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Trends and Factors Associated with Hospitalization Costs for Inflammatory Bowel Disease in the United States

Fang Xu[1], **Yong Liu**[1], **Anne G. Wheaton**[1], **Kristina M. Rabarison**[1], **Janet B. Croft**[1]

[1]Division of Population Health, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 4770 Buford Highway NE, Mailstop F-78, Atlanta, GA 30341, USA

Abstract

Background—Few studies have addressed recent trends in hospitalization costs for inflammatory bowel disease (IBD).

Objective—We explored trends and described patient and hospital factors associated with hospitalization costs for IBD.

Methods—Using data from the 2003–2014 National Inpatient Sample for adults aged ≥ 18 years, we estimated costs using multivariable linear models and assessed linear trends by time periods using piecewise linear regressions.

Results—In 2014, there were an estimated 56,290 hospitalizations for Crohn's disease (CD), with a mean cost of US$11,345 and median cost of US$7592; and 33,585 hospitalizations for ulcerative colitis (UC), with a mean cost of US$13,412 and median cost of US$8873. Higher costs were observed among Hispanic [adjusted cost ratio (ACR) = 1.07; 95% confidence interval (CI) = 1.00–1.14; $p = 0.04$] or other non-Hispanic (ACR = 1.09; 95% CI = 1.02–1.17; $p = 0.01$) CD patients than for non-Hispanic White CD patients. For UC patients, higher costs were observed among men (ACR = 1.09; 95% CI = 1.05–1.13; $p < 0.001$) compared with women and among patients aged 35–44 years, 45–54 years, and 55–64 years compared with those aged 18–24 years. Among all patients, factors associated with higher costs included higher household income, more comorbidities, and hospitals that were government nonfederal versus private, were large versus small, and were located in the West versus Northeast regions. From 2003 to 2008, total costs increased annually by 3% for CD (1.03; 95% CI = 1.02–1.05; $p < 0.001$) and 4% for UC (1.04; 95% CI = 1.02–1.06; $p < 0.001$), but remained unchanged from 2008 to 2014.

Conclusions—The findings are important to identify IBD patients with higher hospitalization costs and to inform policy plans on hospital resource allocation.

✉ Fang Xu, vmf7@cdc.gov.

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Conflict of Interest Fang Xu, Yong Liu, Anne G. Wheaton, Kristina M. Rabarison, and Janet B. Croft have no conflict of interest in the study.

1 Introduction

Inflammatory bowel disease (IBD), which includes Crohn's disease (CD) and ulcerative colitis (UC), is characterized by chronic inflammation of the gastrointestinal tract. An estimated three million US adults reported having had a diagnosis of IBD in 2015 [1]. Although the disease is not common, it is associated with considerable morbidities and psychologic distress that significantly impair patients' quality of life [2–4]. Severe cases, failure to respond to medications or outpatient services, and complications of the disease itself or those resulting from treatment may lead to hospitalization for surgery or medical treatment [5]. Hospitalization rates for CD did not change significantly from 2003 to 2013 [6]. Prior to the beginning of the biologic therapy era in the 1990s, a third of UC patients and approximately 70% of CD patients could expect to eventually require surgery [7]. However, surgical rates in recent decades have declined in both CD and UC, which may be due to new treatments aiming to prevent long-term complications and mucosal healing among IBD patients [8, 9]. Despite the observed decline, the surgical rate remains high, especially among severe cases [10, 11]. For instance, in a study where 562 patients had an IBD diagnosis in 2003 and 2004, the 7-year follow-up cumulative risk of colectomy was 28.5% for CD patients and 12.5% for UC patients [12].

Since IBD is usually diagnosed before the age of 30–40 years with no increased mortality, lifelong disease management imposes a huge financial burden on the US healthcare system [7]. Annual direct costs were estimated to be US$3.6 billion for CD and US$2.7 billion for UC in 2003 and 2004, with hospitalizations accounting for about 31–37% of the direct healthcare costs [13]. A German study, in which 1030 IBD patients were enrolled in 2006 and 2007, reported that 10% of CD and UC patients accounted for 50% and 46% of the total direct costs, respectively [14]. The findings indicated that the disproportionate distribution of healthcare costs was driven by severe cases. Understanding the key patient and hospital characteristics that are associated with hospitalization costs may elucidate the healthcare cost burdens of the disease.

Current data about hospitalization costs in the US are outdated or based on small samples [13, 15, 16]. Although some studies have shown higher direct costs associated with IBD than non-IBD [13, 15], characteristics associated with higher hospitalization costs among IBD patients and recent trends of costs have not been documented. This study identifies patient and hospital characteristics that are associated with hospitalization costs and describes trends in total hospitalization costs from 2003 through 2014 using a nationally representative data source.

