



Rates and trends for inpatient surgeries in pediatric Crohn's disease in the United States from 2003 to 2012



Audrey L. Stokes^a, Afif N. Kulaylat^a, Dorothy V. Rocourt^b, Christopher S. Hollenbeak^{c,*}, Walter Koltun^d, Tolulope Falaiye^e

^a Department of Surgery, The Pennsylvania State University, College of Medicine, Hershey, PA, USA

^b Division of Pediatric Surgery, Department of Surgery, The Pennsylvania State University, College of Medicine, Hershey, PA, USA

^c Department of Public Health Sciences, The Pennsylvania State University, College of Medicine, Hershey, PA, USA

^d Division of Colon and Rectal Surgery, Department of Surgery, The Pennsylvania State University, College of Medicine, Hershey, PA, USA

^e Division of Pediatric Gastroenterology, Department of Pediatrics, The Pennsylvania State University, College of Medicine, Hershey, PA, USA

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ABSTRACT

Background: Pediatric Crohn's disease (CD) is increasing in incidence globally. Trends in specific types of inpatient pediatric CD-related surgical procedures have not been widely reported.

Methods: Patients ≤ 20 years of age with CD were identified in the Kids' Inpatient Database for 2003, 2006, 2009, and 2012. Bowel resection, stoma creation, and perianal or percutaneous drainage procedures were identified using ICD-9 procedure codes, and trends were identified. Logistic regression was used to identify factors associated with surgical intervention and trends.

Results: Rates of overall bowel resection (including ileocolic resection, other small bowel resection, or other colon resection) did not change significantly over time. However, the odds of having a laparoscopic colon resection increased by 41% annually ($p < 0.001$). Rates of subsequent ileostomy formation increased (odds ratio 1.09, $p < 0.001$). Older age, male sex, fewer comorbidities, and treatment in large urban teaching hospitals were also associated with higher odds of undergoing bowel resection.

Conclusions: This study noted a stable rate of all types of bowel resections and increase in post resection ileostomy formation in US pediatric inpatients with CD from 2003–2012. Other rates of many CD-related procedures have remained stable. Further studies correlating the effects of biologic agents on surgical rates are warranted.

Type of study: Treatment Study

Level of evidence: Level III.

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The inflammatory bowel diseases (IBD), including Crohn's disease (CD), have been increasing globally in both incidence and prevalence [1,2]. Pediatric IBD accounts for approximately 20%–30% of incident cases [3,4]. Patients with CD typically exhibit relapsing and remitting course. The lifelong disease burden on the patient and healthcare system will last for a longer period for pediatric patients than adults [1,5–7]. Medical management of Crohn's disease comprises the first-line of therapy for most presentations, and may include steroids, mesalamines, immunomodulators, and – more recently – biologic agents. The initial class of biologics used in the treatment of IBD consisted of anti-TNF- α inhibitors, such as infliximab, and were approved by the FDA for the treatment of pediatric CD in 2006.

* Corresponding author at: The Pennsylvania State University, College of Medicine, Department of Surgery, 500 University Drive, H151, Hershey, PA 17033-0850. Tel.: +1 717 531 5890; fax: +1 717 531 4464.

E-mail address: chollenbeak@psu.edu (C.S. Hollenbeak).

Despite the availability of new therapeutic agents, surgery may still be required for patients with refractory disease, or for those who are intolerant of the side effects. Symptomatic disease, such as that owing to strictures, fistulae, or abscesses, may also prompt the need for surgical intervention [8,9]. In pediatric patients, specifically, poor growth unresponsive to medical therapy may also comprise an important indication for surgery among this population [9]. A recent systematic review determined that cumulative rates of surgery among pediatric Crohn's disease patients ranged from 10% to 72% [3]; on a per-hospitalization basis, rates of surgery have been cited at around 10%–15% per hospitalization [6]. It is unclear, however, whether evolving medical management has impacted the role of surgery in this disease in the pediatric population. Existing studies report overall rates of surgical procedures, but do not distinguish between the various types of surgical procedures required by this population [10]. Additionally, there is disagreement in the literature regarding whether the need for surgical resection is increasing, decreasing, or remaining the same among pediatric CD patients [5,10,11]. Given the shifting landscape in the medical treatment of this

disease, we sought to characterize trends and patterns in specific types of IBD-related surgical procedures on a national level, with the hypothesis that there would be a significant decrease in the amount of bowel resections and perianal procedures performed in this population given the increased utilization of improved medical therapies for refractory disease.

