Burden and Outcomes of Fragmentation of Care in Hospitalized Patients With Inflammatory Bowel Diseases: A Nationally Representative Cohort

Nghia H. Nguyen, MD,* Jiyu Luo, MS,[†] Lucila Ohno-Machado, MD,[‡] William J. Sandborn, MD,* and Siddharth Singh, MD*[§]

Background: Fragmentation of care (FoC) may adversely impact health care quality in patients with chronic diseases. We conducted a US nationally representative cohort study to evaluate the burden and outcomes of FoC in hospitalized patients with inflammatory bowel disease (IBD).

Methods: Using Nationwide Readmissions Database 2013, we created 2 cohorts of superutilizer patients with IBD with 2 hospitalizations (cohort 1: FoC, defined as readmission to nonindex hospital vs no FoC) or 3 hospitalizations (cohort 2: multiple episodes of fragmentation vs single episode of fragmentation vs no FoC) between January and June 2013, which were followed through December 2013. We evaluated burden, pattern, and outcomes of fragmentation (6-month risk of readmission, risk of surgery, and inpatient mortality).

Results: In cohort 1, of 6073 patients with IBD with 2 admissions within 6 months, 1394 (23%) experienced FoC. Fragmentation of care was associated with modestly higher risk of readmission within 6 months (31% vs 28%, $P < 0.01$; adjusted relative risk, 1.11 [1.01–1.21]), without differences in risk of surgery (2.8% vs 4.3%, $P = 0.19$) or in-hospital mortality (0.2% vs 0.5%, $P = 0.22$). In cohort 2, of 1717 patients with 3 hospitalizations within 6 months, the number of patients with multiple episodes of fragmentation was associated with higher risk of readmission compared with patients with single episode of fragmentation or no FoC (52% vs 49% vs 43%, $P = 0.03$).

Conclusions: In a US cohort study, FoC is associated with a modestly higher risk of readmission, without higher risk of surgery or mortality in superutilizer patients with IBD. Future studies focusing on impact of outpatient care and postdischarge coordination are warranted in superutilizer patients.

Key Words: care coordination, value-based care, cost, Crohn's disease, superutilizers

INTRODUCTION

Inflammatory bowel diseases (IBDs) are chronic relapsing and remitting conditions that affect approximately 3 million people in the United States.^{1,2} Inflammatory bowel disease is one of the top 5 most expensive gastrointestinal

conditions, with annual costs exceeding \$10 billion in the United States alone; approximately 40% of spending in patients with IBD is attributed to inpatient care, 18% to emergency department (ED) visits, and 12% to pharmacotherapy.^{3,4} In a nationally representative longitudinal cohort study using the Nationwide Readmission Database

Received for publications April 17, 2020; Editorial Decision August 4, 2020.

From the *Division of Gastroenterology, [†]Division of Biostatistics and Bioinformatics, [‡]Division of Biomedical Informatics, University of California San Diego, La Jolla, California

Author Contribution: SS contributed to the study concept and design. NHN, JL, SS contributed to the acquisition of data. NHN, JL, SS contributed to the analysis and interpretation of data. NHN, SS contributed to the drafting of the manuscript. JL, LOM, WJS contributed to the critical revision of the manuscript for important intellectual content. All authors gave approval of the final manuscript.

Address correspondence to: Siddharth Singh, MD, MS, Division of Gastroenterology, University of California San Diego, 9452 Medical Center Drive, ACTRI 1W501, La Jolla, CA 92093, USA. E-mail: sis040@ucsd.edu.

Supported by: NN is supported by NIH/NIDDK (T32 DK007202). WS is partially supported by NIDDK-funded San Diego Digestive Diseases Research Center (P30 DK120515). SS is supported by NIH/NIDDK K23DK117058, ACG Junior Faculty Development Award #144271, Crohn's and Colitis Foundation Career Development Award #404614. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Conflicts of Interest: WS has received research grants from Atlantic Healthcare Limited, Amgen, Genentech, Gilead Sciences, Abbvie, Janssen, Takeda, Lilly,

Celgene/Receptos, Pfizer, Prometheus Laboratories (now Prometheus Biosciences); has received consulting fees from Abbvie, Allergan, Amgen, Arena Pharmaceuticals, Avexgen Therapeutics, BeiGene, Boehringer Ingelheim, Celgene, Celltrion, Conatus, Cosmo, Escalier Biosciences, Ferring, Forbion, Genentech, Gilead Sciences, Gossamer Bio, Incyte, Janssen, Kyowa Kirin Pharmaceutical Research, Landos Biopharma, Lilly, Oppilan Pharma, Otsuka, Pfizer, Progenity, Prometheus Biosciences (merger of Precision IBD and Prometheus Laboratories), Reistone, Ritter Pharmaceuticals, Robarts Clinical Trials (owned by Health Academic Research Trust, HART), Series Therapeutics, Shire, Sienna Biopharmaceuticals, Sigmoid Biotechnologies, Sterna Biologicals, Sublimity Therapeutics, Takeda, Theravance Biopharma, Tigenix, Tillotts Pharma, UCB Pharma, Ventyx Biosciences, Vimalan Biosciences, Vivelix Pharmaceuticals; and has stock or stock options from BeiGene, Escalier Biosciences, Gossamer Bio, Oppilan Pharma, Prometheus Biosciences (merger of Precision