2 Methods

2.1 Data Sources

The study population was obtained from the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) database, which is obtained from the HCUP partnership and the Agency for Healthcare Research and Quality. In October, 2015 HCUP data started to transition to International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) from ICD-9-CM. As a result, a direct impact on the diagnosis

and procedure codes could be expected on reporting the services [17]. Therefore, the 2014 NIS data were used to study the association between selected characteristics and hospitalization costs, while the 2003–2014 data using the ICD-9-CM throughout the whole period were used to examine trends. Since NIS was redesigned from 2012, trend weights were used for data prior to 2012 to obtain consistent results across years in the trend analysis [18]. The NIS is the largest all-payer inpatient care database including a 20% stratified sample of all discharges from US community hospitals excluding long-term acute care and rehabilitation hospitals. It is sampled from the State Inpatient Databases of states that participated in the project. The 2014 NIS includes about 4400 hospitals and over 7 million discharges. The 2003 through 2014 MarketScan Commercial Claims and Encounter (CCAE) databases from IBM Watson Health [19] were involved in cost calculations. This database includes over 25% of all employer-sponsored healthcare beneficiaries in the US and includes claims data for beneficiaries that are active employees and their dependents, as well as early retirees who are insured by employer-sponsored plans. Detailed information about both databases are described elsewhere [20, 21].

2.2 Study Samples

Discharge records were extracted from the NIS if the patient was aged 18 years or older and had a first-listed diagnosis code of CD or UC. CD was identified with ICD-9-CM diagnosis codes 555 or 555.0–555.9. UC was identified with ICD-9-CM diagnosis codes 556 or 556.0–556.9.

2.3 Study Variables

Hospitalization cost was derived from multiplication of three components including facility hospital charge, professional fee ratio, and cost-to-charge ratio. As the charge represents the amount billed by hospital services without information on actual service cost or amount that hospitals received in payment, a cost-to-charge ratio was used to estimate the cost of inpatient care and adjusted for variation across hospitals and conditions [22]. The NIS contains all-payer inpatient cost-to-charge ratios for all hospitals. The product of cost-to-charge ratios and total hospital charge is total hospitalization cost. The NIS database contains a hospitalization charge, which is the facility charge billed by hospitals and does not include professional or physician fees. Using total hospital charges alone would underestimate total costs of hospitalization by 20–25% [23]. Therefore, we used a previously developed algorithm to calculate the professional fee ratio (PFR) [23] to adjust the estimated total hospitalization costs. From the MarketScan CCAE databases, PFR is defined as the ratio of total payments to facility-only payments per admission attributed to either CD or UC. PFR was then regressed on patient demographic characteristics, health insurance plan type, and discharge status. The mean PFR was derived from each year of MarketScan CCAE databases from 2003 through 2014. In 2014, the mean PFRs were 1.15 for CD and 1.17 for UC. The mean PFR was then multiplied by the NIS facility charge and cost-to-charge ratio to produce the final estimated total hospital costs. For trends analysis, hospitalization costs from 2003 to 2014 were adjusted to the 2014 consumer price index (CPI) from the Bureau of Labor Statistics [24].

From NIS, the explanatory variables included patient and hospital characteristics. Patient characteristics included patients' age at hospitalization (18–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, or ≥ 65 years), sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic others, or missing category), median household income at patients' zip code (US$1–US$39,999, US$40,000–US$50,999, US$51,000–US$65,999, ≥ US$66,000, or missing category), Elixhauser comorbidity [25] categories (0, 1, 2, or ≥ 3), and severity of illness subclass as a measure of loss of function (minor, moderate, major, or extreme). Severity of illness subclass was defined according to patients' extent of physiologic decompensation or organ system loss of function, and likelihood of death [26]. Additional patient factors included chronic conditions (deficiency anemia, coagulopathy, pulmonary circulation disorders, renal failure, and weight loss) related to IBD, length of stay (< 6 or ≥ 6 days), insurance type (Medicare, Medicaid, private insurance, no insurance, or others), discharge status (routine discharge, transferred, home health care, or others), and surgery and emergent visit setting (emergent visit with surgery, emergent visit without surgery, non-emergent visit with surgery, or non-emergent visit with no surgery), with surgery defined by partial or small bowel resection, partial or total colectomy, rectal resection, or fistula repair (ICD-9 procedure codes: 17.3X, 45.6X–45.8X, 48.4X–48.6X, 46.74, 46.76, 48.73, 48.93, 49.11, 49.12, 49.73, 57.43, 58.83, 70.72–70.74). Hospital-related characteristics included hospital region (Northeast, Midwest, South, or West), location and teaching hospital status (rural, urban nonteaching, or urban teaching), hospital size based on bed number (small, medium, or large) [27], and hospital ownership (government nonfederal, private nonprofit, or private investor own).

