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Original Article

Gastroenterol Res. 2021;14(5):268-274

Outcomes of Non-Variceal Upper Gastrointestinal Bleed Stratified by Hospital Teaching Status: Insights From the National Inpatient Sample

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Abstract

Background: Non-variceal upper gastrointestinal bleeding (NVUGIB) is a significant cause of mortality and morbidity in the USA. Currently, there are limited data on the inpatient outcomes of patients admitted with a diagnosis of NVUGIB stratified according to teaching hospital status. We analyzed data from the National Inpatient Sample (NIS) intending to evaluate these outcomes.

Methods: We queried the NIS 2016 and 2017 databases for NVUGIB hospitalizations by teaching hospital status. The primary outcome was inpatient mortality while secondary outcomes were rate of endoscopy for hemostasis, rate of early endoscopy (endoscopy in 1 day or less), mean time to endoscopy, rate of complications including acute kidney injury (AKI), acute respiratory failure (ARF), need for blood transfusion, development of sepsis, need for endotracheal intubation and mechanical ventilation as well as healthcare utilization.

Results: There were over 71 million weighted discharges in the combined 2016 and 2017 NIS database. A total of 94,900 NVUGIB cases were identified with 63.4% admitted in teaching hospitals. The in-hospital mortality for patients admitted with an NVUGIB in teaching hospitals was 1.98% compared to 1.5% in non-teaching hospitals (adjusted odds ratio (aOR): 1.38, 95% confidence interval (CI): 1.08 - 1.77, P = 0.010) when adjusted for biodemographic and hospital characteristics as well as comorbidities. Patients admitted with a diagnosis of NVUGIB in teaching hospitals had a 10% adjusted increased odds of getting endoscopy for hemostasis (27.0% vs. 24.5%, aOR: 1.10, 95% CI: 1.02 - 1.19, P = 0.016) compared to patients in non-teaching hospitals. There was, however, no difference in early endoscopy between the two groups.

Conclusion: Patients admitted at teaching hospitals for an NVUGIB had worse outcomes during hospitalizations including mortality, median length of stay, and total hospital charges when compared to NVUGIB patients managed at non-teaching hospitals.

Keywords: Non-variceal upper gastrointestinal bleeding; Teaching hospital; Non-teaching hospital; Length of stay; Mortality; Total hospital charges

Manuscript submitted June 18, 2021, accepted July 29, 2021
Published online September 9, 2021

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doi: https://doi.org/10.14740/gr1437

Introduction

Upper gastrointestinal bleeding (UGIB) is defined as GI hemorrhage from the oral cavity to the ligament of Treitz [1]. While an estimated 10-20% of UGIB episodes are usually secondary to portal hypertension, the majority of UGIB causes are usually non-variceal [1, 2]. Non-variceal upper gastrointestinal bleeding (NVUGIB) remains a common clinical problem in the USA with an estimated annual incidence of 67 per 100,000 individuals [3]. With the advent of novel pharmacologic and endoscopic techniques for homeostasis, the incidence and mortality of UVUGIB have steadily decreased over the last two decades. However, mortality did not follow this trend and remained with a range of 1-5% [3]. Amongst hospitalized patients with severe comorbidities, the mortality range may even reach 15% [4].

Multiple studies have reported disparities in healthcare and patient safety outcomes when comparing care delivery at teaching vs. non-teaching hospitals [5-7]. While earlier studies have reported a higher quality of care at teaching hospitals , other studies have reported no difference in outcomes in teaching hospitals [5-9]. For example, while Burke et al reported lower mortality rates for common conditions in patients managed at teaching hospitals when compared to non-teaching hospitals [10], Papinacolau et al and Au et al reported no differences in outcomes [6, 7]. It is also well known that teaching hospitals act as leaders in the education of residents and students [5]. With the implementation of work-hour regulations in residency programs, some studies have reported a decrease in short-term mortality among high-risk patients in teaching hospitals managed for common internal medicine conditions; however, data for UGIB are limited [5, 8].

While Patel et al recently evaluated the outcomes of variceal upper GI bleeding in patients stratified by hospital teaching status and reported worse outcomes in teaching hospitals [5], no other study has compared the outcomes of NVUGIB between teaching and non-teaching hospitals. This lack of outcome data on NVUGIB amongst teaching and non-teaching hospitals prompted this research. We aimed to compare outcomes in teaching and non-teaching hospital settings at a national level.

