

# Disparities in postoperative outcomes among diverse patient groups with inflammatory bowel disease

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## Abstract

**Background** Inflammatory bowel disease (IBD) represents a significant burden in the United States. We aim to evaluate disparities in postoperative outcomes among diverse patients undergoing surgery for IBD.

**Methods** The National Inpatient Sample (NIS) (2016-2018) was used to calculate national estimates for a number of postoperative complications in patients with IBD. Statistical analyses were performed using SAS survey procedures when calculating the national estimates.

**Results** A majority of the 107,375 patients (weighted) undergoing surgery for IBD were White (81.7%), rather than Black (10.1%) or Hispanic (8.2%). Black patients had higher rates of postoperative infections compared to White or Hispanic patients (4.2% vs. 3.1% vs. 2.7%,  $P=0.0137$ ). There was a significant difference in morbidity and mortality, with higher rates in Black patients (20.1% vs. 17.1% vs. 17.9%,  $P=0.0029$ ). Black patients experienced longer average hospital stays compared to White or Hispanic patients (12.6 vs. 9.6 vs. 11.2 days,  $P<0.001$ ), despite suffering fewer comorbidities (Modified Charlson Index 1.9 vs. 2.3 vs. 2.0,  $P<0.001$ ).

**Conclusions** This study demonstrated racial disparities in postoperative outcomes, with Black patients experiencing significantly higher rates of postoperative infections, overall morbidity and mortality, and length of stay, despite suffering from fewer comorbidities. This suggests an opportunity to improve equity of care for all patients with IBD by further examining social determinants of health that have not been traditionally studied.

**Keywords** Disparities, postoperative outcomes, inflammatory bowel disease

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## Introduction

Inflammatory bowel disease (IBD), comprising Crohn's disease and ulcerative colitis, represents a significant burden of disease in the United States, with prevalences of 505 per 100,000 and 322 per 100,000, respectively, and is associated with a high healthcare cost and utilization [1]. In the past, the incidence of IBD was thought to have been highest in white and Jewish racial and ethnic groups [2,3]. Overall, the incidence of IBD is increasing [4]. This increase in diagnoses is changing the epidemiology of IBD, with a higher prevalence in non-White populations [5]. Studies estimate that up to one-third of patients with IBD are Black [6]. This shift in epidemiology presents an opportunity to determine whether there are disparities among those suffering from IBD.

There are a number of treatment options for those suffering from IBD. The majority of IBD patients are treated medically [7]. A deeper understanding of the pathophysiology of IBD has broadened the options for medical treatments in IBD patients [8]. Despite an increasing number of medical

therapies for IBD, a large portion of IBD patients require surgery [9]. Disparities in surgical outcomes have been seen in the literature, with Hispanic and Black patients suffering more complications than White patients [10,11]. However, despite this increasingly diverse set of patients with IBD, the literature regarding their surgical outcomes remains limited [12-15].

A better understanding of the disparities in post-surgical outcomes allows targeting of areas for improvement in patient care. This can lead to changes in preoperative management and optimization, potentially decreasing postoperative complications. This study aimed to evaluate disparities in postoperative outcomes among a diverse set of patients undergoing surgery for IBD.

## Materials and methods

### Study population

A retrospective cohort of patients undergoing colorectal surgery for IBD was identified using the Nationwide Inpatient Sample (NIS) database maintained by the Healthcare Cost and Utilization Profile (HCUP) from 2016-2018. The NIS is a large inpatient healthcare database, in which 7 million hospital stays are entered annually, and is used to evaluate inpatient access, quality, outcomes, cost and utilization [16]. All NIS patients 18 and older with a diagnosis of IBD, Crohn's disease or ulcerative colitis, were identified and included based on International Statistical Classification of Diseases (ICD-10) codes K50.0-K51.0. Primary intestinal procedures were characterized using Current Procedural Terminology codes and grouped into simple/anorectal, right sided and small bowel, left colon, and rectal procedures. Postoperative complications were identified using ICD-10 codes.

### Variables

The defined characteristics included race (White, Black, Hispanic), age (years), sex (male, female), primary expected payer (Medicare, Medicaid, private insurance, self-pay, no charge, other), size of hospital (Small, Medium, or Large), location/teaching hospital status (rural, urban non-teaching, urban teaching), and region of hospital (Northeast, Midwest, South, West). The Modified Charlson Comorbidity Index (MCI) was calculated using a number of patient factors within the NIS database [17].