© The Author(s) 2020. Published by Oxford University Press on behalf of Crohn's & Colitis Foundation. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com

doi: 10.1093/ibd/izaa238
Published online 18 September 2020

(NRD) of 47,402 patients with IBD, we estimated that medically treated IBD patients spent a median 6 days in the hospital annually with a subset of high-need, high-cost patients spending over 45 days in the hospital annually with 1 hospitalization every 2 months, and a substantial number of these hospitalizations are preventable.⁵ In a meta-analysis, 30-day and 90-day readmission rates in patients with IBD were 18% and 26%, respectively.⁶ In examining risk factors for readmission, studies have largely focused on clinical and hospitalization characteristics at time of initial admission. There has been very limited assessment of postdischarge care coordination and health care fragmentation.

Fragmentation of inpatient care, defined as readmission to a nonindex hospital, has been well studied in patients undergoing surgery and has been associated with increased morbidity and mortality.⁷⁻⁹ There has been limited assessment of the prevalence and impact of fragmentation of care (FoC) on outcomes in patients with IBD. In England, Warren and colleagues observed that 12%–17% patients with IBD sought inpatient and outpatient care outside of the hospital where their IBD was diagnosed.¹⁰ In the United States, using the State Inpatient Databases of New York and Florida between 2009 and 2013, Cohen-Mekelberg and colleagues observed that 26%–33% patients hospitalized with IBD experienced FoC at time of readmission, and these patients had a higher likelihood of in-hospital mortality and a longer readmission length of stay at time of second hospitalization.¹¹ However, there has been very limited assessment of the longitudinal outcomes after the second hospitalization in patients who experience FoC vs no FoC or the impact of degree of fragmentation (multiply fragmented vs singly fragmented care) on outcomes of patients with IBD.

Therefore, we conducted a nationally representative cohort study using NRD 2013 to evaluate the burden, patterns, and longitudinal outcomes of FoC (readmission to nonindex hospital or 2 hospitalizations to 2 different hospital) vs no FoC (readmission to same hospital) in patients with IBD in the United States (primary analysis). We evaluated among a small subset of patients the association between degree of fragmentation (multiple episodes of fragmentation vs single episode of fragmentation vs no FoC) and longitudinal outcomes (secondary analysis).

METHODS

Data Source

Nationwide Readmission Database is a nationally representative longitudinal database developed and maintained by Healthcare Cost and Utilization Project (HCUP) as a partnership among federal, state, and industry stakeholders and sponsored by Agency for Healthcare Research and Quality (AHRQ).¹² Nationwide Readmission Database 2013 is a composite database drawn from 21 geographically

diverse State Inpatient Databases that tracks patients discharged within a state over the course of 1 calendar year (January 1 to December 31, 2013) and contains more than 100 demographic, clinical, and nonclinical variables from all community hospitals (as defined by the American Hospital Association), public hospitals, and academic medical centers. This database accounts for 49.3% of the US population and, after adjusting for missing patient linkage numbers and overlapping inpatient stays, captures 85% of all discharges from these 21 states. Using this database, we constructed a retrospective cohort of patients hospitalized with IBD to evaluate the impact of FoC.

Study Population and Exposure and Comparators

Cohort 1 (Primary analysis)

We included adults (age 18 years and older) with 2 hospital admissions with a primary or secondary discharge diagnosis of IBD between January and June 2013 were followed for subsequent hospitalization until December 2013 or death. We opted to focus on high-need, high-cost patients, or “superutilizers,” because these patients contribute disproportionately to unplanned health care utilization. Inasmuch as the impact of FoC in surgically treated patients is well known, we chose to focus on patients who were medically treated during the first admission (no surgery) so that their risk of readmission was not influenced by surgical complications. We used the Clinical Classifications Software (CCS) for ICD-9-CM with CCS code 144 to identify patients with IBD.¹² We were unable to reliably distinguish Crohn’s disease and ulcerative colitis. The CCS for ICD-9-CM, developed by HCUP, is a categorization scheme for diagnoses and procedures that collapses ICD-9-CM’s extensive codes into smaller numbers of categories that are both clinically meaningful and more useful for presenting descriptive statistics ([Supplementary Appendix](#)).

