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Risk Factors for Mortality in Lower Intestinal Bleeding

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Abstract

Background and Aims—Previous studies of Lower Intestinal Bleeding (LIB) have limited power to study mortality. We sought to identify characteristics associated with in-hospital mortality in a large cohort of patients with LIB.

Methods—We used the 2002 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) to study a cross-sectional cohort of 227,022 hospitalized patients with discharge diagnoses indicating LIB. Predictors of mortality were identified using multiple logistic regression.

Results—In 2002, an estimated 8,737 patients with LIB (3.9%) died while hospitalized. Independent predictors of in-hospital mortality were age (age >70 vs. <50, odds ratio (OR) 4.91; 95% CI 2.45–9.87), intestinal ischemia (OR 3.47; 95% CI 2.57–4.68), comorbid illness (≥ 2 vs. 0 comorbidities, OR 3.00; 95% CI 2.25–3.98), bleeding while hospitalized for a separate process (OR 2.35; 95% CI 1.81–3.04), coagulation defects (OR 2.34; 95% CI 1.50–3.65), hypovolemia (OR 2.22; 95% CI 1.69–2.90), transfusion of packed red blood cells (OR 1.60; 95% CI 1.23–2.08), and male gender (OR 1.52; 95% CI 1.21–1.92). Colorectal polyps (OR 0.26, 95% CI 0.15–0.45), and hemorrhoids (OR 0.42; 95% CI 0.28–0.64) were associated with a lower risk of mortality, as was diagnostic testing for LIB when added to the multivariate model (OR 0.37, 95% CI 0.28–0.48; $p < 0.001$). Hospital characteristics were not significantly related to mortality. Predictors of mortality were similar in an analysis restricted to patients with diverticular bleeding.

Conclusions—The all-cause in-hospital mortality rate in LIB is low (3.9%). Advanced age, intestinal ischemia and comorbid illness were the strongest predictors of mortality.

INTRODUCTION

Lower intestinal bleeding (LIB), is a common indication for admission to the hospital, but has received comparatively little attention in the literature. The relatively small size of existing studies has limited the ability to study rare outcomes of LIB, including in-hospital mortality. In-hospital mortality in the literature ranges from 1% to 25%.^{1–9} The highest in-hospital

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mortality rates are observed in studies of select patients in which a large proportion undergo emergency surgery.^{2, 5} Recent and more generalizable studies suggest that in-hospital death in patients with LIB is uncommon.^{1, 3, 4, 6–10} Most deaths in LIB are thought to be the result of comorbid conditions or nosocomial complications rather than severe bleeding.⁶ Patients who begin bleeding while hospitalized for another condition also appear to have a higher risk of death compared to those who are admitted with LIB.⁶ However, prior studies have lacked the power to identify multiple independent predictors of mortality, or have utilized combined adverse outcome measures including death and bleeding severity.

The aims of this study were to analyze a nationally representative sample to describe the characteristics of patients hospitalized with LIB in the United States, estimate the in-hospital mortality rate in LIB, and identify patient and hospital characteristics associated with in-hospital mortality in LIB.

MATERIALS and METHODS

Study Design

This was a cross-sectional retrospective cohort study of adult patients hospitalized with LIB at non-federal acute-care hospitals in the United States during the year 2002. The study was determined to be minimal risk in accordance with the Health Insurance Portability and Accountability Act guidelines (45 CFR46.110) and received approval by the institutional review boards at Brigham and Women's Hospital and the University of Washington.

Data Source

We used data from the 2002 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS), sponsored by the Agency for Healthcare Research and Quality (AHRQ).¹¹ The NIS is the largest all-payer inpatient database in the United States. The NIS has been used widely for outcomes and epidemiologic studies across a spectrum of diseases and medical disciplines.^{12–15} The NIS is a stratified probability sample designed to represent all U.S. non-federal acute-care hospitals. Hospitals are stratified according to the following characteristics: geographic region, ownership, location (urban vs rural), teaching status, and bed size. Sampling probabilities are then calculated to select 20% of all hospitals within each stratum. In 2002, the NIS included 995 hospitals in 35 states (20.6% of all U.S. hospitals).

