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The impact of inter-hospital transfer on outcomes in lower gastrointestinal bleeding: a retrospective cohort analysis

Ali Jaan[1†], Zouina Sarfraz[2*†], Adeena Maryyum[3], Umer Farooq[4], Muhammad Farhan Ashraf[5], Fatima Warraich[5], Mark S. Mcfarland[5], Jason Gutman[5] and Karin Dunnigan[5]

Abstract

Background This study investigates the role of interhospital transfer (IHT) in lower gastrointestinal bleeding (LGIB) management and its impact on patient outcomes, focusing on mortality rates, complication occurrences, procedural performance, and resource utilization in patients diagnosed with LGIB.

Methods This retrospective cohort study used data from the National Inpatient Sample database from 2017 to 2020. It included adult patients diagnosed with LGIB, assessing the impact of IHT on outcomes such as mortality, complication rates, procedural performance, and resource utilization. Adjusted odds ratios (AOR) and adjusted mean differences (AMD) were used to evaluate these impacts.

Results A total of 393,495 LGIB patients were analyzed, with 31,565 (8.02%) undergoing interhospital transfer. Transferred patients exhibited significantly higher inpatient mortality (AOR 1.96, $P < 0.01$). They also faced increased risks of acute kidney injury (AOR 1.32, $P < 0.01$), septic shock (AOR 2.11, $P < 0.01$), and intensive care unit admission (AOR: 2.61, $P < 0.01$). These patients were more likely to undergo interventional radiology-guided embolization (AOR 2.68, $P < 0.01$) and showed variations in colonoscopy procedures. Resource utilization was also higher among transferred patients, with an increased mean length of hospital stay by 4.37 days ($P < 0.01$) and higher hospitalization charges (mean difference $61,239, $P < 0.01$).

Conclusion Interhospital transfer in LGIB patients is associated with increased mortality, greater resource utilization, and the need for more specialized procedural interventions. Enhanced clinical vigilance and tailored resource allocation for transferred LGIB patients are necessary. Future research should optimize care strategies for these high-risk patients.

Keywords Lower Gastrointestinal bleeding, Interhospital transfer, Patient outcomes, National inpatient sample, Hospitalization, Resource utilization

†Ali Jaan and Zouina Sarfraz are co-first-authors and contributed equally to this work.

*Correspondence:
Zouina Sarfraz
zouinasarfraz@gmail.com
[1]Department of Internal Medicine, Rochester General Hospital, Rochester, NY, USA
[2]Department of Medicine, Fatima Jinnah Medical University, Queen's Road, Mozang Chungi, Lahore 54000, Pakistan
[3]Department of Medicine, Ayub Medical College, Abbottabad, Pakistan
[4]Department of Gastroenterology, Saint Louis University, St. Louis, MO, USA
[5]Department of Gastroenterology, Rochester General Hospital, Rochester, NY, USA

Introduction

Gastrointestinal bleeding (GIB) represents a significant health burden in the United States, accounting for 250,000 to 300,000 hospitalizations annually. It also contributes to an annual toll of 15,000 to 30,000 deaths and incurs over $1 billion in direct annual expenditure [1, 2]. Lower gastrointestinal bleeding (LGIB), a specific subset of GIB, refers to bleeding that occurs primarily from the large intestine that usually manifests as bright red or maroon colored bowel movements [3–5]. Approximately 80–85% of LGIB cases originate distal to the ileocecal valve [6, 7]. The yearly occurrence of LGIB is reported to be around 20 to 30 cases per 100,000 in the Western countries with estimated mortality rates are 2–4% [8]. Epidemiologically, LGIB accounts for 20–30% of all major GI bleeding cases.

Interhospital transfer (IHT) is frequently utilized to provide patients with specialized care, especially in complex cases such as GIB. However, studies have shown that IHT is associated with worse outcomes in emergency general surgery patient groups [9]. This includes increased adjusted odds of intensive care unit (ICU) transfer and higher 30-day mortality, particularly during nighttime transfers and periods of high care team workload [10]. The importance of timely IHT for LGIB treatments, such as angioembolization, becomes clear when we see that delays in post-IHT angioembolization often lead to ineffective results [11].