We excluded patients based on the following criteria: (1) patients younger than 18 years of age at time of index hospitalization, (2) patients with only 1 hospitalization between January and June 2013, (3) patients with >2 hospitalizations between January and June 2013 (see cohort 2), (4) patients who underwent IBD-related surgery at time of first admission, (5) patients who were transferred from another hospital, (6) missing data for length of hospital stay or (7), or missing data on hospital charges for a given admission.

Fragmentation was defined at time of the second admission, where patients admitted to nonindex hospital were classified as having experienced FoC and patients who were admitted to the same hospital were classified as no FoC. Patients were deemed to be “at-risk” for readmission after the second hospitalization and contributed to follow-up time until December 31, 2013 or death.

Cohort 2 (Secondary analysis)

To analyze the association between degree of fragmentation and longitudinal outcomes in hospitalized patients with IBD, we included adults (age 18 years and older) with 3 hospital admissions with a primary or secondary discharge diagnosis of IBD between January and June 2013 and were followed for subsequent hospitalization until December 2013 or death. For this analysis, degree of fragmentation was defined as multiple episodes of fragmentation if all 3 admissions occurred in 3 different hospitals, single episode of fragmentation if 3 admissions occurred in two different hospitals, or no FoC if all 3 admissions occurred in the same hospital. Patients were deemed to be “at-risk” for readmission after the third hospitalization and contributed to follow-up time until December 31, 2013, or death.

Study design for cohorts 1 and 2, timing of exposure assignment, and outcome measurement are presented in Figure 1.

Outcome

All outcomes were ascertained after the episode of FoC (cohort 1, after second hospitalization; cohort 2, after third hospitalization). Our primary outcome of interest was risk of readmission within 6 months. Secondary outcomes of interest include (1) time to readmission, (2) inpatient mortality, (3) need for IBD-related surgery, (4) risk of severe IBD-related hospitalization (length of stay >7 days or need for IBD-related surgery), and (5) risk of preventable hospitalization during follow-up.

Due to significant variability in quality of hospitals and its impact on risk of readmission, we analyzed the patterns of fragmentation with regard to hospital characteristics and its association with longitudinal outcomes in patients who experienced FoC.¹³ Specifically, we evaluated the impact of location (rural vs urban) of hospitals and teaching status (teaching vs nonteaching) on longitudinal outcomes as surrogates for hospital quality.

Covariates

We abstracted detailed patient and hospital characteristics as detailed in the [Supplementary Appendix](#), including age, sex, primary expected payment source (Medicare, Medicaid, private insurance, self-pay, and other insurance types), income quartile based on household income of the patient’s zip code, relevant comorbidities to calculate Charlson’s Comorbidity Index ([eTable 1](#); smoking, obesity, anemia, congestive heart failure, chronic lung disease, depression, diabetes, hypertension, coagulation disorder, liver disorder, electrolyte abnormalities, peripheral vascular disease, psychoses, chronic pain and renal failure); hospital location, teaching status, and bed size (small, medium, large).¹⁴ Across all hospital admissions, the following procedures, surgeries, and clinical events were also captured: gastrointestinal or hepatic procedures (such as endoscopy, colonoscopy, paracentesis, etc.), IBD-related procedures, gastrointestinal surgeries (such as colostomy, ileostomy, small bowel resection, colorectal resection, local excision of large intestine lesion, etc.), blood transfusions, and parenteral or enteral nutrition ([eTable 2](#)).

We categorized causes for hospitalizations as cardiac, cerebrovascular, respiratory, infections, genitourinary, gastrointestinal (divided into IBD-related vs non-IBD gastrointestinal causes), endocrine/metabolic, neuropsychiatric, malignancies, fractures, thromboembolism, IBD-specific, and others based on primary CCS diagnosis codes ([eTable 3](#)). We investigated the proportion of preventable hospital admissions by utilizing ICD-9 codes for Prevention Quality Indicators (PQIs), which are a set of measures developed by AHRQ that can be used with hospital inpatient discharge data as a “screening tool” to identify ambulatory conditions for which high-quality, community-based outpatient care can potentially prevent hospitalization, complications, or more severe disease ([eTable 4](#)).¹⁵

FIGURE 1. Overview of study design, cohorts, exposure assignment, and outcomes assessment. Each grayscale box with H-1, H-2, etc. refers to hospitalizations corresponding to calendar time on x-axis, and H-1, H-2, etc. refer to unique hospitals to which patients were admitted (eg, a patient with two H-1, H-1 boxes was admitted twice between January 1 and June 30, 2013, to the same hospital).

