

# Inflammatory Bowel Disease Readmissions Are Associated With Utilization and Comorbidity

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Inflammatory bowel disease (IBD) is a chronic relapsing/remitting disease that often requires multispecialty care, medication infusions, surgical resection, and acute hospitalizations. Patients with IBD have high healthcare utilization and carry incremental lifetime healthcare costs that are significantly higher than those of controls without IBD. Hospital care accounts for up to one-third of this cost.<sup>1-3</sup>

A select group of patients with IBD is responsible for a large proportion of this inpatient healthcare utilization, demonstrating the burden of frequent hospitalizations.<sup>4</sup> Chronic and complex medical diseases, such as IBD, have been linked to high readmission rates, which are a substantial burden to the US healthcare system.<sup>5-8</sup> Single-center studies report an all-cause 30-day readmission rate of nearly 20% among patients with IBD compared with a 30-day combined readmission rate of 22.9% for patients with heart failure, acute myocardial infarction, and pneumonia—the conditions targeted as part of the Hospital Readmissions Reduction Program.<sup>5,6,9</sup>

Readmissions are considered a surrogate for poor inpatient care quality and an important end point in the assessment of high-value care.<sup>10,11</sup> Studies in the cardiology and surgical literatures have shown that hospital readmissions are more likely to be associated with higher mortality, longer length of stay, and lower likelihood of discharge home.<sup>12-14</sup> However, the association between IBD readmissions and hospital outcomes has not been described.

With a heightened emphasis on high-value care and the high readmission rates among patients with IBD, we aimed to better understand the association between IBD readmissions and visit outcomes using 2 state-specific inpatient databases. We hypothesized that 30-day readmissions in IBD are associated with poor hospitalization outcomes, specifically increased length of stay and higher rates of comorbid conditions affecting the hospitalization.

## METHODS

We performed a retrospective cohort study using the State Inpatient Databases (SIDs) for New York and Florida from 2009 to 2013. The SIDs are all-payer state-specific databases of inpatient stays

## ABSTRACT

**OBJECTIVES:** Hospital care accounts for up to one-third of the cost of inflammatory bowel disease (IBD) management. A select group of patients with IBD is responsible for a large proportion of this utilization, demonstrating the burden of frequent hospitalizations. We aim to better understand the burden of 30-day readmissions among patients with IBD using a national hospital database.

**STUDY DESIGN:** Retrospective cohort study of state-specific inpatient databases.

**METHODS:** The State Inpatient Databases for New York and Florida were used to identify patients with IBD hospitalized between 2009 and 2013. The prevalence of 30-day IBD-specific readmission was determined. The association between 30-day readmission and visit outcomes, specifically length of stay and a composite of comorbid conditions (venous thromboembolism, pneumonia, sepsis, *Clostridium difficile* infection, enteral and parenteral nutrition, and blood transfusion), was analyzed using multivariable logistic regression.

**RESULTS:** Patients with IBD accounted for 35,514 and 39,506 inpatient stays in New York and Florida, respectively. Of these stays, 13.7% to 16.2% resulted in a 30-day readmission. On multivariable analysis, 30-day readmissions were associated with a longer length of stay than index hospitalizations by 1.00 day (adjusted regression coefficient, 1.00; 95% CI, 0.73-1.26) and a higher likelihood of having a comorbid condition (adjusted odds ratio, 1.83; 95% CI, 1.68-1.99) in New York. Similar associations were confirmed in Florida.

**CONCLUSIONS:** Nearly 1 in 7 hospitalizations of patients with IBD lead to a 30-day readmission. These IBD-specific readmissions are associated with increased utilization and comorbidity. Patients at risk for readmission need to be targeted to improve outcomes and IBD care quality.

*Am J Manag Care.* 2019;25(10):474-481

supported through the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP).<sup>15</sup> The SIDs of New York and Florida were chosen because the states have large, diverse populations. These state-specific SIDs also allow for year-to-year follow-up throughout the study period.<sup>16</sup>

### Inclusion and Exclusion Criteria

Adult IBD hospitalizations were identified using any diagnosis of Crohn disease or ulcerative colitis, identified by *International Classification*

*of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes 555.x or 556.x, respectively. This definition of IBD has previously been well validated.<sup>7</sup> Visits with indeterminate IBD, as defined by a diagnosis of both ulcerative colitis and Crohn disease within the same encounter, were excluded, given difficulty differentiating IBD type.<sup>7</sup> Using patient identifiers, visits were linked to measure 30-day readmission. Patients who died during the index hospitalization and those with less than 30 days of follow-up (ie, index admission within the last 3 months of the study period) were also excluded (**Figure 1**). Our final study population consisted of IBD-specific hospitalizations, defined as a primary diagnosis of IBD or a secondary diagnosis of IBD associated with a primary diagnosis of an IBD-related complication, to exclude readmissions and hospital outcomes that might be primarily driven by other conditions.<sup>17,18</sup> A primary diagnosis of an IBD complication was defined using a previously published schema that includes 9 major complications identified by *ICD-9-CM* codes (active fistulizing disease or intra-abdominal abscess, stricture, bowel obstruction, perianal abscess, lower gastrointestinal hemorrhage, hypovolemia, electrolyte imbalance, anemia, and malnutrition).<sup>17,18</sup>

### Objectives

The primary objective was to determine the prevalence of 30-day IBD-specific readmissions from 2009 to 2013. Our secondary objective was to compare visit-level outcomes associated with readmission, specifically readmission length of stay and a composite of associated comorbid conditions that affect hospitalization. A comorbid condition was defined as a composite of Clinical Classifications Software (CCS) codes for venous thromboembolism, pneumonia, sepsis, *Clostridium difficile* infection, enteral or parenteral nutrition, or blood transfusion. CCS is a tool used to group diagnoses and procedures into meaningful categories using *ICD-9-CM* codes.<sup>19</sup> A subgroup analysis was performed to compare 30-day readmission with visit-level outcomes (readmission length of stay and associated comorbid conditions) among only patients who had multiple hospitalizations over the total study period to account for disease severity.

