	219 (2.1%)	**0.047**	1,026 (4.8%)	666 (2.5%)	**<0.001**
	Peptic Ulcer	6 (0.0%)	2 (0.0%)	0.480	4 (0.0%)	3 (0.0%)	0.710
	Valvular Disease	574 (4.2%)	607 (5.8%)	**<0.001**	2,862 (13.3%)	3,719 (14.0%)	**0.018**
	Weight Loss	648 (4.7%)	417 (4.0%)	**0.011**	1,111 (5.2%)	1,405 (5.3%)	0.480
Invasive Diagnostic Procedure		9,615 (69.5%)	7,148 (68.8%)	0.200	13,817 (64.2%)	15,697 (59.2%)	**<0.001**
Surgical Procedure		2,253 (16.3%)	1,395 (13.4%)	**<0.001**	3,746 (17.4%)	3,518 (13.3%)	**<0.001**
Invasive or Surgical Procedure		10,215 (73.9%)	7,501 (72.2%)	**0.003**	14,710 (68.3%)	16,543 (62.4%)	**<0.001**
Deceased		170 (1.2%)	80 (0.8%)	**<0.001**	654 (3.0%)	619 (2.3%)	**<0.001**

Patients' Characteristics	Adult (18-64 years), N (%)			Elderly (65+), N (%)		
	Male	Female	p	Male	Female	p
All Cases	13,828 (57.1%)	10,395 (42.9%)		21,533 (44.8%)	26,497 (55.2%)	
	Mean (SD)	Mean (SD)	p	Mean (SD)	Mean (SD)	p
Age, Years	51.01 (10.55)	51.00 (10.95)	0.110	77.98 (7.75)	80.09 (8.08)	<0.001
Time to Invasive Diagnostic Procedure, Days	1.41 (1.43)	1.52 (1.35)	<0.001	1.58 (1.42)	1.67 (1.53)	<0.001
Time to Surgical Procedure, Days	2.12 (2.14)	2.30 (2.70)	0.160	2.51 (2.49)	2.52 (2.42)	0.610
Hospital Length of Stay, Days	3.43 (3.55)	3.57 (3.42)	<0.001	4.09 (3.72)	4.20 (3.67)	<0.001
Total Charges, Dollars	26,580 (37,568)	26,035 (30,260)	0.730	28,636 (37,756)	26,822 (46,841)	<0.001

Mortality

1,523 (2.1%) patients presenting with blood in stool died during their stay in the hospital, with most of such patients being White (68%), male (54.1%), and 65+ years old (83.65%)(Table 2). Deceased non-elderly adult patients indicated significantly higher rates of alcohol abuse, while deceased elderly patients showed higher rates of deficiency anemias, chronic blood loss, depression, uncomplicated diabetes, hypertension, hypothyroidism, and valvular disease (Table 2). Compared to patients who survived, deceased patients of both age categories displayed higher rates of congestive heart failure, coagulopathy, liver disease, lymphoma, fluid/electrolyte disorders, metastatic cancer, obesity, pulmonary circulation disorders, and renal failure (Table 2). Patients who died also demonstrated a longer time to first operation (Table 2).

Invasive Diagnostic Status

46,289 patients (64%) in this research cohort underwent invasive diagnostic measures (Supplementary Table 1), the most common of which was invasive diagnostic procedure on the intestine (Supplementary Table 2). Such procedures are classified according to ICD-9 codes 45.11-45.29 – examples include endoscopy, colonoscopy, esophagogastroduodenoscopy, and intestinal biopsies (Supplementary Table 2). Invasive diagnostic tests were conducted on mostly White patients. The mean (SD) age of patients who underwent invasive diagnostic procedures is 64.6 years (9.3) and an even spread between males and females (50.6% male, 49.4% female). Among those who underwent invasive diagnostic testing, common significant comorbidities included hypertension, chronic blood loss, and coagulopathy. On average, patients who underwent invasive diagnostic methods experienced a longer hospital stay and increased time to surgery. 440 of patients undergoing invasive diagnostic measures died, which comprised 28.9% of the total number of patients who died (Supplementary Table 2).

Surgery Status and Outcomes

Among the emergently admitted patients with blood in stool, 10,916 patients (15.1%) underwent surgery (Table 3), the most common of which was operation on the intestine (Supplementary Table 2). These operations are designated under ICD codes 45.00-45.03, 45.03-46.99), and examples include enterotomy, local excisions, colectomy, and intestinal anastomosis (Supplementary Table 2). The mean age of adults who underwent surgery was 2.9 years older than those without operation, while the mean age of elderly patients participating in surgery was 1.8 years younger than their non-surgical counterparts (Table 3). For both groups, most patients were males and White, with adult patients mostly funded by private insurance and elderly patients predominantly receiving Medicare. Most patients received surgery in urban teaching hospitals. Of those who underwent surgical operations, 8,224 patients (75%) also underwent an invasive diagnostic procedure (Supplementary Table 1). 137 (9%) of patients who died underwent surgery.

Risk Factors of Mortality

A logistic regression analysis for mortality was constructed for all patients included in the study. The results are presented in Table 4. Variables used to adjust the model included age, sex, hospital length of stay, invasive diagnostic procedure status, surgical procedure status, and comorbidities, complications or secondary diagnoses during hospitalization. Among patients with a

primary diagnosis of blood in stool, older age, male sex, and increased HLOS posed greater odds of mortality. Bacterial infections and comorbidities such as respiratory diseases, cardiac disease, liver diseases, fluid and electrolyte disorders, and trauma, burns, and/or poisons were associated with more than 2 times greater odds of mortality. Other comorbidities, namely genitourinary diseases, neurological diseases, platelet and white blood cell diseases, and cerebrovascular diseases, were also significant risk factors of mortality.

Table 2. Characteristics of emergency admitted patients with the primary diagnosis of blood in stool (NIS 2005-2014). Data was classified according to outcome categories.

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		Survived	Deceased	p	Survived	Deceased	p
All Cases		23,964 (99.0%)	250 (1.0%)		46,723 (97.3%)	1.273 (2.7%)	
Sex, Female		10,308 (43.0%)	80 (32.0%)	**<0.001**	25,855 (55.3%)	619 (48.6%)	**<0.001**
Race	**White**	12,929 (62.9%)	138 (64.5%)	0.420	31,356 (77.8%)	898 (81.0%)	**0.005**
	Black	4,067 (19.8%)	43 (20.1%)		4,623 (11.5%)	93 (8.4%)	
	Hispanic	2,231 (10.9%)	21 (9.8%)		2,455 (6.1%)	55 (5.0%)	
	Asian/Pacific Islander	581 (2.8%)	9 (4.2%)		906 (2.2%)	35 (3.2%)	
	Native American	189 (0.9%)	0 (0%)		186 (0.5%)	6 (0.5%)	
	Other	550 (2.7%)	3 (1.4%)		783 (1.9%)	21 (1.9%)	
Income Quartile	**Quartile 1**	7,284 (31.2%)	90 (37.2%)	0.120	11,828 (25.8%)	310 (24.9%)	0.300
	Quartile 2	5,992 (25.6%)	63 (26.0%)		12,117 (26.4%)	352 (28.3%)	
	Quartile 3	5,591 (23.9%)	54 (22.3%)		11,810 (25.7%)	299 (24.0%)	
	Quartile 4	4,498 (19.3%)	35 (14.5%)		10,176 (22.2%)	285 (22.9%)	
Insurance	**Private Insurance**	10,110 (42.3%)	77 (30.8%)	**<0.001**	3,133 (6.7%)	86 (6.8%)	0.700
	Medicare	5,291 (22.2%)	83 (33.2%)		42,426 (90.9%)	1,152 (90.6%)	
	Medicaid	4,341 (18.2%)	53 (21.2%)		506 (1.1%)	14 (1.1%)	
	Self-Pay	2,668 (11.2%)	24 (9.6%)		227 (0.5%)	4 (0.3%)	
	No Charge	306 (1.3%)	0 (0%)		17 (0.0%)	1 (0.1%)	
	Other	1,169 (4.9%)	13 (5.2%)		363 (0.8%)	14 (1.1%)	
Hospital Location	**Rural**	2,302 (9.6%)	27 (10.8%)	0.070	6,473 (13.9%)	188 (14.8%)	0.290
	Urban: Non-Teaching	8,478 (35.4%)	71 (28.4%)		18,906 (40.5%)	531 (41.7%)	
	Urban: Teaching	13,184 (55.0%)	152 (60.8%)		21,344 (45.7%)	554 (43.5%)	
Comorbidities	**AIDS**	202 (0.8%)	2 (0.8%)	0.999	17 (0.0%)	0 (0%)	0.999
	Alcohol Abuse	3,655 (15.3%)	59 (23.6%)	**<0.001**	1,263 (2.7%)	35 (2.7%)	0.920
	Deficiency Anemias	5,649 (23.6%)	60 (24.0%)	0.870	11,851 (25.4%)	278 (21.8%)	**0.004**
	Rheumatoid Arthritis	725 (3.0%)	5 (2.0%)	0.350	1,574 (3.4%)	35 (2.7%)	0.230
	Chronic Blood Loss	3,732 (15.6%)	28 (11.2%)	0.060	8,598 (18.4%)	201 (15.8%)	**0.017**
	Congestive Heart Failure	2,123 (8.9%)	36 (14.4%)	**0.002**	11,818 (25.3%)	554 (43.5%)	**<0.001**
	Chronic Pulmonary Disease	4,175 (17.4%)	51 (20.4%)	0.220	11,140 (23.8%)	330 (25.9%)	0.090
	Coagulopathy	2,322 (9.7%)	82 (32.8%)	**<0.001**	3,128 (6.7%)	199 (15.6%)	**<0.001**