The NIS contains patient-level information available in a standard hospital discharge abstract. Up to fifteen discharge and procedure diagnoses (principal and secondary) were available per patient, designated by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Hospital-level characteristics were also available. Data were collected on all discharges from each participating hospital. Not all data elements were uniformly available across states. Eleven of the 35 states in the 2002 NIS did not report patient race, but reported other patient demographics.¹¹

Study Patients

The International Classification of Diseases (ICD) lacks a single, general code indicative of LIB. Therefore, we developed an algorithm to identify patients with LIB using principal and secondary diagnosis codes indicating a specific or potential source of LIB. (The principal diagnosis is the diagnosis determined at discharge to be responsible for the hospital admission). Patients with a principal or secondary diagnosis specific for LIB were included in the study population unless they met the exclusion criteria listed below. The following specific discharge codes for lower intestinal bleeding were included: diverticulosis or diverticulitis of the colon with hemorrhage (ICD-9 codes 562.12, 562.13), angiodysplasia of the intestine with

hemorrhage (569.85), hemorrhage of the rectum and anus (569.3) and internal, external or unspecified hemorrhoids with bleeding (455.2, 455.5, 455.8).

Patients with discharge codes indicative of a potential source of lower intestinal bleeding required a concomitant code of either hemorrhage of the gastrointestinal tract site unspecified (578.9), or acute hemorrhagic anemia (285.1) to be included in the study population. Discharge codes indicating a possible source of lower intestinal bleeding included: Malignant neoplasm of the colon, rectum, rectosigmoid junction or anus (152 to 154, and 230), benign neoplasm of colon or rectum (211.3, 211.4), inflammatory bowel disease (regional enteritis and ulcerative colitis; 555 to 556), infectious enterocolitis (009.0–009.3), noninfectious colitis including radiation enteritis (558), ulceration of the intestine/colon (569.82), vascular injury of the intestine (557), angiodysplasia of the intestine without mention of hemorrhage (569.84), gastrointestinal vessel anomaly (747.61), solitary rectal ulcer syndrome (569.41), and anal fissure (565.0).

Patients with discharge codes reflecting chronic anemia (280.0), occult blood positive stools (792.1), melena (578.1), hematemesis (578.2), or specific or potential sources of upper gastrointestinal bleeding or small intestinal bleeding (see Appendix Table 1 for diagnoses and ICD-9 codes) were excluded. In addition, procedure codes indicating endoscopic or surgical treatment of an upper gastrointestinal or small intestinal source (Appendix Table 1) were reason for exclusion. The analysis was limited to patients 18 years of age or older.

Study Variables

Explanatory variables included patient sociodemographic information (age, gender, race, median household income in zip code of residence, and type of insurance), and bleeding diagnosis. A variable was created for missing values of race. The Deyo adaptation of the Charlson Comorbidity Index for administrative data was used to assess the burden of comorbid illness using ICD-9 discharge codes.¹⁶ Other variables of interest included transfusion(s) of packed red cells (ICD-9-CM 99.04), coagulation defects (V58.61, 286, 790.92), hypovolemia (276.5), admission on a weekend, type of admission (emergent/urgent vs. elective), and a principal versus secondary diagnosis of LIB. We also collected data on receipt of lower endoscopy (45.22–45.27, 45.42, 45.43), anoscopy (49.21, 499.5, 49.4), arteriography (88.47), tagged red blood cell scan (92.19), and surgeries that may be performed for control of LIB, such as colectomy and colostomy (45.41, 45.90–45.95, 45.70, 45.80, 45.03, 45.72–45.79, 46.10, 46.11–46.14, 46.20–46.24, 48.71, 49.71).

Hospital characteristics of interest included teaching status (teaching/non-teaching), location (urban/rural), ownership (government/private), region (Northeast/Midwest/South/West), and number of beds (small/medium/large). The number of beds in each bed size category varied by region and teaching status. For example, rural hospitals designated as small in size tended to have fewer beds than urban, teaching hospitals designated as small in size.

Statistical Analysis

Analyses were performed using SAS, Version 9.1 (SAS Institute, Cary, NC) and SAS-callable SUDAAN, Version 9.0 (Research Triangle Institute, Research Triangle Park, NC). SUDAAN procedures account for complex sampling design (stratification and clustering) and produce unbiased variance estimates and p values. A pre-specified 20% random sub-sample of the 2002 NIS database was used because this random sample was sufficient for the main analyses, and the full NIS database would have required much greater computing resources. The NIS includes sample weights which were developed to enable nationwide estimates. The sample weight is the inverse of the probability of selection within each stratum.