### Covariates and Outcomes

Patient-level and visit-level factors included age, gender, IBD type (ulcerative colitis or Crohn disease), if admission was for a primary

## TAKEAWAY POINTS

Nearly 1 in 7 inflammatory bowel disease (IBD) hospitalizations lead to a 30-day readmission. These IBD-specific readmissions are associated with increased utilization and comorbidity. An awareness of the downstream outcomes associated with 30-day readmissions should drive health system and provider efforts to reduce IBD readmissions and improve outcomes.

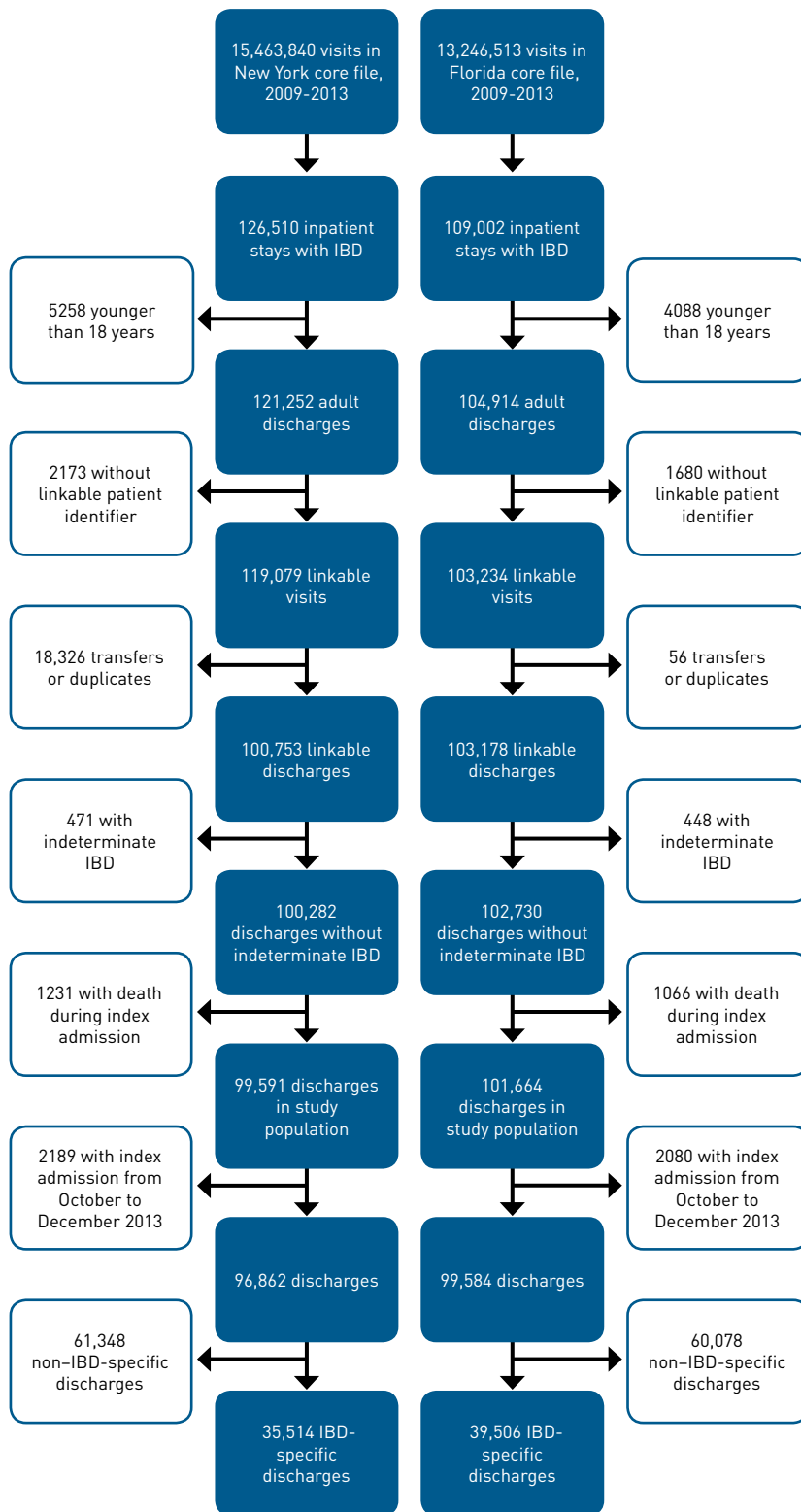
- ▶ Among patients with IBD hospitalized in New York and Florida between 2009 and 2013, 13.7% to 16.2% of inpatient stays resulted in a 30-day readmission.
- ▶ Thirty-day readmissions were associated with a longer length of stay than index hospitalizations.
- ▶ Thirty-day readmissions were associated with a higher likelihood of having an associated comorbid condition.

diagnosis of an IBD complication, admission type, median household income for the patient's zip code, primary payer (Medicare, Medicaid, private, uninsured, or other), race (white, black, or other), and associated psychiatric comorbidities (mood disorder, anxiety, and substance abuse). Admission type was defined as emergent, urgent, or elective. According to HCUP, an emergent admission was defined by an immediate need for medical intervention as a result of a severe, life-threatening, or potentially disabling condition.<sup>15</sup> Urgent admission referred to an immediate need for attention for treatment of a physical or mental disorder.<sup>15</sup> Location was classified according to a rural–urban continuum as large metropolitan, small metropolitan, micropolitan, and not micropolitan or metropolitan. A metropolitan area refers to counties with a population greater than or equal to 1 million; large metropolitan refers to a central inner-city area, and small metropolitan refers to “fringe” suburban areas. Micropolitan, on the other hand, refers to cities with fewer than 250,000 residents. The Elixhauser comorbidity index was also used to compare comorbidities between the readmission and nonreadmission arms. This index was developed for use with administrative databases, is based on *ICD-9-CM* diagnostic codes, and can be used to measure medical comorbidity on the inpatient visit level.<sup>20</sup> A complete list of *ICD-9-CM* codes used to define terms is available in **eAppendix Table 1** (eAppendix available at [ajmc.com](http://ajmc.com)).