There is a scarcity of data on the outcomes of LGIB patients transferred between hospitals. To address this research gap, we conducted a comprehensive retrospective cohort study using the United States National Inpatient Sample (NIS) database.

Methods

Database information

We performed a retrospective cohort study utilizing data for the years 2017–2020 from the NIS database [12]. The NIS is the largest publicly available all-payer inpatient healthcare database, covering 48 states and more than 98% of the U.S. population. It is sampled from the State Inpatient Database (SID) and contains data from approximately seven million hospitalizations each year. A 20-percent stratified sample is gathered from all the U.S. community hospitals, excluding rehabilitation and long-term care hospitals. This data contains information on all hospital stays, regardless of the expected payer for the hospital stay. Each discharge from the resultant data is then weighted (weight equals the total number of discharges from all acute care hospitals in the United States divided by the number of discharges included in the 20% sample) to make the NIS nationally representative. When weighted, the NIS data estimates to around 35 million hospitalizations across the U.S. The NIS aims to make regional and national estimates of healthcare utilization, cost, quality, and outcomes in the U.S. It contains de-identified clinical and demographic elements for each hospital stay at the hospital and patient level.

Study population

We included adult patients (aged ≥ 18 years) admitted with a principal diagnosis of lower gastrointestinal bleeding (LGIB), utilizing International Classification of Diseases, Tenth Revision, Clinical Modifications (ICD-10- CM) codes. To accurately identify all patients with LGIB and not miss any diagnosis codes, we reviewed previously published NIS-based literature on LGIB. The patients were further classified into two groups based on their transfer status. The transfer status is defined in the NIS by using the variable TRAN_IN. In our study, we included patients who were either admitted directly or transferred from another acute-care hospital. Patients transferred from non-acute long-term facilities were excluded. To avoid estimation bias, directly admitted patients were further screened utilizing the TRAN_OUT variable to identify and exclude individuals who were subsequently transferred to another acute care hospital. Finally, recognizing that coronavirus disease 2019 (COVID-19) represents a distinct demographic, patients with a concurrent diagnosis of COVID-19 were excluded. The ICD-10-CM diagnosis and procedure codes used in this study are listed in Supplementary Table 1. Although our study utilized the NIS database, which contains de-identified data, approval was nevertheless sought from the institutional review board. Given the nature of the data, this study was deemed exempt from full review.

Study variables and outcomes

We aimed to assess the impact of inter-hospital transfer status on LGIB. The primary outcome assessed was all-cause inpatient mortality. Secondary outcomes evaluated included septic shock, the need for mechanical ventilation and admission to the intensive care unit (ICU), and resource utilization with total hospitalization charges and length of stay (LOS). We also compared the procedure performance in both groups (i.e., colonoscopy (CSP) and interventional radiology (IR)-guided embolization).

Statistical analysis

STATA, version 14.2 (StataCorp., College Station, Texas, USA) was used for the analyses. Multivariate linear and logistic regression analyses were performed using confounders with a P-value ≤ 0.2 on univariate regression analysis [13]. In addition, we incorporated variables that were considered clinically significant to the outcome, as indicated by previous research, regardless of their statistical significance to the outcome in the univariate analysis [14]. Charlson comorbidity index (CCI) was constructed using ICD-10-CM codes primarily. We also included variables that are part of the ABC and Oakland bleeding risk score in the regression model (including age, sex, hypotension, and hypovolemic shock). The variables included in the final regression analysis for NVUGIB were age (in years), sex, race, CCI, insurance status (Medicare, Medicaid, private, and uninsured), median household income in the patient's zip code, hospital bed size (small, medium, and large), hospital region (Northeast, Midwest, South and West), end-stage renal disease (ESRD), obesity, hypotension, and hypovolemic shock. Since most transfers are to teaching hospitals, we excluded teaching status from the regression model to avoid collinearity.