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		Survived	Deceased	p	Survived	Deceased	p
All Cases		23,964 (99.0%)	250 (1.0%)		46,723 (97.3%)	1.273 (2.7%)	
Comor-bidities	Depression	3,105 (13.0%)	25 (10.0%)	0.170	4,410 (9.4%)	90 (7.1%)	**0.004**
	Diabetes, Uncomplicated	4,684 (19.5%)	42 (16.8%)	0.280	12,013 (25.7%)	277 (21.8%)	**0.001**
	Diabetes, Chronic Complications	981 (4.1%)	13 (5.2%)	0.380	2,280 (4.9%)	64 (5.0%)	0.810
	Drug Abuse	1,311 (5.5%)	7 (2.8%)	0.060	168 (0.4%)	3 (0.2%)	0.630
	Hypertension	11,674 (48.7%)	113 (45.2%)	0.270	33,594 (71.9%)	758 (59.5%)	**<0.001**
	Hypothyroidism	1,783 (7.4%)	17 (6.8%)	0.700	7,834 (16.8%)	169 (13.3%)	**0.001**
	Liver Disease	3,953 (16.5%)	89 (35.6%)	**<0.001**	2,034 (4.4%)	77 (6.0%)	**0.004**
	Lymphoma	181 (0.8%)	5 (2.0%)	**0.025**	577 (1.2%)	38 (3.0%)	**<0.001**
	Fluid/Electrolyte Disorders	5,618 (23.4%)	132 (52.8%)	**<0.001**	12,762 (27.3%)	610 (47.9%)	**<0.001**
	Metastatic Cancer	754 (3.1%)	46 (18.4%)	**<0.001**	1,465 (3.1%)	113 (8.9%)	**<0.001**
	Other Neurological Disorders	1,482 (6.2%)	17 (6.8%)	0.690	4,438 (9.5%)	136 (10.7%)	0.160
	Obesity	2,778 (11.6%)	13 (5.2%)	**0.002**	2,949 (6.3%)	50 (3.9%)	**0.001**
	Paralysis	508 (2.1%)	6 (2.4%)	0.760	1,055 (2.3%)	43 (3.4%)	**0.008**
	Peripheral Vascular Disorders	1,075 (4.5%)	14 (5.6%)	0.400	5,270 (11.3%)	147 (11.5%)	0.770
	Psychoses	1,334 (5.6%)	7 (2.8%)	0.060	936 (2.0%)	31 (2.4%)	0.280
	Pulmonary Circulation Disorders	528 (2.2%)	14 (5.6%)	**<0.001**	2,208 (4.7%)	99 (7.8%)	**<0.001**
	Renal Failure	2,775 (11.6%)	58 (23.2%)	**<0.001**	10,829 (23.2%)	428 (33.6%)	**<0.001**
	Solid Tumor	546 (2.3%)	18 (7.2%)	**<0.001**	1,638 (3.5%)	52 (4.1%)	0.270
	Peptic Ulcer	8 (0.0%)	0 (0%)	0.999	7 (0.0%)	0 (0%)	0.999
	Valvular Disease	1,174 (4.9%)	7 (2.8%)	0.130	6,366 (13.6%)	212 (16.7%)	**0.002**
	Weight Loss	1,025 (4.3%)	40 (16.0%)	**<0.001**	2,351 (5.0%)	159 (12.5%)	**<0.001**
Invasive Diagnostic Procedure		16,658 (69.5%)	92 (36.8%)	**<0.001**	29,152 (62.4%)	348 (27.3%)	**<0.001**
Surgical Procedure		3,612 (15.1%)	33 (13.2%)	0.410	7,162 (15.3%)	104 (8.2%)	**<0.001**
Invasive or Surgical Procedure		17,597 (73.4%)	105 (42.0%)	**<0.001**	30,851 (66.0%)	388 (30.5%)	**<0.001**
		Mean (SD)	Mean (SD)	p	Mean (SD)	Mean (SD)	p
Age, Years		50.96 (10.74)	55.30 (7.50)	**<0.001**	79.07 (7.98)	81.76 (8.18)	**<0.001**
Time to Invasive Diagnostic Procedure, Days		1.46 (1.39)	1.73 (1.91)	0.430	1.62 (1.46)	1.84 (2.53)	0.420
Time to First Surgical Procedure, Days		2.18 (2.32)	3.16 (5.19)	0.440	2.48 (2.35)	4.59 (5.76)	**0.003**
Hospital Length of Stay, Days		3.45 (3.35)	6.63 (9.87)	0.290	4.12 (3.58)	5.39 (6.43)	0.580
Total Charges, Dollars		25,853 (32,992)	73,399 (98,184)	**<0.001**	27,088 (41,066)	47,706 (86,407)	**<0.001**

Table 3. Characteristics of emergency admitted patients with the primary diagnosis of blood in stool (NIS 2005-2014). Data was stratified according to surgery status.