The main outcome of interest was all-cause in-hospital mortality, or death before hospital discharge. Mortality data were missing for 21 discharge records, and these records were excluded from the analysis. The volume of discharges for lower intestinal bleeding in 2002 was calculated for each hospital using unique hospital identification numbers. Hospital volume was analyzed as a continuous variable. In addition, hospitals were grouped into three approximately equal sized categories: low volume (<15 discharges for LIB), moderate volume (15–31 discharges for LIB), and high volume (>31 discharges for LIB).

Weighted univariate analyses were performed using χ^2 tests or logistic regression. Multivariable logistic regression was used to elucidate independent predictors of in-hospital mortality. Age and comorbid illness were included in all models. Other variables with a univariate significance of $p < 0.05$ were entered into the multivariable model, and those maintaining a significance of $p < 0.01$ were retained in the final model. This lower threshold of significance was utilized due to the large size of the study population. To assess the impact of hospital-level characteristics and hospital volume, these variables were added individually to the final multivariable model. Univariate predictors not included in the model were reevaluated as potential confounders, defined as a 10% or greater change in the coefficients of at least two variables in the model.

Separate univariate and multivariable analyses were performed using only patients with a discharge diagnosis of diverticular bleeding. Diverticular bleeding is the most common source of LIB (representing 20–55% of all cases of LIB),^{6, 10} has diagnostic codes specific for bleeding, and results in acute, not chronic or occult blood loss.¹⁷

In addition, we also compared patients who underwent a diagnostic test to those who did not. Diagnostic tests included lower endoscopy, anoscopy, tagged red blood cell scan or arteriography. We also added receipt of a diagnostic test to the final multivariable model of mortality.

RESULTS

Among 1,570,796 discharges in the 20% sample of the 2002 NIS database, 9,391 adult patients were discharged with a diagnosis consistent with LIB. This cohort corresponded to a weighted national estimate of 227,022 discharges for LIB in the United States in the year 2002. Subsequent reported results present the weighted national estimates.

Table 1 summarizes the baseline demographics of all patients discharged with LIB. The mean age of adult patients discharged with LIB was 69.4 years (interquartile range 58.8–81.2 years). Most patients were female (56.2%). Of patients with known race, 75.0% were white. Fifty-nine percent had at least one comorbid condition.¹⁶ The median hospital length of stay was 3.5 days (interquartile range 1.8 to 6.9 days).

Diverticular bleeding was the most common source of LIB (33.1%), followed by hemorrhoids (20.0%), colorectal polyps (13.1%), colorectal cancer (8.2%), intestinal ischemia (6.6%), and angiodysplasia (6.0%) (Table 2). A total of 179,728 patients (79.2%) had either a principal or secondary discharge diagnosis specific for LIB (bleeding diverticula, hemorrhoids, angiodysplasia or rectum/anus). The principal diagnosis was specific for LIB in 44.6%. The remaining 47,294 patients had a potential lower gastrointestinal source as well as a diagnosis of nonspecific gastrointestinal hemorrhage (58.7%) and/or acute hemorrhagic anemia (51.2%).

The majority of patients with LIB were treated at urban hospitals (83.2%) and in hospitals with a large number of beds (62.3%). A total of 38.6% of discharges for LIB were from teaching hospitals. Hospitals with a large number of beds, and urban and teaching hospitals tended to have a high volume of LIB.

A total of 121,393 (53.5%) patients had at least one diagnostic test for LIB. Colonoscopy was performed in 46.3% of patients with LIB, anoscopy in 4.4%, flexible sigmoidoscopy in 4.0%, arteriography in 1.3% and tagged red blood cell scans in 0.48%. Patients in urban hospitals (54.5% vs 48.3%, $p < 0.001$) and hospitals with a higher volume of LIB (high 53.9%, medium 56.2% vs low 49.9%, $p < 0.001$) were more likely to have diagnostic tests, but hospital bedsize was not associated with diagnostic testing. Patients with a diagnostic test had significantly fewer comorbid illnesses (comorbidity score ≥ 2 , 27.7% vs 39.2%, $p < 0.001$); and were less likely to have hypovolemia (7.8% vs 11.8%, $p < 0.001$), coagulopathy (3.0% vs 4.0%, $p = 0.01$), and a secondary diagnosis of bleeding (42.8% vs 65.0%, $p < 0.001$) than those without a diagnostic test.