Postoperative complications (i.e., morbidity) were identified using ICD-10 codes; they included postoperative hemorrhage, postoperative hematoma, wound dehiscence, colostomy complication, urinary tract infection, postoperative infection, renal failure, acute respiratory failure, acute myocardial infarction, deep vein thrombosis, pulmonary embolism, pneumonia, stroke/cerebrovascular attack, death during hospitalization, overall morbidity, and overall morbidity or

mortality. Length of hospital stay (in days) was also used as a secondary outcome.

### Statistical analysis

Statistical analysis was performed using SAS survey procedures to account for the stratification and clustering in the NIS sample when calculating the national estimates. Using the retrospective National Institutes of Health cohort, univariate analysis was performed on covariates to test for differences between races (White, Black, Hispanic) in the study population for each covariate. Continuous variables were compared using a one-way analysis of variance (ANOVA) test to compare means, while categorical variables were compared using Pearson's chi-square test. A P-value of 0.05 was considered significant and was reported for each covariate.

After comparing differences in races between covariates, univariate analysis was then performed on each outcome, including any complication, morbidity or death, to test for difference between races. Length of stay was also included as an outcome variable, as Black patients were seen to have longer hospital stays than Whites and Hispanics, even though the MCI indicated that White patients suffered from more comorbidities. Once again, continuous variables were compared using a one-way ANOVA test, while categorical outcomes were compared using the Pearson chi-squared test to examine differences in outcomes between races. For both covariates and outcome variables, summary statistics were also reported, including percentages for categorical variables, and means and standard errors for continuous variables for each race.

Multivariate logistic regression was then performed using all covariates, including race, as independent variables, with any complication, morbidity or death as the outcome variable. A Wald chi-square test was used to test for significance of each covariate on outcomes, and odds ratios (OR) with 95% confidence intervals (95%CI) from the logistic regression were reported for each covariate. A separate multivariate linear regression analysis was run with length of stay as the outcome variable, reporting estimated regression coefficients for each covariate, and *t*-tests were used to test for the significance of each covariate.

This study was reviewed and approved by the Virginia Commonwealth University Institutional Review Board.

## Results

A total of 107,375 patients (weighted) underwent surgery for IBD. The majority were White (81.7%), rather than Black (10.1%) or Hispanic (8.2%); 56,630 (52.7%) of the patients were female. There was roughly an equivalent number of males and females with IBD among each race. Black and Hispanic patients were younger than White patients (44.1 vs. 44.6 vs. 50.5 years,  $P < 0.001$ ). Forty-seven percent of patients were

diagnosed with Crohn's disease, 24% had ulcerative colitis, while the remainder had unspecified IBD. Ulcerative colitis was the least frequent diagnosis for Black patients (14.7%) compared to the other races. A full description of the patients and demographics within the sample can be found in Table 1.

Most patients, 64275 (59.9%), underwent their operations at large hospitals. Nearly 80% of patients had their surgeries at urban teaching facilities. This trend was seen in all races. Close to half of all patients had private insurance, though private insurance was slightly less common in Black patients (37.9%).

In a pairwise comparison, Black and Hispanic patients had significantly longer hospital stays compared to White patients, with Black patients having the longest overall (12.6 vs. 11.2 vs. 9.6 days,  $P < 0.001$ ). Black patients had higher rates of postoperative infections than White patients, while Hispanic patients had the lowest rates (4.2% vs. 3.2% vs. 2.7%,  $P = 0.0137$ ). Black patients had significantly higher morbidity alone, as well as morbidity and mortality combined, compared to White and Hispanic patients (19.1% and 20.1% vs. 16.2% and 17.1% vs. 16.9% and 17.9%,  $P = 0.0031$  and  $P = 0.0029$ ) (Table 2).

On univariate analysis, Black patients, females, patients with Medicare, patients being treated in medium sized hospitals, patients in rural hospitals, patients in the South, those with indeterminate inflammatory disease/other and those undergoing surgery on the left colon had the highest complication or death rates. The comparisons among variables (race, sex, primary payer, hospital size, location/teaching status, hospital region, calendar year, diagnosis, procedure type) in all categories were statistically significant. The univariate analysis was used to determine the variables for the multivariate analysis.