Statistical Analysis

We used descriptive statistics to describe baseline demographics, hospital characteristics, and index hospitalization characteristics between patients with vs without FoC. Categorical and continuous variables were compared using Pearson χ^2 test and Student *t* test, respectively. Categorical variables are expressed as percentages and continuous variables as median (interquartile range [IQR] and fifth to 95th percentile). To evaluate the independent effect of FoC on longitudinal outcomes, we performed multivariable logistic regression analysis adjusting for (1) hospitalization characteristics at time of second hospitalization (hospitalization severity based on length of stay, IBD-related surgery, severe IBD-related hospitalization, receipt of IBD-related procedures, cost of hospitalization, and Charlson comorbidity index) and (2) for patient (age, sex, income) and hospital (urban vs rural, teaching vs nonteaching, bed size) characteristics at time of second admission. We performed survival analysis using Kaplan-Meier to compare time with readmission in patients with vs without FoC. For secondary analysis on the association between degree of fragmentation and risk of readmission, we performed Pearson χ^2 test and univariate survival analysis. Due to low the number of events, multivariable analysis was not performed for cohort 2. All hypothesis testing was performed using a 2-sided *P* value with a statistical significance threshold of <0.05. All statistical analyses were performed with Stata MP (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

RESULTS

From 14,325,172 discharge records available in NRD 2013 (number of discharges between January 1 and December 31, 2013), we identified 47,402 unique patients with index hospitalizations between January and June 2013 with a primary or secondary discharge diagnosis of IBD. Of these, 6073 patients (12.8%) were admitted twice during this time period (without surgery during the first admission) and formed cohort 1, and 1717 patients (3.6%) were admitted 3 times and formed cohort 2.

Fragmentation of Care vs No Fragmentation of Care (Cohort 1)

Of 6073 patients with 2 hospitalizations between January and June 2013, 1394 (23.0%) experienced FoC (readmission to nonindex hospital). Patient-, hospital-, and hospitalization-level characteristics at time of first hospitalization in patients who subsequently experienced FoC vs no FoC are shown in eTable 5. At baseline before fragmentation, patients who experienced FoC subsequently were younger, more likely to be admitted to a nonteaching, small-medium bed hospital, and were less likely to have undergone an IBD-related endoscopic

procedure. However, there were no significant differences in the burden of comorbidities or mean length of stay.

Outcomes at time of second hospitalization

Patient-, hospital-, and hospitalization- characteristics at time of second hospitalization based on whether patients experienced FoC vs no FoC are shown in Table 1. At time of second hospitalization, no significant differences were observed in rates of IBD-related procedures (24.2% vs 23.6%, *P* = 0.68), IBD-related surgery (3.4% vs 3.9%, *P* = 0.47), mean length of stay (5.2 vs 5.1 days, *P* = 0.35), and risk of severe IBD-related hospitalization (20.3% vs 20.1%, *P* = 0.91) in those who experienced FoC vs no FoC.

Longitudinal outcomes after fragmentation of care episode

Patients who experienced FoC had a higher rate of re-admission within 6 months after the second hospitalization compared with patients who did not experience FoC (31.1% vs 28.6%, *P* = 0.04; Table 2) and had a shorter time to readmission (Fig. 2). However, no significant differences were observed in the rates of inpatient mortality (0.22% vs 0.51%, *P* = 0.22), IBD-related surgery (2.8% vs 4.3%, *P* = 0.19), mean length of stay (5.4 vs 5.7 days, *P* = 0.35), risk of severe IBD-related hospitalization (18.5% vs 21.5%, *P* = 0.20; length of stay >7 days or need for IBD-related surgery), and risk of unplanned and preventable hospitalization in patients who experienced FoC vs no FoC. No significant differences were observed in reasons for subsequent hospitalization (eTable 6).

On univariate analysis, FoC was associated with a 10% higher risk of readmission within 6 months compared with patients who did not experience FoC (relative risk [RR], 1.10; 95% confidence interval [CI], 1.01–1.20). On multivariable analysis, this increased risk persisted after adjusting for hospitalization characteristics at time of second hospitalization (hospitalization severity based on length of stay, IBD-related surgery, severe IBD-related hospitalization, receipt of IBD-related procedures, cost of hospitalization and comorbidity index; RR, 1.11; 95% CI, 1.01–1.21; Table 3A). However, the increased risk was not significant when additionally adjusting for patient (age, sex, income) and hospital (urban vs rural, teaching vs nonteaching, bed size) characteristics (RR, 1.07; 95% CI, 0.97–1.17; Table 3B). Among patients experiencing FoC, the majority of patients moved between urban hospitals (55%) or from one rural hospital to another rural hospital (34%). No significant difference was observed in risk of readmission between patients who moved from urban to a rural hospital vs rural to an urban hospital (34.0% vs 26.7%, *P* = 0.45). Similarly, no significant difference was observed in risk of readmission between patients who moved from a teaching to a nonteaching hospital vs nonteaching to a teaching hospital (31.5% vs 26.5%, *P* = 0.22).