2.4 Statistical Analysis

All analyses were performed separately for CD and UC. Crude counts and weighted percentages were calculated for each category of patient and hospital characteristics. Total hospitalization costs for the US were estimated by applying survey weights and including survey design in the analysis [18, 20]. Mean cost per admission with standard deviation and median cost per admission with interquartile range were calculated. One-way ANOVA was used to compare mean cost among groups for nominal variables, and linear, quadratic, or cubic relationships were tested for ordinal variables. Costs were transformed to natural logarithm to achieve normality and a multivariable linear regression with a generalized equation estimation (GEE) was constructed to estimate log-transformed hospitalization cost accounting for the correlation within hospitals (multiple R^2: 0.1 for CD and UC). The model adjusted for age, sex, race, household income, number of Elixhauser comorbidities, insurance type, hospital region, location and teaching hospital status, hospital size, and hospital ownership. As the objective was to assess the association between patient and hospital characteristics and hospitalization costs, including covariates such as length of stay and surgery setting that are directly and highly correlated with costs may change or suppress the effect of other covariates in the estimation of costs. Therefore, these variables were not included in the model to avoid collinearity issues. Coefficients were then back-transformed to produce cost ratios. For trends analysis, a restricted cubic spline was explored to determine cutoffs for years and a piecewise linear regression (CD: R^2: 0.7; UC: R^2: 0.5) was constructed to estimate linear trends of natural logarithm of total hospitalization costs by time periods. The analysis was performed using SAS-callable SUDAAN 11.0.1 (Research

Triangle Institute, Research Triangle Park, NC, USA) to take weights and complex survey design into account and SAS 9.3 (SAS Institute, Cary, NC, USA).

This study used publicly available data and was exempted by the Centers for Disease Control and Prevention Institutional Review Board.

3 Results

In 2014, there were an estimated 56,290 hospital discharges with a first-listed diagnosis of CD in the US. The total estimated hospitalization cost was US$638.6 million. Mean cost was US$11,345 and median cost was US$7592 (Table 1). Table 3 in "Appendix" shows costs by distribution of patient and hospital characteristics for CD (see electronic supplementary material [ESM]). A total of 55.3% of CD patients were women and 70.8% were non-Hispanic Whites. About 46% of CD hospitalizations were for patients aged 25–44 years and there was a quadratic relationship across age groups showing a higher mean cost among older groups (age ≥ 55 years). Mean cost was higher among non-Hispanic others compared with non-Hispanic White CD patients and among CD patients with higher household income. Highest mean costs were observed among patients with either the highest category of comorbidity or extreme loss of function. Furthermore, mean cost was higher among those with each listed chronic condition than those without these conditions, among those with longer hospital stays, among those transferred to other facilities or those who received home health care than those with routine discharge, and among those having a surgery than those without. Altogether, 16% of CD patients had a surgery, a quarter of whom had it at an emergent setting. CD patients with a surgery accounted for 35.8% of total hospitalization costs among those who had CD hospitalizations in 2014 (results not shown). Uninsured CD patients had a lower mean cost than those privately insured. In addition, mean cost was lower in hospitals in the South region and higher in the West region than in the Northeast region, higher in urban hospitals than rural hospitals, higher in larger hospitals than in medium or small hospitals, and lower in private or investor-owned hospitals than nonfederal government hospitals.

In 2014, there were an estimated 33,585 discharges with a first-listed diagnosis of UC in the US. The total hospitalization cost was US$450.4 million. Mean cost was US$13,412 and median cost was US$8873 (Table 1). Table 4 in "Appendix" shows costs by distribution of patient and hospital characteristics and for UC (see ESM). A total of 51.5% of UC patients were women and 68.9% were non-Hispanic Whites. Overall, there was an increasing linear relationship in mean cost among successive age groups. Lower mean cost was found among women and among non-Hispanic Blacks and Hispanics compared with non-Hispanic Whites. There was a linear relationship between household income categories and mean costs. Highest mean cost was observed among patients with either the highest category of comorbidity or extreme loss of function. Higher mean cost was also found among UC patients with longer hospital stays, among those with each listed chronic condition compared with those without these conditions, and among those transferred to other facilities or those who received home health care compared with those with routine discharge or other discharge status. Furthermore, lower mean cost was found among uninsured patients compared with those privately insured and higher mean cost was found among those with

surgery than those without surgery. Altogether, 15% of UC patients had a surgery, 15% of whom had it in an emergent setting. UC patients with a surgery accounted for 35.0% of total hospitalization costs among those who had UC hospitalizations in 2014 (results not shown). Compared with hospitals located in the Northeast, mean cost was lower in the South region and higher in the West region. Mean cost was higher in larger hospitals, among hospitals that were urban teaching compared with rural, and among nonfederal government hospitals compared with private hospitals.