Prior to applying descriptive statistics, the normality of individual variables was assessed through Kolmogorov-Smirnov test. The continuous variables, specifically length of stay (LOS) and total hospitalization charges, followed a Poisson distribution. Consequently, we employed the Mann-Whitney U test to assess means and Poisson regression to assess the adjusted mean difference in the linear regression model. To analyze binary outcomes, logistic regression was utilized. All *P* values were two-sided, and the threshold for statistical significance was set at *P* less than 0.05.

Results

Patient characteristics

We included a total of 393,495 adult patients admitted with LGIB. Of these, 31,565 (8.02%) were transferred from another acute care hospital, while 361,930 (91.98%) were directly admitted to the hospitals (Fig. 1). Table 1 shows the characteristics of the patients and the hospitals in which they were treated. We found that transferred patients, when compared to non-transferred ones, were younger (66.39 vs. 67.23 years, $P < 0.01$), more likely to be males (52.51% vs. 47.59%, $P < 0.01$), and had higher (≥ 3) CCI scores (40.86% vs. 38.64%, $P < 0.01$). From the hospital standpoint, transferred patients were more often admitted to large-sized (62.63% vs. 48.19%, $P < 0.01$), teaching hospitals (84.65% vs. 71.80%, $P < 0.01$) located in urban areas (95.09% vs. 92.93%, $P < 0.01$). Table 2 shows the prevalence of different comorbidities in our target cohort.

We devised a surrogate LGIB severity score, using diagnostic codes for individual components of Oakland score criteria (Table 3). The severity score was calculated by adding points assigned to each component, as defined by the Oakland score criteria [15]. Patients transferred from another acute care hospital had higher mean severity score than those who were admitted directly (8.35 vs. 7.06, $P < 0.01$).

Mortality and morbidity

LGIB patients who were transferred from another hospital had higher odds of inpatient mortality (adjusted odds ratio (AOR) 1.96, 95% CI (confidence interval) 1.77–2.18, $P < 0.01$) (Table 4). We found that transferred patients had higher adjusted odds of acute kidney injury (AKI) (AOR 1.37, 95% CI 1.28–1.45, $P < 0.01$), AKI requiring dialysis (AOR 2.41, 95% CI 2.07–2.83, $P < 0.01$), septic shock (AOR 2.11, 95% CI 1.91–2.34, $P < 0.01$), mechanical ventilation (AOR 2.63, 95% CI 2.39–2.88, $P < 0.01$), and intensive care unit (ICU) admission (defined by need for vasopressors or mechanical ventilation, with either

