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Original Article

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Evaluating the Impact of Co-Existent Inflammatory Bowel Disease on Hospital-Based Outcomes Among Patients With Acute Pancreatitis: An Analysis of the 2020 National Inpatient Sample Database

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Abstract

Background: Inflammatory bowel disease (IBD) has been associated with increased risk of developing pancreatitis. We analyzed data from the National Inpatient Sample (NIS) with the aim of evaluating the outcomes of acute pancreatitis (AP) in patients with co-existent Crohn's disease (CD) or ulcerative colitis (UC).

Methods: This was a cross-sectional study using the 2020 NIS database. Patients were included if they were more than 18 years old with a principal diagnosis of AP. Main outcome measurements of our study were in-hospital mortality, length of hospital stay, hospital total charges, incidences of hypovolemic shock, severe sepsis with and without shock, acute kidney failure (AKI), and the need for intensive care unit (ICU) care. Statistical analyses were performed on STATA version 18.0.

Results: There were 258,965 (0.8%) admissions with the primary diagnosis of AP among the 32 million discharges in 2020 NIS database. Among patients with AP, a total of 1,930 (0.75%) and 1,170 (0.45%) hospitalizations had co-existing CD and UC, respectively. The overall in-hospital mortality for AP was 1,560 (0.62%). Patients with UC hospitalized for AP had increased odds of in-hospital mortality (adjusted odds ratio (aOR): 3.62, 95% confidence interval (CI): 1.310 - 9.978, P = 0.013) while for patients with CD, there were no in-hospital mortality. Patients with CD had increased odds of developing comorbid AKI (aOR: 1.37, 95% CI: 1.005 - 1.880, P = 0.047) when they present with AP but not those with UC.

Conclusions: Patients hospitalized with AP had increased odds of in-hospital mortality and comorbid AKI when they have co-existent UC and CD, respectively.

Keywords: Acute pancreatitis; Inflammatory bowel disease; Ulcerative colitis; Crohn's disease; Mortality

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Introduction

Acute inflammation of the exocrine pancreas, otherwise known as acute pancreatitis (AP), can damage adjacent tissues and distant organs and has a 1-5% mortality [1]. It is a prominent gastrointestinal reason for hospitalization in the United States, contributing to approximately 300,000 visits to the emergency department annually [2]. Globally, AP incidence among men and women was found to have no significant difference and occurs at an annual rate ranging from 13 to 45 per 100,000 individuals [3].

Inflammatory bowel disease (IBD), which includes Crohn's disease (CD) and ulcerative colitis (UC), is a chronic immune-mediated relapsing-remitting condition in the gastrointestinal tract and other bodily organs [4]. Of the patients, 21-47% diagnosed with IBD manifest extraintestinal complications [4]. Several studies have shown a three to fourfold increased risk of developing AP among CD patients and a twofold higher risk among UC [5-7]. Nonetheless, there is a scarcity of population-wide studies understanding the outcomes of AP in the setting of IBD. To address this gap, we utilized the National Inpatient Sample (NIS) database to evaluate the outcomes of AP in patients with co-existent IBDs.

Materials and Methods

Data source

This study used the NIS database from January 1, 2020, to December 31, 2020, to investigate patients diagnosed with AP. This database is vital for assessing inpatient utilization,

Table 1. ICD-10-CM Diagnostic Codes to Identify Primary Diagnosis and Co-Diagnosis

Diagnosis	Code
AP	K85.00, K85.01, K85.02, K85.80, K85.81, K85.82, K85.90, K85.91, K85.92, K85.10, K85.11, K85.12, K85.20, K85.21, K85.22, K85.30, K85.31, K85.32
UC	K51.00, K51.011, K51.20, K51.30, K51.013, K51.014, K51.018, K51.019, K51.211, K51.212, K51.213, K51.214, K51.218, K51.219, K51.311, K51.312, K51.313, K51.314, K51.318, K51.319, K51.811, K51.812, K51.813, K51.814, K51.818, K51.819, K51.911, K51.912, K51.913, K51.914, K51.918, K51.919
CD	K50.00, K50.011, K50.012, K50.013, K50.014, K50.018, K50.019, K50.10, K50.111, K50.112, K50.113, K50.114, K50.118, K50.118, K50.119, K50.80, K50.811, K50.812, K50.813, K50.814, K50.818, K50.819, K50.90, K50.911, K50.912, K50.913, K50.914, K50.918, K50.919