After adjusting for covariates, the estimated mean cost for CD hospitalizations (Table 2) was significantly higher among Hispanics and non-Hispanic others than non-Hispanic Whites, among patients with household income ≥ US$66,000 compared with < US$40,000, among those with two or more comorbidities compared with those with none, and among those with private insurance compared with those uninsured or with Medicare or Medicaid. Mean cost was higher in hospitals in the West than in the Northeast, among those that were urban rather than rural, and among larger hospitals, but was lower in private hospitals compared with nonfederal government hospitals. For UC, mean cost was higher among men than women, among older adults (except the oldest group) compared with the youngest group, among those with higher household income or larger number of comorbidities, but was lower among uninsured patients compared with privately insured patients. Mean cost for UC was higher in hospitals in the West than in the Northeast, in urban teaching hospitals compared with rural hospitals, in those that were larger, and that were nonfederal government hospitals than private hospitals.

From 2003 to 2014, the estimated number of discharges in the US increased from 42,607 to 56,290 for CD and from 25,078 to 33,585 for UC. Overall, after costs were adjusted to 2014 CPI, there was a decreasing trend for mean cost from US$12,352 to US$11,345 for CD and from US$13,715 to US$13,412 for UC. Total costs increased from US$526.3 million to US$638.6 million for CD and from US$344.0 million to US$450.4 million for UC (Fig. 1). After a piecewise linear regression was fitted, total hospitalization costs increased by 3% annually from 2003 to 2008 ($p < 0.001$) and remained unchanged from 2008 to 2014 ($p = 0.67$) for CD (Fig. 2). A similar trend was observed in UC with total hospitalization costs increasing by an average of 4% per year from 2003 to 2008 ($p < 0.001$) but remaining unchanged from 2008 to 2014 ($p = 0.54$).

4 Discussion

Although the majority of IBD care is received in ambulatory settings, hospitalizations are required when severity of disease progresses. A Canadian study reported that among IBD patients hospitalized between 2011 and 2013, 18% of UC and 20% of CD patients had a bowel resection [28]. In the current study, 15–16% of IBD hospitalizations involved a surgery, accounting for 35% of total IBD hospitalization costs in 2014. The total costs and estimated number of hospital discharges were higher among CD than UC patients. Overall mean costs, however, were higher among UC than CD patients, which was consistent with a previous study conducted at a tertiary care hospital [29]. Furthermore, Hay and Hay reported that the top 2% of CD and UC patients accounted for 34% and 39% of total amount paid, respectively [30]. The current study showed that mean costs were higher than median costs

for both CD and UC, and confirmed that costs were unevenly distributed and were higher for patients with certain sociodemographic characteristics.

In both CD and UC, an increasing number of comorbidities and higher levels of loss of function were strongly associated with higher costs. IBD patients usually have a greater number of co-morbid chronic conditions unrelated to IBD than non-IBD patients [31], with the presence of chronic conditions being associated with considerably higher healthcare costs [32]. Furthermore, comorbidities may impair patients' quality of life, complicate IBD management, lead to poorer treatment outcomes, and ultimately increase overall costs [33]. Some known chronic conditions associated with IBD include deficiency anemia [32], pulmonary circulation disorders such as thrombosis [34], coagulopathy [35], and renal diseases [36]. In the current study, the prevalence of the above conditions ranged from 0.6% for pulmonary circulation disorder among CD patients to 27.3% for deficiency anemia among UC patients. Hospitalizations for patients with these conditions had increased mean and median costs. Other factors, such as length of stay, surgeries, emergent admissions, and non-routine discharge status, that may cause extended or high intensity hospital or service care among IBD patients, were independently associated with higher mean and median costs.

Higher treatment cost has been found among pediatric compared with adult IBD patients because early-onset disease has more severe symptoms [13, 37]. The current study included only adult patients and showed that mean costs were higher among older adult patients, which was consistent with a Canadian study where inpatient hospitalization was the main source of the data [38]. In the multivariable GEE model from the current study, compared with the youngest group (18–24 years), costs for patients in the older age groups (i.e., 35–44 years, 45–54 years, 55–64 years) remained significantly higher among UC patients except for the oldest group (≥ 65 years), but this association was no longer significant among CD patients. One possible explanation from an ad hoc analysis is that surgery rate was similar across age groups among CD patients, but UC patients aged 45–64 years were more likely to receive surgeries in the study populations. Besides age, socioeconomic factors have been reported to be associated with unequal healthcare delivery and utilization [39]. In the GEE models, male UC patients, CD patients who were Hispanic or other non-Hispanic, and IBD patients with higher household income were associated with higher costs than their counterparts. A previous study using NIS found that the ratio of IBD hospitalization to prevalence was disproportionally higher among Hispanics and non-Hispanic Blacks than non-Hispanic Whites [40]. This may indicate more severe clinical presentation among minorities that is likely to be associated with greater healthcare financial burden.