TABLE 1. Patient, Hospital, and Hospitalization Characteristics at Time of Second Hospitalization Based on Whether Patients Experienced Fragmentation of Care vs No Fragmentation of Care (cohort 1)

	Fragmentation of Care N = 1394 (23.0%)	No Fragmentation of Care N = 4679 (77.0%)	P
Age (mean +/- SD)	51.8 (19.1)	55 (19.5)	< 0.001
Female (%)	57.2%	56.1%	0.51
Urban (%)	62.1%	59.5%	0.10
Primary expected payer			< 0.001
Medicare/Medicaid	1: 59.0%	1: 57.3%	
Private insurance	2: 30.6%	2: 34.4%	
Self-pay	3: 5.74%	3: 3.63%	
No charge/others	4: 4.52%	4: 4.51%	
Median household income			0.001
0-25th percentile (\$1–\$37,99)	1: 26.4%	1: 22.0%	
26th to 50th percentile (\$38,000–\$47,999)	2: 25.5%	2: 24.8%	
51st to 75th percentile (\$48,000–\$63,999)	3: 23.3%	3: 25.5%	
76th to 100th percentile (\$64,000 or more)	4: 23.2%	4: 26.4%	
Teaching status			0.14
Metropolitan nonteaching	1: 40.7%	1: 38.0%	
Metropolitan teaching	2: 52.1%	2: 55.1%	
Nonmetropolitan	3: 7.17%	3: 6.97%	
Bed size			0.002
Small	1: 12.1%	1: 8.91%	
Medium	2: 24.5%	2: 22.4%	
Large	3: 65.5%	3: 68.7%	
Deyo-Charlson Comorbidity Index			0.17
0	0: 56.5%	0: 54.2%	
1	1: 19.4%	1: 19.1%	
2 or more	2: 24.1%	2: 26.6%	
IBD-related procedures (%)	24.2%	23.6%	0.68
IBD-related surgery (%)	3.44%	3.91%	0.47
Length of stay (mean +/- SD)	5.21 (5.57)	5.07 (4.99)	0.35
Proportion with severe IBD hospitalization (LOS >7 days OR surgery; %)	20.3%	20.1%	0.91
Cost of hospitalization (mean +/- SD)	11600 (13700)	11100 (13600)	0.21
Unplanned hospitalization (%)	79.8%	83.3%	0.003
Preventable hospitalization (%)	7.32%	10.2%	0.001

Multiple Episodes of Fragmentation vs Single or No Episodes of Fragmentation of Care (Cohort 2)

Of 1717 patients with 3 hospitalizations between January and June 2013, 72 patients (4.2%) experienced multiple episodes of fragmentation (all 3 admissions occurred in 3 different hospitals), 550 patients (32.0%) experienced single episode of fragmentation (3 admissions occurred in 2 different hospitals), and 1095 patients (63.8%) experienced no FoC (all 3 admissions occurred in the same hospital). Multiple episodes of fragmentation were associated with a shorter time to readmission (Fig. 3) and a higher rate of re-admission within 6 months after the third hospitalization compared with patients who experienced a single episode of

fragmentation or patients who experienced no FoC (52% vs 49% vs 43%, $P = 0.03$).

DISCUSSION

Reducing unplanned readmissions is an important aspect of improving quality of health care delivery and decreasing health care costs in patients with chronic conditions like IBD. Though fragmentation of inpatient care (ie, readmission to different hospitals) suggests suboptimal health care delivery, its impact on risk of readmissions is unclear. In this nationally representative cohort study of superutilizer patients with IBD with at least 2 or 3 hospitalizations within 6 months, we made several key observations regarding the impact of FoC. First, we

TABLE 2. Longitudinal Outcomes in Patients Who Experienced Fragmentation of Care vs No Fragmentation of Care (cohort 1)

Outcomes at Time of 3rd Hospitalization	Fragmentation of Care	No Fragmentation of Care	<i>P</i>
	N = 1394 (23.0%)	N = 4679 (77.0%)	
Readmission with 6 months (%)	31.1%	28.1%	0.04
Mortality at 3rd Hosp (%)	0.215%	0.513%	0.22
Unplanned hospitalization (%)	83.4%	84.1%	0.77
Preventable hospitalization (%)	8.78%	12.0%	0.08
IBD-related procedures (%)	26.1%	23.7%	0.35
Surgery (%)	2.77%	4.33%	0.19
Proportion with severe IBD hospitalization (LOS >7 days OR surgery; %)	18.5%	21.5%	0.20
Cost of hospitalization (mean +/- SD)	11500 (13100)	12800 (22000)	0.21
Length of stay (mean +/- SD)	5.41 (5.62)	5.65 (7.42)	0.35