Materials and Methods

Data source and study population

We conducted a retrospective cohort study of hospitalizations in 2016 and 2017 with a principal diagnosis of NVUGIB which included acute peptic ulcer, site unspecified with hemorrhage, ulcer of the esophagus with bleeding, acute duodenal ulcer with hemorrhage, angiodysplasia of stomach and duodenum with bleeding, Dieulafoy lesion (hemorrhagic) of stomach and duodenum, Mallory-Weiss syndrome with hemorrhage, and acute gastritis with bleeding. We used ICD-10 codes obtained from literature review of similar validated studies done on NVUGIB [11-13].

Data were sourced from the Nationwide Inpatient Sample (NIS) database for 2016 and 2017. The NIS is a database of hospital inpatient stays derived from billing data submitted by hospitals to statewide data organizations across the USA, covering more than 97% of the US population [14]. Each year approximates a 20% stratified sample of discharges from US community hospitals, excluding rehabilitation and long-term acute care hospitals. This dataset is weighted to obtain national estimates. Both the 2016 and 2017 databases are entirely coded using the International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS). In the NIS, diagnoses are divided into one principal diagnosis and secondary diagnosis. A principal diagnosis was the main ICD-10 code for the hospitalization. Secondary diagnoses were any ICD-10 code other than the principal diagnosis.

This manuscript is exempt from IRB approval as it involves data without patient identifiers. The data used in this study are readily available online at https://www.hcup-us.ahrq.gov. Ethical compliance with human/animal studies is not applicable as there were no animals used in this study and the study involves data without patient identifiers.

Inclusion criteria and study variables

The study population consisted of all hospitalizations for NVUGIB in the NIS 2016 and 2017. Study variables included sociodemographic and hospital characteristics including age, race, gender, primary payer, mean household income by quartile, disposition, hospital bed size, hospital location, and hospital teaching status which were included in the database. We used ICD-10 codes to obtain the comorbidities mapped from Deyo's adaptation of the widely validated Charlson Comorbidity Index (CCI) mentioned in the Supplementary Material 1 (www.gastrores.org) [15]. We excluded patients less than 18 years and elective hospitalization.

Outcomes measures

The primary outcome was comparing inpatient mortality from NVUGIB between teaching and non-teaching hospitals. Secondary outcomes studied included rate of endoscopy for hemostasis, rate of early endoscopy (endoscopy in 1 day or less), mean time to endoscopy, rate of complications including acute kidney injury (AKI), acute respiratory failure (ARF), need for blood transfusion, development of sepsis, need for endotracheal intubation and mechanical ventilation. We also compared the mean length of stay (LOS) and the mean total hospital charges (THC) between teaching and non-teaching hospitals as a surrogate marker for healthcare cost utilization.

Statistical analysis

We analyzed the data using Stata® Version 16 software (StataCorp, Texas, USA). We conducted all the analysis using the weighted samples for national estimates in adjunct with Healthcare Cost and Utilization Project (HCUP) regulations for using the NIS databases. Age grouped as 18 - 39 years representing young adults, 40 - 64 years representing middle-aged adults, and 65 years above representing elderly. We calculated comorbidities as proportions of the cohorts and used the Chi-square test to compare characteristics between the index and readmissions. We used univariable regression to compare both primary and secondary outcomes to obtain adjusted odds ratios (aORs). We carried out a backward stepwise multivariable regression analysis on sex, age categories, race, primary payer, household income quartiles, hospital bed size, hospital location, and 17 comorbidities that make up the CCI, which is similar to the model employed by Moore et al for assessing comorbidity burden in administrative databases [16]. Selection involved removing variables with $P \geq 0.2$ and adding variables with $P < 0.1$ to create the final model for readmissions. The final model included age categories, sex, race, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), moderate or severe liver disease, metastatic solid tumor, myocardial infarction, congestive heart failure, cerebrovascular disease, paraplegia, mild liver disease, chronic pulmonary disease, rheumatologic disease, peptic ulcer disease, and renal disease.

Ethical considerations

The NIS lacks patient identifiers. In keeping with other HCUP databases, the NIS does not require Cook County Health Institutional Review Board approval for analysis.

Results

Patient and hospital characteristics

There was a total of 94,900 hospitalizations for NVUGIB, of

which 60,175 (63.4%) were in teaching hospitals. Patients in teaching hospitals were significantly younger (mean age 62.8 vs. 64.8 years, P < 0.001) and involved a lower proportion of women compared to non-teaching hospitals. Teaching hospitals had higher proportions of non-white patients and patients with private insurance. A larger proportion of hospitalizations in the teaching hospitals had a median income greater than the 50th centile compared to non-teaching hospitals.

