

Trends in Hospitalizations of Children With Inflammatory Bowel Disease Within the United States From 2000 to 2009

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Background: The incidence and prevalence of pediatric inflammatory bowel disease (IBD) seems to be increasing in North America and Europe. Our objective was to evaluate hospitalization rates in children with IBD in the United States during the decade 2000 to 2009.

Methods: We analyzed cases with a discharge diagnosis of Crohn disease (CD) and ulcerative colitis (UC) within the Healthcare Cost and Utilization Project Kids' Inpatient Database, Agency for Healthcare Research and Quality.

Results: We identified 61,779 pediatric discharges with a diagnosis of IBD (CD, 39,451 cases; UC, 22,328 cases). The number of hospitalized children with IBD increased from 11,928 to 19,568 (incidence, 43.5–71.5 cases per 10,000 discharges per year; $P < 0.001$). For CD, the number increased from 7757 to 12,441 (incidence, 28.3–45.0; $P < 0.001$) and for UC, 4171 to 7127 (15.2–26.0; $P < 0.001$). Overall, there was a significant increasing trend for pediatric hospitalizations with IBD, CD, and UC ($P < 0.001$). In addition, there was an increase in IBD-related complications and comorbid disease burden ($P < 0.01$).

Conclusion: There was a significant increase in the number and incidence of hospitalized children with IBD in the United States from 2000 to 2009.

Key Words: Crohn disease, ulcerative colitis, inflammatory bowel disease, epidemiology, children, adolescents, Healthcare Cost and Utilization Project Kids' Inpatient Database

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Recent studies from North America and Europe have reported an increase in the incidence and prevalence of pediatric inflammatory bowel disease (IBD). Benchimol et al¹ demonstrated that the prevalence of pediatric IBD in Ontario, Canada, increased from 42.1 to 56.3 per 100,000 population during a period of 11 years ending in 2005. During the same period, the incidence increased from 9.5 to 11.4 per 100,000. In Scotland, pediatric IBD is estimated to have increased 76% from 1990–1995 to 2003–2008.² A Finnish study reported that the

incidence of childhood IBD increased 3-fold to 15 per 100,000 from 1987 to 2003 with a mean rate of increase of 6.5% per year.³

Currently, there are no national studies evaluating the incidence of pediatric IBD for the United States. However, US regional studies suggest a similar increase in disease incidence. A community-based study from Northern California determined that the incidence of ulcerative colitis (UC) increased 2.7-fold and Crohn disease (CD) increased 2.0-fold.⁴ Comparable findings have been reported from other regions of the United States.^{5,6} These data, however, are too readily influenced by local and institutional biases. In an attempt to correlate suspected changes in epidemiology with hospitalizations, we therefore analyzed a US national health care administrative database for the purposes of our study. Our objective was to estimate the secular trends in the rate of hospitalization and disease-related complications in children with IBD in the United States.

MATERIALS AND METHODS

We used the Healthcare Cost and Utilization Project Kids' Inpatient Database (HCUP-KID) sponsored by the Agency for Healthcare Research and Quality to obtain the data for this study. Individual hospitalizations (ie, discharge level, not patient level information, is collected) of patients who are 20 years or younger at the time of admission in acute care hospitals within the United States are deidentified and maintained in the HCUP-KID as unique entries. Each discharge entry includes 1 primary and 1 to 24 secondary diagnoses based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis codes. The HCUP-KID provides an individual-level population weight to generate national level estimates of total cases. All data in this manuscript are presented as national estimates. For each of the years included in this study (2000, 2003, 2006, and 2009), the HCUP-KID contains between 7,291,032 and 7,370,203 weighted pediatric cases.

The primary variables in this study were the presence of a diagnosis of IBD (CD or UC). We extracted all entries with any discharge diagnosis of CD (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes 555.0–555.2, and 555.9) or UC (556.0–556.6, and 556.8, 556.9). We excluded any discharge that had dual diagnoses of CD and UC from our analyses. Inflammatory bowel disease–related complications were defined as: (1) active fistulizing disease or intra-abdominal abscess (537.4, 567.2, 567.21, 567.22, 569.5, 569.81, 569.83, 593.3, 596.1, and 619.1), (2) stricturing disease (560.9 and 537.3), (3) bowel obstruction (560.0, 560.1, 560.2, 560.30, 560.31, 560.32, 560.39, 560.81, 560.89, 560.9, and 568.0), and (4) perianal abscess (566). These definitions have been used previously by other investigators.^{7,8} We assessed systemic comorbidity using the 29 disease states (eg, anemia, chronic pulmonary disease, coagulopathy, fluid and electrolyte disorders, liver disease, and weight loss) within the Elixhauser comorbidity index.^{9,10} This is a widely

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used index, in which higher scores indicate a greater comorbid disease burden.^{11,12}

We categorized patients by age (1–5, 6–10, 11–15, and 16–20 years) and US geographic region (northeast, midwest, south, and west). We did not include children younger than 1 year in this study. Newborn infants as part of routine hospital deliveries comprise a significant proportion of entries in the HCUP-KID; for example, uncomplicated births accounted for approximately 38% of all hospital discharges in 2009. Given that most newborns are healthy and the incidence of IBD is extremely low in children younger than 1 year, the inclusion of this age group was expected to confound our analyses.