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		No Surgery	Surgery	p	No Surgery	Surgery	p
All Cases		20,584 (84.9%)	3,649 (15.1%)		40,774 (84.9%)	7,267 (15.1%)	
Sex, Female		9,000 (43.7%)	1,395 (38.2%)	**<0.001**	22,979 (56.4%)	3,518 (48.4%)	**<0.001**
Race	**White**	11,101 (63.0%)	1,975 (62.6%)	0.49	27,452 (78.2%)	4,835 (76.3%)	**0.006**
	Black	3,500 (19.9%)	611 (19.4%)		3,939 (11.2%)	778 (12.3%)	
	Hispanic	1,899 (10.8%)	356 (11.3%)		2,078 (5.9%)	436 (2.2%)	
	Asian/Pacific Islander	494 (2.8%)	96 (3.0%)		803 (2.3%)	138 (2.2%)	
	Native American	152 (0.9%)	37 (1.2%)		164 (0.5%)	28 (0.4%)	
	Other	471 (2.7%)	82 (2.6%)		682 (1.9%)	122 (1.9%)	
Income Quartile	**Quartile 1**	6,290 (31.4%)	1,086 (30.4%)	0.53	10,301 (25.7%)	1,841 (25.8%)	**0.022**
	Quartile 2	5,127 (25.6%)	934 (26.1%)		10,694 (26.7%)	1,789 (25.0%)	
	Quartile 3	4,806 (24.0%)	848 (23.7%)		10,231 (25.5%)	1,893 (26.5%)	
	Quartile 4	3,827 (19.1%)	708 (19.8%)		8,846 (22.1%)	1,624 (22.7%)	
Insurance	**Private Insurance**	8,668 (42.2%)	1,527 (42.0%)	**0.003**	2,693 (6.6%)	530 (7.3%)	0.08
	Medicare	4,488 (21.9%)	889 (24.4%)		37,040 (90.9%)	6,576 (90.6%)	
	Medicaid	3,790 (18.5%)	607 (16.7%)		459 (1.1%)	62 (0.9%)	
	Self-Pay	2,315 (11.3%)	379 (10.4%)		197 (0.5%)	34 (0.5%)	
	No Charge	253 (1.2%)	53 (1.5%)		17 (0.0%)	1 (0.0%)	
	Other	1,004 (4.9%)	181 (5.0%)		322 (0.8%)	57 (0.8%)	
Hospital Location	**Rural**	2,059 (10.0%)	271 (7.4%)	**<0.001**	5,925 (14.5%)	744 (10.2%)	**<0.001**
	Urban: Non-Teaching	7,267 (35.3%)	1,292 (35.4%)		16,447 (40.3%)	3,019 (41.5%)	
	Urban: Teaching	11,258 (54.7%)	2,086 (57.2%)		18,402 (45.1%)	3,504 (48.2%)	
Comor-bidities	**AIDS**	184 (0.9%)	20 (0.5%)	**0.035**	12 (0.0%)	5 (0.1%)	0.1
	Alcohol Abuse	3,096 (15.0%)	622 (17.0%)	**0.002**	1,040 (2.6%)	259 (3.6%)	**<0.001**
	Deficiency Anemias	4,838 (23.5%)	876 (24.0%)	0.51	10,402 (25.5%)	1,740 (23.9%)	**0.005**
	Rheumatoid Arthritis	630 (3.1%)	101 (2.8%)	0.34	1,369 (3.4%)	243 (3.3%)	0.95
	Chronic Blood Loss	3,112 (15.1%)	654 (17.9%)	**<0.001**	7,411 (18.2%)	1,396 (19.2%)	**0.036**
	Congestive Heart Failure	1,774 (8.6%)	387 (10.6%)	**<0.001**	10,476 (25.7%)	1,912 (26.3%)	0.27
	Chronic Pulmonary Disease	3,534 (17.2%)	696 (19.1%)	**0.005**	9,631 (23.6%)	1,854 (25.5%)	**<0.001**
	Coagulopathy	1,912 (9.3%)	493 (13.5%)	**<0.001**	2,747 (6.7%)	582 (8.0%)	**<0.001**
	Depression	2,715 (13.2%)	416 (11.4%)	**0.003**	3,912 (9.6%)	596 (8.2%)	**<0.001**
	Diabetes, Uncomplicated	3,945 (19.2%)	784 (21.5%)	**0.001**	10,282 (25.2%)	2,014 (27.7%)	**<0.001**
	Diabetes, Chronic Complications	813 (3.9%)	183 (5.0%)	**0.003**	1,934 (4.7%)	415 (5.7%)	**<0.001**
	Drug Abuse	1,156 (5.6%)	164 (4.5%)	**0.006**	140 (0.3%)	31 (0.4%)	0.27

Patients' Characteristics		Adult (18-64 years), N (%)			Elderly (65+), N (%)		
		No Surgery	Surgery	p	No Surgery	Surgery	p
All Cases		20,584 (84.9%)	3,649 (15.1%)		40,774 (84.9%)	7,267 (15.1%)	
Comor-bidities	Hypertension	9,825 (47.7%)	1,970 (54.0%)	**<0.001**	29,178 (71.6%)	5,200 (71.6%)	0.995
	Hypothyroidism	1,518 (7.4%)	282 (7.7%)	0.45	6,855 (16.8%)	1,155 (15.9%)	0.053
	Liver Disease	3,171 (15.4%)	875 (24.0%)	**<0.001**	1,641 (4.0%)	473 (6.5%)	**<0.001**
	Lymphoma	169 (0.8%)	17 (0.5%)	**0.023**	520 (1.3%)	95 (1.3%)	0.82
	Fluid/Electrolyte Disorders	4,770 (23.2%)	986 (27.0%)	**<0.001**	11,393 (27.9%)	1,994 (27.4%)	0.38
	Metastatic Cancer	687 (3.3%)	113 (3.1%)	0.45	1,420 (3.5%)	159 (2.2%)	**<0.001**
	Other Neurological Disorders	1,268 (6.2%)	232 (6.4%)	0.65	4,033 (9.9%)	548 (7.5%)	**<0.001**
	Obesity	2,326 (11.3%)	467 (12.8%)	**0.009**	2,377 (5.8%)	623 (8.6%)	**<0.001**
	Paralysis	448 (2.2%)	66 (1.8%)	0.16	952 (2.3%)	147 (2.0%)	0.1
	Peripheral Vascular Disorders	892 (4.3%)	198 (5.4%)	**0.003**	4,575 (11.2%)	845 (11.6%)	0.31
	Psychoses	1,185 (5.8%)	159 (4.4%)	**0.001**	846 (2.1%)	122 (1.7%)	**0.027**
	Pulmonary Circulation Disorders	438 (2.1%)	105 (2.9%)	**0.005**	1,927 (4.7%)	381 (5.2%)	0.06
	Renal Failure	2,279 (11.1%)	558 (15.3%)	**<0.001**	9,404 (23.1%)	1,859 (25.6%)	**<0.001**
	Solid Tumor	477 (2.3%)	87 (2.4%)	0.81	1,463 (3.6%)	229 (3.2%)	0.06
	Peptic Ulcer	5 (0.0%)	3 (0.1%)	0.11	3 (0.0%)	4 (0.1%)	**0.012**
	Valvular Disease	961 (4.7%)	220 (6.00%)	**<0.001**	5,505 (13.5%)	1,076 (14.8%)	**0.003**
	Weight Loss	845 (4.1%)	220 (6.0%)	**<0.001**	2,100 (5.2%)	416 (5.7%)	**0.043**
Invasive Diagnostic Procedure		14,072 (68.4%)	2,696 (73.9%)	**<0.001**	23,993 (58.8%)	5,528 (76.1%)	**<0.001**
Deceased		217 (1.1%)	33 (0.9%)	0.41	1,169 (2.9%)	104 (1.4%)	**<0.001**
		Mean (SD)	Mean (SD)	p	Mean (SD)	Mean (SD)	p
Age, Years		50.56 (10.96)	53.50 (8.86)	**<0.001**	79.41 (8.07)	77.66 (7.40)	**<0.001**
Time to Invasive Diagnostic Procedure, Days		1.43 (1.36)	1.61 (1.56)	**<0.001**	1.59 (1.37)	1.80 (1.87)	**<0.001**
Hospital Length of Stay, Days		3.29 (3.09)	4.63 (5.06)	**<0.001**	3.96 (3.39)	5.22 (4.93)	**<0.001**
Total Charges, Dollars		24,269 (28,645)	38,021 (56,257)	**<0.001**	25,491 (38,006)	39,587 (62,821)	**<0.001**

Table 4. Backward logistic regression analysis to evaluate the associations between mortality and different factors in emergency admitted patients with the primary diagnosis of blood in stool (NIS 2005-2014). Mortality was the dependent variable (R^2=0.202).