We found that mean cost was highest in the West for both CD and UC. A previous analysis of NIS data found that mean hospitalization costs, for all hospitalizations, not just for IBD, were highest in the West [41]. However, Kappelman et al. [13] found no regional difference in direct costs for CD, while costs for UC were higher for patients in the Northeast compared with the West. Their study differed in many ways from the current study. For instance, they assessed costs including inpatient, outpatient, and pharmaceutical services while the current study only included hospitalization costs. In addition, they used claims data between 2003 and 2004 from 87 health plans while the current study, using 2014

NIS, included insured and uninsured hospital stays. In the current study, private hospitals were associated with lower hospitalization costs than government nonfederal hospitals. A previous study showed that publicly insured or uninsured IBD patients were more likely to have inpatient and emergent admissions in public hospitals [42], which could result from acute conditions from delayed care among uninsured patients and, subsequently, high healthcare expenditures. Urban teaching hospitals and large hospitals were associated with higher costs in both types of IBD. Similar to other diseases, costs per hospital stay in rural hospitals were less than those in urban hospitals, and large hospitals were more common in urban hospitals than rural hospitals [43]. Furthermore, the current study found CD patients with Medicare or Medicaid had about 5–6% lower costs. A previous study found that publicly insured IBD patients had higher inpatient costs than privately insured patients based on the annual per capita mean expenditure [42]. Despite the different cost assessment in the two studies, an ad hoc analysis suggested that CD patients with Medicare or Medicaid in the current studies were less likely to have surgery than privately insured patients.

In the current study, hospital discharges increased from 2003 to 2014 with more discharges for CD than UC. Our data suggest that total hospitalization cost peaked at 2008 for both types of IBD, with an average annual increase of 3% for CD and 4% for UC from 2003 to 2008. From 2008 to 2014, total hospitalization cost did not increase. IBD-related surgeries have been reported to have declined in recent years [10, 11]. Over the last decade, new IBD treatments such as immunosuppressant therapy and biologic therapies have evolved and seem to have been accompanied by a decreased surgery rate [5, 44]. While surgery is a major contributor to hospitalization costs, declining surgery rates in recent years may explain why total costs no longer increased although number of hospitalization discharges continued to increase. The current study showed an overall declining trend in mean cost and continuous increasing trend in number of discharges after 2008, which may explain an overall non-increasing cost trend in the latter period. On the other hand, while the surgery rate has decreased, biologic therapies are not more cost effective than surgical treatments [45]. Cost-effectiveness studies of biologic therapies are currently inconclusive with respect to combinations of therapies and timing of the treatments [45, 46]. However, biological therapies help improve quality-adjusted life-years and treatment outcomes among IBD patients [45, 46]. Therefore, optimal treatment strategies are warranted to ensure long-term remission and cost-effective quality of care among affected persons.

The study findings can inform IBD-related health policy makers for better disease management. First, although there are no strategies to prevent IBD, early diagnosis and intervention may reduce hospitalization rates. Outpatient visits were found to be a protective factor for IBD hospitalizations and surgeries [16]. As a result, gastroenterologist care, multidisciplinary chronic disease management, patients' adherence to treatment regimen, and patient education are all important for IBD management. Focusing strategic healthcare planning on patients who are older, minorities, patients with comorbidities, and those who receive inpatient care in government hospital settings may result in cost savings. Second, IBD-related hospitalization imposes a great resource burden on large, urban hospitals and on certain regions of the US. Optimizing hospital resource allocation at national, regional or local level may lower inpatient utilization. Examples include improving cost effectiveness

of diagnostic tests and involvement of responsibilities and resources from key stakeholders, such as nurses and healthcare workers.

The study is subject to several limitations. First, the NIS data is at the discharge level, therefore, readmissions and per capita costs could not be evaluated. Furthermore, the data has limited information about patient demographic characteristics. For instance, median household income at patients' zip code was used as a proxy for patients' household income. NIS may also lack other patient or hospital characteristics that are correlated with costs. By including these variables, we could have had an improved model fit. Second, only total charge data were available, so we were not able to assess charges for individual procedures or medications. Third, administrative data are subject to coding errors. Fourth, although we used a previously developed algorithm [23] to adjust the mean PFR obtained from the MarketScan databases to total hospital costs, the costs were estimated and did not reflect the actual amount of payments from the patients to physicians and facilities. Last, the NIS only contains inpatient admission data. Therefore, we were not able to assess costs associated with outpatient services. A major strength of this analysis is the large sample size in this national database.