CD and UC groups are mutually exclusive. AP: acute pancreatitis; CD: Crohn's disease; UC: ulcerative colitis.

accessibility, costs, quality of care, and outcomes in the United States at regional and national levels. It stands as the largest publicly available all-payer database for inpatient healthcare, incorporating data from approximately 7 million hospital stays annually, representing around 35 million hospital admissions nationwide when weighted. Information regarding all procedures conducted during hospital stays is derived from discharge abstracts within the NIS. Other key details included in the database are patient demographics, length of hospital stay (LOS), postoperative complications, in-hospital mortality, and hospital characteristics. However, the NIS database lacks information regarding issues emerging after the discharge of patients from the hospital [8].

Study sample

This study's inclusion criteria consisted of selecting patients from the 2020 NIS who were older than 18 and admitted with a principal diagnosis of AP. Primary diagnosis of AP and a co-diagnosis of CD, or UC were identified by utilizing the International Classification of Diseases, Tenth Revision Clinical Modification (ICD-10-CM) diagnostic codes (Table 1).

Study outcomes

Our study's primary outcome was in-hospital mortality, a variable contained in the NIS dataset. LOS, hospital total charges incurred, and development of complications like hypovolemic shock, sepsis, acute kidney injury (AKI), and the need for intensive care unit (ICU) care were the secondary outcomes. The NIS dataset provides a variable for LOS and total charges incurred. Other secondary outcomes were identified using ICD-10-CM codes. Our main determinant variables were CD or UC. Both variables were mutually exclusive.

Control variables

Sociodemographic characteristics included age in years at admission, sex, race, annual income, and primary third-party payer (health insurance). We also controlled for the patient's Charlson Comorbidity Index Score (CCIS).

Statistical analysis

Values were expressed as either mean ± standard deviations or numbers with percentages, as appropriate. Recommended discharge and hospital weights were incorporated into the data (discharge weights were used to create national estimates for all analyses). We conducted univariate analyses to detect variables independently associated with the study outcomes. Any variable with a univariate test with a P-value < 0.20 was accepted as a candidate for the multivariable models, along with all variables of known clinical importance. We chose a $P < 0.20$ threshold in the univariate analysis as a screening criterion to ensure that potentially important variables are not excluded prematurely, particularly those that may not show strong univariate associations but could become significant in the presence of other covariates in the multivariable model due to confounding or interaction effects.

We utilized STATA version 18.0 (StataCorp LLC, Texas, USA) for statistical analyses, and $P < 0.05$ was considered statistically significant after multivariate logistic regression. Since our study used the NIS database, which contains de-identified patient data, it is classified as exempt from formal review by the ethics committee of our institution per the guidelines for research using publicly available data. As a result, institutional review board (IRB) approval was not required for this study. However, we adhered to all relevant ethical standards, and we followed the data use agreement provided by the Healthcare Cost and Utilization Project (HCUP) to make sure compliance with regulations regarding the use of de-identified datasets.

Results

In our analysis of the 2020 NIS database, 258,965 patients were hospitalized with a primary diagnosis of AP, representing a prevalence of 0.8% among approximately 32 million discharges and an in-hospital mortality rate of 0.62%. Among these, 15,240 patients presented with severe forms of AP, including pancreatic necrosis and infection. The identified etiologies included 79,704 cases of alcoholic AP, 42,120 cases of biliary AP, and 3,774 cases of drug-induced AP. Of all patients admitted with AP, 3,100 (1.19%) had a concurrent diagnosis of IBD, comprising 1,930 (0.75%) with CD and 1,170 (0.45%) with UC.