Patients' Characteristics (Number of Patients=73,920)	Mortality (N=1,525)	
	OR (95% CI)	P value
Age, Years	1.02 (1.01, 1.03)	**<0.001**
Invasive Diagnostic/Therapeutic Procedures	0.24 (0.22, 0.27)	**<0.001**
Surgical Procedures	0.58 (0.48, 0.70)	**<0.001**
Hospital Length of Stay, Days	1.01 (1.001, 1.02)	**0.001**

Patients' Characteristics (Number of Patients=73,920)	Mortality (N=1,525)	
	OR (95% CI)	P value
Sex, Male	1.48 (1.33, 1.65)	**<0.001**
Bacterial Infections (Other than Tuberculosis)	2.09 (1.78, 2.44)	**<0.001**
Respiratory Diseases	2.44 (2.18, 2.72)	**<0.001**
Cardiac Diseases	2.03 (1.77, 2.34)	**<0.001**
Liver Diseases	2.46 (2.09, 2.90)	**<0.001**
Genitourinary System Diseases	1.34 (1.20, 1.51)	**<0.001**
Fluid and Electrolyte Disorders	2.21 (1.98, 2.47)	**<0.001**
Neurological Diseases	1.15 (1.03, 1.29)	**0.016**
Platelet and White Blood Cell Diseases	1.22 (1.04, 1.42)	**0.012**
Trauma, Burns, and Poisons	2.71 (2.34, 3.14)	**<0.001**
Cerebrovascular Diseases	1.42 (1.18, 1.71)	**<0.001**
Coagulopathy		
Peripheral Vascular Diseases		
Neoplasms		
Tuberculosis		
Nonbacterial Infections		
Anemia and/or Hemorrhage		
Digestive Diseases other than Liver		
Diabetes		
Drug Abuse/Withdrawal/Dependence		
Alcohol Abuse/Withdrawal/Dependence		
Tobacco Use	**Removed Via**	
Hypertension	**Stepwise**	
Endocrine Diseases	**Backward**	
Nutritional/Weight Disorders	**Elimination**	
Musculoskeletal System and Connective Tissue Diseases		
Psychiatric Diseases		
Skin Diseases		
Long Term Medication Usage		
Diseases of Oral Cavity, Salivary Glands, and Jaw		
Sleep Disorders		
Lack of Physical Evidence		
Inappropriate Diet and Eating Habits		
High Risk Lifestyle Behaviors		
Social Factors		

Table 5 summarizes the lifestyle, comorbidities and secondary diagnoses of patients. There was no significant difference in lifestyle elements between the survived and deceased patients. However, the same comorbidities that remained in the final regression model as the significant predictors of mortality were significantly more prevalent in deceased patients than in the survived ones (Table 5).

All adult patients together were assessed by generalized additive model to see if there was a nonlinear relationship between HLOS and mortality. Figure 1 shows the nonlinear relationship. The lowest rate of mortality was observed on day 3, after which the mortality increased significantly (EDF=7.40, P<0.0001). Since the ascending section of the U-shaped relationship in Figure 1 showed a linear relationship between HLOS and mortality after day 3, a multivariable logistic model was built on this subgroup of patients (N=10,289) which showed an OR of 1.29 (1.23-1.35). The mortality rate in the ascending section of plot was 0.9% (Figure 1).

Similarly, all elderly patients together were assessed by generalized additive model to see if there was a non-linear relationship between HLOS and mortality. Figure 2 shows the complexity of the relationship. The lowest rate of mortality was observed on day 3, after which the mortality increased significantly (EDF=9.50, P<0.0001). Since the ascending part of the U-shaped relationship in Figure 2 revealed a linear relationship between HLOS and mortality after day 3, a multivariable logistic model was built on this subgroup of patients (N=25,034) which showed an OR of 1.15 (1.13-1.18). The mortality rate in the ascending section of plot was 2.4% (Figure 2).

Figure 1. Multivariable generalized additive model to draw the association of mortality and hospital length of stay in adult patients. EDF=7.40(P<0.0001) shows the significance of non-linear relationshipafter adjusting the model for age, gender, race, income quartile, hospital location, health care insurance, invasive diagnostic procedure, and modified frailty index. Mean (SD) HLOS was 3.5 (3.5) days. HLOS in 10,289 patients was 3 days or longer of which 92 patients died (0.9%). After day 3, the odds of mortality increased significantly. OR (95%CI) of mortality for ascending section of HLOS was 1.29 (1.23-1.35).

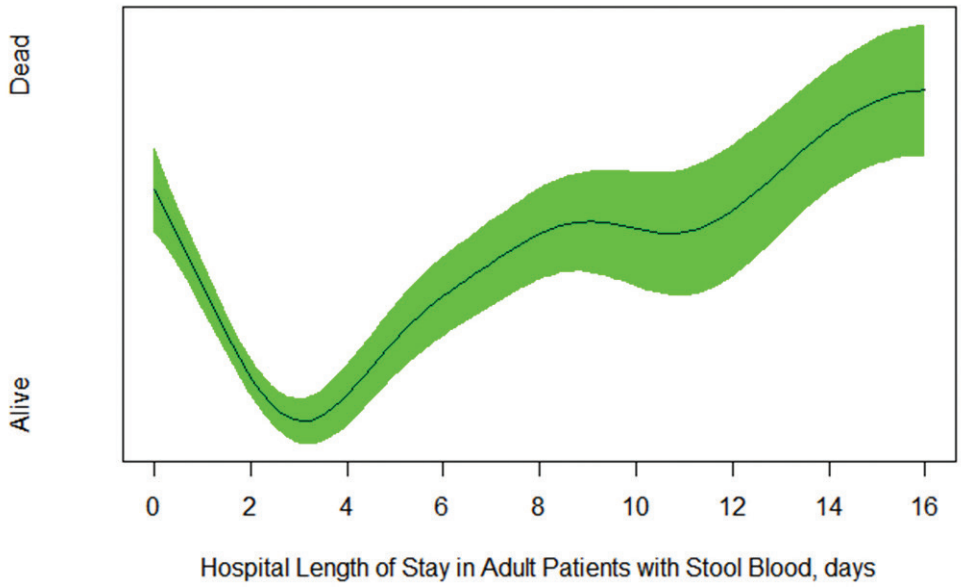

Figure 2. Multivariable generalized additive model to draw the association of mortality and hospital length of stay in elderly patients. EDF=9.50 (P<0.0001) shows the significance of non-linear relationship after adjusting the model for age, gender, race, income quartile, hospital location, health care insurance, invasive diagnostic procedure, and modified frailty index. Mean (SD) HLOS was 4.15 (3.7) days.HLOS in 25,034 patients was 3 days or longer of which 620 patients died (2.4%). After day 3, the odds of mortality increased significantly. OR (95%CI) of mortality for ascending section of HLOS was 1.15 (1.13-1.18).

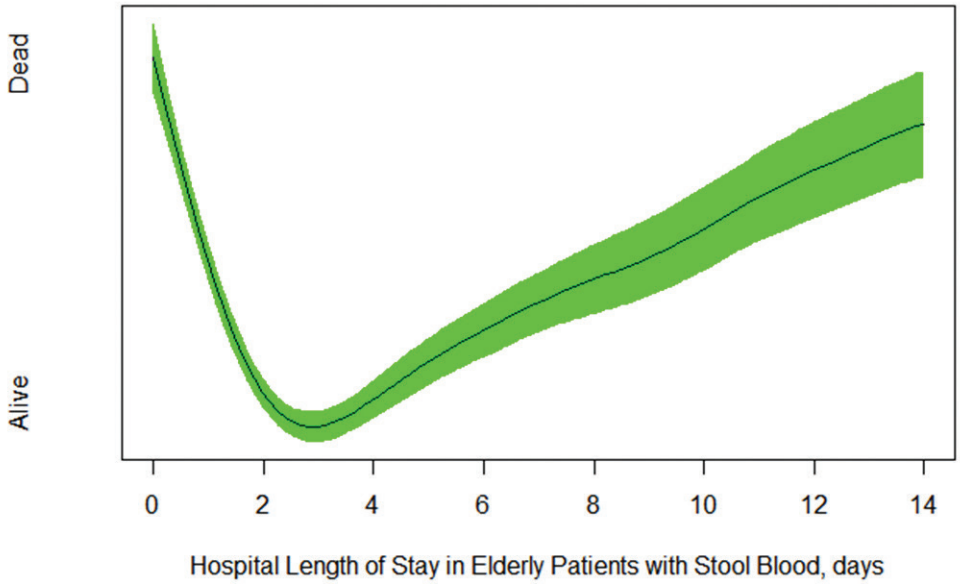

Table 5. Lifestyle, comorbidities and secondary diagnoses of patients emergently admitted with a primary diagnosis of blood in stool (NIS 2005-2014). Data was stratified according to survival status.