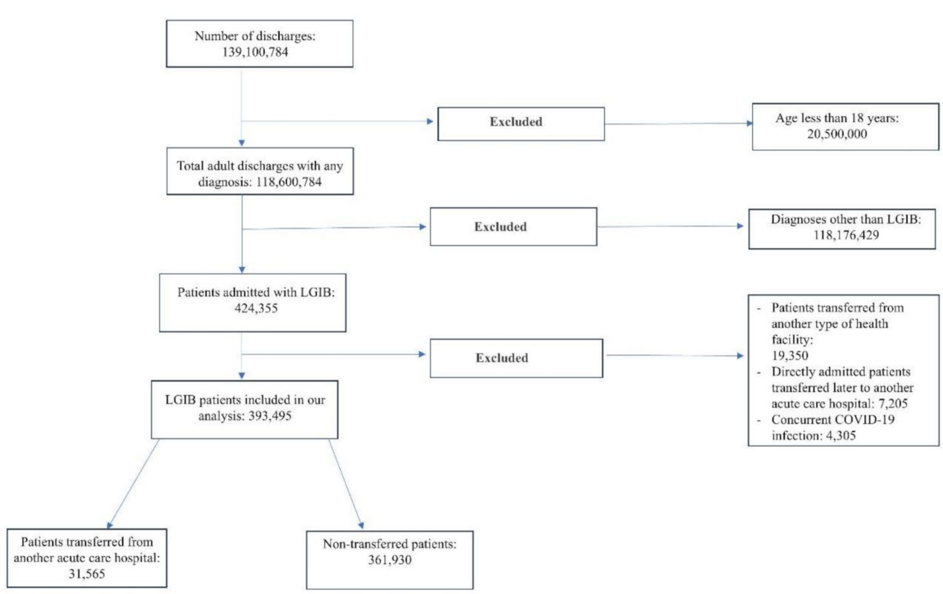


Fig. 1 Flow diagram depicting the inclusion and exclusion of patients with LGIB

Table 1 Demographics of lower Gastrointestinal bleeding hospitalizations, stratified by Inter-Hospital transfer status

LGIB + Age >= 18: (n = 393,495)			
Baseline Characteristics	**Non-transferred (n = 361,930)**	**Transferred (n = 31,565)**	**P-value**
Mean age (years)	67.23	66.29	< 0.01
Sex, %			< 0.01
Female	52.41	47.49	
Male	47.59	52.51	
Race, %			< 0.01
White	68.13	75.50	
African American	19.14	16.08	
Hispanic	10.03	6.50	
Asian or Pacific Islander	2.70	1.92	
Charlson comorbidity index, %			< 0.01
1	31.75	29.24	
2	29.61	29.90	
≥ 3	38.64	40.86	
Median household income in the patient's zip code (quartile), %			< 0.01
1st (0-25th)	30.20	34.35	
2nd (26th-50th)	25.85	32.64	
3rd (51st-75th)	24.08	19.36	
4th (76th-100th)	19.87	13.65	
Insurance status, %			< 0.01
Medicare	73.10	71.09	
Medicaid	10.04	10.30	
Private	14.44	16.48	
Uninsured	2.42	2.13	
Hospital region, %			< 0.01
Northeast	19.75	17.64	
Midwest	21.18	30.37	
South	41.38	36.44	
West	17.69	15.55	
Hospital bed size, %			< 0.01
Small	20.71	12.90	
Medium	31.10	24.47	
Large	48.19	62.63	
Hospital Location, %			< 0.01
Rural	7.07	4.91	
Urban	92.93	95.09	
Hospital Teaching Status, %			< 0.01
Nonteaching	28.20	15.35	
Teaching	71.80	84.65	

Abbreviations-LGIB: Lower gastrointestinal bleeding

indicating ICU admission) (AOR 2.61, 95% CI 2.39–2.86, $P < 0.01$).

Analysis of major adverse cardiac and cerebrovascular events (MACCE) revealed that patients transferred from another acute care hospital had elevated odds of acute heart failure (AOR 1.23, 95% CI 1.11–1.35, $P < 0.01$), acute myocardial infarction (AOR 2.20, 95% CI 1.87–2.58, $P < 0.01$), ventricular arrhythmias (AOR 1.58, 95% CI 1.36–1.83, $P < 0.01$), and acute transient ischemic attack/stroke (AOR 2.69, 95% CI 2.29–3.17, $P < 0.01$) (Table 4).

Procedural performance

We found that transferred patients had slightly higher rates of diagnostic CSP (AOR 1.11, 95% CI 1.03–1.20, $P < 0.01$) but lower odds of CSP with intervention (AOR 0.85, 95% CI 0.79–0.92, $P < 0.01$) and repeat colonoscopy (AOR 0.84, 95% CI 0.75–0.94, $P < 0.01$). There was no difference in the total number of colonoscopies performed among the two cohorts (AOR 0.96, 95% CI 0.90–1.02, $P = 0.17$). Furthermore, the transferred patients had significantly elevated odds of undergoing IR-guided embolization (AOR 2.68, 95% CI 1.93–3.74, $P < 0.01$) (Fig. 2). Further analysis revealed that the mean duration between