5 Conclusion

There were some common and unique patterns of patient and hospital characteristics associated with hospitalization costs for CD and UC. As IBD is a life-long chronic condition, and disease management imposes significant costs to individuals and the healthcare system, understanding sociodemographic and clinical factors associated with high hospitalization costs is important to identify high-risk IBD patients. In addition, the impact of hospital characteristics on costs can inform policy plans on optimization of hospital resource allocation that may reduce hospitalization costs for IBD. Future studies should explore the underlying mechanism that causes the changes in hospitalization costs, and assess overall cost differences in relation to different treatment modalities and quality of care received by IBD patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are not publicly available because a Data User Agreement is individually required for HCUP NIS and MarketScan databases, but the software code underpinning the analysis is available from the corresponding author on reasonable request.

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Key Points for Decision Makers

In 2014, the mean hospitalization costs were US$11,345 for Crohn's disease and US$13,412 for ulcerative colitis in the US.

Hospitalization costs increased from 3% for Crohn's disease and 4% for ulcerative colitis from 2003 to 2008, but remained unchanged from 2008 to 2014 for both diseases. The trends in hospitalization costs reflect changes in the inpatient treatment modality for inflammatory bowel disease (IBD) in the US during this period.

The cost study identified some common and unique patterns of patient and hospital characteristics associated with hospitalization costs for Crohn's disease and ulcerative colitis, which can inform policy plans on optimization of hospital resource allocation that may reduce hospitalization costs for IBD.

Understanding sociodemographic and clinical factors associated with high hospitalization costs is important to identify high-risk patients with IBD.

Among high-risk IBD patients, comprehensive disease management and strategic healthcare planning in outpatient settings may lower inpatient resource utilization.

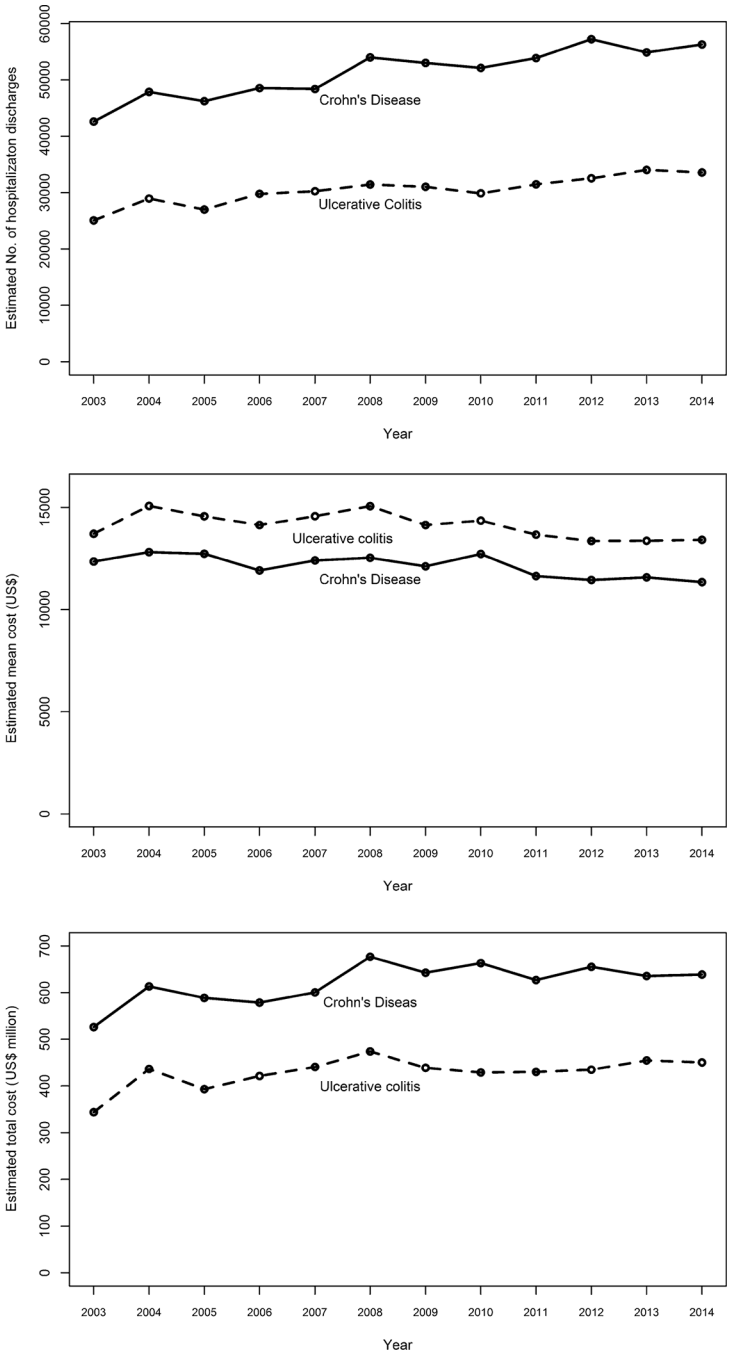

Fig. 1.