In-hospital Mortality

The all-cause in-hospital mortality in patients discharged with LIB was 3.9%, accounting for an estimated 8,737 in-hospital deaths nationwide in 2002. A total of 11.9% of deaths occurred on hospital day 1, 23.3% on days 2–5, 21.4% on days 6–10, and 43.4% on day 11 or later. In the univariate analysis, patients who died were significantly older than patients who survived (mean age 75.5 years vs. 69.1 years, $p < 0.001$). Men with LIB were significantly more likely to die while in the hospital than women (4.5% vs 3.4%, $p = 0.01$). In-hospital mortality also increased with the burden of comorbid illness (7.1% for patients with a comorbid score ≥ 2 vs. 1.7% for those with no comorbidities, $p < 0.001$). Patients with coagulation defects or on chronic anticoagulants were at a significantly increased risk of in-hospital mortality (9.7% vs. 3.6%, $p = 0.001$), as were those with hypovolemia (9.0% vs. 3.3%, $p < 0.001$). Patients with a secondary diagnosis of bleeding (bleeding was not determined at discharge to be the indication for hospital admission) also had significantly higher in-hospital mortality when compared to those with a principal diagnosis of LIB (5.8% vs. 1.8%, $p < 0.001$). Patients with Medicare as the primary payer were more likely to die than those with other types of insurance (4.3% vs. 2.9%, $p = 0.001$). Race, median household income, weekend admission, and type of admission were not predictive of mortality in the univariate analysis.

In the unadjusted analysis, there was marked variation in in-hospital mortality across the spectrum of bleeding diagnoses. For example, patients with intestinal ischemia had a mortality rate of 13.4% compared to no deaths observed in patients with anal fissures. Hospital characteristics including hospital volume, number of beds, teaching status, and location were not significantly related to in-hospital mortality in the univariate analysis.

In-hospital mortality was lower in patients with a diagnostic test than in patients without a diagnostic test (1.8% vs 6.2%, $p < 0.001$). Nevertheless, in patients with and without a diagnostic test, the univariate predictors of mortality were similar to those in the overall cohort.

In the multivariable analysis of the overall cohort, advanced age was the strongest independent predictor of in-hospital mortality (Table 3). Comorbidity score was also strongly associated with in-hospital death, as were coagulopathy, hypovolemia and transfusion of packed red blood cells. Patients with a secondary diagnosis of bleeding were significantly more likely to die while in the hospital, suggesting that bleeding that occurs after hospitalization for another disease process portends a poorer prognosis. The increased risk of in-hospital mortality in men compared to women persisted in the multivariable analysis. Intestinal ischemia was the only bleeding diagnosis associated with increased in-hospital mortality. Diagnoses of hemorrhoids and colorectal polyps were associated with decreased odds of in-hospital mortality. Insurance payer, as well as inflammatory bowel disease, angiodysplasia, colorectal cancer, noninfectious colitis, and colon ulcer were not statistically significant predictors in the adjusted analysis. None of the hospital characteristics was significantly associated with in-hospital mortality when added to the final multivariable model.

Diagnostic testing was associated with a lower risk of in-hospital mortality when added to the other independent predictors of mortality (adjusted OR 0.37, 95% CI 0.28–0.48; $p<0.001$). When adjusted for diagnostic testing, the other associations with mortality remained essentially unchanged.

The multivariable model for patients with a diagnosis of diverticular bleeding was similar to the model for the entire cohort (Table 4). The factors in the full model that were not significant in the model of patients with diverticular bleeding alone (aside from other bleeding diagnoses) were age (although the magnitude of the odds ratios were similar and the trend was significant) gender and coagulopathy.

DISCUSSION

This study provides a distinctive national perspective on LIB. The large patient population enabled us to estimate the mortality associated with LIB, and to identify multiple adjusted predictors of in-hospital death. An estimated 3.9% of patients with a discharge diagnosis consistent with LIB died while hospitalized in 2002. Factors associated with significantly increased in-hospital mortality were advanced age, intestinal ischemia, comorbid illness, onset of bleeding after hospitalization for a separate disease process (secondary bleeding), coagulopathy, hypovolemia, transfusion(s) of packed red blood cells, and male gender. Patients diagnosed with hemorrhoids, colorectal polyps, and anal fissures were at a decreased risk of in-hospital mortality.