Comorbidity distribution between both settings was varied. Patients in non-teaching centers were more likely to have comorbid dementia (9.3% vs. 7.5%, P < 0.001), peptic ulcer disease (28.6% vs. 26.7%, P = 0.009), chronic pulmonary disease, and diabetes without complications, while patients in teaching centers had a higher proportion of HIV (0.5% vs. 0.2%, P = 0.009), renal disease (22.4 vs. 20.3, P = 0.001) and diabetes with chronic complications.

There was also significant regional and size distribution relative to teaching status as shown in Table 1.

Outcomes

Primary outcome: in-hospital mortality

The in-hospital mortality for patients admitted with an NVUGIB in teaching hospitals was 1.98% compared to 1.5% in non-teaching hospitals (aOR: 1.38, 95% CI: 1.08 - 1.77, P = 0.010) when adjusted for biodemographic and hospital characteristics as well as comorbidities. Early endoscopy was associated with a significantly lower odds of mortality (aOR: 0.66, 95% CI: 0.45 - 0.97, P = 0.033) adjusted for confounders.

Secondary outcomes

Patients admitted with a diagnosis of NVUGIB in teaching hospitals had a 10% adjusted increased odds of getting endoscopy for hemostasis (27.0% vs. 24.5%, aOR: 1.10, 95% CI: 1.02 - 1.19, P = 0.016) compared to patients in non-teaching hospitals. There was, however, no difference in early endoscopy between the two groups. Teaching hospitals had higher odds of complications including the need for mechanical ventilation (6.4% vs. 3.9%, aOR: 1.62, 95% CI: 1.38 - 1.90), and development of AKI (21.9 vs. 18.8, aOR: 1.17, 95% CI: 1.07 - 1.28, P < 0.001). Teaching hospitals had a higher mean LOS and mean THC when compared to patients admitted with the same diagnosis in non-teaching hospitals as detailed in Table 2.

Discussion

Utilizing a nationwide database, we aimed to compare mortality and other outcomes such as time to endoscopy, odds of developing renal failure, respiratory failure, sepsis, need for transfusion, mechanical intubation/ventilation, THC and LOS for NVUGIB among teaching versus non-teaching hospitals in the USA. Among 94,900 patients with NVUGIB hospitalizations, the median LOS, THC, and mortality were higher in teaching versus non-teaching hospitals. The odds of requiring intubation with subsequent mechanical ventilation, developing acute renal failure and ARF were also found to be subsequently higher in teaching hospitals. Teaching hospitals are widely reputed for a higher quality of care delivery, specialized services, advanced technologies, and innovative research [17]. Previous studies have found that risk-adjusted mortality and LOS were lower for patients admitted in major teaching hospitals than for patients in minor, and non-teaching hospitals [10, 18]. In a recent study, it was found that amongst 589,180 individuals admitted for gastrointestinal bleeding, the 30-day mortality was 6.3% vs. 7.0% in major vs. minor teaching hospitals, respectively [10]. Factors such as hospital volume, early technology adaptation, and even teaching intensity were associated with higher performance and lower mortality among teaching hospitals [10, 19]. In our study, we discovered worse overall outcomes at teaching hospitals.

Our study demonstrates that in-hospital mortality, odds of developing acute renal failure/respiratory failure, requiring intubation with subsequent mechanical ventilation, LOS, and THC were higher in patients admitted to teaching hospitals for NVUGIB compared to non-teaching hospitals. We attribute these findings primarily to the acuity of cases seen in primary academic medical centers. A study looking at the acuity among emergency departments found that the median case acuity in teaching hospitals not only was higher but also fell outside the interquartile range of non-teaching hospitals [20]. It makes sense then that since sicker patients are admitted to teaching hospitals, the overall inpatient outcomes would also be worse. The acuity of the cases managed at teaching hospitals probably impacts the mortality and in turn leads to extended LOS and higher THC.

Teaching hospitals have also been reported to rely heavily on government, Medicare, and Medicaid subsidies for both graduate medical education and patient reimbursement for revenue generation [21-23]. They are also known to serve the poor, underserved populations in the USA, which operate at a lower financial margin when compared to non-teaching hospitals [19]. It is well known that hospitals that are well financed are more equipped to improve and provide better patient quality care [21, 24, 25]. This may account for worse outcomes observed in teaching hospitals when compared to non-teaching hospitals in our study.