	Adult, N (%)			Elderly, N (%)		
Lifestyle, Comorbidities and Secondary Diagnoses (ICD-9 Codes)	**Survived**	**Deceased**	**P value**	**Survived**	**Deceased**	**P value**
Observations	23,964 (99)	250 (1)		46,723 (97)	1,273 (3)	
Tuberculosis (010.0-018.96)	6 (0.0)	0 (0)	0.999	8 (0.0)	0 (0)	0.999
Bacterial Infections Other than Tuberculosis (020.0-041.9, 790.7)	1,126 (5)	56 (22)	**<0.001**	2,773 (6)	231 (18)	**<0.001**
Nonbacterial Infections (042, 795.71, V08, 045.0-139.8, 790.8, and/or presence of Comorbidity of AIDS)	2,830 (12)	57 (23)	**<0.001**	1,703 (4)	58 (5)	0.090
Diabetes (250.0-250.93, V58.67, and/or presence of Comorbidity of Diabetes Uncomplicated or Diabetes Chronic Complications)	5,702 (24)	55 (22)	0.510	14,361 (31)	343 (27)	**0.004**
Hypertension (401.0-405.99, 796.2, and/or presence of Comorbidity of Hypertension)	11,698 (49)	113 (45)	0.260	33,635 (72)	758 (60)	**<0.001**
Anemia and/or Hemorrhage (280.0-285.9, 784.7, 784.8, and/or presence of Comorbidity of Anemia)	15,824 (66)	177 (71)	0.110	35,245 (75)	927 (73)	**0.033**
Respiratory Diseases (415.0-417.9, 460-519.9, 784.91, 786, and/or presence of Comorbidity of COPD, ILD or Pulmonary Circulation Disease)	6,384 (27)	151 (60)	**<0.001**	16,257 (35)	776 (61)	**<0.001**
Coagulopathy (286.0-286.9, 790.92, V58.61, V58.63, and/or presence of Comorbidity of Coagulopathy)	4,851 (20)	101 (40)	**<0.001**	12,829 (28)	415 (33)	**<0.001**
Cardiac Diseases (391.X, 392.0, 393.398.99, 410.0-414.9, 420.0-429.9, 794.3X, 785.XX, and/or presence of Comorbidity of CHF or Valvular Diseases)	7,737 (32)	164 (66)	**<0.001**	31,480 (67)	1,076 (85)	**<0.001**
Cerebrovascular Diseases (325, 430-438)	571 (2)	14 (6)	**<0.001**	2,937 (6)	133 (10)	**<0.001**
Peripheral Vascular Diseases (440-457.9, and/or presence of Comorbidity of Peripheral Vascular Disorders)	7,597 (32)	52 (21)	**<0.001**	14,432 (31)	246 (19)	**<0.001**

	Adult, N (%)			Elderly, N (%)		
Lifestyle, Comorbidities and Secondary Diagnoses (ICD-9 Codes)	**Survived**	**Deceased**	**P value**	**Survived**	**Deceased**	**P value**
Liver Diseases (570-573.9, 790.4, 794.8, and/or presence of Comorbidity of Liver Diseases)	4,399 (18)	103 (41)	**<0.001**	2,466 (5)	116 (9)	**<0.001**
Diseases of Digestive System other than Liver (530.00-569.9, 574.0-579.9, 787, 001.0-009.3, and/or presence of Comorbidity of Peptic Ulcer)	17,502 (73)	137 (55)	**<0.001**	33,552 (72)	612 (48)	**<0.001**
Diseases of Oral Cavity, Salivary Glands, and Jaws (520-529)	166 (0.7)	0 (0)	0.190	170 (0.4)	3 (0.2)	0.450
Nutritional/Weight Disorders (260-273.9, 275.XX,277.0-278.8, 783.XX, 799.3-799.4, and/or presence of Comorbidity of Weight Loss)	9,145 (38)	104 (42)	0.270	22,981 (49)	549 (43)	**<0.001**
Endocrine Diseases (240.0-259.9, 991.0-992.9, and/or presence of Comorbidity of Endocrine Diseases)	7,222 (30)	73 (29)	0.750	20,156 (43)	480 (38)	**<0.001**
Genitourinary System Diseases (580.0-629.9, 403.XX, 791.XX, 788.XX, and/or presence of Comorbidity of Renal Diseases)	6,478 (27)	135 (54)	**<0.001**	21,992 (47)	845 (66)	**<0.001**
Neurological Diseases (317.0-326, 330.0-337.9, 340-359.9, 392, 780.0-780.09, 780.2-780.4, 317-319, 290.XX, 294.XX, 781.0-782.0, and/or presence of Comorbidity of Paralysis or Other Neurological Disorders or Paralysis)	4,433 (19)	64 (26)	**0.004**	12,960 (28)	488 (38)	**<0.001**
Diseases of the Musculoskeletal System and Connective Tissue (274.XX, 710.0-739, and/or presence of Comorbidity of Rheumatoid Arthritis or Lupus)	5,368 (22)	28 (11)	**<0.001**	14,838 (32)	297 (23)	**<0.001**
Fluid and Electrolyte Disorders (275.0-276.9, 458.0-459.9, and/or presence of Comorbidity of Fluid and Electrolyte Disorders)	7,342 (31)	158 (63)	**<0.001**	16,132 (35)	761 (60)	**<0.001**
Neoplasms (140.0-239.9, V10.XX, and/or presence of Comorbidity of Lymphoma, Metastatic Diseases, or Tumor)	5,698 (24)	95 (38)	**<0.001**	16,150 (35)	374 (29)	**<0.001**
Platelet and White Blood Cell Diseases (204.0-208.92, 287.0-288.9, 238.71)	2,703 (11)	59 (24)	**<0.001**	4,135 (9)	175 (14)	**<0.001**
Psychiatric Diseases (293.XX, 295.0-302.9, 306.0-316, 780.1, V62.8, V15.4, and/or presence of Comorbidity of Psychoses)	5,599 (23)	44 (18)	**0.032**	7,198 (15)	178 (14)	0.170
Skin Diseases (680.0-709.9, 782.1-782.9)	1,479 (6)	35 (14)	**<0.001**	3,500 (8)	179 (14)	**<0.001**
Trauma, Burns and Poisoning (800-999)	1,419 (6)	73 (29)	**<0.001**	2,775 (6)	252 (20)	**<0.001**
Drug Abuse/Withdrawal/Dependence (292.0-292.9, 304.0-304.93, 305.2-305.93, and/or presence of Comorbidity of Drug Abuse)	1,324 (6)	7 (3)	0.060	224 (0.5)	4 (0.3)	0.400
Alcohol Abuse/Withdrawal/Dependence (291.0-291.9, 303.0-303.93, 305.0-305.03, and/or presence of Comorbidity of Alcohol Abuse)	3,655 (15)	59 (24)	**<0.001**	1,263 (3)	35 (3)	0.920
Tobacco Use (305.1)	7,461 (31)	58 (23)	**0.007**	8,659 (19)	178 (14)	**<0.001**
Long-Term Medications/Radiotherapy (V58.0-V58-2, V58.62, V58.64-V58.66, V58.68-V58.69)	2,814 (12)	24 (10)	0.300	7,346 (16)	123 (10)	**<0.001**
Social Factors (V60.0-V62.6, V63.0-V64.3, V15.81)	1,229 (5)	13 (5)	0.960	1,281 (3)	26 (2)	0.130
Sleep Disorders (327, 780.5, V69.4, V69.5)	1,686 (7)	14 (6)	0.380	2,525 (5)	39 (3)	**<0.001**
Lack of Physical Exercise (V69.0)	1 (0.0)	0 (0)	0.999	3 (0.0)	0 (0)	0.999
Inappropriate Diet and Eating Habits (V69.1)	0 (0)	0 (0)		0 (0)	0 (0)	
High Risk Lifestyle Behaviors (V69.2, V69.3)	1 (0.0)	0 (0)	0.999	0 (0)	0 (0)	
Body Mass Index of Less than 18.9 (V85.0)	128 (8)	5 (28)	**<0.001**	412 (19)	18 (35)	**0.003**
Body Mass Index of 19-24.9 (V85.1)	126 (8)	4 (22)		331 (15)	12 (24)	
Body Mass Index of 25.0-29.9 (V85.21-V85.25)	130 (8)	4 (22)		242 (11)	3 (6)	
Body Mass Index of 30.0 and over (V85.30-V85.45)	1,163 (75)	5 (28)		1,184 (55)	18 (35)	