Using a multivariate logistic regression model controlling for covariates (Tables 3,4), Black patients were more likely to suffer from postoperative morbidity or mortality than White patients (odds ratio [OR] 0.762, 95%confidence interval [CI] 0.675-0.861). Those with Medicare and Medicaid had higher odds of morbidity and mortality than those with private insurance (OR 1.584, 95%CI 1.426 and OR 1.594, 95%CI 1.418-1.793). Patients undergoing surgery in rural or urban nonteaching hospitals had higher odds of

**Table 1** Demographics

Characteristic	Overall (n=107375)	White (n=87765)	Black (n=10815)	Hispanic (n=8795)	P-value
Age (mean±SEM)	49.33±0.13	50.45±0.15	44.12±0.41	44.57±0.50	<0.001
Sex: Female [n (%)]	56630 (52.74%)	46520 (53.05%)	5820 (53.84%)	4290 (48.78%)	0.0018
Modified Charlson Index	2.22±0.02	2.28±0.02	1.93±0.05	1.98±0.06	<0.001
Diagnosis					
Crohn's disease	50375 (46.92%)	41285 (47.66%)	5840 (54.00%)	2710 (30.81%)	<0.001
Ulcerative colitis	25880 (24.10%)	22255 (25.36%)	1585 (14.66%)	2040 (23.20%)	
Other inflammatory	31120 (28.98%)	23685 (26.99%)	3390 (31.35%)	4045 (45.99%)	
Payment type					
Medicare	32825 (30.57%)	28010 (31.94%)	2790 (25.85%)	2025 (23.02%)	<0.001
Medicaid	15125 (14.09%)	9590 (10.93%)	3025 (28.02%)	2510 (28.54%)	
Private	53330 (49.67%)	45855 (52.28%)	4090 (37.89%)	3385 (38.49%)	
Self-pay	3025 (2.82%)	1975 (2.25%)	470 (4.35%)	580 (6.60%)	
No charge	260 (0.24%)	155 (0.18%)	50 (0.46%)	55 (0.63%)	
Other	2730 (2.54%)	2120 (2.42%)	370 (3.43%)	240 (2.73%)	
Procedure type					
Left colon	38160 (35.54%)	31895 (36.34%)	3245 (30.01%)	3020 (34.34%)	<0.001
Rectal	2240 (2.09%)	1865 (2.13%)	220 (2.03%)	155 (1.76%)	
Right colon & small bowel	66460 (62.0%)	53625 (61.10%)	7255 (67.08%)	5580 (63.45%)	
Simple/anorectal	515 (0.48%)	380 (0.43%)	95 (0.88%)	40 (0.46%)	
Hospital size					
Small	15950 (14.85%)	12750 (14.53%)	1715 (15.86%)	1485 (16.88%)	0.0794
Medium	27150 (25.29%)	22065 (25.14%)	2745 (25.38%)	2340 (26.61%)	
Large	64275 (59.86%)	52950 (60.33%)	6355 (58.76%)	4970 (56.51%)	
Location/teaching status					
Rural	4735 (4.41%)	4250 (4.84%)	310 (2.87%)	175 (1.99%)	<0.001
Urban nonteaching	17470 (16.27%)	14220 (16.20%)	1440 (13.31%)	1810 (20.58%)	
Urban teaching	85170 (79.32%)	69295 (78.96%)	9065 (83.82%)	6810 (77.43%)	
Hospital region					
Northeast	21500 (20.02%)	18435 (21.01%)	1725 (15.95%)	1340 (15.24%)	<0.001
Midwest	26680 (24.85%)	23460 (26.73%)	2440 (22.56%)	780 (8.87%)	
South	40160 (37.40%)	30960 (35.28%)	5685 (52.57%)	3515 (39.97%)	
West	19035 (17.73%)	14910 (16.99%)	965 (8.93%)	3160 (35.93%)	