Table 2 Comorbidities of lower Gastrointestinal bleeding hospitalizations, stratified by Inter-Hospital transfer status

LGIB + Age >= 18: (*n* = 393,495)			
Variables	**Non-transferred (*n* = 361,930)**	**Transferred (*n* = 31,565)**	***P*-value**
Hypovolemic shock, %	1.43	2.19	< 0.01
Congestive heart failure, %	27.87	32.00	< 0.01
History of myocardial infarction, %	27.76	31.76	< 0.01
History of cerebrovascular disease, %	10.78	11.41	0.13
Peripheral vascular disease, %	5.83	6.94	< 0.01
Chronic obstructive pulmonary disease, %	14.61	16.28	< 0.01
Diabetes, %	30.97	32.73	< 0.01
Rheumatoid arthritis, %	2.53	2.47	0.78
Peptic ulcer disease, %	5.08	5.40	0.09
Dementia, %	9.03	7.65	< 0.01
Mild liver disease, %	6.95	6.38	0.08
Cirrhosis, %	5.63	7.38	< 0.01
Malignancy/metastatic disease, %	6.34	6.73	0.23
AIDS, %	0.54	0.38	0.10
Hemiplegia or paraplegia, %	1.50	3.44	< 0.01
Obesity, %	17.72	19.02	0.01
Chronic kidney disease, %	10.52	11.37	0.03

Abbreviations-LGIB: Lower gastrointestinal bleeding, AIDS: Acquired immunodeficiency syndrome

Table 3 Surrogate severity score for lower Gastrointestinal bleeding hospitalizations, derived from component variables of the Oakland score

LGIB + Age >= 18: (*n* = 405,005)			
Variables (Points per Oakland score)	**Non-transferred (*n* = 373,195)**	**Transferred (*n* = 31,810)**	***P*-value**
Age group			< 0.01
< 40 years (0 point), %	8.04	7.94	
40–69 years (1 point), %	40.55	42.72	
≥ 70 years (2 points), %	51.41	49.34	
Male sex (1 point), %	47.59	52.51	< 0.01
Previous lower gastrointestinal bleeding (1 point), %	1.37	0.87	< 0.01
Tachycardia (3 points), %	2.77	2.71	0.77
Hypotension (4 points), %	9.29	10.80	< 0.01
Shock (5 points), %	1.54	2.71	< 0.01
Posthemorrhagic anemia (13 points), %	31.15	40.47	< 0.01
*Surrogate severity score, mean	7.06	8.35	< 0.01

*Calculated by adding points assigned to each component, as defined by the Oakland score criteria

the initial presentation to the final intervention (CSP or IR-guided embolization) was shorter in transferred patients (3.34 vs. 4.97 days, $P < 0.01$).

Resource utilization

From a resource utilization viewpoint, transferred patients had an increased mean LOS by 4.37 days (Absolute percent difference (APD) 1.56, 95% CI 1.51–1.62, $P < 0.01$) and higher total hospitalization charges by a mean of $61,239 (APD 1.65, 95% CI 1.56–1.75, $P < 0.01$) (Table 3). Additionally, a higher proportion of transferred patients were discharged to rehabilitation facilities compared to their non-transferred counterparts (AOR 1.52, 95% 1.42–1.63, $P < 0.01$).

Discussion

This study investigated the impact of the IHT status on the outcomes of patients with LGIB. It involved a comprehensive analysis of 393,495 adult patients, distinguishing between those transferred from another acute care hospital and those directly admitted. The transferred patients, constituting 8.02% of the total studied population of lower GI bleeding, were notably younger, predominantly male, and more likely to be White. The predominance of male and White patients among transfers could reflect underlying referral biases and disparities in healthcare access [16]. In addition, transferred patients were more likely to reside in areas with lower income quartile and had higher comorbidity scores compared to their non-transferred counterparts. This suggests that socioeconomic factors and healthcare resource