Statistical analyses were performed using Statistical Analysis Software version 9.2 (SAS Institute, Cary, NC). The rate of hospitalization (incidence) of children with IBD is reported as per 10,000 total discharges, and the incidence of IBD-related complications is reported as per 100 discharges of IBD. Categorical data are reported as incidences and percentages. The χ^2 test was used for comparing differences. The Cochran-Armitage trend test was used to assess time trends in disease incidence. The threshold for significance for these analyses was $P < 0.05$.

RESULTS

For the decade 2000–2009, there were a total of 11,022,102 discharges for children older than 1 year. Of these total discharges, 61,779 had a diagnosis of IBD (CD, 39,451; and UC, 22,328 discharges). During the period of this study, there was a significant increase in the total number and incidence of hospitalized children with IBD (Table 1). For discharges with any diagnosis of IBD (CD and UC), the number increased from 11,928 in 2000 to 19,568 in 2009. This represents a 65% increase (43.5–71.52 cases per 10,000 discharges per year; $P < 0.001$). When discharges with diagnoses of CD were considered, the number increased from 7757 in 2000 to 12,441 in 2009 (59% increase in incidence; 28.3–45.0 cases per 10,000 discharges per year; $P < 0.001$). For discharges with a diagnosis of UC, the number increased from 4171 in 2000 to 7127 in 2009 (71% increase in incidence; 15.2–26.0 cases per 10,000 discharges per year; $P < 0.001$). Using trend analyses, we confirmed a significant increasing trend in the incidence of hospitalized children with IBD overall and in CD and UC ($P < 0.001$). Furthermore, this increasing trend was present for each age category and geographic region evaluated in this study ($P < 0.001$; data not shown).

We next assessed the trend in the incidence of IBD-related complications and high comorbid disease burden for the period

TABLE 1. Incidence of Hospitalizations of Children With IBD Within the United States From 2000 to 2009

Disease		Year			
		2000	2003	2006	2009
IBD	Number	11,928	14,289	15,994	19,568
	Incidence*	43.5	51.4	57.9	71.5
CD	Number	7757	9265	9988	12,441
	Incidence	28.3	33.3	36.2	45.0
UC	Number	4171	5024	6006	7127
	Incidence	15.2	18.1	21.8	26.0

*Incidence is calculated as the number of cases per 10,000 discharges during each specified year. For each year, the incidences are significantly different for each disease type ($P < 0.001$). There are increasing trends in the incidences of IBD, CD, and UC ($P < 0.001$).

TABLE 2. Incidence of Disease-Related Complications and High Comorbid Disease Burden in Hospitalized Children with IBD Within the United States From 2000 to 2009

Characteristic	Incidence*			
	2000	2003	2006	2009
Fistula, intra-abdominal abscess	6.6	6.9	6.9	7.3
Stricture	3.3	3.5	3.2	3.7
Obstruction	10.5	10.7	10.6	11.7
Perianal abscess	1.9	2.1	2.4	2.4
≥3 comorbidities	3.2	4.8	5.6	7.5

*Incidence is calculated as number per 100 IBD discharges during each specified year. A significant increasing trend ($P < 0.001$) was observed for each of the characteristics except stricture ($P = 0.17$).

(Table 2). Our analysis revealed an increasing trend in the incidence of active fistulizing disease or intra-abdominal abscess (10.6% increase; 6.6–7.3 cases per 100 discharges of IBD per year; $P < 0.01$), bowel obstruction (11.4% increase; 10.5–11.7 cases per 100 discharges of IBD per year; $P < 0.01$), and perianal abscess (26.3% increase; 1.9–2.4 cases per 100 discharges of IBD per year; $P < 0.01$). No significant trend was noted for stricturing disease. We also observed an increasing trend in the number of children hospitalized with IBD who had 3 or more comorbidities (Table 2; 134% increase, 3.2–7.5 cases per 100 discharges of IBD; $P < 0.001$).

DISCUSSION

We found an increase in both the total number and incidence of pediatric IBD hospitalizations during recent years. In addition, the associated disease complications and severity of the disease seem to be increasing. To our knowledge, this study represents the largest investigation to date with regard to the number of cases of hospitalized children with IBD in the United States related to more than 61,000 weighted cases of children with IBD admitted to US hospitals from 2000 to 2009. The HCUP databases have been used in a similar manner to achieve national level estimates of disease incidence and to investigate associated conditions in hospitalized patients within the United States.¹³ We found a large and significant increase in the incidence of hospitalizations for children with IBD during the 4 triennial periods of our study. This included cases of both CD and UC across all pediatric age groups except infants who were excluded from our analyses. Most studies have indicated an increasing trend of CD in children but a stable incidence of pediatric-onset UC.¹⁴ Our results, however, indicate a comparable increase in hospitalizations for children with both diseases. We found an increasing trend in hospitalizations in each region of the United States consistent with published regional data of an increasing incidence of IBD in children.^{4–6} We also determined that the incidence of disease-related complications and the comorbid burden in children hospitalized with IBD had increased significantly during the period of our study.