FIGURE 2. Time to readmission in patients with IBD with 2 hospitalizations within 6 months with vs without fragmentation of care at time of second hospitalization.

observed that fragmentation is common, with approximately 1 in 4 readmissions occurring to a nonindex hospital; however, multiple episodes of fragmentation are uncommon, occurring in 4% of patients with 3 hospitalizations in a 6-month period of time. Second, we observed that fragmentation alone was not associated with adverse outcomes during the second hospitalization. Third, on longitudinal follow-up after an episode of fragmentation, we observed a modestly higher risk of readmission in patients who experienced fragmentation, without an increase in risk of surgery, inpatient mortality, or severe hospitalization. This increased risk of readmission was exacerbated in patients who experienced multiple episodes of fragmentation compared with patients who experienced 1 episode of fragmentation or no FoC. Our findings imply that in contrast to surgical domains where continuity of inpatient care at place of surgery

is important, fragmentation of inpatient care in medically treated patients with IBD may not severely impact longitudinal outcomes. Even though our findings need to be corroborated, other approaches examining postdischarge care coordination, patient-centered medical homes with multi-disciplinary outpatient care coordination, and improving overall quality of hospitals may yield greater benefit in improving quality of health care for patients with chronic diseases like IBD.

Our observed rates of fragmentation of inpatient care are comparable to those observed for other chronic diseases in the United States. Nationally, overall 30-day readmission rate in patients hospitalized for any indication was 11.9% based on NRD 2013; of these, 22.5% episodes occurred to a nonindex hospital.⁷ Among all patients with IBD with 2 hospitalizations in a 90-day period, Cohen-Mekelburg and colleagues observed 26%–32% rate of fragmentation of care in Florida and New York.¹¹ Previous studies have identified younger age, public payer or uninsured status, and low socioeconomic status as being associated with fragmentation of inpatient care.^{7,11,16}

Although Cohen-Mekelburg and colleagues observed that fragmentation negatively affected outcomes during the second hospitalization, including higher inpatient mortality and longer length of stay in patients with IBD, we did not observe any significant differences in rates of IBD-related surgery, mean length of stay, or risk of severe IBD-related hospitalization.¹¹ Because our cohort was designed primarily to study longitudinal outcomes after episode of fragmentation, we only included patients who were alive at end of the second hospitalization (and “at-risk” for subsequent readmission), we could not examine the effect of fragmentation on inpatient mortality during second hospitalization. In contrast to Cohen-Mekelburg and colleagues, we only focused on medically treated patients with IBD, excluding patients who underwent surgery at time of first hospitalization. Fragmentation of inpatient care in surgically treated patients has been consistently shown to adversely effect outcomes.^{8,9} It is unclear to what extent surgically treated

TABLE 3. Multivariable Analysis: Association Between Fragmentation of Care and Risk of Readmission Within 6 Months After Adjusting for (A) Severity of Index Hospitalization and (B) Patient and Hospital Characteristics

A.		
	Relative risk	95% CI
Fragmentation of care (yes vs no)	1.10	1.01–1.20
Sex (Female vs male)	1.05	0.96–1.13
Age (per 1 y increase)	0.993	0.990–0.995
Comorbidity index		
1 vs 0	1.27	1.14–1.40
2 or more vs 0	1.40	1.27–1.53
Length of stay, second hospitalization (per 1 d increase)	1.02	1.01–1.03
Severe, second hospitalization (yes vs no)	1.12	0.96–1.29
IBD-related surgery, second hospitalization (yes vs no)	0.60	0.42–0.82
IBD-related endoscopic procedures, second hospitalization (yes vs no)	0.84	0.75–0.94
B.		
	Relative risk	95% CI
Fragmentation of care (yes vs no)	1.09	0.99–1.19
Sex (Female vs male)	1.05	0.97–1.14
Age (per 1 y increase)	0.993	0.990–0.995
Urban hospital (vs rural)	1.17	1.07–1.28
Income		
Quartile 2 vs 1	1.03	0.92–1.15
Quartile 3 vs 1	0.98	0.87–1.09
Quartile 4 vs 1	0.89	0.79–1.01
Teaching status		
Metropolitan teaching vs metropolitan nonteaching	0.97	0.89–1.06
Nonmetropolitan vs metropolitan nonteaching	1.13	0.95–1.32
Hospital bedsize		
Medium vs small	1.03	0.88–1.21
Large vs small	1.08	0.93–1.24
Comorbidity index		
1 vs 0	1.26	1.14–1.40
2 or more vs 0	1.39	1.26–1.53
Length of stay, second hospitalization (per 1 d increase)	1.02	1.00–1.03
Severe, second hospitalization (yes vs no)	1.12	0.96–1.29
IBD-related surgery, second hospitalization (yes vs no)	0.61	0.43–0.83
IBD-related endoscopic procedures, second hospitalization (yes vs no)	0.84	0.75–0.94