Discussion

Hospital Length of Stay (HLOS)

Results from our study reflect a nonlinear relationship between HLOS and mortality, with a significant increase in mortality after day 3.The elevated mortality rates during days 1-2 may indicate higher disease acuity among emergently-admitted patients with the primary diagnosis of blood in stool, while the second rise in mortality after day 3 may reflect increased risk of nosocomial infections, exacerbated disease severity due to prolonged time to surgery, or acquired complications secondary to extended hospital stays. Nonlinear associations between HLOS and mortality have been previouslyreported in the literature[10–12]. A multicenter cohort study on heart failure patients between 2003 and 2012 found that the rate of mortality increased in a nonlinear fashion with respect to HLOS, with the highest mortality rates among patients with the longest HLOS[10]. Lingsma et al. also reported increased odds of mortality among heart failure patients who were in the upper quartile HLOS[7].

Previous studies have sought to discern factors associated with extended hospital length of stay. A Danish population-based study on patients with acute stroke reported an association between in-hospital medical complications and longer HLOS, with certain complications (ie. pneumonia) contributing to increased mortality[13]. Lanas et al. reported that lower GI complications were associated with higher mortality and longer HLOS than upper GI complications[14]. Additionally, Devani et al. found that among patients hospitalized with lower GI bleeding, early colonoscopy was associated with a 32% shorter HLOS compared to patients with late colonoscopy[15]. A separate retrospective study of 565 hospitalizations for lower GI hemorrhage similarly determined that earlier colonoscopy predicted earlier hospital discharge[16]. Further investigation is needed to better characterize which patient populations may optimally benefit from early diagnostic procedures such as colonoscopies, and whether the potential benefits of shortened HLOS outweigh the risks of complications for more medically frail individuals.

Bacterial Infections

Patients with non-Tuberculosis bacterial infections had 2.09 times greater odds of mortality as indicated in the backward logistic regression analysis. While the specific bacterial types were not delineated in our data, previous studies, including a retrospective cohort study in Spain, have found that multi-drug resistant organisms increase the risk of hospital in-mortality in patients with hospital acquired infections[17,18]. In this study, multi-drug resistant *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the primary contributors to increased mortality[17]. Similar findings have been reported elsewhere in the literature, with *P. aeruginosa* infections commonly implicated in increased length of hospital stay[19–22]. Vancomycin resistance has also been found to be independently associated with increased mortality among patients with enterococcal bacteremia[23]. Of note, Barrasa-Villar et al., postures that other comorbid factors, such as complicated diabetes, previous hospitalization or ICU stay, and polymicrobial infections, increase care needs of vulnerable patients, which ultimately results in longer hospital stay irrespective of infection by an antibiotic-sensitive or resistant microorganism[17]. Infection mitigation strategies are an ongoing area of investigation, with frequently cited tactics including hand hygiene monitoring and intervention strategies, improved equipment and surface disinfection, isolation of high-risk patients, and establishment of Antibiotic Stewardship Programs[24–28].

Sex and Age

Male sex was found to be associated with increased odds of mortality among patients emergently admitted with blood in stool. Consistent with this finding, Niikura et al. analyzed data from a nationwide database in Japan and found an association between in-hospital death from lower GI tract bleeding and male sex[29]. Another study conducted by Longstreth et al. found that the incidence of hospitalization for acute upper GI bleeding was twice as high in male patients as in female patients[30]. This association between male sex and mortality could, in part, be explained by the increased prevalence of coagulopathy, liver disease, lymphoma, pulmonary circulation disorders, renal failure, and solid tumors among males. Such comorbidities contribute to one's modified frailty index, which was found be associated with increased odds of mortality among the patients in this study. Longstreth et al. also found that peptic ulcer was the most common cause of upper GI bleed and was also more common among males than females[30].

Age was also a significant risk factor of mortality among the patient population in this study. Koziel et

al. reports a similarly increased mortality rate among elderly patients with gastrointestinal bleeding[31]. Such trends correspond to increased incidence of pathologies commonly resulting in GI bleeding, as well use of increased rates of comorbidities and polypharmacy. Diverticulosis coli is the most common etiology of GI bleeding, the incidence of which increases with age from approximately 5% among those at age 40 to 65% at age 85[32]. Lenti et al. also reports a high index of comorbidity to be associated with high odds of gastrointestinal bleeding in elderly patients[33]

Comorbidities

Comorbidities associated with higher risk of mortality were numerous – notably, cardiac diseases, respiratory diseases, liver diseases, fluid and electrolyte abnormalities, and trauma, burn, and poison history were all associated with a greater than two-fold increased mortality risk. Liver cirrhosis has been associated with GI tract pathologies, such as esophageal varices and portal hypertension, that can cause GI bleeding and anemia[34]. Barletta et al. also indicates acute or chronic liver disease as a risk factor for GI bleeding among patients with severe septic sepsis or septic shock[35]. Chronic hepatic disease can also lead to pulmonary circulation disorders and heart failure, which are other diseases subsumed under the respiratory and cardiac disease risk factor categories.

Previous studies have described associations between respiratory disease, GI bleeding, and mortality. Siddiqui et al. also found that in-hospital mortality rate was significantly higher in patients with acute respiratory distress syndrome (ARDS) complicated by gastrointestinal bleeds[36].Among the common etiologies listed in this study, ARDS secondary to aspiration pneumonia was associated with a 2.098 times higher likelihood of GI bleeding. Fluid and electrolyte abnormalities, another risk factor of mortality in this study, can occur in the setting of CKD. Toke et al. reports increased frequency of GI bleeding in patients with CKD, as well as an associated increase in mortality relative to the general population[37]. This bleeding tendency could be attributed to uremic platelet dysfunction, dialysis-associated heparin use, and use of antiplatelet and anticoagulation agents[38]. Upper GI bleeding can also occur secondary to stress ulcers among patients in the ICU, with excessive blood loss further increasing morbidity and mortality among such patients[39]. Severe burns and head trauma or multiple trauma are cited as risk factors for stress ulcers[39].

Certain medications taken by patients with one or more of the previously comorbidities may also underly the increased mortality. Schrutka et al. indicates that two thirds of patients with heart failure and preserved ejection fraction have a medical indication to take oral anticoagulants to protect against thromboembolism[40]. Anticoagulant medications and nonsteroidal anti-inflammatory drugs have a widely-documented association with gastrointestinal adverse effects due to damage of gastric and duodenal mucosa, resulting in lower GI bleeding and perforation[41]

Invasive Diagnostic Procedure and Surgery

Results from this study suggest that patients undergoing invasive diagnostic procedures and/or surgery were less likely to die than those who did not. These findings may support the utility of diagnostic and/or surgical procedures among emergently-admitted patients with blood in stool. A retrospective cohort study from 2005-2014 similarly indicated that invasive diagnostic procedure is a protective factor among elderly patients undergoing emergency admission for chronic duodenal ulcers[42]. Notably however, other studies have found that urgent colonoscopy, the most common diagnostic tool for lower GI bleeding, does not reduce mortality[43,44]. Thus, invasive diagnostic procedures may be associated with reduced mortality odds for certain patient populations, while not conferring protection from mortality for other populations. Levy et al. found that, while invasive diagnostic procedures were risk factors of mortality for patients with hemorrhoids requiring operation, among hemorrhoids patients not requiring surgery, invasive diagnostic procedures were associated with lower odds of mortality[45]. Among this latter cohort of patients who did not undergo surgery, prolonged hospital length of stay significantly increased the odds of mortality. Therefore, among patients not requiring surgery, prompt diagnostic procedures may be advantageous for inherently lowering mortality odds, as well as potentially mitigating the mortality risks associated with prolonged hospital stay.