The reason for the large increase in the number of hospitalizations of children with IBD during the last decade is not clear. The increase in the prevalence of pediatric IBD is likely an underlying factor.^{4–6} Our findings of a coincident increase in IBD disease-specific complications and coexisting comorbidity suggest that an increase in the severity of this disease has contributed to a greater need for hospitalization. In addition, changes in the epidemiology of frequently associated diseases

might play a role in the observed increase in incidence of IBD. For example, we demonstrated recently that the incidence of *Clostridium difficile* infection (a comorbidity not included in the Elixhauser index used in this current study) has increased in hospitalized children with IBD.¹⁵ The nature of this study renders it impossible to determine the relative impact of these possibilities on the observed increase in hospitalization rates. In addition, the constraints of the database do not enable us to determine whether patients were admitted to the hospital due to an IBD-related flare or complication or for an unrelated medical condition.

In summary, our results demonstrate an increase in the rate of hospitalizations for children with CD and UC in the United States during the decade extending from 2000 to 2009. Further investigation using large nonhospitalization data sets (eg, pediatric IBD consortium registry) is needed to determine if our findings are indicative of an overall increase in the incidence and prevalence of childhood IBD in the United States.

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REFERENCES

1. Benchimol EI, Guttman A, Griffiths AM, et al. Increasing incidence of paediatric inflammatory bowel disease in Ontario, Canada: evidence from health administrative data. *Gut*. 2009;58(11):1490–1497.
2. Henderson P, Hansen R, Cameron FL, et al. Rising incidence of pediatric inflammatory bowel disease in Scotland. *Inflamm Bowel Dis*. 2012;18(6):999–1005.
3. Lehtinen P, Ashorn M, Iltanen S, et al. Incidence trends of pediatric inflammatory bowel disease in Finland, 1987–2003, a nationwide study. *Inflamm Bowel Dis*. 2011;17(8):1778–1783.
4. Abramson O, Durant M, Mow W, et al. Incidence, prevalence, and time trends of pediatric inflammatory bowel disease in Northern California, 1996 to 2006. *J Pediatr*. 2010;157(2):233–239 e231.
5. Kugathasan S, Judd RH, Hoffmann RG, et al. Epidemiologic and clinical characteristics of children with newly diagnosed inflammatory bowel disease in Wisconsin: a statewide population-based study. *J Pediatr*. 2003;143(4):525–531.
6. Loftus CG, Loftus EV Jr, Harmsen WS, et al. Update on the incidence and prevalence of Crohn's disease and ulcerative colitis in Olmsted County, Minnesota, 1940–2000. *Inflamm Bowel Dis*. 2007;13:254–261.
7. Ananthakrishnan AN, McGinley EL, Binion DG. Does it matter where you are hospitalized for inflammatory bowel disease? A nationwide analysis of hospital volume. *Am J Gastroenterol*. 2008;103(11):2789–2798.
8. Nguyen GC, Bayless TM, Powe NR, et al. Race and health insurance are predictors of hospitalized Crohn's disease patients undergoing bowel resection. *Inflamm Bowel Dis*. 2007;13(11):1408–1416.
9. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. *Med Care*. 1998;36(1):8–27.
10. HCUP Comorbidity Software. Healthcare Cost and Utilization Project (HCUP). January 2013. Agency for Healthcare Research and Quality, Rockville, MD. Available at: <http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>. Accessed January 20, 2013.
11. Werner RM, Asch DA, Polsky D. Racial profiling: the unintended consequences of coronary artery bypass graft report cards. *Circulation*. 2005;111(10):1257–1263.
12. Zhu H, Hill MD. Stroke: the Elixhauser Index for comorbidity adjustment of in-hospital case fatality. *Neurology*. 2008;71(4):283–287.
13. Nylund CM, Goudie A, Garza JM, et al. *Clostridium difficile* infection in hospitalized children in the United States. *Arch Pediatr Adolesc Med*. 2011;165(5):451–457.
14. Benchimol EI, Fortinsky KJ, Gozdyra P, et al. Epidemiology of pediatric inflammatory bowel disease: a systematic review of international trends. *Inflamm Bowel Dis*. 2011;17(1):423–439.
15. Pant C, Anderson MP, Deshpande A, et al. Health care burden of *Clostridium difficile* infection in hospitalized children with inflammatory bowel disease. *Inflamm Bowel Dis*. 2013;19(5):1080–1085.