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Rates and burden of surgical site infections associated with pediatric colorectal surgery: insight from the National Surgery Quality Improvement Program

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ABSTRACT

Purpose: The purpose of this study was to characterize the rates of surgical site infections (SSI) associated with colorectal procedures in children and the relative burden of these events within the scope of pediatric surgical practice.
Methods: The NSQIP-Pediatric Public Use File was queried for all pediatric surgery procedures captured from 50 hospitals during 2012—2013. Rates of incisional and deep organ/space SSIs (ISSI and OSI, respectively) were calculated for all procedures, and the relative burden of SSIs from the entire dataset attributable to colorectal procedures was determined.
Results: Colorectal procedures accounted for 2.5% (2872/114,395) of the NSQIP-P caseload and contributed 7.1% of the SSI burden. The SSI rate for all colorectal procedures was 5.9% (ISSI:3.2%; OSI:2.7%), and the highest rates were associated with total abdominal colectomy (11.4%) partial colectomy (8.3%), and colostomy closure (5.0%). Inflammatory bowel disease contributed the greatest relative burden of SSIs among colorectal diagnoses (24.9%; ISSI:22%; OSI:28.6%), followed by Hirschsprung's Disease (14.2%; ISSI:15.4%; OSI:12.8%) and anorectal malformations (12.4%; ISSI:17.6%; OSI:6.4%).
Conclusion: Colorectal procedures are responsible for a disproportionate burden of SSIs within pediatric surgery. The rate and relative burden of SSIs are particularly high for colostomy closure, partial colectomy, and procedures for inflammatory bowel disease. Efforts to reduce SSI burden may be best focused on this cohort of children.

Colorectal procedures have consistently been associated with relatively high rates of infectious complications in the adult population, with surgical site infection (SSI) rates reported to be as high as 45% [1,2]. Major efforts have been focused on reducing infectious complications in this high risk population, including SSI-reduction bundles, regional collaborative programs for knowledge sharing and infection prevention, and critical evaluation of the role of bowel preparation as a prophylactic adjunct [3,4]. Although extensive data have been published in the adult surgical literature characterizing the disproportionate burden of SSIs attributable to colorectal surgery, little is known regarding the rates and burden of SSIs attributable to colorectal procedures in children [1].

The American College of Surgeons (ACS) National Surgical Quality Improvement Program Pediatric (NSQIP-P) collects risk-adjusted outcomes data within the 30-day post-operative period using standardized definitions and a rigorous chart review process for a wide scope of pediatric surgical procedures [5,6]. The program has been used to guide the prioritization of quality improvement efforts in pediatric neurosurgery, orthopedic surgery, urology, and otolaryngology, among others [7–10].

The purpose of this study was to use the NSQIP-P database to characterize rates of SSIs associated with the most commonly encountered colorectal conditions and procedures in children. Furthermore, we wished to estimate the relative burden of these events within the scope of pediatric surgical practice with the goal of identifying procedures and diagnoses most in need of comparative effectiveness studies and consensus guidelines for infection prevention.

1. Methods

1.1. Data source

Data were collected from 50 hospitals participating in NSQIP-P from 2012 to 2013. NSQIP-P is a multi-specialty program that was established to collect and provide risk-adjusted comparative performance data for surgical procedures at the hospital-level [5,6,11]. Data are abstracted from each institution by a full-time ACS-trained clinical reviewer using standardized definitions and a rigorous chart review process. Cases are selected based on current procedural terminology (CPT) codes using a random sampling of approximately 35 procedures per 8-day cycle, resulting in approximately 1400 cases per institution annually. Outcomes included in NSQIP include SSIs and other adverse events,

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demographic data, and a variety of perioperative laboratory and clinical variables collected for the purpose of risk adjustment [5].

1.2. Study population

We identified all patients less than 18 years of age with a CPT code indicating a colorectal procedure (Table 1). The CPT codes were further aggregated into more generic but clinically relevant procedural groups for analysis when appropriate (Table 1). For example, CPT 44205 ("Laparoscopy; colectomy, partial, with removal of terminal ileum with ileocolostomy") was combined with 44160 ("Colectomy, partial, with removal of terminal ileum with ileocolostomy"), and 44140 ("Colectomy, partial, w/anastomosis"), to create a category of "Partial Colectomy". Multiple colorectal procedures performed during the same operative encounter (e.g. partial colectomy + ostomy) were grouped together for the purpose of SSI rate and burden analysis.

1.3. Analysis of SSI rates and burden

Our primary outcomes of interest were SSI rates and the relative SSI burden associated with colorectal procedures. Surgical site infections are identified and recorded in the NSQIP-P database by clinical chart abstractors using standardized definitions from the Centers for Disease Control (CDC) criteria for superficial and deep incisional SSIs, and organ/space SSIs [12]. For the purpose of this analysis, we combined superficial and deep incisional SSIs into a single category. Overall rates of SSIs (and rates of incisional and organ/space SSIs individually) were calculated for the entire cohort of colorectal procedures, and for the most common procedures and procedural groups, colorectal conditions, and diagnosis–procedure pairs.