<sup>†</sup>Weighted National Estimate

**Table 2** Outcomes by race

Outcomes	Overall (n=107375)	White (n=87765)	Black (n=10815)	Hispanic (n=8795)	P-value
Hospital stay (days)	10±0.08	9.56±0.08	12.55±0.34	11.19±0.36	<0.001
Any complication	17745 (16.53%)	14200 (16.18%)	2060 (19.05%)	1485 (16.88%)	0.0031
Morbidity or mortality	18770 (17.48%)	15025 (17.13%)	2170 (20.09%)	1575 (17.94%)	0.0029

**Table 3** Logistic regression for complication/death

Variable	Odds ratio	95%CI
Black vs. White	1.312	1.162-1.481
Hispanic vs. White	1.010	0.880-1.160
Rectal vs. left	0.492	0.362-0.669
Right & small bowel vs. left	0.673	0.626-0.725
Simple/anorectal vs. left	0.611	0.322-1.159
Age	1.010	1.006-1.013
Modified Charleston Index	1.096	1.071-1.120
Female vs. male	1.094	1.016-1.179
Medicare vs. private insurance	1.584	1.426-1.759
Medicaid vs private insurance	1.594	1.418-1.793
Self-pay vs. private insurance	1.432	1.135-1.807
No charge vs. private insurance	0.832	0.339-2.039
Other vs. private insurance	1.551	1.232-1.952
Small hospital vs. large	1.038	0.930-1.158
Medium hospital vs. large	1.119	1.025-1.222
Rural vs. urban teaching	1.377	1.163-1.630
Urban nonteaching vs. urban teaching	1.346	1.224-1.480
Northeast vs. south	0.843	0.753-0.943
Midwest vs. south	0.839	0.756-0.931
West vs. south	1.002	0.904-1.111
Crohn's disease vs. other inflammatory	0.761	0.696-0.832
Ulcerative colitis vs. other inflammatory	0.763	0.662-0.819

CI, confidence interval

postoperative morbidity and mortality than those at urban teaching facilities (OR 1.377, 95%CI 1.163-1.630 and OR 1.346 95%,CI 1.224-1.480). Age was not a significant predictor of complications or death. Black patients had significantly longer hospital stays on univariate analysis. A separate multivariate analysis was performed, controlling for covariates, which demonstrated that Black patients' hospital stays were long regardless of other factors.

## Discussion

Using a large and diverse database, our study has demonstrated significantly different rates of post-surgical

complications across various races. Overall, rates of complications were slightly higher for Black patients compared to White or Hispanic patients. Similarly to previously reported data, Black patients had significantly higher rates of postoperative infections, morbidity and mortality, the cause of which remains unknown [13,15,18,19]. Our study adds to the literature, as it specifically addresses patients with IBD as the diversity in these patients continues to expand.

Notably, along with postoperative infections, Black patients experienced significantly longer hospital stays than White or Hispanic patients, by almost 3 days. This has further implications of increased costs to the patients and hospitals. A number of studies in the literature similarly describe an extended length of stay for Black patients after bariatric surgical procedures [5,14,20,21]. Dotson *et al* reported that Black children with Crohn's disease had longer hospital stays (6.8 vs. 6.3 days) compared to White children. Similarly, Gunnells *et al* reported that Black adults with IBD had a longer index length of stay as well as a higher readmission rate than patients of other races [22,23]. Our study contributes to the growing evidence that Black patients, and specifically those with IBD, have longer hospital stays, a finding that warrants further investigation. In our study, this significant difference in length of stay was despite Black patients with IBD having fewer comorbidities. A number of factors other than clinical status can lead to a longer hospital stay. It may be difficult to discharge patients because they do not have social support at home, they struggle with transportation or live far from the hospital. Health literacy can impact patients' ability to manage wounds or ostomy care. These factors are hard to capture within a database, but are an area that can be explored preoperatively with multidisciplinary allies to shorten the length of hospital stay and decrease costs.