Table 2. Characteristics of Hospitalizations for AP by CD Status

Patient characteristics	CD group		
	With CD	Without CD	P-value
Patients, n (%)	1,930 (0.75)	257,035 (99.3)	
Gender			0.015
Male	940 (48.7)	141,626 (55.1)	
Female	990 (51.3)	115,409 (44.9)	
Race			< 0.001
White	1,573 (81.5)	163,731 (63.7)	
Black	214 (11.1)	44,724 (17.4)	
Hispanic	102 (5.2)	33,672 (13.1)	
Charlson Comorbidity Index score, n (%)			0.024
0	840 (43.5)	94,846 (36.9)	
1	606 (31.4)	81,737 (31.8)	
2	249 (12.9)	38,041 (14.8)	
≥ 3	235 (12.2)	42,668 (16.6)	
Insured type, n (%)			0.001
Medicaid	666 (34.5)	73,255 (28.5)	
Medicare	407 (21.1)	69,656 (27.1)	
Private	730 (37.8)	86,364 (33.6)	
Location/teaching status of hospital			0.934
Rural	214 (11.1)	29,816 (11.6)	
Urban non-teaching	396 (20.5)	53,977 (21.0)	
Urban teaching	1,320 (68.4)	173,499 (67.5)	
Relative bed size category of hospital			0.355
Small	481 (24.9)	70,428 (27.4)	
Medium	531 (27.5)	74,283 (28.9)	
Large	921 (47.7)	112,581 (43.8)	
Etiologies of AP			
Alcoholic AP	347 (18.0)	79,166 (30.8)	< 0.01
Biliary AP	214 (11.1)	41,897 (16.3)	< 0.01
Drug-induced AP	85 (4.4)	3,598 (1.4)	< 0.01

AP: acute pancreatitis; CD: Crohn's disease.

Patient characteristics

AP with a co-diagnosis of CD (AP/CD)

The AP/CD group was mostly females, Whites, and had more Medicaid hospitalizations than the AP/non-CD group (Table 2). Stratified by etiologies of AP, 18.0% of the CD patients had alcoholic AP, 11.1% had biliary AP, and 4.4% had drug-induced AP. Notably, it was found that patients with a history of CD had a significantly increased incidence of drug-induced AP than the non-CD patients (4.4% vs. 1.4%, P < 0.01).

AP with co-diagnosis of UC (AP/UC)

The AP/UC group had a higher distribution of Whites, primarily "private" health insurance, patients coming from locations with the highest median annual income, and CCIS of "0" than the AP/non-UC group (Table 3). Stratified by etiologies of AP, 17.5% of the UC patients had alcoholic AP, 9.4% had biliary AP, and 8.6% had drug-induced AP. Similar to the CD group, it was found that patients with a history of UC had a significantly increased incidence of drug-induced AP than the non-UC patients (8.6% vs. 1.4%, P < 0.01).

Primary outcome

There was no statistically significant difference in in-hospital mortality between patients with AP with and without a history of IBD (CD + UC) (0.65% vs. 0.62%, P = 0.93). Notably, no deaths were observed among patients with both AP and CD. However, mortality was significantly higher in patients with

Table 3. Characteristics of Hospitalizations for AP by UC Status

Patient characteristics	UC group		
	With UC	Without UC	P-value
Patients, n (%)	1,170 (0.45)	257,795 (99.5)	
Gender			0.723
Male	631 (53.9)	141,787 (55.0)	
Female	541 (46.2)	116,008 (45.0)	
Race			0.004
White	899 (76.8)	164,473 (63.8)	
Black	149 (12.7)	44,856 (17.4)	
Hispanic	82 (7.0)	33,513 (13.0)	
Charlson Comorbidity Index score, n (%)			0.027
0	535 (45.7)	95,126 (36.9)	
1	305 (26.0)	81,979 (31.8)	
2	180 (15.4)	38,154 (14.8)	
≥ 3	150 (12.8)	42,536 (16.5)	
Insured type, n (%)			0.021
Medicaid	293 (25.0)	73,472 (28.5)	
Medicare	366 (31.3)	69,862 (27.1)	
Private	449 (38.4)	86,619 (33.6)	
Location/teaching status of hospital			0.028
Rural	95 (8.1)	29,904 (11.6)	
Urban non-teaching	190 (16.2)	54,137 (21.0)	
Urban teaching	885 (75.6)	174,012 (67.5)	
Relative bed size category of hospital			0.057
Small	285 (24.4)	70,636 (27.4)	
Medium	280 (23.9)	74,503 (28.9)	
Large	605 (51.7)	112,914 (43.8)	
Etiologies of AP			
Alcoholic AP	205 (17.5)	79,401 (30.8)	< 0.01
Biliary AP	110 (9.4)	42,020 (16.3)	< 0.01
Drug-induced AP	101 (8.6)	3,609 (1.4)	< 0.01

AP: acute pancreatitis; UC: ulcerative colitis.