Most prior studies of LIB have assessed relatively small cohorts from individual academic centers, often focusing on specific diagnoses or severely bleeding patients. For these reasons, mortality estimates for LIB have ranged broadly, and predictors of in-hospital mortality have been difficult to define. Longstreth studied the epidemiology of LIB in a cohort of 219 patients.⁶ In this population-based study, the in-hospital mortality was 3.6%, almost identical to what we found; however this estimate was based on only 8 in-hospital deaths. Das and colleagues developed both multiple logistic regression models and artificial neural networks to predict in-hospital mortality, recurrent bleeding and intervention for bleeding control in patients with LIB,⁴ and again, the ability to accurately identify predictors of in-hospital mortality was limited by the small numbers of deaths: 4 (3%) in the training group and 4 (6%) and 8 (6%) in the validation groups. When Velayos et al. analyzed predictors of adverse in-hospital outcome in LIB other than severe bleeding, only 3 patients (3%) died;¹⁸ ongoing or recurrent bleeding was the only independent predictor of adverse outcome.

Our findings emphasize the importance of underlying health status in determining outcomes of LIB. We found that age, burden of comorbid illness, and bleeding after admission for a separate process were strong and consistent predictors of in-hospital mortality. In addition, intestinal ischemia was strongly related to in-hospital mortality in all analyses, presumably due to underlying atherosclerosis and/or precipitating hypotensive episodes as well as subsequent bowel infarction and acidosis. Indeed, intestinal ischemia was significantly associated with a secondary diagnosis of bleeding ($p<0.001$). In contrast, diverticular bleeding, a common source of severe bleeding that is not necessarily associated with systemic illness, was not associated with the risk of mortality. Nevertheless, hypovolemia, anticoagulation, and the need for blood transfusion were also independent predictors suggesting that bleeding severity is also important.

Male gender was a significant predictor of in-hospital mortality in this study. Male gender was also associated with poor outcomes in a study of LIB by Das and colleagues.⁴ In our study, comorbid illness may partially explain the higher mortality in men compared to women (mean comorbidity score 2.6 vs. 2.3, $p<0.001$). However, men tended to be younger than women

(mean age 67.3 vs. 70.9 years, $p<0.001$), and were less likely to have intestinal ischemia (5.1% vs. 7.7%, $p<0.001$). Men underwent more diagnostic tests than women (55.2% versus 52.2%, $p=0.01$), suggesting that underutilization of therapeutic procedures did not play a role.

We found that patients undergoing diagnostic tests were less likely to die than those who did not. These patients were presumably more likely to have had a confirmed source of LIB, and the lower mortality in this subgroup may reflect the low mortality in LIB compared to other disorders. Patients with a diagnostic test were also on average healthier than patients without diagnostic testing (lower comorbidity scores, rates of hypovolemia, coagulopathy and secondary bleeding). The lower mortality in patients undergoing diagnostic testing could also reflect a therapeutic and/or diagnostic benefit of these interventions. Receipt of endoscopic bleeding control was uncommon (302 patients), and was not a significant predictor when added to the model (adjusted HR 0.67, 95% CI 0.31–1.44, $p=0.30$). However, the lack of statistical significance may reflect a Type 2 error related to an inadequate number of patients with endoscopic hemostasis.

We found no significant differences in mortality according to hospital characteristics. Hospital characteristics have influenced outcomes including death in a variety of other conditions, particularly those that involve complex procedural interventions,^{12, 14} although a large study of academic versus community hospitals found no differences in mortality with upper gastrointestinal bleeding.¹⁹ The lack of influence of hospital characteristics on mortality in LIB may indicate that interventions to control LIB do not reduce mortality in the majority of patients, as bleeding stops spontaneously in 80% of cases.⁷

The primary strengths of this study relate to the large, nationally representative patient population of more than 9,000 patients with LIB (representing an estimated 227,022 patients nationwide) across a wide spectrum of hospitals and geographic locations. This scope enabled the analysis and identification of multiple predictors of in-hospital mortality including hospital characteristics. Thus, our results are likely to be generalizable across a range of locations and practice settings, except federal hospitals which are not included in the NIS database.