IBD patients contributed to the negative observed effect of fragmentation in their study. In an era of when hospitalists and nocturnists primarily manage inpatients without explicit continuity of care or input from patients' outpatient consultants or primary care physicians, the lack of negative impact of fragmentation exclusively within the inpatient setting is not unexpected.^{17,18} In a cohort of patients with decompensated cirrhosis, Okafor and colleagues also observed no differences in risk of inpatient mortality in those with FoC vs no FoC.¹⁶ They argued that patients with complex conditions may potentially benefit from seeing different providers if the overall quality of care is higher. Though there is risk of inadequate transfer of information and excessive and duplicative diagnostic testing

with fragmented care, with improving health information exchange and health system connectedness as mandated in the Affordable Care Act 2009, this risk is lower than what it was in the last decade.

The novel contribution of our study is studying the longitudinal impact of FoC on risk of subsequent readmission, surgery, and mortality. Although we observed a modest 10% higher risk of readmission within 6 months among those who experienced fragmentation vs no fragmentation, we did not observe any increase in risk of IBD-related surgery, inpatient mortality, length of stay, risk of severe IBD-related hospitalization, or preventable or unplanned hospitalization. Though multiple episodes of fragmentation

FIGURE 3. Time to readmission in patients with IBD with 3 hospitalizations within 6 months, depending on degree of fragmentation of care (multiple episodes of fragmentation of care vs single episode of fragmentation vs no fragmentation).

were uncommon, it was associated with a higher risk of readmission than single episodes of fragmentation. These findings suggest that fragmentation of inpatient care by itself may not dramatically impact longitudinal patient outcomes. These findings are similar to Okafor and colleagues who observed that 30-day risk of readmission and inpatient mortality after second hospitalization was not different in patients with decompensated cirrhosis who did and did not experience FoC.¹⁶ Other factors may contribute more to longitudinal outcomes in high-need, high-cost patients with IBD. Beyond patient-level factors, overall hospital quality or performance is a key factor that contributes to readmission risk. Krumholz and colleagues observed that when the same patients were admitted with similar diagnoses to multiple hospitals in the best and worst performance quartiles on the basis of the Centers for Medicare and Medicaid Services hospital-wide readmission measure, they had a significantly higher risk of readmission after hospitalization at worse performing facilities.¹³ When examining patterns of fragmentation in relation to hospital location (rural vs urban) and academic status (teaching vs nonteaching) as rough surrogates for hospital quality, we observed nonsignificant trends toward lower risk of readmission in those who moved from rural to urban hospital and those who moved from teaching to nonteaching hospital. Besides hospital quality, postdischarge care coordination with early outpatient clinic follow-up and remote monitoring has been demonstrated to reduce short-term risk of readmissions in other chronic diseases.^{19,20} Regueiro and colleagues have demonstrated a positive impact of a resource-intensive, multidisciplinary IBD

specialty medical home on reducing unplanned health care utilization in a small subset of very high health care utilizers.²¹ These factors should be examined in more details to understand the burden and develop interventions to reduce the risk of unplanned health care utilization and improve quality of health care delivery in IBD.

Though our study draws its strength from a large sample of patients who were longitudinally followed over the course of a year, it has some limitations. First, all analyses are based on administrative codes and CCS, which have inherent limitations both with regard to misclassification of IBD diagnosis and being unable to capture disease severity, medication use, and exact cause of admissions. Second, we were unable to discern reasons for fragmentation and qualify them as “appropriate” or “inappropriate.” As previously described, some fragmentation may be appropriate if it involves admission to a higher level of care or one with appropriate specialty care.¹¹ We attempted to evaluate this by examining patterns of fragmentation, but it was limited by a small sample size. Third, we focused only on patients who were discharged alive after 2 (or 3) hospitalizations, excluding sicker patients who may have died during the hospitalization. This may introduce selection bias. However, IBD is not associated with increased risk of mortality, and risk of mortality bias is low. Likewise, we focused on high-need, high-cost patients who had at least 2 hospitalizations within a 6-month period; this constituted only 12.8% of all patients with IBD who were hospitalized. However, these superutilizer patients contribute disproportionately to health care costs and, hence, merit closer evaluation. Finally, NRD is inherently limited because it captures admissions only within state boundaries, such that readmissions and fragmentation occurring outside state boundaries will not be captured.