In our study, we found that patients managed in teaching hospitals had higher odds of obtaining an esophagogastroduodenoscopy (EGD) (27% vs. 24.5%) when compared to patients managed at non-teaching hospitals. Our findings are echoed by studies that report that patients managed at teaching patients managed at teaching hospitals were more likely to get an EGD when compared to patients managed at non-teaching hospitals [5]. Both healthcare facilities were however found to have a similar time to endoscopy (< 1 day). It is interesting that although patients managed at teaching hospitals were more likely to obtain an EGD, patients at teaching hospitals still had worse overall outcomes. We hypothesize that these outcomes may pertain to the technical expertise required in performing endoscopic procedures. Indeed, EGD and therapeutic endoscopy interventions are crucial in the successful management of patients with NVUGIB. The less desirable

Table 1. Patient and Hospital Characteristics of Hospitalizations With NVUGIB by Hospital Setting

Variable	Non-teaching hospital, %	Teaching hospital, %	P-value
N = 94,900	n = 34,725 (36.6%)	n = 60,175 (63.4%)	
Patient characteristics			
Age, years, mean ± SE	64.8 ± 0.5	62.8 ± 0.4	< 0.001
18 - 44 years	14.4	16.5	
45 - 64 years	30.5	34.1	
> 64 years	55.1	49.4	
Women	40.3	37.7	< 0.001
Racial distribution			< 0.001
White	72.9	64.4	
Black	9.3	14.7	
Hispanic	9.0	11.1	
Others	8.8	9.8	
Charlson Comorbidity Index score			<0.001
0	19.1	19.2	
1	25.5	23.2	
2	17.4	16.2	
≥ 3	38.0	41.4	
Primary payer			< 0.001
Medicare	62.1	55.9	
Medicaid	14.2	16.6	
Private	18.1	21.5	
Uninsured	5.6	6.0	
Median annual income in patient's zip code, US$[a]			< 0.001
1 - 43,999	32.3	30.0	
44,000 - 55,999	29.3	24.8	
56,000 - 73,999	22.2	24.5	
≥ 74,000	16.2	20.7	
Comorbidities			
Myocardial infarction	8.7	9.1	0.390
Congestive heart failure	15.1	16.7	0.004
Peripheral vascular disease	8.5	8.8	0.488
Cerebrovascular disease	4.7	5.1	0.205
Dementia	9.3	7.5	< 0.001
Chronic pulmonary disease	21.3	19.6	0.007
Rheumatologic disease	3.1	2.8	0.384
Peptic ulcer disease	28.6	26.7	0.009
Mild liver disease	8.2	9.7	< 0.001
Diabetes without complications	16.5	15.1	0.014
Diabetes with complications	10.4	12.1	0.001
Hemiplegia/paraplegia	0.8	1.1	0.118
Renal disease	20.3	22.4	0.001
Any malignancy	3.6	3.9	0.482
Moderate or severe liver disease	7.4	9.5	< 0.001

Table 1. Patient and Hospital Characteristics of Hospitalizations With NVUGIB by Hospital Setting - *(continued)*

Variable	Non-teaching hospital, %	Teaching hospital, %	P-value
Metastatic solid tumor	2.0	2.5	0.036
HIV/AIDS	0.2	0.5	0.009
Hospital characteristics			
Hospital region			< 0.001
Northeast	11.7	20.3	
Midwest	19.7	21.6	
South	42.4	36.3	
West	26.2	21.8	
Hospital bed size			< 0.001
Small	12.8	23.0	
Medium	28.9	32.5	
Large	58.3	44.5	

[a]For 2017. NVUGIB: non-variceal upper gastrointestinal bleeding; SE: standard error of the mean; HIV: human immunodeficiency virus; AIDS: acquired immunodeficiency syndrome.

outcomes of patients with NVUGIB demonstrated by teaching hospitals in our study may be attributed in part to the level of competencies attained by the gastroenterology trainees in teaching hospitals. It has been reported that medical trainees may have a higher risk of being involved in medical errors [26]. This vulnerability may be related to their level of endoscopic skills, inexperience in handling unusual endoscopic presentations, level of attending physician supervision, and lack of hand-off mechanism between the primary GI service and the on-call GI service. These issues tend to be more challenging from July through September each year when the GI fellows begin their training. So although patients at teaching hospitals had more endoscopies, and both centers had similar times to early EGD, the level of competencies may have had an effect observed in our cohort of patients.