1. Methods

1.1. Data

The Kid's Inpatient Database (KID) is part of the Healthcare Cost and Utilization Project (HCUP). It is updated with a year of data on a triennial basis. We looked at the years 2003, 2006, 2009, and 2012. KID is a database designed to specifically assess the use of inpatient hospital services by newborns, children and adolescents. The data collection is designed to be nationally representative, and intended to help inform decision-making at the national, state, and community levels [12,13]. Data including patient demographics, International Classification of Diseases, 9th Revision, Clinical Modification (*ICD-9*) diagnosis and procedure codes were abstracted from the database. Comorbidities were identified using the Elixhauser comorbidity measures generated using the Agency for Healthcare Research and Quality comorbidity software. Only variables that were available for all 4 years of obtained data from the database were used in the study.

1.2. Patient selection

Patients with an *ICD-9* diagnosis code of 555.X were classified as having Crohn's disease (CD). To exclude cases with possible indeterminate colitis, we excluded patients with *ICD-9* codes for both CD and UC during the hospitalization ($n = 411$), as well as patients admitted as traumas ($n = 75$). Additional exclusions for observations with missing data were applied in order to generate a sample population with uniformly available data: patients lacking data on age ($n = 91$), sex ($n = 120$), race ($n = 5459$), payer ($n = 24$), mortality ($n = 9$), charges ($n = 1961$), income quartile per zip code ($n = 413$), and hospital bed size ($n = 582$) were excluded. The final analysis sample included 20,710 hospitalizations involving a primary or secondary diagnosis of Crohn's disease.

1.3. Procedure identification

ICD-9 procedure codes were used to identify relevant surgical procedures, including small bowel resection (45.6X), both open (45.7X, 45.8X, 48.4X, 48.5X, 48.6X) and laparoscopic (17.3X) colon resections, and both ileostomy (46.01, 46.2X) and colostomy (46.03, 46.1X) creation. Ileocolic resections (codes 45.72, 45.73, 17.32, and 17.33) were considered separately from small bowel and other colon resections, as these were the most commonly performed type of intestinal resection. No *ICD-9* procedure code was available for perianal seton placement, so identification of perianal procedures was limited to incision of perirectal tissue (48.81) and incision of perianal abscess (49.01). Percutaneous drainage was indicated by *ICD-9* code 54.91. These procedures are reported as proportions of hospitalizations involving these procedures, since hospitalization-level data but not patient-level data were available.

1.4. Statistical analysis

Patient demographics and hospital characteristics were determined from the available data and presented in Table 1. We first sought to identify any significant trends in the occurrence of these procedures: (1) resection, (2) stoma creation, (3) perianal drainage and (4) percutaneous drainage, using regression analyses. Logistic regression was then used to model the occurrence of either bowel resection or stoma creation as a function of patient characteristics and hospital-related

Table 1

Patient demographics and hospital characteristics.

Variable	(n = 20,710)
Age (mean, years)	16.0
Age 0–6 years	1.8%
Age 6–10 years	4.6%
Age 10–20 years	93.6%
Sex	
Male	50.9%
Female	49.1%
Race	
White	71.6%
Black	15.3%
Hispanic	7.8%
Asian	1.5%
Other	3.9%
Sum of comorbidities	0.85
Type of admission	
Elective	18.1%
Nonelective	81.9%
Payer	
Medicaid	24.7%
Commercial	65.4%
Other	9.8%
Hospital size	
Small	10.5%
Medium	24.0%
Large	65.6%
Hospital setting	
Rural	5.0%
Urban nonteaching	22.9%
Urban teaching	72.1%
Hospital region	
Northeast	26.1%
Midwest	21.8%
South	35.3%
West	16.8%

covariates. The area under the receiver operating characteristic (ROC) curve was used to indicate goodness of fit of logistic regression models. Statistical analyses were performed with STATA software (version 12.1, StataCorp, College Station, TX, USA). Graphs were constructed using R software (version 3.2.1, www.r-project.org). Statistical significance was defined as a *p*-value of <0.05.

2. Results

2.1. Descriptive statistics

Characteristics of patients are presented in Table 1. Hospitalized CD patients were, on average, 16.0 years of age with a slight male predominance (50.9%). The majority of hospitalizations involved patients of white race, followed by black race and then Hispanic ethnicity (Table 1). The average number of comorbidities per patient was 0.85, and the majority of admissions were considered nonelective (81.9%). Commercial insurance providers comprised the majority of payers among hospitalizations (65.4%). Hospitalized patients with Crohn's disease were most frequently admitted to large teaching hospitals in urban areas (Table 1), and were most predominately in the Southern United States.

2.2. Surgical rates and trends

2.2.1. Intestinal resection

Over time, the proportion of hospitalizations involving an intestinal resection did not change significantly, from 10.4% in 2003 to 9.8% in 2012 ($p = 0.537$). This observation was consistent when considering various types of intestinal resections separately: the incidence of ileocolic resection (odds ratio [OR] 1.00 annually, $p = 0.918$), small bowel resection (OR 0.98, $p = 0.445$), and other types of colon resections (OR 1.03, $p = 0.118$) did not change significantly over time

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