In summary, we observed that 1 in 4 high-need, high-cost patients with IBD is readmitted to a nonindex hospital, though rates of multiple episodes of fragmentation are low. Fragmentation of inpatient care, particularly multiple episodes of fragmentation, is associated with a modestly higher risk of readmission within 6 months but not with an increase in risk of IBD-related surgery, severe hospitalization, length of stay, or inpatient mortality in medically treated patients with IBD. Future approaches examining postdischarge care coordination, patient-centered medical homes with multidisciplinary outpatient care coordination, and improving overall quality of hospitals may yield greater benefit in improving quality of health care for patients with chronic diseases like IBD, rather than attempting solely to mitigate fragmentation of inpatient care.

SUPPLEMENTARY DATA

Supplementary data is available at *Inflammatory Bowel Diseases* online.

REFERENCES

- Dahlhamer JM, Zammiti EP, Ward BW, et al. Prevalence of inflammatory bowel disease among adults aged ≥ 18 years - United States, 2015. *MMWR Morb Mortal Wkly Rep*. 2016;65:1166–1169.
- Mehra F. Report: economic implications of inflammatory bowel disease and its management. *Am J Manag Care*. 2016;22:s51–s60.
- Dieleman JL, Cao J, Chapin A, et al. US health care spending by payer and health condition, 1996–2016. *JAMA*. 2020;323:863–884.
- Peery AF, Crockett SD, Murphy CC, et al. Burden and cost of gastrointestinal, liver, and pancreatic diseases in the United States: update 2018. *Gastroenterology*. 2019;156:254–272.e11.
- Nguyen NH, Khera R, Ohno-Machado L, et al. Annual burden and costs of hospitalization for high-need, high-cost patients with chronic gastrointestinal and liver diseases. *Clin Gastroenterol Hepatol*. 2018;16:1284–1292.e30.
- Nguyen NH, Koola J, Dulai PS, et al. Rate of risk factors for and interventions to reduce hospital readmission in patients with inflammatory bowel diseases. *Clin Gastroenterol Hepatol*. 2019. doi: [10.1016/j.cgh.2019.08.042](https://doi.org/10.1016/j.cgh.2019.08.042).
- Burke RE, Jones CD, Hosokawa P, et al. Influence of nonindex hospital readmission on length of stay and mortality. *Med Care*. 2018;56:85–90.
- Martinez RA, Franklin KN, Hernandez AE, et al. Readmissions to an alternate hospital in patients undergoing vascular intervention for claudication and critical limb ischemia associated with significantly higher mortality. *J Vasc Surg*. 2019;70:1960–1972.
- Zafar SN, Shah AA, Channa H, et al. Comparison of rates and outcomes of readmission to index vs nonindex hospitals after major cancer surgery. *JAMA Surg*. 2018;153:719–727.
- Warren LR, Clarke JM, Arora S, et al. Transitions of care across hospital settings in patients with inflammatory bowel disease. *World J Gastroenterol*. 2019;25:2122–2132.
- Cohen-Mekelburg S, Rosenblatt R, Gold S, et al. Fragmented care is prevalent among inflammatory bowel disease readmissions and is associated with worse outcomes. *Am J Gastroenterol*. 2019;114:276–290.
- NRD. *Healthcare Cost and Utilization Project (HCUP)*. Rockville, MD: Agency for Healthcare Research and Quality; 2015.
- Krumholz HM, Wang K, Lin Z, et al. Hospital-readmission risk - isolating hospital effects from patient effects. *N Engl J Med*. 2017;377:1055–1064.
- Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. *J Clin Epidemiol*. 1994;47:1245–1251.
- Patel KK, Vakharia N, Pile J, et al. Preventable admissions on a general medicine service: prevalence, causes and comparison with AHRQ prevention quality indicators-a cross-sectional analysis. *J Gen Intern Med*. 2016;31:597–601.
- Okafor PN, Nnadi AK, Okoli O, et al. Same- vs different-hospital readmissions in patients with cirrhosis after hospital discharge. *Am J Gastroenterol*. 2019;114:464–471.
- Wachter RM, Pantilat SZ. The “continuity visit” and the hospitalist model of care. *Am J Med*. 2001;111:40S–42S.
- White HL, Glazier RH. Do hospitalist physicians improve the quality of inpatient care delivery? A systematic review of process, efficiency and outcome measures. *BMC Med*. 2011;9:58.
- Le Berre M, Maimon G, Sourial N, et al. Impact of transitional care services for chronically ill older patients: a systematic evidence review. *J Am Geriatr Soc*. 2017;65:1597–1608.
- Singh S, Brill JV, Proudfoot JA, et al. Project Sonar: a community practice-based intensive medical home for patients with inflammatory bowel diseases. *Clin Gastroenterol Hepatol*. 2018;16:1847–1850.e1.
- Regueiro M, Click B, Holder D, et al. Constructing an inflammatory bowel disease patient-centered medical home. *Clin Gastroenterol Hepatol*. 2017;15:1148–1153.e4.