As reported above, White patients in our study had more medical comorbidities than Black patients. Despite this, Black patients still suffered from more postoperative complications than White patients. This finding is not supported in the literature, where in general, a higher MCI was associated with worse postoperative outcomes in surgical oncology patients and orthopedic patients [24,25]. Focusing on Black patients, a study of patients undergoing knee and hip arthroplasty demonstrated similar results, with Black patients suffering from more postoperative complications despite having lower MCI scores [26]. It is unclear why the MCI failed to predict outcomes in this study, since it has often been used to accurately predict outcomes in the literature [17]. This suggests that the MCI may not be valid for diverse patient populations. There may be other important factors, in addition to patient comorbidities, that contribute to the length hospital of stay,

**Table 4** Linear regression on length of hospital stay

Variable	Regression coefficient	95%CI	P-value
Race: Black	2.079	1.436 to 2.723	<0.001
Race: Hispanic	0.677	-0.005 to 1.360	0.0517
(Reference=White)			
Rectal	-4.254	-4.930 to -3.579	<0.001
Right & small bowel	-1.537	-1.866 to -1.207	<0.001
Simple/anorectal	-3.145	-5.221 to -1.069	0.0030
(Reference=left)			
Age	-0.063	-0.083 to -0.042	<0.001
Modified Charlson Index	0.752	0.596 to 0.907	<0.001
Female sex	-0.573	-0.869 to -0.276	<0.001
(Reference=male)			
Medicare	1.159	0.726 to 1.594	<0.001
Medicaid	3.046	2.392 to 3.701	<0.001
Self-pay	1.827	0.814 to 2.841	<0.001
No charge	1.252	-0.843 to 3.348	0.2413
Other	1.147	0.0354 to 2.259	0.0431
(Reference=private insurance)			
Small hospital	-0.943	-1.388 to -0.497	<0.001
Medium hospital	-0.348	-0.720 to 0.023	0.0665
(Reference=large)			
Rural	-1.547	-2.138 to -0.956	<0.001
Urban nonteaching	-0.380	-0.816 to 0.056	0.0877
(Reference=urban teaching)			
Northeast	-0.029	-0.493 to 0.435	0.9031
Midwest	-0.559	-0.988 to -0.131	0.0105
West	-0.435	-0.890 to 0.020	0.0610
(Reference=south)			
Crohn's disease	-0.874	-1.283 to -0.272	<0.001
Ulcerative colitis	-0.753	-1.2340 - -0.272	0.0021
(Reference=ID/O)			
Had any complication	9.495	8.880 to 10.110	<0.001
(Reference=no complication)			

CI, confidence interval

such as social determinants of health and access to specialized care, such as gastroenterology and colorectal surgeons. High social vulnerability has been shown to increase morbidity following colorectal surgery [27]. These factors are hard to uncover in large database studies that have limited access to personal health information. This information is beyond the scope of this paper, but can guide future studies focusing on patients limited to one hospital or region to identify patients with high social vulnerability preoperatively.

The nature of the database limited our study to patients' information from the initial hospital stay. This does not capture their entire post-surgical course and could leave out a number of post-surgical complications and hospital readmissions after the initial discharge. Complication rates, though statistically significantly different, were similar in percentage values. The clinical significance of these small differences is unclear, but is likely to be relevant given the large number of patients included in the database. Capturing the entire postoperative course for patients through 90 days or even a year could widen these percentages, as has been shown in previous publications [10].

This database also does not include such social determinants of health as social support at home, food security, transportation limits and patient's distance from the hospital. This limits the interpretation of the results; however, our study adds to the growing body of literature on disparities in IBD and highlights the need to focus on other social determinants of health for this vulnerable population. In addition, this study was limited by a lack of specific IBD treatment information, such as steroids or type of biologics being used preoperatively. This limits the ability to determine disease severity or degree of immunosuppression, both of which could contribute to outcomes.

In conclusion, racially diverse patients with IBD suffer from higher rates of mortality and complications such as postoperative infection rate, and longer hospital stays after colorectal surgery compared to White patients. Further research is needed to determine whether the disparities still exist or widen after a patient's initial hospital discharge. This information could potentially change preoperative management to improve patient outcomes and decrease the length of hospital stay.



## Summary Box

### What is already known:

- The incidence of inflammatory bowel disease (IBD) is increasing
- There is a higher prevalence of non-White patients with IBD
- Black and Hispanic patients have worse surgical outcomes than White patients

### What the new findings are:

- Black patients having surgery for IBD have higher rates of postoperative infections, morbidity and mortality
- Black patients having surgery for IBD have longer hospital stay
- White patients have more postoperative comorbidities, yet fewer complications than Black patients after IBD surgery

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