UC compared to those without UC (1.72% vs. 0.61%, P = 0.03). When stratified by AP etiology, no deaths were reported among patients with alcoholic or biliary AP and concurrent UC. In contrast, patients with drug-induced AP and a history of UC had a 5% mortality rate, which was statistically significant (P < 0.01). On multivariable regression analysis, patients with AP/UC were more likely to die in the hospital (adjusted odds ratio (aOR): 3.62, 95% CI: 1.310 - 9.978, P = 0.013) than patients without UC (Table 4).

Secondary outcomes

The average LOS for patients hospitalized with AP was 4.2 days, with a mean total hospital charge of $45,090. Among these patients, 634 (0.24%) developed hypovolemic shock, 1,860 (0.72%) experienced sepsis with or without shock, 33,979 (13.1%) developed AKI, and 239 (0.09%) required admission to the ICU.

Our multivariable regression analysis revealed that patients with AP and a concurrent history of CD had significantly increased odds of developing AKI, with an aOR of 1.37 (P = 0.047) (Table 5). When AP cases were stratified into mild (without infection or necrosis) and severe forms, the association remained significant in the mild AP subgroup; patients with mild AP and a history of CD demonstrated higher odds of AKI (aOR: 1.40, P = 0.044). In contrast, among patients with severe AP, the presence or absence of CD did not significantly

Table 4. Results of Multivariate Regression Analysis With UC as a Main Determinant Factor of Patient's Outcomes

Outcomes	UC group				
	aOR	Linearized coefficient	Standard error	95% confidence interval (LL, UL)	P- value
In-hospital mortality	3.616		1.872	1.310, 9.978	0.013
Length of stay (days)		0.080	0.243	-0.396, 0.557	0.741
Hypovolemic shock	3.924		2.859	0.941, 16.370	0.061
Sepsis with or without shock	2.661		1.368	0.971, 7.291	0.057
Acute kidney injury	1.187		0.245	0.792, 1.778	0.407

Each row represents the results of an independent multivariate regression after controlling for age, gender, race, Charlson comorbidity index, median annual income, insurance type, region of hospital, hospital bed size, and hospital teaching status. aOR: adjusted odds ratio; LL: lower limit; UC: ulcerative colitis; UL: upper limit.

impact AKI outcomes (aOR: 1.23, P = 0.678).

No statistically significant differences were observed in secondary outcomes among patients with AP and a concurrent history of CD, including LOS, total hospital charges, or the incidence of complications such as hypovolemic shock, sepsis, or ICU admission. Patients with AP and a history of UC did not demonstrate any significant differences in any of the secondary outcomes, including development of AKI.

Discussion

AP is characterized by sudden inflammation and pancreatic tissue damage, which can extend to surrounding or distant organs, and is the most common pancreatic disorder that can present in association with IBD. Studies have shown that IBD patients have an increased risk of developing AP than the general population [9]. In a retrospective multicenter study conducted in Spain, the risk of developing AP among IBD patients was 1.6% [10]. Weber et al [11] observed a 1.4% risk of developing AP among CD patients. A population-based cohort study in Taiwan found an overall rate of AP occurrence in IBD patients to be 3.56 times higher than those without IBD [12].

The primary reasons for AP occurrence in patients with IBD are gallstones and medications. Other less common etiologies are balloon enteroscopy, hypercalcemia, post-endoscopic retrograde cholangiopancreatography, and hypertriglyceridemia [3]. There is a twofold risk of developing gallstones in CD patients compared to the general population. Conversely, the formation of gallstones does not appear to be associated with UC [13].

This study finding parallels with previous studies that showed an elevated risk of AP among CD patients in comparison to UC [14-16]. Potential reasons for the elevated occurrence of AP in individuals with CD than those with UC may stem from variances in medical treatments, increased association with gallstone formation, increased incidence of macronutrient and micronutrient deficiencies, and duodenal involvement in CD causing AP secondary to ampullary inflammation.

Multiple studies have shown that one of the reasons for AP occurrence in IBD patients is medication-induced [10, 17]. Thiopurines constitute a significant cause of medication-induced AP in patients with IBD. Thiopurine-induced AP (TIP) is higher in CD patients than in those with UC. TIP typically has a mild course, and patients usually experience immediate clinical improvement after discontinuing the medication. Additionally, females have a 3.4-fold increased risk of developing TIP [10]. These could be possible explanations for the finding of no mortality report during our study period and mostly females presenting with AP in co-existent CD in our study.