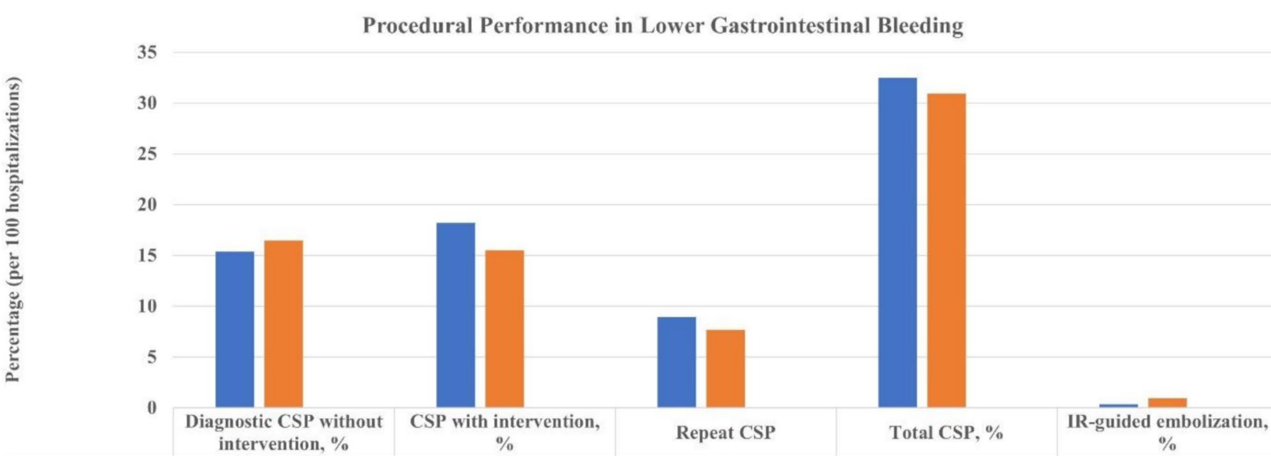
Table 4 Unadjusted and adjusted outcomes of lower Gastrointestinal bleeding hospitalizations, stratified by Inter-Hospital transfer status

LGIB + Age >= 18: (*n* = 393,495)				
Outcomes	**Non-transferred (*n* = 361,930)**	**Transferred (*n* = 31,565)**	**Adjusted OR (95% CI)**	***P*-value**
Mortality, %	4.21	8.60	1.96 (1.77–2.18)	< 0.01
AKI, %	26.86	33.87	1.37 (1.28–1.45)	< 0.01
AKI requiring dialysis, %	1.56	4.29	2.41 (2.07–2.83)	< 0.01
Septic shock, %	4.13	8.90	2.11 (1.91–2.34)	< 0.01
Mechanical ventilation, %	5.24	13.12	2.63 (2.39–2.88)	< 0.01
*Requiring ICU admission, %	6.02	14.76	2.61 (2.39–2.86)	< 0.01
Major adverse cardiac and cerebrovascular events				
Acute heart failure, %	8.59	11.04	1.23 (1.11–1.35)	< 0.01
Acute myocardial infarction, %	1.46	3.41	2.20 (1.87–2.58)	< 0.01
Ventricular arrhythmias, %	2.28	3.98	1.58 (1.36–1.83)	< 0.01
Acute transient ischemic attack/stroke, %	1.29	3.53	2.69 (2.29–3.17)	< 0.01
Resource utilization (95% CI)				
Mean LOS, d	7.07	11.44	**1.56 (1.51–1.62)	< 0.01
Mean THC, USD	85,294	146,533	**1.65 (1.56–1.75)	< 0.01
Rehabilitation discharge, %	18.43	25.27	1.52 (1.42–1.63)	< 0.01

Abbreviations-LGIB: Lower gastrointestinal bleeding; OR: Odds ratio; CI: Confidence interval; AKI: Acute kidney injury; ICU: Intensive care unit; IR: Interventional radiology; LOS: Length of hospital stay; THC: Total hospitalization charges; USD: United States dollar