### Statistical Analysis

A multivariable logistic regression analysis was performed to evaluate factors associated with readmission within 30 days of discharge compared with the index hospitalization, controlling for variables that were statistically associated with readmission with a  $P < .05$  on univariable analysis. A separate multivariable logistic regression analysis was performed to evaluate the association between comorbid conditions and 30-day readmission compared with the index hospitalization. The association between length of stay and 30-day readmission compared with the index hospitalization was also analyzed using multivariable linear regression. For this length-of-stay model, a priori covariates included age, IBD type, associated comorbid conditions, IBD-related surgery, disposition against medical advice, in-hospital death, mood disorder, substance abuse disorder, and Elixhauser comorbidity index score. For comorbid

**FIGURE 1.** Flow Diagram of Study Population After Inclusion and Exclusion Criteria Were Applied



IBD indicates inflammatory bowel disease.

conditions, a priori covariates included age, IBD type, IBD-related surgery, mood disorder, substance abuse, and Elixhauser comorbidity index score.

Descriptive statistics were reported as medians and interquartile ranges for nonparametric continuous variables and as frequencies and percentages for categorical variables. Associations were first reported in a univariable analysis using the Wilcoxon sum rank test for nonparametric continuous variable comparisons and using  $\chi^2$  or Fisher's exact tests as appropriate for categorical variables. The standard errors were adjusted further to control for clustering at the hospital level. All statistical analyses were performed using STATA MP version 14.0 (StataCorp Inc; College Station, Texas). The study protocol was reviewed by the Weill Cornell Medicine Institutional Review Board and deemed exempt.

## RESULTS

Using the New York and Florida SID core files, 15,463,840 and 13,246,513 hospital discharges, respectively, from the period 2009 to 2013 were examined. Among these, 0.8% included a diagnosis of IBD. After exclusions, the remaining sample included 35,514 and 39,506 inpatient stays among 19,559 and 19,676 patients in New York and Florida, respectively (Figure 1). In New York and Florida, 13.7% and 16.2% of inpatient visits, respectively, resulted in readmission within 30 days.

In the New York and Florida cohorts, 43.2% and 44.3% had ulcerative colitis, respectively, and 56.8% and 55.7% had Crohn disease. In New York and Florida, 53.2% and 54.6% were female, respectively. The baseline patient- and visit-level characteristics for both New York and Florida are shown in Table 1, with few notable differences between New York and Florida populations. Whereas New York's population of hospitalized patients with IBD had higher household incomes and subsequently more private insurance beneficiaries, Florida had a larger Medicare-insured and uninsured population with IBD. As it relates to visit-level outcomes, a majority of hospitalizations led to a discharge home (82.2% and 83.7% in New York and Florida, respectively). Of hospitalizations in New York and Florida, 15.3% and

10.9% included an IBD-related surgery, respectively, and 21.4% and 25.9% included an inpatient colonoscopy. The 2 populations were otherwise similar.

In New York, 30-day readmission was associated with a diagnosis of Crohn disease over ulcerative colitis, age younger than 65 years, urgent admission type, Medicare or Medicaid payer, black race, mood disorder, anxiety, substance abuse, and a higher Elixhauser comorbidity index score, and it was inversely associated with female gender on multivariable analysis. In Florida, we saw similar associations apart from admission type and race, which were no longer statistically significant (Table 2).

On multivariable logistic regression when controlling for a priori covariates, 30-day readmission visits were associated with a higher likelihood of having a comorbid condition (New York: adjusted odds ratio [OR], 1.83; 95% CI, 1.68-1.99; Florida: adjusted OR, 1.79; 95% CI, 1.64-1.95) compared with the index hospitalization (Figure 2). The associations between individual comorbid conditions and readmission are reported in Table 3. Readmissions were also associated with a longer length of stay by 1.00 to 1.23 days compared with the index hospitalization (New York: adjusted regression coefficient, 1.00; 95% CI, 0.73-1.26; Florida: adjusted regression coefficient, 1.23; 95% CI, 0.98-1.48) (Figure 2).

A subgroup analysis comparing outcomes among only patients who had been hospitalized more than once demonstrated persistent associations between 30-day readmission and longer length of stay (New York: adjusted regression coefficient, 1.50; 95% CI, 1.25-1.76; Florida: adjusted regression coefficient, 1.07; 95% CI, 0.82-1.31). Persistent associations between readmission and a higher likelihood of having a comorbid condition were also evident (New York: adjusted OR, 1.54; 95% CI, 1.44-1.65; Florida: adjusted OR, 1.55; 95% CI, 1.42-1.69) (eAppendix Table 2).

## DISCUSSION

This study confirms that patients with IBD have high healthcare utilization, with 13.7% to 16.2% of IBD-related hospitalizations leading to a 30-day readmission. Further, IBD readmissions are more likely to have a longer length of stay and higher frequency of a comorbid condition than index hospitalizations, providing further motivation to address readmissions in any discussion to improve IBD quality measures.