This study also has several limitations. NIS data lack the clinical detail available in other study designs. Such data are useful for denoting the severity of underlying disease including bleeding, and for confirming the presence of LIB and the cause of death. Nonetheless, the c-statistic for the logistic model of mortality was 0.80, suggesting that our analysis discriminated effectively between patients who survived and those who died. The reliance on ICD-9 codes to identify patients with LIB is challenging because many potential sources lack codes that specifically indicate bleeding,^{6, 20} and our estimate of the number of patients discharged with LIB is likely to be upwardly biased. Although our case identification algorithm attempted to exclude individuals with chronic or occult bleeding, upper gastrointestinal bleeding, or conditions associated with bleeding in the absence of bleeding, patients with these diagnoses may have been included in our cohort. Likewise, inaccuracies in coding may have led to inclusion of patients without LIB. In support of our patient identification algorithm, the breakdown of sources of bleeding in the current study is very similar to those reported in the recent literature.^{6, 9, 10, 20} In addition, we performed a secondary analysis in patients with diverticular bleeding and found similar results.

In this large, nationwide study we found that the all-cause in-hospital mortality rate in LIB is low (3.9%). The mortality rate of 1.8% in patients undergoing a diagnostic test suggests that the actual mortality rate in LIB may be even lower. Increasing age and comorbid illness, intestinal ischemia, bleeding after admission for another disorder, coagulopathy and hypovolemia were the strongest predictors of in-hospital mortality. These findings suggest that aggressive supportive care and management of comorbid conditions are more likely to improve

in-hospital mortality rates in LIB than early, potentially therapeutic interventions. Because in-hospital deaths are uncommon in LIB, efforts focused on improving other in-hospital outcomes and preventing recurrent events in the patients who survive will likely have the greatest impact.

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Table 1

Characteristics of Patients Discharged with Acute Lower Intestinal Bleeding in the 2002 Nationwide Inpatient Sample^a

Characteristic	Weighted Number	Weighted %	Unadjusted In-hospital Mortality (%)
Total number of subjects	227,022	100	3.9
Age			
< 50 yrs	32,230	14.2	0.7
50–70 yrs	60,369	26.6	3.6
> 70 yrs	134,423	59.2	4.7
Female gender	127,626	56.2	3.4
Race/ethnicity			
White	124,864	55.0	4.0
Black	23,397	10.3	5.0
Hispanic	11,274	5.0	2.6
Asian	3,666	1.6	4.2
Other	3,191	1.4	2.5
Missing race	60,602	26.7	3.5
Primary payment source			
Medicare	153,769	67.7	4.3
Private	51,236	22.6	2.8
Medicaid	12,182	5.4	2.7
Other	9,713	4.3	3.4
Comorbidity score ^b			
0	93,388	41.1	1.7
1–2	58,586	25.8	3.1
≥ 2	75,049	33.1	7.1
Transfusion of packed red blood cells	47,501	20.9	6.1

^a All numbers and percentages are weighted to provide nationwide estimates.

^b Deyo adaptation of the Charlson Comorbidity Score for use with administrative data ¹⁶.

Table 2

Bleeding Diagnoses in Patients Discharged with Acute Lower Intestinal Bleeding in the 2002 Nationwide Inpatient Sample ^a

Bleeding diagnosis	Weighted Number*	Weighted %*	Unadjusted In-hospital mortality (%)
Diverticular bleeding	75,050	33.1	2.5
Hemorrhoids	45,386	20.0	1.3
Colorectal polyps	29,636	13.1	1.1
Colorectal cancer	18,640	8.2	6.2
Intestinal ischemia	14,920	6.6	13.4
Angiodysplasia	13,712	6.0	2.6
Noninfectious colitis	11,060	4.9	1.8
Inflammatory bowel disease	10,010	4.4	2.2
Colon ulcer	3,661	1.6	1.4
Solitary rectal ulcer syndrome	3,238	1.4	4.0
Anal fissure	2,181	1.0	0
Infectious colitis	1,552	0.7	2.1
Radiation enteritis	915	0.4	5.6

^a All numbers and percentages are weighted to provide nationwide estimates.

Patients could have more than one discharge code consistent with bleeding or a potential source of bleeding. Therefore, totals do not equal 100%.