*Defined by the need for vasopressors &/or mechanical ventilation

**Adjusted percentage difference



	Diagnostic CSP without intervention, %	CSP with intervention, %	Repeat CSP	Total CSP, %	IR-guided embolization, %
Non-transferred	15.36	18.18	8.92	32.5	0.35
Transferred	16.44	15.52	7.67	30.9	0.92
P - value	0.03	< 0.01	< 0.01	0.01	< 0.01

Fig. 2 Procedural performance in LGIB among transferred and non-transferred patients

distribution may play a role in transfer patterns, as lower-income areas may have limited access to advanced interventions, necessitating transfers to tertiary care centers. The elevated comorbid status among transferred patients is understandable, as patients with a high comorbidity index often require transfer due to the increased risk of hemodynamic instability and the need for advanced interventions such as IR-guided embolization [17]. Geographically, a higher proportion of transfers occurred from the Midwest and were more commonly admitted to large hospitals and teaching institutions. This regional discrepancy may be attributed to variations in healthcare infrastructure, with a higher prevalence of rural areas in the Midwest and, consequently, a greater number of community and critical access hospitals in those regions [17]. The observed disparities in racial and demographic characteristics between transferred and non-transferred patients highlight the need for further investigation into potential systemic barriers in access to specialized care for LGIB."

Previous research reports an overall mortality rate of 6.3% in patients with GIB [18]. In the absence of prior mortality data for inpatient transfers with LGIB, it is noteworthy that our study contributes valuable insights. Previous investigations, such as the study conducted by Sedarous et al. (2020), have highlighted significant trends and outcomes associated with the transfer of patients suffering from upper GIB [19]. This research found an increase in transfers between 2007 and 2014, with transferred patients often experiencing higher in-hospital mortality rates, decreased utilization of essential diagnostics like upper endoscopy, longer hospital stays, and increased total hospital costs. In contrast, our study demonstrates that patients transferred for LGIB treatment face significantly higher odds of inpatient mortality, AKI, septic shock, and the necessity for intensive care. These heightened risks underscore the critical nature of LGIB management in transferred patients, emphasizing the necessity for increased clinical vigilance and dedicated resources in treating this subgroup.

We found a notable difference in procedural interventions for LGIB. Transferred patients were seen more likely to undergo IR-guided embolization while displaying lower odds of colonoscopy-related interventions and repeat colonoscopies. These findings suggest a trend towards more aggressive or specialized intervention in transferred patients, likely due to the severity and complexity of their conditions. A retrospective review highlights challenges specific to the timing and efficacy of angioembolization in transferred LGIB patients [11]. It was observed that a notable proportion of patients who underwent Computerized Tomographic Mesenteric Angiography (CTMA) at non-specialized hospitals experienced favorable outcomes. However, the success of angioembolization was limited among those transferred specifically for this intervention. This highlights concerns regarding the timing of interventions after transfer, as significant delays at tertiary centers, especially before undergoing embolization, contribute to worse outcomes. There appears to be a distinct association between delayed angioembolization upon reaching the tertiary hospital and the probability of an unsuccessful procedure [11]. Thus, delay in obtaining timely angioembolization may emerge as a crucial factor influencing the overall outcomes of LGIB transferred to tertiary hospitals. Considering the colonoscopy results alongside the findings from IR embolization, it appears that the rationale for transfer is primarily aimed at facilitating IR procedures rather than interventions related to colonoscopy. This observation suggests that while the effectiveness of colonoscopy in managing LGIB remains undisputed, the transfer process may prioritize more immediate, IR-related interventions to address severe bleeding, highlighting a targeted approach in the management of these complex cases.