Although 30-day readmission rates are slightly lower than those reported in single-center studies, they may be a more accurate estimate of IBD-specific readmissions given our multihospital sample and strict criteria for identification of IBD-specific hospitalizations.<sup>5-8</sup> This study validates other single-center and national database analyses that demonstrate the ability to characterize factors associated with IBD-related readmissions. Crohn disease denoted an approximately 50% higher risk of readmission in our analysis compared with ulcerative colitis. This is likely a result of the greater complexity and aggressive nature of Crohn disease compared with ulcerative colitis, along with a stronger association with acute and

**TABLE 1.** Baseline Characteristics of IBD-Specific Hospitalizations

	New York	Florida
<b>Visit-Level Characteristics</b>		
n	35,514	39,506
Diagnosis, %		
Primary IBD diagnosis	91.4	87.9
Secondary IBD diagnosis	8.6	12.3
Primary diagnosis IBD complication	8.6	12.3
Admission type, %		
Emergent	80.1	80.0
Urgent	7.0	9.6
Elective	12.9	10.4
Other	a	a
Number of procedures, median (IQR)	1 (0-3)	1 (0-2)
Weekend admit, %	20.1	21.9
Location, %		
Large metropolitan	73.4	65.5
Small metropolitan	17.4	28.3
Micropolitan	6.8	4.2
Not micropolitan or metropolitan	2.4	2.0
Mood disorder, %	13.1	15.3
Anxiety, %	7.8	10.5
Substance abuse, %	3.5	4.8
<b>Patient-Level Characteristics</b>		
n	19,559	19,676
IBD type, %		
Ulcerative colitis	43.2	44.3
Crohn disease	56.8	55.7
Age in years, %		
18-34	34.4	28.9
35-49	25.2	24.3
50-64	21.2	21.9
≥65	19.2	24.9
Female gender, %	53.2	54.6
Median household income, %		
Lower than 25th percentile	17.8	26.6
25th-50th percentile	20.3	30.8
50th-75th percentile	21.5	29.0
Greater than 75th percentile	40.4	13.5
Number of chronic conditions, median (IQR)	3 (2-4)	3 (2-5)
Payer, %		
Medicare	22.6	29.9
Medicaid	16.7	10.4
Private	53.5	42.0
Uninsured	4.8	13.5
Other	2.4	4.2
Race, %		
White	69.7	72.3
Black	10.5	10.1
Other	19.8	17.6

(continued)

**TABLE 1.** (Continued) Baseline Characteristics of IBD-Specific Hospitalizations

	New York	Florida
<b>Visit-Level Outcomes</b>		
In-hospital mortality, %	0.2	0.1
Disposition, %		
Home	82.2	83.7
Skilled nursing facility	3.5	4.1
Home with aide	10.6	8.5
Against medical advice	2.4	2.7
Operating room procedure, %	18.4	14.2
IBD-related surgery, %	15.3	10.9
Colonoscopy, %	21.4	25.9
Comorbid conditions, %		
Venous thromboembolism	4.3	5.0
Pneumonia	1.1	1.2
Sepsis	1.5	1.6
<i>Clostridium difficile</i>	2.5	1.7
Enteral and parenteral nutrition	5.9	4.7
Blood transfusion	10.9	10.6
Length of stay in days, median (IQR)	4 [2-7]	4 [2-6]
Total charge, median (IQR)	\$20,877 (\$11,684- \$37,677)	\$30,056 (\$19,330- \$49,348)

IBD indicates inflammatory bowel disease; IQR, interquartile range.

\*Not reported given n <10.

chronic pain and higher frequency of surgery. We also report a higher likelihood of 30-day rehospitalization among patients younger than 65 years. The relationship between younger age and higher inpatient healthcare utilization has previously been described and is confounded by multiple factors, including that younger patients tend toward a more aggressive disease course and have a lower likelihood of having an established primary care provider.<sup>7</sup> Micic et al, in a nationwide analysis of IBD readmissions in 2013, reported a lower 7% readmission rate, although they utilized different criteria for defining IBD complications that have not been validated using HCUP data.<sup>8</sup> However, they similarly identified Crohn disease and younger age as predictors of readmission.<sup>8</sup>

Additionally, this study confirms an association between all-cause readmission and psychiatric comorbidities. Mood disorder, anxiety, and substance abuse have been shown to contribute to readmission both within and outside the IBD literature.<sup>7,8,21</sup> The impact of psychiatric disorders on rehospitalization is multifactorial, with poor patient engagement, an absence of social support, and lack of postdischarge resources as potential contributors.<sup>21</sup> Perhaps psychiatric comorbidities should be targeted and optimized prior to discharge or in the outpatient transition to reduce readmission.

Disparities in rehospitalization also exist, suggesting differences in care quality by primary payer and race. A study of the 2013 National Readmission Database demonstrated a similar association with public payer, although over a shorter 1-year time period.<sup>7</sup> The racial

differences noted in the New York SID are similar to the findings of another recent study using a national surgery registry that black patients undergoing colorectal surgery have a 60% higher likelihood of 30-day all-cause readmission and an increased length of stay compared with white patients.<sup>22</sup> These findings need to be further validated given their isolated significance in the New York SID. These disparities by payer type and race are likely multifactorial, with patient-level and system-level factors contributing and pointing to a gap in quality in inpatient care. Given the persistent association with rehospitalization when controlling for comorbidity, other confounding factors likely contribute to this disparity, including care access issues and insufficient availability of outpatient resources to vulnerable individuals.

Disparities and differences in care must be addressed, but our demonstration that readmissions are in fact associated with worse outcomes further supports the argument to prioritize efforts to reduce readmissions in the hospitalized population with IBD. Not only are readmissions associated with a length of stay longer than that of the index admission, but they are also associated with an increase in the likelihood of having an associated comorbid condition. Any discussion of hospital readmissions has emphasized the financial burden of hospitalization and length of hospital stay. However, readmissions also carry a higher medical burden for patients, including the need for blood transfusions, enteral or parenteral nutrition, or related comorbidities, such as venous thromboembolism, pneumonia, sepsis, or *C difficile* infection. Because retrospective data cannot assess causality, those patients with a higher medical burden may be at higher risk for readmission, confounding these results. We aimed to address this with a subgroup analysis of patients who had multiple hospitalizations and, by excluding those with a single admission, further reaffirmed that readmissions were associated with poor clinical outcomes.