Though the CD group did not show any mortality, there was an increased odds of mortality among UC group presenting with AP in our study. This finding could partly be due to the commonly used medication in UC patients, i.e., 5-aminosalicylic acid (5-ASA) agents. The 5-ASA compounds, such as sulfasalazine, olsalazine, and mesalamine, have been associated with drug-induced AP [18]. Notably, our study identified a 5% mortality rate among patients with drug-induced AP who also had a co-existing history of UC. Typically, 5-ASA-induced pancreatitis is mild, although there are cases of severe necrotizing pancreatitis [18]. The precise cause of the increased mortality among UC patients observed in our study is

Table 5. Results of Multivariate Regression Analysis With CD as a Main Determinant Factor of Patient's Outcomes

Outcomes	CD group				
	aOR	Linearized coefficient	Standard error	95% confidence interval (LL, UL)	P- value
Length of stay		0.006	0.241	-0.468, 0.479	0.982
Sepsis with or without shock	1.741			0.642, 4.720	0.276
Acute kidney injury	1.375			1.004, 1.880	0.047

Each row represents the results of an independent multivariate regression after controlling for age, gender, race, Charlson comorbidity index, median annual income, insurance type, region of hospital, hospital bed size, and hospital teaching status. In-hospital mortality or hypovolemic shoch were not included as outcomes, there were no cases in this study sample. aOR: adjusted odds ratio; LL: lower limit; CD: Crohn's disease; UL: upper limit.

unknown and warrants further investigation.

Our study also revealed an increased risk of AKI among patients with CD who were admitted with AP. AKI is a well-recognized complication of severe AP [19], and in our cohort, it occurred in 13.1% of hospitalized patients with AP. In severe AP, AKI develops due to a combination of factors stemming from the inflammatory response and pancreatic enzyme activation. This leads to volume depletion, endothelial damage, and renal vasoconstriction, ultimately impairing kidney function [19]. Interestingly, in our study, CD was significantly associated with a higher risk of AKI among patients presenting with mild AP, but not in those with severe forms. One possible explanation is that CD itself is a chronic inflammatory condition often associated with subclinical renal impairment, volume depletion from gastrointestinal losses, or medication-related nephrotoxicity, all of which may predispose patients to renal injury even in the absence of severe pancreatic inflammation.

Limitations

The NIS database is restricted to in-hospital stays and lacks outpatient 30-day follow-up data. It would not be possible for this database to record deaths that happen after discharge. Secondly, ICD-10 codes are used to identify comorbidities in NIS; however, the results could be skewed by coding errors or missed data. The NIS does not include information about medications. Consequently, this analysis could not provide data on medications that might have contributed to the poor outcomes in AP. Furthermore, the database lacks clinical details such as IBD disease activity or flare status at the time of admission. Therefore, we were unable to determine whether the observed increased mortality in patients with UC was related to a concurrent IBD flare. Likewise, disease severity scores for IBD or AP-specific severity indices could not be incorporated into our analysis. Future prospective studies with access to granular clinical, pharmacologic, and disease activity data are needed to better understand these associations.

Conclusion

Our study found that there is an increased risk of complications among AP patients including in-hospital mortality and AKI when they have co-existent UC and CD, respectively. Future research should focus on developing policies to enhance outcomes for patients with both AP and IBD.

Acknowledgments

None to declare.

Financial Disclosure

None to declare.

Conflict of Interest

None to declare.

Informed Consent

Our study utilized the National Inpatient Sample database comprising de-identified patient data. As the data are anonymized and do not contain personally identifiable information, the study was exempt from informed consent requirements.

Author Contributions

Formulation of idea, methodology, and writing - original draft preparation: Dheeraj Alexander. Biostatistics: Dheeraj Alexander and Olga Santiago-Rivera. Writing - review and editing: Laith H. Jamil.

Data Availability

This study utilized the NIS database, publicly available through HCUP of the Agency for Healthcare Research and Quality (AHRQ). The NIS comprises de-identified patient data, ensuring compliance with patient confidentiality and privacy regulations. Researchers can access the NIS data by purchasing it from the HCUP Central Distributor. Detailed information on data access procedures is available on the HCUP website: https://hcup-us.ahrq.gov/tech_assist/centdist.jsp.

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