Estimated number of hospitalization discharges, hospitalization mean cost, and total costs for Crohn's disease and ulcerative colitis as the first-listed diagnosis in the US from 2003 to 2014. Hospitalization mean cost and total costs were adjusted to the 2014 consumer price index

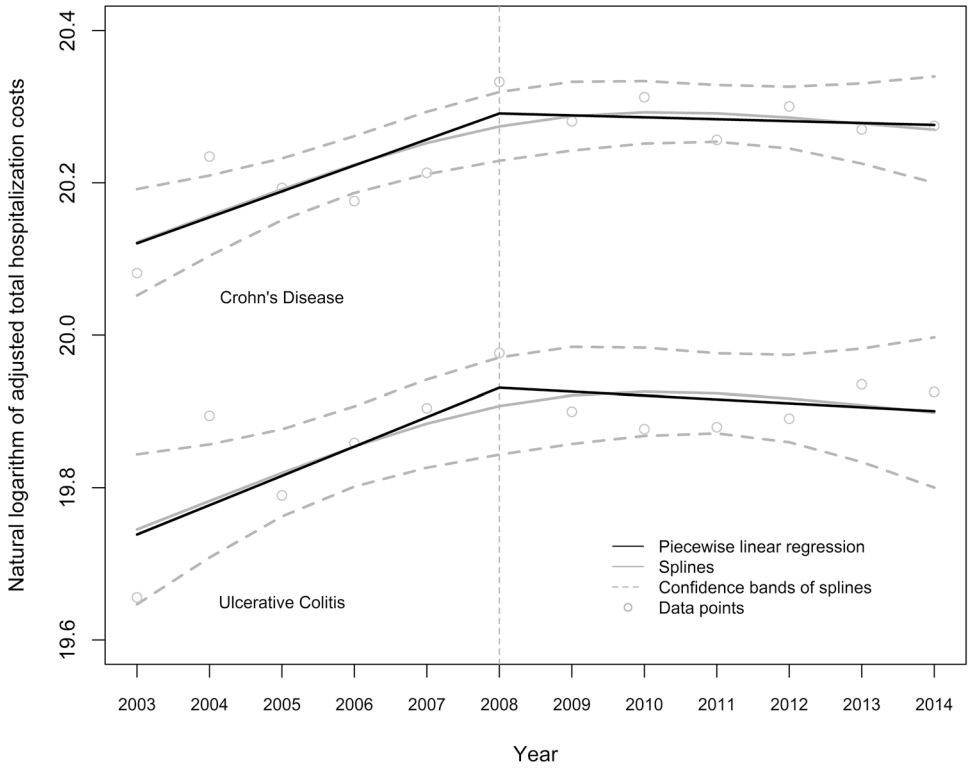

Fig. 2.

Trends in hospitalization costs for Crohn's disease and ulcerative colitis as the first-listed diagnosis from 2003 to 2014. Total hospitalization cost and total costs were adjusted to the 2014 consumer price index. Total hospitalization cost was converted as natural logarithm. For CD, between 2003 and 2008, the natural exponential function of coefficient was 1.03 with 95% CI (1.02–1.05), $p < 0.001$; between 2008 and 2014, the natural exponential function of coefficient was 1.00 with 95% CI (0.99–1.01), $p = 0.67$. For UC, between 2003 and 2008, the natural exponential function of coefficient was 1.04 with 95% CI (1.02–1.06), $p < 0.001$; between 2008 and 2014, the natural exponential function of coefficient was 0.99 with 95% CI (0.98–1.01), $p = 0.54$

Table 1

Number of hospital discharges and hospitalization costs for Crohn's disease and ulcerative colitis as the first-listed diagnosis among adults aged ≥ 18 years: 2014 National Inpatient Sample

Number of hospital discharges and hospitalization costs	Crohn's disease	Ulcerative colitis
Unweighted N	11,258	6717
Weighted N	56,290	33,585
Total costs (US$, million)[a]	638.6	450.4
Mean cost (US$) per admission (standard deviation)	11,345 (197)	13,412 (268)
Median cost (US$) per admission (interquartile range)	7592 (4926–12,801)	8873 (5726–15,154)