### Limitations

This study is limited by its retrospective nature and administrative data source, which limit our ability to obtain granular data, such as IBD disease severity, and create a misclassification bias for study population identification, which is dependent on billing codes. Further, although our statistical analysis evaluates associations between 30-day hospital readmission and predefined outcomes, causality cannot be assessed. Although we controlled for confounders in our multivariable analysis, there is also the potential for additional immeasurable confounders. The all-payer nature of this data source, the longitudinal follow-up, and the ability to compare states do strengthen our results and allow us to generalize our main end points. To control for some of these limitations, we performed a sensitivity analysis to confirm that a focus on patients with multiple hospitalizations led to similar results. Our study period from 2009 to 2013 allows us to evaluate readmissions over a 5-year period but also potentially limits generalizability to the present day and may not represent the influences of more recent policy. Although the SID is state specific rather than nationally representative, as

**TABLE 2.** Multivariable Logistic Regression Analysis of Factors Associated With 30-Day Readmission in New York and Florida\*

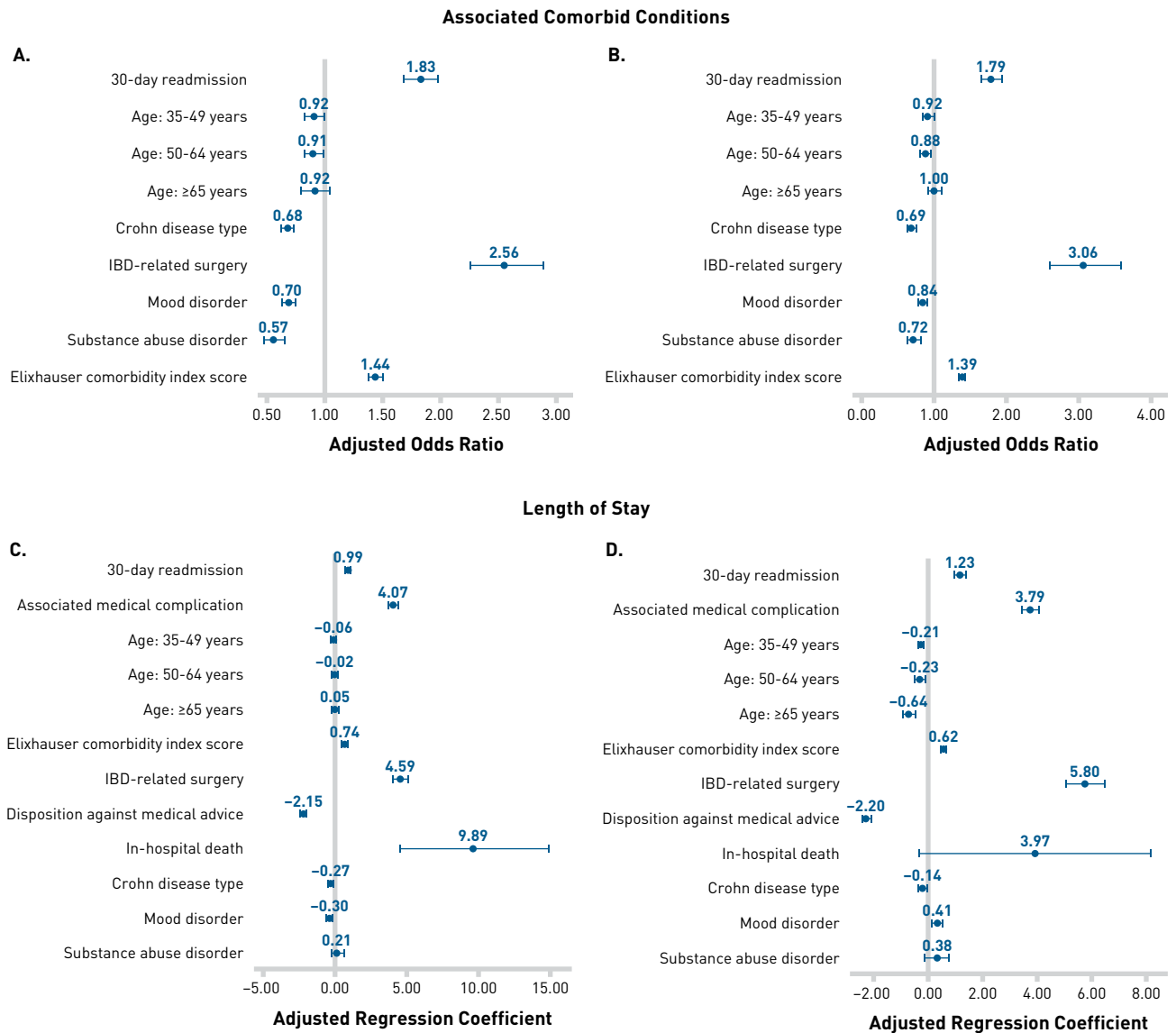
Covariables	New York 30-Day Readmission			Florida 30-Day Readmission		
	Adjusted OR	95% CI	P	Adjusted OR	95% CI	P
IBD type						
Ulcerative colitis	Ref	Ref	Ref	Ref	Ref	Ref
Crohn disease	<b>1.45</b>	<b>1.34-1.57</b>	<b>&lt;.001</b>	<b>1.53</b>	<b>1.41-1.65</b>	<b>&lt;.001</b>
Age in years						
18-34	<b>2.19</b>	<b>1.86-2.58</b>	<b>&lt;.001</b>	<b>2.84</b>	<b>2.43-3.31</b>	<b>&lt;.001</b>
35-49	<b>1.88</b>	<b>1.60-2.22</b>	<b>&lt;.001</b>	<b>2.18</b>	<b>1.87-2.54</b>	<b>&lt;.001</b>
50-64	<b>1.41</b>	<b>1.21-1.65</b>	<b>&lt;.001</b>	<b>1.55</b>	<b>1.33-1.82</b>	<b>&lt;.001</b>
≥65	Ref	Ref	Ref	Ref	Ref	Ref
Female sex	<b>0.82</b>	<b>0.74-0.90</b>	<b>&lt;.001</b>	<b>0.75</b>	<b>0.70-0.81</b>	<b>&lt;.001</b>
Admission type						
Emergent	1.16	0.98-1.37	.096	0.96	0.83-1.12	.629
Urgent	<b>1.88</b>	<b>1.29-2.75</b>	<b>.001</b>	1.09	0.88-1.36	.43
Elective	Ref	Ref	Ref	Ref	Ref	Ref
Other	<sup>b</sup>	<sup>b</sup>	<sup>b</sup>	0.50	0.05-5.00	.553
Race						
White	Ref	Ref	Ref	Ref	Ref	Ref
Black	<b>1.35</b>	<b>1.17-1.56</b>	<b>&lt;.001</b>	1.03	0.92-1.15	.649
Other	1.08	0.94-1.23	.294	0.96	0.87-1.07	.494
Payer						
Medicare	<b>1.53</b>	<b>1.31-1.78</b>	<b>&lt;.001</b>	<b>1.68</b>	<b>1.49-1.90</b>	<b>&lt;.001</b>
Medicaid	<b>1.55</b>	<b>1.38-1.74</b>	<b>&lt;.001</b>	<b>1.83</b>	<b>1.62-2.07</b>	<b>&lt;.001</b>
Private	Ref	Ref	Ref	Ref	Ref	Ref
Uninsured	0.80	0.64-1.00	.046	1.13	0.99-1.29	.08
Other	0.83	0.60-1.14	.249	1.31	1.12-1.54	.001
Median household income						
Below 25th percentile	Ref	Ref	Ref	Ref	Ref	Ref
25th-50th percentile	1.06	0.91-1.23	.481	0.97	0.89-1.07	.563
50th-75th percentile	1.19	1.01-1.41	.041	0.90	0.80-1.01	.079
Greater than 75th percentile	1.06	0.89-1.27	.534	0.86	0.76-0.98	.027
Mood disorder	1.09	0.95-1.26	.218	<b>1.35</b>	<b>1.24-1.47</b>	<b>&lt;.001</b>
Anxiety	<b>1.39</b>	<b>1.22-1.59</b>	<b>&lt;.001</b>	<b>1.24</b>	<b>1.14-1.35</b>	<b>&lt;.001</b>
Substance abuse	<b>1.29</b>	<b>1.07-1.57</b>	<b>.009</b>	<b>1.64</b>	<b>1.46-1.84</b>	<b>&lt;.001</b>
Elixhauser comorbidity index score	<b>1.13</b>	<b>1.10-1.15</b>	<b>&lt;.001</b>	<b>1.10</b>	<b>1.07-1.12</b>	<b>&lt;.001</b>
Weekend admit				<b>1.09</b>	<b>1.02-1.17</b>	<b>.010</b>
Location						
Large metropolitan				Ref	Ref	Ref
Small metropolitan				0.91	0.82-1.01	.073
Micropolitan				0.78	0.62-0.97	.026
Not micropolitan or metropolitan				0.74	0.54-1.00	.048