Finally, in our study, NVUGIB patients managed at teaching and non-teaching hospitals were found to have no statistically significant differences in the need for red blood cells (RBC) transfusion between the two groups. Patients managed at teaching and non-teaching hospitals had no difference in their time to endoscopy as mentioned above. Since endoscopy is vital to management to NVUGIB, it is understandable that

Table 2. Outcomes of NVUGIB Patients Managed at Non-Teaching vs. Teaching Hospitals

Outcome	Non-teaching hospital, %	Teaching hospital, %	aOR (95% CI)	P-value
No. (%)	n = 34,725 (36.6%)	n = 60,175 (63.4%)		
Primary outcome				
In-hospital mortality	1.50	1.98	1.38 (1.08 - 1.77)	0.010*
Secondary outcomes				
Endoscopy	24.5	27.0	1.10 (1.02 - 1.19)	0.016*
Time to endoscopy, mean, days	1.0	1.1	0.0 (-0.1 - 0.1)	0.763
Early endoscopy	19.3	20.7	1.06 (0.98 - 1.16)	0.162
Intubation	3.3	5.4	1.62 (1.36 - 1.94)	< 0.001*
Mechanical ventilation	3.9	6.4	1.62 (1.38 - 1.90)	< 0.001*
Transfusion of blood products	34.7	32.2	0.94 (0.88 - 1.01)	0.112
Acute renal failure	18.8	21.9	1.17 (1.07 - 1.28)	< 0.001*
Acute respiratory failure	4.4	5.8	1.28 (1.10 - 1.50)	0.002*
Sepsis	1.8	2.3	1.16 (0.92 - 1.47)	0.213
Length of stay, mean, days	4.1	4.6	0.5[a] (0.4 - 0.6)	< 0.001*
Total hospital charges, mean, US$	45168	51605	2,253[a] (230 - 4,275)	0.029*

*Statistically significant. [a]Adjusted mean difference. aOR: adjusted odds ratio; CI: confidence interval; NVUGIB: non-variceal upper gastrointestinal bleeding.

both cohorts would have no difference in their need for RBC transfusion if they obtained endoscopy at similar times.

Our study has several strengths. Concerning our literature review, this is one of the few studies that has evaluated hospital outcomes of NVUGIB at teaching vs. non-teaching hospitals. Our use of the largest inpatient hospitalization database in the USA increases the power of our study. Our scientific questioning and analysis technique also contributes new information to a largely understudied topic of teaching hospital status effect on the outcomes on NVUGIB.

Our study is not without its limitations however, and the current limitations are as follows. The retrospective nature of our study establishes associations but cannot imply causality. In our study, we had a higher number of patients managed at teaching hospitals vs. non-teaching hospitals. The NIS reports data on hospitalization rather than individual patients, hence patients hospitalized on multiple occasions can be counted multiple times [27]. NIS does not account for the acuity or severity of the patient's condition on admission, hence we cannot determine if this may have affected our hospital outcomes [28]. NIS does not contain laboratory data, vital signs, or medication use and so we could not calculate pre-endoscopic risk scores, Glasgow or Blatchford scores. Our data do not have specific information on the involvement of fellows, the training or expertise of the fellows. We also could not identify specific interventions that were done during endoscopy. Finally, we were unable to obtain information on post-discharge follow-up in our cohort of patients.

Conclusion

Our study demonstrated that patients managed for NVUGIB at non-teaching hospitals had better in-hospital outcomes when compared to NVUGIB patients managed at teaching hospitals. Further research is encouraged to evaluate why patients at non-teaching hospitals fared better. Nonetheless, our findings contribute novel information on this topic.

Supplementary Material

Suppl 1. Used ICD-10 Codes

Acknowledgments

None to declare.

Financial Disclosure

None to declare.

Conflict of Interest

None to declare.

Informed Consent

Not applicable.

Author Contributions

Jennifer C. Asotibe MD, Hafeez Shaka MD, and Emmanuel Akuna MD are credited with substantial contributions to the drafting of the manuscript, interpretation of the data, design of the work, revision of intellectual content, and final approval of the submitted version of the manuscript. Niveda Shekar MD, Hassam Shah MD, and Marcelo Ramirez MD are credited with the drafting of the manuscript, literature review,and discussion of data. Syed Ali Amir Sherazi MD, and Katayoun Khoshbin MD are credited with the literature review and revision of intellectual content for the manuscript. Hemant Mutneja MD, and Bashar Attar MD are credited with critical revision of the entire manuscript, literature review, and final approval of the submitted manuscript.

Data Availability

The authors declare that data supporting the findings of this study are available within the article.

Abbreviations

NVUGIB: non-variceal upper gastrointestinal bleeding; UGIB: upper gastrointestinal bleeding; NIS: National Inpatient Sample; HCUP: Healthcare Cost and Utilization Project; LOS: length of stay; THC: total hospital charges; GI: gastrointestinal

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