The reduced odds of mortality among patients with surgery may suggest intrinsic benefits of undergoing operation, or they may reflect improved odds of survival among patients who are deemed medically stable enough to tolerate surgery. Regardless, this notable

finding warrants a discussion of the factors that may affect outcomes of surgery. Among patients with ventral hernias requiring emergency admission and surgery, male sex and delayed operation were shown to be risk factors of mortality for both elderly and non-elderly adults[46,47]. Delayed operation was determined to be associated with higher odds of mortality among emergently-admitted patients with pleural empyema, as well as patients with arterial embolism and thrombosis requiring emergency admission[48,49]. Advanced age is also associated with increased postoperative morbidity and mortality – among the elderly,risk factors such as complex surgery, certain preoperative comorbidities, frailty, and malnutrition have been described as additional indicators of poor postoperative outcomes[50,51]. Thus, surgery may improve odds of survival if delivered promptly but must also be weighed against risks of complications, infections, and prolonged hospital stay, especially for elderly patients. Further investigation into the role of surgery in mitigating mortality risk, as well as other variables that confer reduced odds of mortality with operation, is warranted.

Study Strengths

This study examined a large patient population of national scope across a variety of hospital types and geographic locations. Such an expansive dataset conferred enhanced generalizability and holistic assessment of risk factors of in-hospital mortality. The large sample size also enabled accurate statistical analysis.

Limitations

Data utilized for this study did not specify the etiology of blood in stool (upper vs. lower GI tract), severity of cases, history of prior bleeds, or medication status. Investigation of these characteristics in future studies is needed to better delineate risk factors for mortality and to better inform best practices in management of patients with upper vs lower GI bleed.

Conclusion

The odds of mortality were significantly increased in older, male patients and in patients with non-Tuberculosis bacterial infections,while mortality odds were decreased among patients who underwent invasive diagnostic procedures and/or surgery. Mortality risk was also increased among patients with certain comorbidities and/or a hospital length of stay beyond three days.

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Supplementary Table 1. Characteristics of emergency admitted patients with the primary diagnosis of blood in stool. Data was stratified according to invasive diagnostic status, NIS 2005-2014.

		Adult (18 – 64), N (%)			Elderly (65+), N (%)		
		No Invasive	Invasive	p	No Invasive	Invasive	p
All CaseS		7,465 (30.8%)	16,768 (69.2%)		18,520 (38.6%)	29,521 (61.4%)	
Sex, Female		3,247 (43.5%)	7,148 (42.6%)	0.2	10,800 (58.3%)	15,697 (53.2%)	<0.001
Race	White	4,053 (63.2%)	9,023 (62.8%)		12,670 (79.8%)	19,617 (76.7%)	
	Black	1,219 (19.0%)	2,892 (20.1%)		1,682 (10.6%)	3,035 (11.9%)	
	Hispanic	741 (11.6%)	1,514 (10.5%)		838 (5.3%)	1,676 (6.6%)	
	Asian/Pacific Islander	154 (2.4%)	436 (3.0%)		360 (2.3%)	581 (2.3%)	
	Native American	71 (1.1%)	118 (0.8%)		69 (0.4%)	123 (0.5%)	
	Other	172 (2.7%)	381 (2.7%)	0.004	262 (1.6%)	542 (2.1%)	<0.001
Income Quartile	Quartile 1	2,331 (32.2%)	5,045 (30.8%)		4,744 (26.1%)	7,398 (25.5%)	
	Quartile 2	1,955 (27.0%)	4,106 (25.1%)		4,996 (27.5%)	7,487 (25.8%)	
	Quartile 3	1,645 (22.7%)	4,009 (24.5%)		4,475 (24.6%)	7,649 (26.3%)	
	Quartile 4	1,316 (18.2%)	3,219 (19.7%)	<0.001	3,958 (21.8%)	6,512 (22.4%)	<0.001
Insurance	Private Insurance	2,851 (38.4%)	7,344 (43.9%)		1,122 (6.1%)	2,101 (7.1%)	
	Medicare	1,772 (23.8%)	3,605 (21.6%)		16,965 (91.7%)	26,651 (90.4%)	
	Medicaid	1,541 (20.7%)	2,856 (17.1%)		175 (0.9%)	346 (1.2%)	
	Self-Pay	824 (11.1%)	1,870 (11.2%)		77 (0.4%)	154 (0.5%)	
	No Charge	99 (1.3%)	207 (1.2%)		9 (0.0%)	9 (0.0%)	
	Other	344 (4.6%)	841 (5.0%)	<0.001	146 (0.8%)	233 (0.8%)	<0.001