IBD indicates inflammatory bowel disease; OR, odds ratio; ref, reference.

\*Covariates included variables that were statistically associated with readmission on univariable analysis with a  $P < .05$ . Significant results ( $P < .05$ ) are in bold.

<sup>b</sup>Not reported given  $n < 10$ .

**FIGURE 2.** Associations Among 30-Day Readmissions, Associated Comorbid Conditions, and Length of Stay\*



IBD indicates inflammatory bowel disease.

\*Panels A and B describe the higher likelihood of a composite of associated comorbid conditions in New York and Florida, respectively, among 30-day readmissions compared with the index hospitalization. For comorbid condition, a priori covariates included age, IBD type (Crohn disease compared with ulcerative colitis), IBD-related surgery, mood disorder, substance abuse, and Elixhauser comorbidity index score. Panels C and D describe the longer length of stay in New York and Florida, respectively, among 30-day readmissions compared with the index hospitalization. For the length-of-stay model, a priori covariates included age, IBD type (Crohn disease compared with ulcerative colitis), associated comorbid conditions, IBD-related surgery, disposition against medical advice, in-hospital death, mood disorder, substance abuse disorder, and Elixhauser comorbidity index score.

the Nationwide Inpatient Sample or the National Readmission Database are, it allows us to follow patients beyond a 1-year period, particularly when using the New York and Florida SIDs.<sup>16</sup>

## CONCLUSIONS

Rehospitalization rates for IBD are similar to those for other chronic conditions such as congestive heart failure, which has received

a large amount of attention in readmission reduction efforts.<sup>23,24</sup> Quality initiatives implemented in patients with heart failure resulted in a significant reduction in rehospitalizations, suggesting the potential to also reduce IBD readmissions if similar endeavors are applied.<sup>24</sup> An awareness of the downstream outcomes associated with 30-day readmissions in IBD, specifically, should drive health system and provider efforts to reduce IBD readmissions and improve outcomes.

Nearly 1 in 7 hospitalizations of patients with IBD lead to a 30-day readmission. Differences and disparities in readmissions exist and should be targeted to close the gap and improve delivery of high-quality IBD care. Readmissions are associated with poor hospital outcomes for patients with IBD, including an increased length of stay and an increase in comorbid conditions. Readmissions in IBD need to be at the forefront of efforts to improve IBD health outcomes within our healthcare systems. ■

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**Source of Funding:** None.

**Author Disclosures:** The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (SC-M, MU); acquisition of data (SC-M, MU); analysis and interpretation of data (SC-M, RR, BW, NS, BF, AKW, SS, ES, RB, MU); drafting of the manuscript (SC-M, RR, BW, NS, BF, AKW, SS, ES, RB); critical revision of the manuscript for important intellectual content (SC-M, RR, BW, NS, BF, AKW, SS, ES, RB, MU); statistical analysis (SC-M, RR); administrative, technical, or logistic support (SC-M); and supervision (MU).