The relative burden of all SSIs in the NSQIP-P dataset attributable colorectal procedures was calculated by dividing the number of SSIs associated with colorectal procedures by the total number of SSIs from all pediatric surgery procedures in the NSQIP-P database. Within the cohort of patients undergoing colorectal procedures, we further calculated the relative contribution of SSI burden based on the most common colorectal procedures and procedure groups, colorectal diagnosis, and procedure–diagnosis pairs.

All statistical analysis was performed using Microsoft Excel (Microsoft; Redmond, WA) and SAS Enterprise Guide v. 5.1 (SAS Institute; Cary, NC). This study was approved by the institutional review board at our institution (BCH#P00017851).

Table 1
Current procedure terminology (CPT) codes used to identify the study cohort on the basis of colorectal procedures and procedure groups.

Procedures and procedure groups	Current procedure terminology codes
Colostomy	44188; 44320; 44322; 44605
Colostomy closure	44620; 44625; 44626; 44227
Colostomy revision	44340; 44345; 44346
Partial colectomy	44160; 44140; 44205; 44204; 44145; 44207; 44147; 44208; 45123
Partial colectomy + colostomy	44141; 44143; 44206; 44208; 45110
Partial colectomy + diverting ostomy	44144
Proctocolectomy +/− ostomy	45113; 45397; 45119; 45110; 45112; 45120
Pullthrough (PT) +/− ostomy	45120; 45121; 45397; 45112; 45119; 44157; 45123; 45395; 45111; 45113
Repair of high imperforate anus	46730; 46735; 46740; 46742
Repair of low imperforate anus	46716
Total abdominal colectomy (TAC) + PT	44211; 44158; 44157
TAC + PT + diverting ostomy	44211; 44158; 44211; 44212
TAC +/− ostomy	44210; 44150; 44151; 44155; 44156; 44210; 44212

2. Results

2872 colorectal procedures were identified, accounting for 2.5% (2872/114,395) of all pediatric surgical procedures. The most common colorectal procedures performed was a partial colectomy (n = 600, 21%), followed by colostomy closure (n = 360, 13%), pullthrough procedure with or without an ostomy (n = 360, 13%), colostomy (n = 342, 12%), and repair of high imperforate anus (n = 293, 10%).

2.1. Distribution of colorectal diagnoses and related procedures

The most common colorectal diagnoses in the NSQIP-P database included anorectal malformations (ARM) (747/2872, 26%), Hirschsprung's Disease (HD) (457/2872, 16%), inflammatory bowel disease (IBD) (430/2872, 15%), colonic dysmotility disorders (139/2872, 4.8%) and necrotizing enterocolitis (NEC; 124/2872, 4.3%). Other diagnoses associated with colorectal procedures were relatively rare, and in 25.6% of cases the diagnosis was recorded as the symptom or indication leading to the colorectal procedure (e.g. "perforation", "attention to colostomy") rather than the actual pathologic diagnosis (n = 735/2872) (Fig. 1). The mean age of children with the diagnosis of ARM was 0.83 years (SD 1.88), HD 1.72 years (SD 3.3), and IBD 15.2 years (SD 14.32).

The most commonly performed procedures for ARM were repair of high imperforate anus, followed by colostomy, repair of low imperforate anus, and colostomy closure (Table 2). The most commonly performed procedures for HD were pullthrough (PT) with or without an ostomy (n = 315/457, 61%), followed by colostomy (n = 77/457, 16.8%) and partial colectomy with or without an ostomy (n = 52/457, 11.4%). The most common procedures performed for IBD were partial colectomy (n = 160/430, 37.2%), total abdominal colectomy (TAC) with or

Table 2
Distribution of procedural groupings for associated diagnoses.

Procedure group	N	%
Anorectal malformation	747	26
Repair of high imperforate anus (N = 291, 39%)		
Colostomy (N = 144, 19%)		
Repair of low imperforate anus (N = 136, 18%)		
Colostomy closure (N = 74, 10%)		
Other (N = 102, 14%)		
Hirschsprung's Disease	457	16
Pullthrough (PT) +/− ostomy (N = 315, 69%)		
Colostomy (N = 77, 17%)		
Partial colectomy +/− ostomy (N = 51, 11%)		
Other (N = 14, 3%)		
Inflammatory bowel disease	430	15
Partial colectomy (N = 160, 37%)		
Total abdominal colectomy +/− ileostomy (N = 108, 25%)		
Proctocolectomy +/− ostomy (N = 71, 17%)		
Other (N = 91, 21%)		
Necrotizing enterocolitis	124	4.3
Partial colectomy +/− ostomy (N = 59, 48%)		
Partial colectomy (N = 44, 35%)		
Other (N = 21, 17%)		
Other specified diagnoses*	379	13.2
Partial colectomy (N = 156, 41%)		
Colostomy closure (N = 65, 17%)		
Other (N = 158, 42%)		
Nonspecific diagnoses§	735	25.6
Partial colectomy (N = 210, 29%)		
Colostomy closure (N = 198, 27%)		
Other (N = 327, 44%)		

Procedure group percentages represent the % of the procedure within the specific diagnosis group.

* Other includes less common diagnoses such as intestinal neoplasm, intussusception, volvulus, complicated appendicitis, gastroschisis, etc.

§ Nonspecific diagnoses = diagnosis based on symptoms or indication for procedure rather than pathologic diagnosis.