Table 3
Multivariable Analysis of Factors Associated with In-Hospital Mortality in Lower Intestinal Bleeding^a

Characteristic	Adjusted OR (95% CI)	p Value
Age		
< 50 yrs	1.00	Reference group
50–70 yrs	3.67 (1.78 – 7.53)	<0.001
> 70 yrs	4.91 (2.45 – 9.87)	<0.001
Intestinal ischemia	3.47 (2.57 – 4.68)	<0.001
Comorbidity score ^b		
0	1.00	Reference group
1	1.43 (1.02 – 2.00)	0.04
≥2	3.00 (2.25 – 3.98)	<0.001
Secondary diagnosis of bleeding ^c	2.35 (1.81 – 3.04)	<0.001
Coagulopathy	2.34 (1.50 – 3.65)	<0.001
Hypovolemia	2.22 (1.69 – 2.90)	<0.001
Transfusion of packed red blood cells	1.60 (1.23 – 2.08)	<0.001
Male gender	1.52 (1.21 – 1.92)	<0.001
Colorectal polyp	0.26 (0.15 – 0.45)	<0.001
Hemorrhoids	0.42 (0.28 – 0.64)	<0.001

^a Logistic regression model adjusted for all listed variables.

^b Deyo adaptation of the Charlson Comorbidity Score for use with administrative data ¹⁶.

^c Bleeding was not determined at discharge to be the indication for hospital admission

Table 4
Multivariable Analysis of Factors Associated with In-Hospital Mortality in Patients with a Discharge Diagnosis of Diverticular Bleeding^a

Characteristic	Adjusted OR (95% CI)	p Value
Age		
< 50 yrs	1.0	Reference group
50–70 yrs	1.61 (0.20 – 12.93)	0.65
> 70 yrs	3.37 (0.45 – 25.0)	0.24
Comorbidity score ^b		
0	1.0	Reference group
1	1.69 (1.01 – 2.83)	0.04
≥2	3.11 (1.92 – 5.03)	<0.001
Hypovolemia	2.54 (1.58 – 4.09)	<0.001
Secondary diagnosis of bleeding ^c	2.10 (1.39 – 3.17)	<0.001
Transfusion of packed red blood cells	1.72 (1.15 – 2.58)	0.009

^aLogistic regression model adjusted for all variables listed.

^bDeyo adaptation of the Charlson Comorbidity Score for use with administrative data ¹⁶.

^cBleeding was not determined at discharge to be the indication for hospital admission

APPENDIX Table 1

Diagnoses and corresponding ICD-9 codes used to exclude patients with potential upper gastrointestinal bleeding or chronic blood loss

Diagnosis	ICD-9 Code
Chronic anemia	280.0
Occult blood positive stools	792.1
Melena	578.1
Hematemesis	578.2
Esophageal varices with hemorrhage	456.0, 456.20
Esophagitis	530.1
Esophageal ulcer	530.2
Mallory-Weiss tear	530.7
Esophageal hemorrhage unspecified	530.82
Gastric ulcer, acute with hemorrhage ± perforation	531.0, 531.2
Gastric ulcer, chronic or unspecified with hemorrhage ± perforation	531.4, 531.6
Duodenal ulcer, acute with hemorrhage ± perforation	532.0, 532.2
Duodenal ulcer, chronic or unspecified with hemorrhage ± perforation	532.4, 532.6
Peptic ulcer, acute with hemorrhage ± perforation	533.0, 533.2
Peptic ulcer, chronic or unspecified with hemorrhage ± perforation	533.4, 533.6
Gastrojejunal ulcer, acute with hemorrhage ± perforation	534.0, 534.2
Gastrojejunal ulcer, chronic or unspecified with Hemorrhage ± perforation	534.4, 534.6
Gastritis and duodenitis	535
Angiodysplasia of the stomach or duodenum with hemorrhage	537.83
Diverticulosis or diverticulitis of the small intestine with hemorrhage	562.02, 562.03
Small intestinal cancer	152
Procedure	ICD-9 code
Endoscopic control of esophageal bleeding	42.33
Suture of laceration of the esophagus	42.82
Surgical ligation of esophageal varices	42.91
Endoscopic ligation of esophageal varices	43.41
Partial gastrectomy	43.5, 43.6, 43.7, 43.8
Vagotomy	44.0
Pyloroplasty	44.2
Suture of gastric or duodenal ulcer for bleeding control	44.40, 44.41, 44.42
Endoscopic control of gastric or duodenal bleeding	44.43
Transcatheter embolization of gastric or duodenal ulcer	44.44
Other control of hemorrhage of stomach or duodenum	44.49
Suture of laceration of the stomach	44.61
Surgical ligation of gastric varices	44.91
Insertion of Sengstaken tube/esophageal tamponade	96.06