[a]Rounded to millions; total costs based on the weighted population

Table 2

Associations of patient and hospital characteristics with hospitalization costs for Crohn's disease and ulcerative colitis

Characteristics	Crohn's disease		Ulcerative colitis	
	Adjusted cost ratio[a]	*p* value	Adjusted cost ratio[a]	*p* value
Age groups (years)				
18–24	1.00 (referent)	–	1.00 (referent)	–
25–34	0.97 (0.93–1.01)	0.13	1.06 (1.00–1.12)	0.07
35–44	0.96 (0.92–1.01)	0.09	1.09 (1.02–1.15)	0.007
45–54	0.96 (0.91–1.00)	0.07	1.14 (1.07–1.22)	< 0.001
55–64	1.00 (0.95–1.06)	0.92	1.15 (1.08–1.23)	< 0.001
≥ 65	1.04 (0.98–1.12)	0.19	1.07 (0.99–1.16)	0.10
Sex				
Men	0.99 (0.97–1.02)	0.65	1.09 (1.05–1.13)	< 0.001
Women	1.00 (referent)	–	1.00 (referent)	–
Race				
Non-Hispanic White	1.00 (referent)	–	1.00 (referent)	–
Non-Hispanic Black	0.98 (0.94–1.02)	0.35	0.95 (0.90–1.01)	0.09
Hispanic	1.07 (1.00–1.14)	0.04	0.97 (0.91–1.02)	0.23
Non-Hispanic Others	1.09 (1.02–1.17)	0.01	1.08 (1.00–1.17)	0.06
Missing	1.02 (0.95–1.09)	0.60	1.08 (0.97–1.20)	0.16
Household income ($)				
1–39,999	1.00 (referent)	–	1.00 (referent)	–
40,000–50,999	1.00 (0.97–1.04)	0.85	1.03 (0.98–1.09)	0.24
51,000–65,999	1.03 (0.99–1.07)	0.19	1.07 (1.01–1.13)	0.02
≥ 66,000	1.08 (1.03–1.12)	0.001	1.13 (1.06–1.19)	< 0.001
Missing	1.11 (1.00–1.24)	0.05	1.13 (1.01–1.27)	0.04
Elixhauser comorbidities				
0	1.00 (referent)	–	1.00 (referent)	–
1	1.03 (1.00–1.07)	0.08	1.02 (0.96–1.07)	0.53
2	1.16 (1.11–1.20)	< 0.001	1.09 (1.03–1.15)	0.003
≥ 3	1.37 (1.32–1.43)	< 0.001	1.36 (1.28–1.44)	< 0.001

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Characteristics	Crohn's disease		Ulcerative colitis	
	Adjusted cost ratio[a]	*p* value	Adjusted cost ratio[a]	*p* value
Insurance type				
Medicare	0.95 (0.91–0.99)	0.01	1.00 (0.94–1.07)	0.94
Medicaid	0.94 (0.90–0.97)	< 0.001	1.00 (0.95–1.05)	0.94
Private insurance	1.00 (referent)	–	1.00 (referent)	–
No insurance	0.92 (0.87–0.97)	0.002	0.86 (0.81–0.91)	< 0.001
Others	0.97 (0.89–1.06)	0.55	0.91 (0.82–1.00)	0.05
Hospital region				
Northeast	1.00 (referent)	–	1.00 (referent)	–
Midwest	0.99 (0.94–1.05)	0.83	0.93 (0.87–1.00)	0.05
South	0.98 (0.93–1.03)	0.35	0.95 (0.89–1.00)	0.06
West	1.26 (1.19–1.35)	< 0.001	1.17 (1.09–1.25)	< 0.001
Teaching hospital				
Rural	1.00 (referent)	–	1.00 (referent)	–
Urban nonteaching	1.09 (1.03–1.15)	0.004	1.07 (1.00–1.15)	0.05
Urban teaching	1.18 (1.12–1.25)	< 0.001	1.20 (1.12–1.29)	< 0.001
Hospital size				
Small	1.00 (referent)	–	1.00 (referent)	–
Medium	1.02 (0.98–1.07)	0.30	0.99 (0.93–1.05)	0.73
Large	1.09 (1.04–1.14)	< 0.001	1.10 (1.04–1.16)	0.002
Hospital ownership				
Government, nonfederal	1.00 (referent)	–	1.00 (referent)	–
Private, non-profit	0.92 (0.87–0.97)	0.003	0.92 (0.86–0.98)	0.02
Private, investor owned	0.81 (0.76–0.87)	< 0.001	0.81 (0.74–0.88)	< 0.001

[a]Models were adjusted by all the variables listed in the table. The dependent variable, cost, was transformed using a natural logarithm. Coefficients were then back transformed to obtain the adjusted cost ratio