		Adult (18 – 64), N (%)			Elderly (65+), N (%)		
		No Invasive	Invasive	p	No Invasive	Invasive	p
All CaseS		7,465 (30.8%)	16,768 (69.2%)		18,520 (38.6%)	29,521 (61.4%)	
Hospital Location	Rural	1,047 (14.0%)	1,283 (7.7%)		3,457 (18.7%)	3,212 (10.9%)	
	Urban: Non-Teaching	2,541 (34.0%)	6,018 (35.9%)		7,249 (39.1%)	12,217 (41.4%)	
	Urban: Teaching	3,877 (51.9%)	9,467 (56.5%)	**<0.001**	7,814 (42.2%)	14,092 (47.7%)	**<0.001**
Comorbidities	AIDS	78 (1.0%)	126 (0.8%)	**0.021**	5 (0.0%)	12 (0.0%)	0.44
	Alcohol Abuse	1,156 (15.5%)	2,562 (15.3%)	0.68	384 (2.1%)	915 (3.1%)	**<0.001**
	Deficiency Anemias	1,614 (21.6%)	4,100 (24.5%)	**<0.001**	4,620 (24.9%)	7,522 (25.5%)	0.19
	Rheumatoid Arthritis	223 (3.0%)	508 (3.0%)	0.86	617 (3.3%)	995 (3.4%)	0.82
	Chronic Blood Loss	825 (11.1%)	2,941 (17.5%)	**<0.001**	3,108 (16.8%)	5,699 (19.3%)	**<0.001**
	Congestive Heart Failure	669 (9.0%)	1,492 (8.9%)	0.87	5,048 (27.3%)	7,340 (24.9%)	**<0.001**
	Chronic Pulmonary Disease	1,351 (18.1%)	2,879 (17.2%)	0.08	4,452 (24.0%)	7,033 (23.8%)	0.59
	Coagulopathy	816 (10.9%)	1,589 (9.5%)	**<0.001**	1,338 (7.2%)	1,991 (6.7%)	**0.044**
	Depression	979 (13.1%)	2,152 (12.8%)	0.55	1,832 (9.9%)	2,676 (9.1%)	**0.002**
	Diabetes, Uncomplicated	1,427 (19.1%)	3,302 (19.7%)	0.3	4,520 (24.4%)	7,776 (26.3%)	**<0.001**
	Diabetes, Chronic Complications	308 (4.1%)	688 (4.1%)	0.93	783 (4.2%)	1,566 (5.3%)	**<0.001**
	Drug Abuse	435 (5.8%)	885 (5.3%)	0.08	55 (0.3%)	116 (0.4%)	0.09
	Hypertension	3,557 (47.6%)	8,238 (49.1%)	**0.033**	12,962 (70.0%)	21,416 (72.5%)	**<0.001**
	Hypothyroidism	525 (7.0%)	1,275 (7.6%)	0.12	3,216 (17.4%)	4,794 (16.2%)	**0.001**
	Liver Disease	1,271 (17.0%)	2,775 (16.5%)	0.36	658 (3.6%)	1,456 (4.9%)	**<0.001**
	Lymphoma	76 (1.0%)	110 (0.7%)	**0.003**	265 (1.4%)	350 (1.2%)	**0.02**
	Fluid/Electrolyte Disorders	1,816 (24.3%)	3,940 (23.5%)	0.16	5,460 (29.5%)	7,927 (26.9%)	**<0.001**
	Metastatic Cancer	359 (4.8%)	441 (2.6%)	**<0.001**	802 (4.3%)	777 (2.6%)	**<0.001**
	Other Neurological Disorders	523 (7.0%)	977 (5.8%)	**<0.001**	2,219 (12.0%)	2,362 (8.0%)	**<0.001**
	Obesity	836 (11.2%)	1,957 (11.7%)	0.29	934 (5.0%)	2,066 (7.0%)	**<0.001**
	Paralysis	194 (2.6%)	320 (1.9%)	**0.001**	504 (2.7%)	595 (2.0%)	**<0.001**
	Peripheral Vascular Disorders	320 (4.3%)	770 (4.6%)	0.29	1,974 (10.7%)	3,446 (11.7%)	**0.001**
	Psychoses	502 (6.7%)	842 (5.0%)	**<0.001**	398 (2.1%)	570 (1.9%)	0.1
	Pulmonary Circulation Disorders	193 (2.6%)	350 (2.1%)	**0.016**	878 (4.7%)	1,430 (4.8%)	0.61
	Renal Failure	861 (11.5%)	1,976 (11.8%)	0.58	4,303 (23.2%)	6,960 (23.6%)	0.39
	Solid Tumor	228 (3.1%)	336 (2.0%)	**<0.001**	804 (4.3%)	888 (3.0%)	**<0.001**
	Peptic Ulcer	1 (0.0%)	7 (0.0%)	0.26	0 (0%)	7 (0.0%)	**0.048**
	Valvular Disease	343 (4.6%)	838 (5.0%)	0.18	2,460 (13.3%)	4,121 (14.0%)	**0.036**
	Weight Loss	318 (4.3%)	747 (4.5%)	0.49	1,098 (5.9%)	1,418 (4.8%)	**<0.001**
Surgical Procedure		953 (12.8%)	2,696 (16.1%)	**<0.001**	1,739 (9.4%)	5,528 (18.7%)	**<0.001**
Deceased		158 (2.1%)	92 (0.5%)	**<0.001**	925 (5.0%)	348 (1.2%)	**<0.001**

	Adult (18 – 64), N (%)			Elderly (65+), N (%)		
	No Invasive	Invasive	p	No Invasive	Invasive	p
All CaseS	7,465 (30.8%)	16,768 (69.2%)		18,520 (38.6%)	29,521 (61.4%)	
	Mean (SD)	Mean (SD)	p	Mean (SD)	Mean (SD)	p
Age, Years	50.89 (10.87)	51.05 (10.66)	0.56	80.74 (8.28)	78.14 (7.65)	**<0.001**
Time to Surgical Procedure, Days	1.66 (2.44)	2.39 (2.31)	**<0.001**	2.13 (2.63)	2.64 (2.38)	**<0.001**
Hospital Length of Stay, Days	2.84 (3.34)	3.78 (3.52)	**<0.001**	3.64 (3.62)	4.47 (3.70)	**<0.001**
Total Charges, Dollars	19,936 (30,605)	29,204 (35,896)	**<0.001**	22,032 (51,282)	31,144 (36,453)	**<0.001**

Supplementary Table 2. Characteristics of emergency admitted patients with the primary diagnosis of blood in stool. Data was stratified according to surgical procedure, NIS 2005-2014.

Surgical Procedure (ICD 9 Code)	Adults, N (%)			Elderly, N (%)		
	Survived	Deceased	p	Survived	Deceased	p
Operations on Esophagus (42.01-42.19, 42.31-42.99)	274 (98.9%)	3 (1.1%)	0.77	394 (98.0%)	8 (2.0%)	0.41
Operations on Stomach (43.0-44.03, 44.21-44.99)	454 (98.1%)	9 (1.9%)	**0.05**	1,104 (97.6%)	27 (2.4%)	0.58
Operations on Intestine (45.00-45.03, 45.30-46.99)	2,284 (99.9%)	3 (0.1%)	**<0.001**	5,222 (98.8%)	63 (1.2%)	**<0.001**
Operations on Appendix (47.01-47.99)	8 (100%)	0 (0%)	0.999	9 (90.0%)	1 (10.0%)	0.24
Operations on Rectum, Rectosigmoid, and Perirectal Tissue (48.0-48.1, 48.31-48.99)	475 (99.4%)	3 (0.6%)	0.5	829 (99.2%)	7 (0.8%)	**0.001**
Operations on Anus (49.01-49.12, 49.31-49.99)	32 (100%)	0 (0%)	0.999	46 (100%)	0 (0%)	0.64
Operations on Liver (50.0, 50.21-50.99)	4 (80.0%)	1 (20.0%)	0.051	2 (100%)	0 (0%)	0.999
Operations on Gallbladder and Biliary Tract (51.01-51.04, 51.21-51.99)	34 (97.1%)	1 (2.9%)	0.31	56 (100%)	0 (0%)	0.41
Operations on Pancreas (52.01-52.09, 52.21-52.99)	4 (100%)	0 (0%)	0.999	4 (100%)	0 (0%)	0.999
Operations on Hernia (53.00-53.9)	13 (100%)	0 (0%)	0.999	23 (95.8%)	1 (4.2%)	0.48
Operations on Other Operations on Abdominal Region (54.0-54.19, 54.3-54.99)	469 (95.7%)	21 (4.3%)	**<0.001**	307 (91.6%)	28 (8.4%)	**<0.001**

Invasive Diagnostic Procedure (ICD 9), N (%)	Survived	Deceased	p	Survived	Deceased	p
Invasive Diagnostic Procedure on Esophagus (42.21-42.29)	26 (100%)	0 (0%)	0.999	51 (98.1%)	1 (1.9%)	0.999
Invasive Diagnostic Procedure on Stomach (44.11-44.19)	53 (96.4%)	2 (3.6%)	0.11	91 (97.8%)	2 (2.2%)	0.999
Invasive Diagnostic Procedure on Intestine (45.11-45.29)	16,472 (99.5%)	91 (0.5%)	**<0.001**	28,829 (98.8%)	337 (1.2%)	**<0.001**
Invasive Diagnostic Procedure on Rectum, Rectosigmoid, and Perirectal Tissue (48.21-48.29)	449 (100%)	0 (0%)	**0.016**	659 (98.7%)	9 (1.3%)	**0.035**
Invasive Diagnostic Procedure on Anus (49.21-49.29)	54 (100%)	0 (0%)	0.999	101 (97.1%)	3 (2.9%)	0.88
Invasive Diagnostic Procedure on Liver (50.11-50.19)	40 (100%)	0 (0%)	0.999	53 (98.1%)	1 (1.9%)	0.999
Invasive Diagnostic Procedure on Gallbladder and Biliary Tract (51.10-51.19)	13 (100%)	0 (0%)	0.999	20 (95.2%)	1 (4.8%)	0.43
Invasive Diagnostic Procedure on Pancreas (52.11-52.19)	6 (100%)	0 (0%)	0.999	10 (90.9%)	1 (9.1%)	0.26
Invasive Diagnostic Procedure on Other Operations on Abdominal Region (54.21-54.29)	16 (100%)	0 (0%)	0.999	15 (88.2%)	2 (11.8%)	0.07[DS73]