A multicenter study conducted in Ontario evaluated the resource utilization in a cohort of patients admitted for nonmalignant LGIB [20]. It found an average hospital stay of 7.5 days and an average case cost of $4,832. Factors such as older age and the presence of comorbid illnesses, particularly coronary artery disease, were evaluated as potential contributors to the increased LOS and higher costs. This highlights the significant impact of patient demographics and comorbid conditions on healthcare resource utilization [20–23]. Advancing a step further, our study explored the role of IHT on resource utilization among LGIB patients and found that transferred patients exhibited increased hospital stay lengths and higher hospitalization charges which can be explained by higher comorbid burden in the transferred cohort.

This study highlights the complex challenges involved in managing LGIB in patients who require IHT, stressing the importance of recognizing the increased risk profiles and the greater resource needs of these patients. To enhance outcomes, future research should focus on developing strategies that ensure prompt, efficient, and effective care for LGIB patients who are transferred, with the goal of improving their prognoses and reducing the strain on healthcare systems.

Our study has several limitations. Given the inherent limitations of the database, we lack data on the grade of nosocomial services offered as well as movement from a secondary hospital to a tertiary center. The retrospective design limited our ability to achieve complete randomization of the cohorts [24]. Even though we adjusted for potential confounders using multivariate regression analysis, there remains a possibility of residual confounding [25]. Additionally, depending on diagnosis codes rather than clinical parameters can lead to the misclassification of diagnoses. However, we utilized ICD-10 codes for data extraction, which are more specific than ICD-9 codes [26].

Our study has several strengths. To our knowledge, this is the first study that evaluated the impact of inter-hospital transfer status on the outcomes of LGIB at the national level. We employed the NIS database, which incorporates data from a wide range of hospitals across nearly all states in the United States. This confers enhanced external validity and generalizability to our study and helps mitigate biases associated with practice patterns observed in single- or multi-center studies [27]. Additionally, we were able to account for different socioeconomic and hospital factors, including household income estimates and hospitalization costs, which are not feasible in institution-based studies. Furthermore, although severity scales such as the ABC and Oakland bleeding risk score could not be calculated owing to the unavailability of laboratory values, we devised a qualitative surrogate severity scale to account for the severity of LGIB.

Conclusion

In this analysis of LGIB outcomes influenced by IHT, our findings elucidate distinct challenges in the management of transferred patients. The study highlights the heightened risks and complexities these patients face, characterized by increased mortality rates, higher incidences of acute complications, and the necessity for intensive care. A significant observation was the tendency of transferred patients to receive IR-guided embolization more frequently than non-transferred patients, who typically underwent more colonoscopy-related interventions. This trend not only underscores the severity of their conditions but also suggests potential inefficiencies in pre-transfer management, as indicated by the longer mean duration from admission to final intervention observed in directly admitted patients compared to those transferred from other hospitals. Delays occurring during the transfer process have been associated with less favorable outcomes, highlighting the importance of streamlining the transfer process for these patients to ensure prompt intervention. Our study's insights are crucial for optimizing patient outcomes and resource allocation in LGIB management. Future research should focus on developing targeted strategies to enhance care coordination and efficacy, ultimately improving prognosis for transferred LGIB patients while reducing the burden on the healthcare system.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12876-025-03755-9.

Supplementary Material 1

Author contributions

All authors (Ali Jaan, Zouina Sarfraz, Adeena Maryyum, Umer Farooq, Muhammad Farhan Ashraf, Fatima Warraich, Mark Mcfarland, Jason Gutman, Karin Dunnigan) contributed to the drafting, original draft preparation, methodology, and final review of the manuscript. Ali Jaan supervised the study and Zouina Sarfraz is the guarantor.

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Not applicable.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study did not involve primary data collection from human participants, as it exclusively utilized secondary data from publicly available sources (the National Inpatient Sample Database), which are de-identified and exempt from requiring ethical approval. While ethical approval for the use of this dataset was sought by the Office of Human Research Protection Rochester Rochester Health, the study was deemed exempt from full review due to the nature of the data. All research activities were conducted in compliance with relevant ethical guidelines, including the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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