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**TABLE 3.** Individual Comorbid Conditions and Association With 30-Day IBD-Specific Readmission

Variable	30-Day Readmission	Not Readmitted	P	Unadjusted OR	95% CI
<b>New York</b>					
Venous thromboembolism	7.3%	3.9%	<.001	1.96	1.73-2.21
Pneumonia	1.6%	1.0%	<.001	1.64	1.28-2.10
Sepsis	2.6%	1.3%	<.001	2.03	1.66-2.49
<i>Clostridium difficile</i> infection	4.4%	2.2%	<.001	2.00	1.71-2.34
Total enteral and parenteral nutrition	12.3%	4.8%	<.001	2.76	2.50-3.05
Blood transfusion	13.6%	10.5%	<.001	1.34	1.22-1.46
<b>Florida</b>					
Venous thromboembolism	8.4%	4.3%	<.001	2.04	1.84-2.26
Pneumonia	2.0%	1.0%	<.001	1.95	1.58-2.40
Sepsis	3.0%	1.3%	<.001	2.33	1.96-2.78
<i>Clostridium difficile</i> infection	2.7%	1.5%	<.001	1.86	1.56-2.22
Total enteral and parenteral nutrition	8.8%	3.9%	<.001	2.42	2.18-2.68
Blood transfusion	11.9%	10.3%	<.001	1.17	1.08-1.27

IBD indicates inflammatory bowel disease; OR, odds ratio.

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**eAppendix Table 1.** List of the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* Diagnostic and Procedure Codes

Term	ICD-9-CM code
Diagnostic codes	
Inflammatory bowel disease	
Crohn's disease	555.0, 555.1, 555.2, 555.9
Ulcerative colitis	556.0, 556.1, 556.2, 556.3, 556.4, 556.5, 556.6, 556.8, 556.9
Primary IBD-related complication	
Fistulizing disease or intra-abdominal abscess	537.4, 567.2, 567.21, 567.22, 569.5, 569.81, 569.83, 593.3, 596.1, 619.1
Bowel obstruction	560.0, 560.1, 560.2, 560.3, 560.31, 560.32, 560.39, 560.8, 560.81, 560.89, 560.9, 568.0
Stricturing disease	560.9, 537.3
Hematochezia	578.9, 569.3
Malnutrition	263.0, 263.1, 263.8, 263.9
Anemia	280, 280.0, 280.1, 280.9, 285.1, 285.9
Perianal disease	566
Hypovolemia	276.52
Electrolyte abnormality	276.1, 276.8
Associated comorbid conditions	
Venous thromboembolism	451.0, 451.11, 451.19, 451.2, 451.81, 451.82, 451.83, 451.84, 451.89, 451.9, 452, 453.0, 453.1, 453.2, 453.3, 453.40, 453.41, 453.42, 453.50, 453.51, 453.52, 453.6, 453.71, 453.72, 453.73, 453.74, 453.75, 453.76, 453.77, 453.79, 453.8, 453.81, 453.82, 453.83, 453.84, 453.85, 453.86, 453.87, 453.89, 453.9, V1251, V1252
Pneumonia	003.22, 020.3, 020.4, 020.5, 021.2, 022.1, 031.0, 039.1, 052.1, 055.1, 073.0, 083.0, 112.4, 114.0, 114.4, 114.5, 115.05, 115.15, 115.95, 130.4, 136.3, 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.3, 482.30, 482.31, 482.32, 482.39, 482.4, 482.40, 482.41, 482.42, 482.49, 482.8, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483, 483.0, 483.1, 483.8, 484.1, 484.3, 484.5, 484.6, 484.7, 484.8, 485, 486, 513.0, 517.1
Sepsis	003.1, 020.2, 022.3, 036.2, 038.0, 038.1, 038.10, 038.11, 038.12, 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 054.5, 449, 771.81, 790.7, 995.91, 995.92
<i>Clostridium difficile</i> infection	008.45
Enteral and parenteral nutrition	966, 991.5
Blood transfusion	990.0, 990.1, 990.2, 990.3, 990.4, 990.5, 990.6, 990.7, 990.8, 990.9

Psychiatric comorbidities	
Mood disorder	293.83, 296.00, 296.01, 296.02, 296.03, 296.04, 296.05, 296.06, 296.10, 296.11, 296.12, 296.13, 296.14, 296.15, 296.16, 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.40, 296.41, 296.42, 296.43, 296.44, 296.45, 296.46, 296.50, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.7, 296.80, 296.81, 296.82, 296.89, 296.90, 296.99, 300.4, 311
Anxiety	293.84, 300.00, 300.01, 300.02, 300.09, 300.10, 300.20, 300.21, 300.22, 300.23, 300.29, 300.3, 300.5, 300.89, 300.9, 308.0, 308.1, 308.2, 308.3, 308.4, 308.9, 309.81, 313.0, 313.1, 313.21, 313.22, 313.3, 313.82, 313.83
Substance abuse	292.0, 292.11, 292.12, 292.2, 292.81, 292.82, 292.83, 292.84, 292.85, 292.89, 292.9, 304.00, 304.01, 304.02, 304.03, 304.10, 304.11, 304.12, 304.13, 304.20, 304.21, 304.22, 304.23, 304.30, 304.31, 304.32, 304.33, 304.40, 304.41, 304.42, 304.43, 304.50, 304.51, 304.52, 304.53, 304.60, 304.61, 304.62, 304.63, 304.70, 304.71, 304.72, 304.73, 304.80, 304.81, 304.82, 304.83, 304.90, 304.91, 304.92, 304.93, 305.20, 305.21, 305.22, 305.23, 305.30, 305.31, 305.32, 305.33, 305.40, 305.41, 305.42, 305.43, 305.50, 305.51, 305.52, 305.53, 305.60, 305.61, 305.62, 305.63, 305.70, 305.71, 305.72, 305.73, 305.80, 305.81, 305.82, 305.83, 305.90, 305.91, 305.92, 305.93, 648.30, 648.31, 648.32, 648.33, 648.34, 655.50, 655.51, 655.53, 760.72, 760.73, 760.75, 779.5, 965.00, 965.01, 965.02, 965.09, V654.2
Procedure codes	
Inflammatory bowel disease-related surgery	
Partial excision of large intestine	45.7
Multiple segmental resection of large intestine	45.71
Cecectomy	45.72
Right hemicolectomy	45.73
Resection of transverse colon	45.74
Left hemicolectomy	45.75
Sigmoidectomy	45.76
Other partial excision of large intestine	45.79
Total intra-abdominal colectomy	45.8
Laparoscopic total intra-abdominal colectomy	45.81
Open total intra-abdominal colectomy	45.82

Other and unspecified total intra-abdominal colectomy	45.83
Intestinal anastomosis	45.9
Intestinal anastomosis, not otherwise specified	45.90
Small-to-small intestinal anastomosis	45.91
Anastomosis of small intestine to rectal stump	45.92
Other small-to-large intestinal anastomosis	45.93
large-to-large intestinal anastomosis	45.94
anastomosis to anus (i.e. pouch)	45.95
Other excision of small intestine	45.6
Multiple segmental resection of small intestine	45.61
Other partial resection of small intestine (i.e. jejunectomy, ileectomy, duodenectomy)	45.62
Total removal of small intestine	45.63
Exteriorization of intestine	46.0
Exteriorization of small intestine (i.e loop ileostomy)	46.01
Resection of exteriorized segment of small intestine	46.02
Exteriorization of large intestine	46.03
Resection of exteriorized segment of large intestine	46.04
Colostomy	46.1
Colostomy, not otherwise specified	46.10
Temporary colostomy	46.11
Permanent colostomy	46.13
Delayed opening of colostomy	46.14
Ileostomy	46.2
Ileostomy, not otherwise specified	46.20
Temporary ileostomy	46.21
Continent ileostomy	46.22
Other permanent ileostomy	46.23
Delayed opening of ileostomy	46.24
Pull-through resection of rectum, not otherwise specified	48.40
Laparoscopic pull-through resection of rectum	48.42
Open pull-through resection of rectum	48.43
Other pull-through resection of rectum	48.49
Abdominoperineal resection of rectum	48.5
Abdominoperineal resection of rectum, not otherwise specified	48.50
Laparoscopic abdominoperineal resection of rectum	48.51
Open abdominoperineal resection of rectum	48.52
Other abdominoperineal resection of rectum	48.59

Other resection of rectum	48.6
Trans-sacral rectosigmoidectomy	48.61
Anterior resection of rectum with synchronous colostomy	48.62
Other anterior resection of rectum	48.63
Posterior resection of rectum	48.64
Duhamel resection of rectum	48.65
Other, partial proctectomy	48.69
Laparoscopic multiple segmental resection of large intestine	17.31
Laparoscopic cecectomy	17.32
Laparoscopic right hemicolectomy	17.33
Laparoscopic resection of transverse colon	17.34
Laparoscopic left hemicolectomy	17.35
Laparoscopic sigmoidectomy	17.36
Other laparoscopic partial excision of large intestine	17.39
Colonoscopy	45.23, 45.24, 45.25

**eAppendix Table 2.** Subgroup Analysis of Outcomes Associated With Inflammatory Bowel Disease Specific 30-Day Readmission Stays Among High Utilizers (those who have been hospitalized more than once)

New York			
Medical complication	Adjusted OR	P-value	95% confidence interval
<b>30 day readmission</b>	<b>1.54</b>	<b>&lt;0.001</b>	<b>1.44, 1.65</b>
Age	1.01	<0.001	1.01, 1.01
IBD type (Crohn's disease)	0.87	<0.001	0.81, 0.92
IBD surgery	2.12	<0.001	1.89, 2.38
Mood disorder	0.67	<0.001	0.63, 0.72
Substance abuse	0.54	<0.001	0.47, 0.62
Elixhauser index	1.27	<0.001	1.23, 1.31
LOS	Adjusted regression coefficient	P-value	95% confidence interval
<b>30 day readmission</b>	<b>1.50</b>	<b>&lt;0.001</b>	<b>1.25, 1.76</b>
Age	0.00	0.537	-0.00, 0.01
IBD type (Crohn's)	-0.03	0.790	-0.23, 0.17
Hospital complication	4.20	<0.001	3.86, 4.53
IBD surgery	5.41	<0.001	4.72, 6.10
Against Medical Advice	-3.06	<0.001	-3.33, -2.78
In-hospital death	4.10	<0.001	1.87, 6.32
Mood disorder	0.34	0.030	0.08, 0.61
Substance abuse	1.46	<0.001	1.06, 1.85
Elixhauser index	0.56	<0.001	0.49, 0.62
Florida			
Medical complication	Adjusted OR	P-value	95% confidence interval
<b>30 day readmission</b>	<b>1.55</b>	<b>&lt;0.001</b>	<b>1.42, 1.69</b>
Age	1.00	<0.001	1.00, 1.00
IBD type (Crohn's disease)	0.65	<0.001	0.59, 0.72
IBD surgery	2.86	<0.001	2.43, 3.36
Mood disorder	0.83	<0.001	0.75, 0.91
Substance abuse	0.69	<0.001	0.59, 0.82
Elixhauser index	1.39	<0.001	1.35, 1.42
LOS	Adjusted regression coefficient	P-value	95% confidence interval
<b>30 day readmission</b>	<b>1.07</b>	<b>&lt;0.001</b>	<b>0.82, 1.31</b>
Age	-0.02	<0.001	-0.02, -0.01
IBD type (Crohn's)	0.00	0.983	-0.28, 0.27
Hospital complication	3.90	<0.001	3.49, 4.32
IBD surgery	6.27	<0.001	5.41, 7.12
Against Medical Advice	-2.41	<0.001	-2.65, -2.18
In-hospital death	4.16	0.059	-0.16, 8.47
Mood disorder	0.49	<0.001	0.22, 0.76
Substance abuse	0.42	0.191	-0.21, 1.05
Elixhauser index	0.65	<0.001	0.48, 0.82